



Protecting, maintaining and improving the health of all Minnesotans

December 14, 2004

Paul H. Lohaus, Director
Office of State and Tribal Programs
US Nuclear Regulatory Commission
One While Flint North
11555 Rockville Pike, 3rd Floor
Rockville, Maryland 20852

Dear Mr. Lohaus:

In response to your Final Application Comments dated October 19, 2004, and related communications from your office, the Minnesota Department of Health (MDH) has revised its Final Agreement State Application. As indicated in the enclosed response, MDH has incorporated the rule changes requested by your staff as well as changes requested by the Administrative Law Judge that approved the final rules. A copy of the modified rules, which indicates those changes, is being provided to assist in the review.

After your review of the enclosed response, MDH requests that you provide an updated timeline for the Agreement State process. As previously indicated, MDH is planning on assuming that responsibility in September of 2005. The timeline should assist in identifying whether or not that goal remains achievable.

If you have any questions concerning the Minnesota's Final Agreement State Application, please contact George F. Johns, Jr. at (651) 642-0492 or me at (651) 215-0945.

Sincerely,

Linda B. Bruemmer, Manager
Asbestos, Indoor Air, Lead & Radiation
Environmental Health Division
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Attachments: Response Document
Enclosures 1 through 15
Chapter 4731

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STP

STP-006 Template

1 Department of Health

2 Adopted Permanent Rules Relating to Radiation Safety

3 GENERAL PROVISIONS

4 4731.0100 DEFINITIONS.

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

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

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

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

20 Subp. 5. Active maintenance. "Active maintenance" means
21 any significant remedial activity needed during the period of
22 institutional control to maintain a reasonable assurance that
23 the performance objectives in Code of Federal Regulations, title
24 10, sections 61.41 and 61.42, are met. Active maintenance
25 includes ongoing activities, such as the pumping and treatment
26 of water from a disposal unit, or one time measures, such as
27 replacement of a disposal unit cover. Active maintenance does

1 not include custodial activities such as repair of fencing,
2 repair or replacement of monitoring equipment, revegetation,
3 minor additions to soil cover, minor repair of disposal unit
4 covers, and general disposal site upkeep, such as mowing grass.

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

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

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

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

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

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

25 Subp. 12. Airborne radioactive material. "Airborne
26 radioactive material" means radioactive material dispersed in
27 the air in the form of dusts, fumes, particulates, mists,

1 vapors, or gases.

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

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

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

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

18 Subp. 15. Annual limit on intake or ALI. "Annual limit on
19 intake" or "ALI" means the derived limit for the amount of
20 radioactive material taken into the body of an adult worker by
21 inhalation or ingestion in a year. ALI is the smaller value of
22 intake of a given radionuclide in a year by the reference man
23 that would result in a committed effective dose equivalent of
24 five rems (0.05 Sv) or a committed dose equivalent of 50 rems
25 (0.5 Sv) to any individual organ or tissue. ALI values for
26 intake by ingestion and by inhalation of selected radionuclides
27 are given in part 4731.2750.

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

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

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

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

26 Subp. 20. Associated equipment. "Associated equipment"
27 means equipment, which is used in conjunction with a

1 radiographic exposure device to make radiographic exposures,
2 that drives, guides, or comes in contact with the sealed source
3 when it is used as an exposure head, for example a guide tube,
4 control tube, control cable, removable source stop, "J" tube, or
5 collimator.

6 Subp. 21. Atmosphere-supplying respirator.

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

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

13 A. meets the requirements in part 4731.4412; or

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

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

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

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

22 (4) a permit issued by a commissioner an NRC
23 master material licensee broad scope medical use permitted.

24 Subp. 23. Authorized nuclear pharmacist. "Authorized
25 nuclear pharmacist" means a pharmacist who:

26 A. meets the requirements in part 4731.4413;

27 B. is identified as an authorized nuclear pharmacist

1 on:

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

5 (2) a permit issued by ~~a-commissioner~~ an NRC
6 master material licensee that authorizes medical use or the
7 practice of nuclear pharmacy;

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

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

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

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

19 Subp. 24. Authorized user. "Authorized user" means:

20 A. an individual allowed to use radioactive materials
21 as indicated on a license and having met the requirements of
22 that license; or

23 B. a licensed practitioner of the healing arts who:

24 (1) meets the requirements in part 4731.4415, and
25 in parts 4731.4433, 4731.4436, 4731.4443 to 4731.4445,
26 4731.4459, 4731.4461, or 4731.4479; or

27 (2) is identified as an authorized user on:

1 (a) ~~a-commissioner~~, an NRC, or agreement
2 state license that authorizes the medical use of radioactive
3 material;

4 (b) a permit issued by ~~a-commissioner~~ an NRC
5 master material licensee that is authorized to permit the
6 medical use of radioactive material;

7 (c) a permit issued by ~~a-commissioner~~, an
8 NRC, or agreement state specific licensee of broad scope that is
9 authorized to permit the medical use of radioactive material; or

10 (d) a permit issued by ~~a-commissioner~~ an NRC
11 master material license broad scope permittee that is authorized
12 to permit the medical use of radioactive material.

13 Subp. 25. Background radiation. "Background radiation"
14 means radiation from cosmic sources; naturally occurring
15 radioactive material, including radon, except as a decay product
16 of source or special nuclear material; and global fallout as it
17 exists in the environment from the testing of nuclear explosive
18 devices or from past nuclear accidents such as Chernobyl that
19 are not under the control of the licensee. Background radiation
20 does not include radiation from source, radioactive, or special
21 nuclear materials regulated by the commissioner.

22 Subp. 26. Becquerel or Bq. One "becquerel" or "Bq" is
23 equal to one disintegration per second. One curie is equal to
24 3.7×10^{10} becquerels. The conventional system equivalent is
25 the curie.

26 Subp. 27. Bioassay or radiobioassay. "Bioassay" or
27 "radiobioassay" means the determination of kinds, quantities, or

1 concentrations, and, in some cases, the locations of radioactive
2 material in the human body, whether by direct measurement (in
3 vivo counting) or by analysis and evaluation of materials
4 excreted or removed from the human body.

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

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

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

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

22 Subp. 32. By-product material. "By-product material"
23 means:

24 A. any radioactive material, except special nuclear
25 material, yielded in, or made radioactive by, exposure to the
26 radiation incident to the process of producing or utilizing
27 special nuclear material; or

1 B. the tailings or wastes produced by the extraction
2 or concentration of uranium or thorium from ore processed
3 primarily for its source material content, including discrete
4 surface wastes resulting from solution extraction processes.
5 Underground ore bodies depleted by such solution extraction
6 operations are not by-product material.

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

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

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

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

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

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

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

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

5 Subp. 38. Collective dose. "Collective dose" is the sum
6 of the individual doses received in a given period of time by a
7 specified population from exposure to a specified source of
8 radiation.

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

14 Subp. 40. Commencement of construction. "Commencement of
15 construction" means any clearing of land, excavation, or other
16 substantial action that would adversely affect the natural
17 environment of a site but does not include:

18 A. changes desirable for the temporary use of the
19 land for public recreational uses; or

20 B. necessary borings to determine site
21 characteristics or other preconstruction monitoring to establish
22 background information related to the suitability of a site or
23 to the protection of environmental values.

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

26 Subp. 42. Committed dose equivalent or $H_{T,50}$. "Committed
27 dose equivalent" or " $H_{T,50}$ " means the dose equivalent to organs

1 or tissues of reference (T) that will be received from an intake
2 of radioactive material by an individual during the 50-year
3 period following the intake.

4 Subp. 43. Committed effective dose equivalent or $H_{E,50}$.
5 "Committed effective dose equivalent" or " $H_{E,50}$ " is the sum of
6 the products of the weighting factors (W_T) applicable to each of
7 the body organs or tissues that are irradiated and the committed
8 dose equivalent to these organs or tissues ($H_{E,50} = \sum W_T H_{T,50}$).

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

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

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

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

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

27 Subp. 49. Controlled area. "Controlled area" means an

1 area:

2 A: outside of a restricted area but inside the site
3 boundary, access to which can be limited by the licensee or
4 registrant for any reason; or

5 B: ~~in which the exposure of persons to radiation is~~
6 ~~under the supervision of a radiation safety officer;~~

7 A: ~~controlled area requires a control of access, occupancy,~~
8 ~~and working conditions for radiation protection purposes.~~

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

13 Subp. 51. Curie or Ci. One "curie" or "Ci" is the
14 quantity of radioactive material that decays at the rate of 3.7
15 $\times 10^{10}$ disintegrations per second (dps). The SI equivalent is
16 the becquerel.

17 Subp. 52. Declared pregnant woman. "Declared pregnant
18 woman" means a woman who has voluntarily informed the licensee
19 or registrant, in writing, of her pregnancy and the estimated
20 date of conception. The declaration remains in effect until the
21 declared pregnant woman withdraws the declaration in writing or
22 is no longer pregnant.

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

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

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

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

7 Subp. 55. Deep dose equivalent or H_d . "Deep dose
8 equivalent" or " H_d ," which applies to external whole-body
9 exposure, is the dose equivalent at a tissue depth of one
10 centimeter (1,000 mg/cm²).

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

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

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

26 Subp. 59. Derived air concentration-hour or DAC-hour.
27 "Derived air concentration-hour" or "DAC-hour" is the product of

1 the concentration of radioactive material in air, expressed as a
2 fraction or multiple of the derived air concentration for each
3 radionuclide, and the time of exposure to that radionuclide, in
4 hours. A licensee or registrant may take 2,000 DAC-hours to
5 represent one ALI, equivalent to a committed effective dose
6 equivalent of five rems (0.05 Sv).

7 Subp. 60. Disposable respirator. "Disposable respirator"
8 means a respirator for which maintenance is not intended and
9 that is designed to be discarded after excessive breathing
10 resistance, sorbent exhaustion, physical damage, or
11 end-of-service-life renders it unsuitable for use. Examples of
12 this type of respirator are a disposable half-mask respirator or
13 a disposable escape-only self-contained breathing apparatus.

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

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

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

27 Subp. 64. Dose or radiation dose. "Dose" or "radiation

1 dose" means absorbed dose, dose equivalent, effective dose
2 equivalent, committed dose equivalent, committed effective dose
3 equivalent, or total effective dose equivalent.

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

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

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

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

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

23 Subp. 69. Effective dose equivalent or H_E . "Effective
24 dose equivalent" or " H_E " means the sum of the products of the
25 dose equivalent to the organ or tissue (H_T) and the weighting
26 factors (W_T) applicable to each of the body organs or tissues
27 that are irradiated. ($H_E = \sum W_T H_T$).

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

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

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

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

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

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

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

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

26 Subp. 76. Exclusive use. "Exclusive use" means the sole
27 use by a single consignor of a conveyance for which all initial,

1 intermediate, and final loading and unloading are carried out
2 according to the direction of the consignor or consignee. The
3 consignor and the carrier must ensure that any loading or
4 unloading is performed by personnel having radiological training
5 and resources appropriate for safe handling of the consignment.
6 The consignor must issue specific instructions, in writing, for
7 maintenance of exclusive use shipment controls and include them
8 with the shipping paper information provided to the carrier by
9 the consignor.

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

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

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

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

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

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

27 Subp. 83. Filtering facepiece or dust mask. "Filtering

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

5 Subp. 84. Fissile material. "Fissile material" means
6 plutonium-238, plutonium-239, plutonium-241, uranium-233,
7 uranium-235, or any combination of these radionuclides. Fissile
8 material does not include unirradiated natural or depleted
9 uranium or natural or depleted uranium that has been irradiated
10 in thermal reactors only. Certain exclusions from fissile
11 material controls are provided in parts 4731.0400 to 4731.0424.

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

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

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

23 Subp. 88. General license. "General license" means a
24 license that ~~permits-the-licensee-to-obtain-and-use-source~~
25 ~~material-such-as-uranium-in-less-than-stipulated-quantities-or~~
26 ~~to-obtain-other-radionuclides-in-quantities-no-greater-than-the~~
27 ~~amount-permitted-in-the-license-for-commercial,-industrial,-or~~

1 ~~research-purposes,-but-not-for-external-or-internal~~
2 ~~administration-to-human-beings~~ is provided by rule, grants
3 authority to a person for certain activities involving
4 radioactive material, and is effective without the filing of an
5 application with the commissioner or the issuance of a licensing
6 document to a particular person. The commissioner may require
7 registration by the particular general licensee.

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

- 12 A. the geologic repository operations area; and
13 B. the portion of the geologic setting that provides
14 isolation of the radioactive waste.

15 Subp. 90. Government agency. "Government agency" means an
16 executive department, commission, independent establishment, or
17 corporation wholly or partly owned by the United States or the
18 state of Minnesota and which is an instrumentality of the United
19 States or the state of Minnesota or a board, bureau, division,
20 service, office, officer, authority, administration, or other
21 establishment in the executive branch of federal government.

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

25 Subp. 92. Guide tube or projection sheath. "Guide tube"
26 or "projection sheath" means a flexible or rigid tube, such as a
27 "J" tube, for guiding the source assembly and the attached

1 control cable from the exposure device to the exposure head.
2 Guide tube or projection sheath includes the connections
3 necessary for attachment to the exposure device and to the
4 exposure head.

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

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

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

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

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

25 Subp. 97. High radiation area. "High radiation area"
26 means an area, accessible to individuals, in which radiation
27 levels from radiation sources external to the body could result

1 in an individual receiving a dose equivalent in excess of 0.1
2 rem (1 mSv) in one hour at 30 centimeters from the radiation
3 source or 30 centimeters from any surface that the radiation
4 penetrates.

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

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

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

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

16 Subp. 102. Individual monitoring. "Individual monitoring"
17 means:

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

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

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

26 Subp. 103. Individual monitoring devices. "Individual
27 monitoring devices" means devices designed to be worn by a

1 single individual for the assessment of dose equivalent such as
2 film badges, thermoluminescence dosimeters, pocket ionization
3 chambers, or personal air sampling devices.

4 Subp. 104. Industrial radiographer or radiographer.

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

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

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

24 Subp. 107. Industrial radiography or radiography.

25 "Industrial radiography" or "radiography" means an examination
26 of the structure of materials by nondestructive methods,
27 utilizing ionizing radiation to make radiographic images.

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

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

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

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

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

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

1 supervisor present.

2 Subp. 114. Irretrievable well logging source.

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

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

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

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

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

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

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

27 Subp. 121. Licensed practitioner of the healing arts.

1 "Licensed practitioner of the healing arts" means a health
2 professional for diagnostic or healing treatment of human and
3 animal maladies who is licensed under Minnesota Statutes,
4 chapter 147, 153, or 156, Minnesota Statutes, section 148.01 or
5 150A.05, subdivision 1, clause (4), or Minnesota Statutes 1961,
6 sections 148.11 to 148.16, for the lawful practice of medicine,
7 podiatry, veterinary medicine, chiropractic, dentistry, or
8 osteopathy, respectively.

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

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

24 Subp. 123. Logging supervisor. "Logging supervisor" means
25 an individual who uses licensed material or provides personal
26 supervision in the use of licensed material at a temporary job
27 site and who is responsible to the licensee for ensuring

1 compliance with this chapter and the conditions of the license.

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

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

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

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

17 Subp. 128. Low dose-rate remote afterloader. "Low
18 dose-rate remote afterloader" means a brachytherapy device that
19 remotely delivers a dose rate of less than or equal to 200 rads
20 (2 Gy) per hour at the point or surface where the dose is
21 prescribed.

22 Subp. 129. Low specific activity material or LSA. "Low
23 specific activity material" or "LSA" means radioactive material
24 with limited specific activity that satisfies the descriptions
25 and limits in subpart 130, 131, or 132. Shielding materials
26 surrounding the LSA material may not be considered in
27 determining the estimated average specific activity of the

1 package contents. LSA material must be in group I, group II, or
2 group III.

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

5 A. ores containing only naturally occurring
6 radionuclides, such as uranium and thorium, and uranium or
7 thorium concentrates of such ores;

8 B. solid unirradiated natural uranium or depleted
9 uranium or natural thorium or their solid or liquid compounds or
10 mixtures;

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

13 D. mill tailings, contaminated earth, concrete,
14 rubble, other debris, and activated material in which the
15 radioactive material is essentially uniformly distributed and
16 the average specific activity does not exceed $10^{-6} A_2/g$.

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

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

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

25 Subp. 132. Low specific activity material group III. "Low
26 specific activity material group III" means solids, such as
27 consolidated wastes and activated materials, in which:

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

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

10 C. the average specific activity of the solid does
11 not exceed $2 \times 10^{-3} A_2/g$.

12 Subp. 133. Low toxicity alpha emitters. "Low toxicity
13 alpha emitters" means:

14 A. natural uranium, depleted uranium, natural
15 thorium;

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

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

21 Subp. 134. Management. "Management" means the chief
22 executive officer or other individual having the authority to
23 manage, direct, or administer a licensee's activities or the
24 delegate of a chief executive officer or other individual having
25 the authority to manage, direct, or administer a licensee's
26 activities.

27 Subp. 135. Manual brachytherapy. "Manual brachytherapy"

1 means a type of brachytherapy in which the brachytherapy sources
2 are manually placed topically on or inserted either into the
3 body cavities that are in close proximity to a treatment site or
4 directly into the tissue volume.

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

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

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

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

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

27 Subp. 141. Member of the public. "Member of the public"

1 means an individual other than an individual receiving an
2 occupational dose.

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

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

9 Subp. 144. Minor. "Minor" means an individual less than
10 18 years of age.

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

15 Subp. 146. Monitoring. "Monitoring means:

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

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

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

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

1 Subp. 149. Natural uranium. "Natural uranium" means
2 uranium with the naturally occurring distribution of uranium
3 isotopes, approximately 0.711 weight percent uranium-235, and
4 the remainder by weight essentially uranium-238.

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

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

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

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

23 Subp. 154. Normal form radioactive material. "Normal form
24 radioactive material" means radioactive material that has not
25 been demonstrated to qualify as special form radioactive
26 material.

27 Subp. 154a. NRC. "NRC" means the United States Nuclear

1 Regulatory Commission.

2 Subp. 155. Occupational dose. "Occupational dose" means
3 the dose received by an individual in the course of employment
4 in which the individual's assigned duties involve exposure to
5 radiation or to radioactive material from registered, licensed,
6 or unlicensed sources of radiation, whether in the possession of
7 a licensee, registrant, or other person. Occupational dose does
8 not include doses received:

9 A. from background radiation;

10 B. from any medical administration the individual has
11 received;

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

14 D. from voluntary participation in medical research
15 programs; or

16 E. as a member of the public.

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

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

25 Subp. 158. Output. "Output" means the exposure rate, dose
26 rate, or a quantity related in a known manner to these rates
27 from a brachytherapy source, teletherapy remote afterloader, or

1 gamma stereotactic radiosurgery unit for a specified set of
2 exposure conditions.

3 Subp. 159. Package.

4 A. "Package" means the packaging together with its
5 radioactive contents as presented for transport;

6 B. "fissile material package" means a fissile
7 material packaging together with its fissile material contents;
8 and

9 C. "Type B package" means a Type B packaging together
10 with its radioactive contents. On approval, a Type B package
11 design is designated by the NRC as B(U) unless the package has a
12 maximum normal operating pressure of more than 700 kPa (100
13 lb/in²) gauge or a pressure relief device that would allow the
14 release of radioactive material to the environment under the
15 tests specified in Code of Federal Regulations, title 10,
16 section 71.73, for hypothetical accident conditions, in which
17 case it will receive a designation B(M). B(U) refers to the
18 need for unilateral approval of international shipments. B(M)
19 refers to the need for multilateral approval of international
20 shipments. There is no distinction made in how packages with
21 these designations may be used in domestic transportation. To
22 determine their distinction for international transportation,
23 see DOT regulations in Code of Federal Regulations, title 49,
24 part 173. A Type B package approved before September 6, 1983,
25 was designated only as Type B. Limitations on its use are
26 specified in Code of Federal Regulations, title 10, section
27 71.13.

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

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

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

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

26 Subp. 164. Patient intervention. "Patient intervention"
27 means actions by the patient or human research subject, whether

1 intentional or unintentional, such as dislodging or removing
2 treatment devices or prematurely terminating the administration.

3 Subp. 165. Permanent radiographic installation.

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

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

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

17 A. is physically present at a temporary job site;

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

20 C. can give immediate assistance.

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

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

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

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

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

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

17 Subp. 174. Preceptor. "Preceptor" means an individual who
18 provides or directs the training and experience required for an
19 individual to become an authorized user, an authorized medical
20 physicist, an authorized nuclear pharmacist, or a radiation
21 safety officer.

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

25 A. in a written directive; or

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

1 4731.4434.

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

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

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

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

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

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

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

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

26 Subp. 180. Public dose. "Public dose" means the dose
27 received by a member of the public from exposure to radiation or

1 radioactive material released by a licensee or registrant or to
 2 any other source of radiation under the control of a licensee or
 3 registrant. Public dose does not include occupational dose or
 4 doses received from background radiation, from any medical
 5 administration the individual has received, from exposure to
 6 individuals administered radioactive material and released
 7 according to part 4731.4427, or from voluntary participation in
 8 medical research programs.

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

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

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

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

23 Subp. 183. Quality factor.

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

26 Type of radiation	Quality	Absorbed dose
27	factor	equal to a unit
28		dose equivalent ^a
29		

(Q)

1			
2			
3	X-, gamma, or beta radiation	1	1
4			
5	Alpha particles,	20	0.05
6	multiple-charged particles,		
7	fission fragments, and heavy		
8	particles of unknown charge		
9			
10	Neutrons of unknown energy	10	0.1
11			
12	High-energy protons	10	0.1
13			
14	^a Absorbed dose in rad equal to one rem or the absorbed dose in		
15	gray equal to one sievert.		

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

27	Neutron energy	Quality	Fluence per unit
28	(MeV)	factor ^a (Q)	dose equivalent ^b
29			(neutrons cm ²
30			rem ⁻¹)
31	2.5×10^{-8}	2	980×10^6
32	1×10^{-7}	2	980×10^6
33	1×10^{-6}	2	810×10^6
34	1×10^{-5}	2	810×10^6
35	1×10^{-4}	2	840×10^6

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1	1×10^{-3}	2	980×10^6
2	1×10^{-2}	2.5	1010×10^6
3	1×10^{-1}	7.5	170×10^6
4	5×10^{-1}	11	39×10^6
5	1	11	27×10^6
6	2.5	9	29×10^6
7	5	8	23×10^6
8	7	7	24×10^6
9	10	6.5	24×10^6
10	14	7.5	17×10^6
11	20	8	16×10^6
12	40	7	14×10^6
13	60	5.5	16×10^6
14	1×10^2	4	20×10^6
15	2×10^2	3.5	19×10^6
16	3×10^2	3.5	16×10^6
17	4×10^2	3.5	14×10^6

18 ^aValue of quality factor (Q) at the point where the dose
19 equivalent is maximum in a 30-cm diameter cylinder
20 tissue-equivalent phantom.

21 ^bMonoenergetic neutrons incident normally on a 30-cm diameter
22 cylinder tissue-equivalent phantom.

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

26 Subp. 185. Quarter. "Quarter" means a period of time
27 equal to one-fourth of the year observed by the licensee or

1 registrant, approximately 13 consecutive weeks---A-quarterly
2 test-must-be-performed-approximately-13-weeks-apart, four-times
3 per-year, provided that the first quarter in a year coincides
4 with the starting date of the year and that no day is omitted or
5 duplicated in consecutive quarters.

6 Subp. 186. Rad. "Rad" is the special unit of absorbed
7 dose. One rad is equal to an absorbed dose of 100 ergs/gram or
8 0.01 joule/kilogram (0.01 Gy).

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

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

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

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

27 Subp. 191. Radiation protection. "Radiation protection"

1 means the use of shielding, protective clothing, protective
2 equipment, and other means to eliminate or reduce exposure to
3 ionizing radiation.

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

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

8 A. has the training, knowledge, authority, and
9 responsibility to apply appropriate radiation protection
10 regulations according to ~~parts~~ part 4731.4130, or parts
11 4731.4411, and 4731.4415 on behalf of the licensee; and

12 B. for radioactive materials in the healing arts:
13 (1) meets the requirements in this chapter; or
14 (2) is identified as the radiation safety officer
15 in:

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

18 (b) a medical use permit issued by a
19 ~~commissioner~~ an NRC master material licensee.

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

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

27 Subp. 196. Radioactive waste or waste. "Radioactive waste"

1 or "waste" means those low-level radioactive wastes containing
2 source, special nuclear, or radioactive material that are
3 acceptable for disposal in a land disposal facility.

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

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

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

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

27 Subp. 201. Rem. "Rem" is the special unit of any of the

1 quantities expressed as dose equivalent. The dose equivalent in
2 rems is equal to the absorbed dose in rads multiplied by the
3 quality factor (1 rem = 0.01 sievert).

4 Subp. 202. Research and development. "Research and
5 development" means:

6 A. theoretical analysis, exploration, or
7 experimentation; or

8 B. the extension of investigative findings and
9 theories of a scientific or technical nature into practical
10 application for experimental and demonstration purposes,
11 including the experimental production and testing of models,
12 devices, equipment, materials, and processes.

13 Research and development does not include the internal or
14 external administration of radioactive material, or the
15 radiation therefrom, to human beings, unless the research using
16 human subjects is conducted according to part 4731.4401.

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

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

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

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

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

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

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

25 Subp. 210. Sealed source and device registry. "Sealed
26 source and device registry" means the national registry that
27 contains all the registration certificates, generated by both

1 the NRC and agreement states, that summarize the radiation
2 safety information for sealed sources and devices and describe
3 the licensing and use conditions approved for the product.

4 Subp. 211. Self-contained breathing apparatus.

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

8 Subp. 212. Shallow dose equivalent or H_S . "Shallow dose
9 equivalent" or " H_S " means the dose equivalent at a tissue depth
10 of 0.007 centimeter (7 mg/cm^2) averaged over an area of one
11 square centimeter. Shallow dose equivalent applies to the
12 external exposure of the skin or an extremity.

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

17 Subp. 214. SI. "SI" means the international system of
18 units.

19 Subp. 215. Sievert or Sv. "Sievert" or "Sv" is the SI
20 unit of any of the quantities expressed as dose equivalent. The
21 dose equivalent in sieverts is equal to the absorbed dose in
22 grays multiplied by the quality factor identified in subpart 183
23 ($1 \text{ Sv} = 0.01 \text{ } \underline{100} \text{ rems}$).

24 Subp. 216. Site area emergency. "Site area emergency"
25 means a situation in which events may occur, are in progress, or
26 have occurred that could lead to a significant release of
27 radioactive material and that could require a response by

1 off-site response organizations to protect persons off-site.

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

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

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

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

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

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

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

22 B. ores that contain by weight 1/20 of one percent
23 (0.05 percent) or more of:

24 (1) uranium;

25 (2) thorium; or

26 (3) any combination thereof.

27 Source material does not include special nuclear material.

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

4 Subp. 224. Special form radioactive material. "Special
5 form radioactive material" means radioactive material that
6 satisfies the following conditions:

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

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

12 C. it satisfies the requirements of Code of Federal
13 Regulations, title 10, section 71.75. A special form
14 encapsulation designed according to Code of Federal Regulations,
15 title 10, section 71.4, in effect on June 30, 1983, and
16 constructed before July 1, 1985, and a special form
17 encapsulation designed according to Code of Federal Regulations,
18 title 10, section 71.4, in effect on March 31, 1996, and
19 constructed before April 1, 1998, may continue to be used. Any
20 other special form encapsulation must meet the specifications of
21 this subpart.

22 Subp. 225. Special nuclear material. "Special nuclear
23 material" means:

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

1 nuclear material; or

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

4 Special nuclear material does not include source material.

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

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

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

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

27 Subp. 230. Storage container. "Storage container" means a

1 container in which sealed sources are secured and stored.

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

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

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

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

19 Subp. 235. Surface contaminated object or SCO. "Surface
20 contaminated object" or "SCO" means a solid object that is not
21 itself classed as radioactive material, but that has radioactive
22 material distributed on any of its surfaces. SCO is classified
23 in two groups, with surface activity not exceeding the following
24 limits:

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

26 (1) the nonfixed contamination on the accessible
27 surface averaged over 300 cm^2 , or the area of the surface if

1 less than 300 cm^2 , does not exceed:

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

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

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

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

11 (b) $0.1 \text{ } \mu\text{Ci}/\text{cm}^2$ ($4 \times 10^3 \text{ Bq}/\text{cm}^2$) for all
12 other alpha emitters; and

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

16 (a) $1 \text{ } \mu\text{Ci}/\text{cm}^2$ ($4 \times 10^4 \text{ Bq}/\text{cm}^2$) for beta and
17 gamma and low toxicity alpha emitters; or

18 (b) $0.1 \text{ } \mu\text{Ci}/\text{cm}^2$ ($4 \times 10^3 \text{ Bq}/\text{cm}^2$) for all
19 other alpha emitters; and

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

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

25 (a) $10^{-2} \text{ } \mu\text{Ci}/\text{cm}^2$ ($400 \text{ Bq}/\text{cm}^2$) for beta and
26 gamma and low toxicity alpha emitters; or

27 (b) $10^{-3} \text{ } \mu\text{Ci}/\text{cm}^2$ ($40 \text{ Bq}/\text{cm}^2$) for all other

1 alpha emitters;

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

5 (a) $20 \text{ } \mu\text{Ci}/\text{cm}^2$ ($8 \times 10^5 \text{ Bq}/\text{cm}^2$) for beta and
6 gamma and low toxicity alpha emitters; or

7 (b) $2 \text{ } \mu\text{Ci}/\text{cm}^2$ ($8 \times 10^4 \text{ Bq}/\text{cm}^2$) for all other
8 alpha emitters; and

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

12 (a) $20 \text{ } \mu\text{Ci}/\text{cm}^2$ ($8 \times 10^5 \text{ Bq}/\text{cm}^2$) for beta and
13 gamma and low toxicity alpha emitters; or

14 (b) $2 \text{ } \mu\text{Ci}/\text{cm}^2$ ($8 \times 10^4 \text{ Bq}/\text{cm}^2$) for all other
15 alpha emitters.

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

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

1 radiation.

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

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

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

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

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

20 Subp. 243. Total effective dose equivalent or TEDE.
21 "Total effective dose equivalent" or "TEDE" means the sum of the
22 deep dose equivalent for external exposures and the committed
23 effective dose equivalent for internal exposures.

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

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

5 Subp. 246. Transport index. "Transport index" means the
6 dimensionless number, rounded up to the next tenth, placed on
7 the label of a package to designate the degree of control to be
8 exercised by the carrier during transportation. The transport
9 index is determined as follows:

10 A. for nonfissile material packages, the number
11 determined by multiplying the maximum radiation level in
12 millisievert (mSv) per hour at 3.3 feet (one meter) from the
13 external surface of the package by 100 (equivalent to the
14 maximum radiation level in millirem per hour at 3.3 feet (one
15 meter)); or

16 B. for fissile material packages, the number
17 determined by multiplying the maximum radiation level in
18 millisievert per hour at 3.3 feet (one meter) from the external
19 surface of the package by 100 (equivalent to the maximum
20 radiation level in millirem per hour at 3.3 feet (one meter))
21 or, for criticality control purposes, the number obtained as
22 described in parts 4731.0400 to 4731.0424, whichever is larger.

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

26 Subp. 248. Tritium neutron generator target source.
27 "Tritium neutron generator target source" means a tritium source.

1 used within a neutron generator tube to produce neutrons for use
2 in well logging applications.

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

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

11 Subp. 251. Type of use. "Type of use" means use of
12 radioactive material under part 4731.4404, 4731.4432, 4731.4434,
13 4731.4440, 4731.4450, 4731.4460, or 4731.4463.

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

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

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

26 Subp. 255. Unrefined and unprocessed ore. "Unrefined and
27 unprocessed ore" means ore in its natural form prior to any

1 processing, such as grinding, roasting, or beneficiating, or
2 refining.

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

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

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

14 Subp. 259. Very high radiation area. "Very high radiation
15 area" means an area accessible to individuals in which radiation
16 levels from radiation sources external to the body could result
17 in an individual receiving an absorbed dose in excess of 500
18 rads (5 Gy) in one hour at one meter from a radiation source or
19 one meter from any surface that the radiation generates
20 penetrates. At very high doses received at high dose rates,
21 units of absorbed dose (rads and grays) are appropriate, rather
22 than units of dose equivalent (rems and sieverts).

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

24 Subp. 261. Weighting factor or W_T . "Weighting factor" or
25 W_T for an organ or tissue (T) is the proportion of the risk of
26 stochastic effects resulting from irradiation of that organ or
27 tissue to the total risk of stochastic effects when the whole

1 body is irradiated uniformly. For calculating the effective
2 dose equivalent, the values of W_T are:

3 Organ Dose Weighting Factors

4	Organ or tissue	W_T
5	Gonads	0.25
6	Breast	0.15
7	Red bone marrow	0.12
8	Lung	0.12
9	Thyroid	0.03
10	Bone surface	0.03
11	Remainder	0.30^1
12	Whole Body	1.00^2

13 ¹0.30 results from 0.06 for each of five remainder organs
14 (excluding the skin and the lens of the eye) that receive the
15 highest doses.

16 ²For the purpose of weighting the external whole body dose (for
17 adding it to the internal dose), a single weighting factor,
18 $W_T=1.0$, has been specified. The use of other weighting factors
19 for external exposure may be approved on a case-by-case basis
20 until such time as specific guidance is issued.

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

23 Subp. 263. Well logging or logging. "Well logging" or
24 "logging" means all operations involving the lowering and
25 raising of measuring devices or tools that contain licensed
26 material or are used to detect licensed materials in wells or

1 borings to obtain information about the well, boring, or
2 adjacent formations, which may be used in oil, gas, mineral,
3 groundwater, or geological exploration.

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

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

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

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

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

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

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

1 Subp. 269. Year. "Year" means the 12-month period of time
2 used to determine compliance with this chapter, beginning in
3 January unless the licensee changes the starting date of the
4 12-month period used to determine compliance by the licensee,
5 provided that the change is made at the beginning of the year
6 and that no day is omitted or duplicated in consecutive years.

7 4731.0200 GENERAL APPLICATIONS.

8 Subpart 1. Purpose:--Radiation-can-be-instrumental-in-the
9 improvement-of-health,-welfare,-and-productivity-of-the-public
10 if-properly-used-but-may-impair-the-health-of-people-and-the
11 industrial-and-agricultural-potentials-of-the-state-if
12 improperly-used:--The-commissioner-has-the-statutory-authority
13 and-duty-to-adopt,-amend,-and-enforce-rules-to-prevent-dangers
14 to-public-health-from-radiation:--This-includes-the-preservation
15 and-protection-of-public-health,-control-of-radiation-producing
16 devices-and-radioactive-sources,-the-handling,-storage,
17 transportation,-use,-and-disposal-of-radioactive-isotopes-and
18 fissionable-materials-within-the-state,-and-securing-information
19 concerning-the-nature-and-extent-of-the-use-of-radioactive
20 material-within-this-state-

21 Subp.-2- Applicability.

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

1 radioactive material.

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

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

11 Subp. 3~~+~~ 2. Exemptions or variances. The commissioner
12 may, according to parts 4717.7000 to 4717.7050, grant an
13 exemption or variance from the requirements of this chapter, if
14 it is determined to be authorized by law, would not endanger
15 life or property, and is otherwise in the public interest.

16 Subp. 4~~+~~ 3. Responsibilities.

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

20 B. It is the responsibility of each applicant or
21 licensee to notify the commissioner of any change in information
22 related to the regulated activity that has an impact on public
23 health and safety according to this subpart. Notification must
24 be provided to the commissioner within two working days of
25 identifying the information. This item does not apply to
26 information that a person is otherwise required to provide to
27 the commissioner by other reporting requirements of this chapter.

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

4 Subp. 5- 4. Submissions. Except as otherwise specified in
5 this chapter, all communications and reports under this chapter
6 must be addressed to or delivered in person to: Minnesota
7 Department of Health, Radioactive Materials Unit, 1645 Energy
8 Park Drive, Suite 300, St. Paul, Minnesota, 55108-2970.

9 ~~Subp. 6---Interpretations---Except-as-specifically~~
10 ~~authorized-by-the-commissioner-in-writing,no-interpretation-of~~
11 ~~this-chapter-by-any-officer-or-employee-of-the-commissioner,~~
12 ~~other-than-a-written-interpretation-by-the-attorney-general,-is~~
13 ~~binding-upon-the-commissioner-~~

14 4731.0210 RECORDS.

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

25 Subp. 2. Format and safeguarding.

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

1 may be:

2 (1) the original;

3 (2) a reproduced copy;

4 (3) a microform, if authorized personnel

5 authenticate the copy or microform and the microform is capable

6 of producing a clear copy throughout the required retention

7 period; or

8 (4) stored in electronic media with the

9 capability for producing legible, accurate, and complete records

10 during the required retention period.

11 B. Records, such as letters, drawings, and

12 specifications, must include all pertinent information, such as

13 stamps, initials, and signatures.

14 C. A licensee must maintain adequate safeguards

15 against tampering with and loss of records.

16 Subp. 3. Reporting units. A licensee must use the units

17 curie, rad, or rem or the international systems of units (SI) as

18 appropriate, including multiples and subdivisions, and must

19 clearly indicate the units of all quantities on records required

20 under this chapter.

21 Subp. 4. Shipment manifests. Notwithstanding the

22 requirements of subpart 3, when recording information on

23 shipment manifests, required under part 4731.2450, subpart 2,

24 information must be recorded in SI units or in SI and units as

25 specified in subpart 3.

26 Subp. 5. Distinguishing quantities. A licensee must make

27 a clear distinction among the quantities entered on records

1 required under this chapter, for example, among the quantities
2 of total effective dose equivalent, shallow dose equivalent,
3 lens dose equivalent, deep dose equivalent, and committed
4 effective dose equivalent.

5 4731.0230 REQUEST FOR WRITTEN STATEMENTS.

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

11 4731.0240 DATA PRIVACY.

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

15 4731.0250 INSPECTIONS AND TESTING.

16 Subpart 1. Inspections.

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

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

26 Subp. 2. Tests.

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

5 (1) radioactive material;

6 (2) facilities wherein the radioactive material
7 is utilized or stored;

8 (3) radiation detection and monitoring
9 instruments; and

10 (4) other equipment and devices used in
11 connection with the utilization or storage of radioactive
12 material.

13 4731.0260 VIOLATIONS, ENFORCEMENT, AND PENALTIES.

14 Violations found by a routine inspection, complaint based
15 inspection, incident or accident inspection, or other inspection
16 deemed necessary by the commissioner must be brought into
17 compliance within 30 days from the date of the inspection report
18 or as otherwise instructed in writing. All violations are
19 subject to penalty under Minnesota Statutes, sections 144.989 to
20 144.993.

21 4731.0270 MODIFICATION AND REVOCATION OF LICENSES.

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

26 Subp. 2. Revocation and suspension. A license may be

1 revoked, suspended, or modified, in whole or in part:

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

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

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

12 Subp. 3. Notice of noncompliance. Except in cases of
13 willfulness or when the public health, interest, or safety
14 requires otherwise, the commissioner shall not modify, suspend,
15 or revoke a license unless, prior to the institution of
16 proceedings, facts or conduct that warrant such action are
17 called to the attention of the licensee in writing and the
18 licensee is accorded an opportunity to demonstrate or achieve
19 compliance with all lawful requirements.

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

24 4731.0280 DELIBERATE MISCONDUCT.

25 A. A licensee, registrant, applicant for a license or
26 registration, or employee of a licensee, registrant, or
27 applicant, or a contractor, including a supplier or consultant,

1 subcontractor, or employee of a contractor or subcontractor of a
2 licensee, registrant, or applicant who knowingly provides to a
3 licensee, registrant, applicant, contractor, or subcontractor
4 any components, equipment, materials, or other goods or services
5 that relate to a licensee's, registrant's, or applicant's
6 activities in this chapter may not:

7 (1) engage in deliberate misconduct that causes
8 or would have caused, if not detected, a licensee, registrant,
9 or applicant to be in violation of a rule, an order, or a term,
10 condition, or limitation of a license issued by the
11 commissioner; or

12 (2) deliberately submit to the commissioner, a
13 licensee, a registrant, an applicant, or a licensee's,
14 registrant's, or applicant's contractor or subcontractor
15 information that the person submitting the information knows to
16 be incomplete or inaccurate in some respect material to the
17 commissioner.

18 B. A person who violates item A may be subject to
19 enforcement action under part 4731.0260.

20 C. For purposes of this part, deliberate misconduct
21 by a person means an intentional act or omission that the person
22 knows:

23 (1) would cause a licensee, registrant, or
24 applicant to be in violation of a rule, an order, or a term,
25 condition, or limitation of a license issued by the
26 commissioner; or

27 (2) constitutes a violation of a requirement,

1 procedure, instruction, contract, purchase order, or policy of a
2 licensee, registrant, applicant, contractor, or subcontractor.

3 4731.0290 EMPLOYEE PROTECTION.

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

6 4731.0300 FEDERAL JURISDICTION EXCLUSION.

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

10 4731.0315 CRITICAL MASS.

11 Subpart 1. Calculation.

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

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

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

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

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

23 B. For each kind of special nuclear material,
24 determine the ratio between the quantity of that special nuclear
25 material and the quantity under item A for the same kind of
26 special nuclear material. The sum of the ratios for all kinds

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1 of special nuclear materials in combination must not exceed
2 unity. For example, the following quantities in combination
3 would not exceed the limitation and are within the formula, as
4 follows:

5 (175 grams U-235/350) + (50 grams U-233/200) + (50 grams
6 Pu/200) = 1

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

15 4731.0355 RECIPROCITY.

16 Subpart 1. Application; recognition.

17 A. Applications for reciprocal recognition of
18 licenses issued by the NRC or other agreement states may be made
19 by completing a report of proposed activity reciprocity form
20 prescribed by the commissioner. The form may be obtained by
21 contacting the Department of Health, Radioactive Materials Unit,
22 1645 Energy Park Drive, Suite 300, St. Paul, Minnesota
23 55108-2970.

24 B. The commissioner shall reciprocally recognize
25 radioactive materials licenses issued by the NRC or another
26 agreement state according to this part. The NRC maintains
27 jurisdiction in nonagreement states, areas of exclusive federal

1 jurisdiction within agreement states, and offshore waters.

2 Subp. 2. Review and inspection.

3 A. The commissioner shall review applications for
4 reciprocity for compliance with this chapter in the same manner
5 as applications from within the state. The application must be
6 signed and dated by the radiation safety officer or the
7 responsible management representative.

8 B. Inspections by the commissioner may be performed
9 on any licensee who has been granted a reciprocal license.
10 Considerations for selecting reciprocal licensees for inspection
11 include:

12 (1) potential risk to employees, the public, or
13 the environment;

14 (2) activities that are new or unusual for the
15 state;

16 (3) the frequency of the licensee entering the
17 state to perform activities;

18 (4) the length of time to complete the intended
19 activity; and

20 (5) the concern expressed by the public about a
21 specific activity.

22 C. The frequency of inspection for any particular
23 licensee is dependent on the considerations listed in item B.

24 Subp. 3. Licenses of radioactive material, source and
25 special nuclear material in quantities not sufficient to form a
26 critical mass.

27 A. Subject to this chapter, a person who holds a

1 specific license from the NRC or an agreement state, and issued
2 by the agency having jurisdiction where the licensee maintains
3 an office for directing the licensed activity and at which
4 radiation safety records are normally maintained, is granted a
5 general license to conduct the activities authorized in such
6 licensing document within this state for a period not in excess
7 of 180 days in a one-year period if:

8 (1) the out-of-state licensee notifies the
9 commissioner in writing at least three days before engaging in
10 the activities in the state. The notification must include:

11 (a) the name of the company for whom service
12 will be performed;

13 (b) the name and telephone number of the
14 individual representing the company under unit (a);

15 (c) the location where services will be
16 performed;

17 (d) the start date;

18 (e) the duration of the service;

19 (f) the type of service to be performed;

20 (g) the name of individuals performing the
21 service; and

22 (h) identification of the sources of
23 radiation to be used;

24 (2) the notification is accompanied by a copy of
25 the current licensing document;

26 (3) the licensing document does not limit the
27 activity authorized by the document to specified installations

1 or locations; and

2 (4) the licensee pays the reciprocity fee under
3 Minnesota Statutes, section 144.1205.

4 B. The out-of-state licensee must:

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

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

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

13 C. The out-of-state licensee must not transfer or
14 dispose of radioactive material possessed or used under the
15 general license under this part except by transfer to a person
16 who is specifically licensed by the NRC or an agreement state to
17 receive the material or who is exempt from the requirements for
18 a license for the material under part 4731.3025.

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

24 E. ~~The commissioner may waive the requirement for~~
25 ~~filing additional written notifications during the remainder of~~
26 ~~the one-year reciprocity period following the receipt of the~~
27 ~~initial notification from a person engaging in activities under~~

1 ~~the-general-license-granted-under-item-A-~~

2 ~~P-~~ Failure to provide the required information or fee
3 may result in denial of reciprocity privileges.

4 ~~G-~~ F. Notwithstanding item A, a person who holds a
5 specific license issued by the NRC or an agreement state
6 authorizing the holder to manufacture, transfer, install, or
7 service a device described in parts 4731.3200 to 4731.3245
8 within areas subject to the jurisdiction of the licensing body
9 is granted a general license to install, transfer, demonstrate,
10 or service the device if:

11 (1) the person files a report with the
12 commissioner within 30 days after the end of each calendar
13 quarter in which any device is transferred to or installed in
14 this state. The report must identify each general licensee to
15 whom the device is transferred by name and address, the type and
16 model number of devices transferred, and the quantity and type
17 of radioactive material contained in the device;

18 (2) the device has been manufactured, labeled,
19 installed, and serviced under applicable provisions of the
20 specific license issued to the person by the NRC or an agreement
21 state;

22 (3) the person provides assurance that any labels
23 required to be affixed to the device under rules of the
24 authority that licensed manufacture of the device bear the
25 statement "Removal of this label is prohibited"; and

26 (4) the holder of the specific license furnishes
27 to each general licensee to whom the device is transferred or on

1 whose premises the device is installed a copy of the general
2 license issued under this item, or under equivalent rules of the
3 agency having jurisdiction over the manufacture and distribution
4 of the device.

5 Hr G. The commissioner may withdraw, limit, or
6 qualify acceptance of a specific license or equivalent licensing
7 document issued by the NRC or an agreement state or a product
8 distributed under the licensing document upon determining that
9 the action is necessary to prevent undue hazard to public health
10 and safety or property.

11 Subp. 4. Jurisdictional status.

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

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

23 TRANSPORTATION OF LICENSED MATERIAL

24 4731.0400 SCOPE; ENFORCEMENT NOTICE.

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

1 Subp. 2. Application of other law. The packaging and
2 transport of licensed material are subject to this chapter; Code
3 of Federal Regulations, title 10, parts 21, 70, and 73; and the
4 regulations of other agencies, such as the NRC, DOT, and United
5 States Postal Service, having jurisdiction over means of
6 transport. The requirements of parts 4731.0400 to 4731.0424 are
7 in addition to, and not in substitution for, other requirements.

8 Subp. 3. Applicability.

9 A. Parts 4731.0400 to 4731.0424 apply to any licensee
10 authorized by a specific or general license issued by the
11 commissioner to receive, possess, use, or transfer licensed
12 material, if the licensee delivers that material to a carrier
13 for transport, transports the material outside the site of usage
14 as specified in an NRC or agreement state license, or transports
15 that material on public highways. Parts 4731.0400 to 4731.0424
16 do not authorize possession of licensed material.

17 B. Parts 4731.0400 to 4731.0424 apply to any person
18 required to obtain a certificate of compliance if the person
19 delivers radioactive material to a common or contract carrier
20 for transport or transports the material outside the confines of
21 the person's plant or other authorized place of use.

22 Subp. 4. Enforcement notice. This part is notice to all
23 persons who knowingly provide to any licensee; radiographer
24 ~~certification~~ certificate holder; quality assurance program
25 approval holder; applicant for a license,
26 radiographer ~~certification~~ certificate, or quality assurance
27 program approval; or contractor or subcontractor of any of them

1 components, equipment, materials, or other goods or services,
2 that relate to a licensee's, ~~certification~~ certificate holder's,
3 quality assurance program approval holder's, or applicant's
4 activities subject to parts 4731.0400 to 4731.0424, that they
5 may be individually subject to the commissioner's enforcement
6 action for violation of part 4731.0405.

7 4731.0401 REQUIREMENT FOR LICENSE.

8 No licensee shall deliver licensed material to a carrier
9 for transport or transport licensed material, except as
10 authorized in a general license or a specific license issued by
11 the commissioner or as exempted under parts 4371.0400 to
12 4731.0424.

13 4731.0402 TRANSPORTATION OF LICENSED MATERIAL.

14 Subpart 1. DOT regulations.

15 A. A licensee who transports licensed material
16 outside of the site of usage, as specified in a license issued
17 by the NRC or an agreement state, or where transport is on
18 public highways or a licensee who delivers licensed material to
19 a carrier for transport must comply with the applicable DOT
20 regulations in Code of Federal Regulations, title 49, parts 170
21 to 189, appropriate to the mode of transport.

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

24 (1) packaging, Code of Federal Regulations, title
25 49, part 173, subparts A, B, and I;

26 (2) marking and labeling, Code of Federal

1 Regulations, title 49, part 172, subpart D, sections 172.400 to
2 172.407 and 172.436 to 172.440, and subpart E;

3 (3) placarding, Code of Federal Regulations,
4 title 49, part 172, subpart F, especially sections 172.500 to
5 172.519 and 172.556, and appendices B and C;

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

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

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

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

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

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

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

22 (3) vessel, Code of Federal Regulations, title
23 49, part 176, subparts A to F and M; and

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

26 Subp. 2. Compliance; waiver. If DOT regulations are not
27 applicable to a shipment of licensed material, a licensee must

1 conform to the standards and requirements of the DOT specified
2 in subpart 1 to the same extent as if the shipment or
3 transportation were subject to DOT regulations. A request for
4 modification, waiver, or exemption from those requirements, and
5 any notification referred to in those requirements, must be
6 filed with or made to the commissioner.

7 4731.0403 EXEMPTIONS.

8 Subpart 1. Physicians. A physician licensed by a state to
9 dispense drugs in the practice of medicine is exempt from part
10 4731.0402 with respect to transport by the physician of licensed
11 material for use in the practice of medicine. A physician
12 operating under this exemption must be licensed under parts
13 4731.4400 to 4731.4527 or equivalent regulations of the NRC or
14 an agreement state.

15 Subp. 2. Low level materials. A licensee is exempt from
16 the requirements of parts 4731.0400 to 4731.0424 with respect to
17 shipment or carriage of a package containing radioactive
18 material having a specific activity not greater than 0.002 $\mu\text{Ci/g}$
19 (70 Bq/g).

20 4731.0405 DELIBERATE MISCONDUCT.

21 Subpart 1. Applicability. This part applies to:

22 A. a licensee;

23 B. an industrial radiographer certification
24 certificate holder;

25 C. a quality assurance program approval holder;

26 D. an applicant for a license, certification, or

1 quality assurance program approval;

2 E. a contractor, including a supplier or consultant,
3 or subcontractor to any person under items A to D; and

4 F. an employee of any person under items A to E.

5 Subp. 2. Prohibition. A person under subpart 1 who
6 knowingly provides to another person under subpart 1 any
7 components, materials, or other goods or services that relate to
8 a licensee's, ~~certification~~ certificate holder's, quality
9 assurance program approval holder's, or applicant's activities
10 subject to this chapter may not:

11 A. engage in deliberate misconduct that causes or
12 would have caused, if not detected, a licensee,
13 ~~certification~~ certificate holder, quality assurance program
14 approval holder, or applicant to be in violation of a rule;
15 order; or term, condition, or limitation of any license,
16 certification, or approval issued by the commissioner, the NRC,
17 or an agreement state; or

18 B. deliberately submit to the NRC or an agreement
19 state, a licensee, a ~~certification~~ certificate holder, a quality
20 assurance program approval holder, an applicant for a license,
21 certification, or quality assurance program approval, or a
22 licensee's, applicant's, ~~certification~~ certificate holder's, or
23 quality assurance program approval holder's contractor or
24 subcontractor, information that the person submitting the
25 information knows to be incomplete or inaccurate in some respect
26 material to the NRC or an agreement state.

27 Subp. 3. Penalty. A person who violates subpart 2 is

1 subject to enforcement action.

2 Subp. 4. Definition. For purposes of subpart 2,
3 deliberate misconduct by a person means an intentional act or
4 omission that the person knows:

5 A. would cause a licensee, certification certificate
6 holder, quality assurance program approval holder, or applicant
7 for a license, certification, or quality assurance program
8 approval to be in violation of any rule; order; or term,
9 condition, or limitation of a license or certification issued by
10 the NRC or an agreement state; or

11 B. constitutes a violation of a requirement,
12 procedure, instruction, contract, purchase order, or policy of a
13 licensee, certification certificate holder, quality assurance
14 program approval holder, or applicant or the contractor or
15 subcontractor of any of them.

16 4731.0406 GENERAL LICENSE; NRC-APPROVED PACKAGE.

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

22 Subp. 2. Approved quality assurance program. The general
23 license issued under subpart 1 applies only to a licensee who
24 has a quality assurance program approved by the commissioner as
25 complying with parts 4731.0420 and 4731.0421 and Code of Federal
26 Regulations, title 10, part 71, subpart H.

27 Subp. 3. Compliance with conditions.

1 A. The general license issued under subpart 1 applies
2 only to a licensee who:

3 (1) has a copy of the certificate of compliance
4 or other approval of the package and has the drawings and other
5 documents referenced in the approval relating to the use and
6 maintenance of the packaging and to the actions to be taken
7 before shipment;

8 (2) complies with the terms and conditions of the
9 license, certificate, or other approval, as applicable, and the
10 applicable requirements of this chapter; and

11 (3) submits in writing to the NRC, before the
12 licensee's first use of the package, the licensee's name and
13 license number and the package identification number specified
14 in the package approval.

15 B. The general license issued under subpart 1 applies
16 only when the package approval authorizes use of the package
17 under the general license under subpart 1.

18 C. For a Type B or fissile material package, the
19 design of which was approved by the NRC before April 1, 1996,
20 the general license under subpart 1 is subject to the additional
21 restrictions of part 4731.0407.

22 4731.0407 PREVIOUSLY APPROVED PACKAGES.

23 Subpart 1. Type B package. A Type B package previously
24 approved by the NRC, but not designated as B(U) or B(M) in the
25 identification number of the NRC certificate of compliance, may
26 be used under the general license issued under part 4731.0406 if:

27 A. fabrication of the packaging was satisfactorily

1 completed by August 31, 1986, as demonstrated by application of
2 its model number according to part 4731.0414, item C;

3 B. a package used for a shipment to a location
4 outside the United States is subject to multilateral approval,
5 as defined in DOT regulations under Code of Federal Regulations,
6 title 49, section 173.403; and

7 C. a serial number that uniquely identifies each
8 packaging that conforms to the approved design is assigned to
9 and legibly and durably marked on the outside of each packaging.

10 Subp. 2. Type B, LSA, fissile material package. A Type
11 B(U) package, a Type B(M) package, a low specific activity (LSA)
12 material package, or a fissile material package previously
13 approved by the NRC, but without the designation "-85" in the
14 identification number of the NRC certificate of compliance, may
15 be used under the general license issued under part 4731.0406 if:

16 A. fabrication of the package is satisfactorily
17 completed by April 1, 1999, as demonstrated by application of
18 its model number according to part 4731.0414, item C;

19 B. a package used for a shipment to a location
20 outside the United States is subject to multilateral approval,
21 as defined in DOT regulations under Code of Federal Regulations,
22 title 49, section 173.403; and .

23 C. a serial number that uniquely identifies each
24 packaging that conforms to the approved design is assigned to
25 and legibly and durably marked on the outside of each packaging.

26 4731.0408 GENERAL LICENSE; DOT SPECIFICATION CONTAINER.

27 Subpart 1. License for specification containers. A

1 general license is issued to any licensee of the commissioner to
2 transport, or to deliver to a carrier for transport, licensed
3 material in a specification container for fissile material or
4 for a Type B quantity of radioactive material according to DOT
5 regulations under Code of Federal Regulations, title 49, parts
6 173 and 178.

7 Subp. 2. Approved quality assurance program. The general
8 license issued under subpart 1 applies only to a licensee who
9 has a quality assurance program approved by the commissioner as
10 complying with parts 4731.0420 and 4731.0421 and Code of Federal
11 Regulations, title 10, sections 71.37 and 71.105.

12 Subp. 3. Specification conditions. The general license
13 issued under subpart 1 applies only to a licensee who:

14 A. has a copy of the specification; and

15 B. complies with the terms and conditions of the
16 specification and the applicable requirements of this chapter.

17 Subp. 4. Use within United States. The general license
18 issued under subpart 1 is subject to the limitation that the
19 specification container may not be used for a shipment to a
20 location outside the United States except by multilateral
21 approval, as defined under Code of Federal Regulations, title
22 49, section 173.403.

23 4731.0409 GENERAL LICENSE; FOREIGN-APPROVED PACKAGE.

24 Subpart 1. License for foreign-approved package. A
25 general license is issued to any licensee of the commissioner to
26 transport, or to deliver to a carrier for transport, licensed
27 material in a package the design of which has been approved in a

1 foreign national competent authority certificate that has been
2 revalidated by the DOT as meeting the applicable requirements of
3 Code of Federal Regulations, title 49, section 171.12.

4 Subp. 2. Approved quality assurance program. Except as
5 otherwise provided in parts 4731.0400 to 4731.0424, the general
6 license issued under subpart 1 applies only to a licensee who
7 has a quality assurance program approved by the commissioner as
8 complying with parts 4731.0420 and 4731.0421 and Code of Federal
9 Regulations, title 10, sections 71.37 and 71.105.

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

13 Subp. 4. Certificate conditions. The general license
14 issued under subpart 1 applies only to a licensee who:

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

19 B. complies with the terms and conditions of the
20 certificate and revalidation and with the applicable
21 requirements of this chapter. With respect to the quality
22 assurance provisions of parts 4731.0420 and 4731.0421, the
23 licensee is exempt from design, construction, and fabrication
24 considerations.

25 4731.0410 GENERAL LICENSE; FISSILE MATERIAL, LIMITED QUANTITY
26 PER PACKAGE.

27 Subpart 1. License to transport or deliver fissile

1 material. A general license is issued to any licensee of the
2 commissioner to transport fissile material, or to deliver
3 fissile material to a carrier for transport, without complying
4 with the package standards of part 4731.0412 and Code of Federal
5 Regulations, title 10, sections 71.41 to 71.77, if the material
6 is shipped according to this part.

7 Subp. 2. Approved quality assurance program. The general
8 license issued under subpart 1 applies only to a licensee who
9 has a quality assurance program approved by the commissioner as
10 complying with parts 4731.0420 and 4731.0421 and Code of Federal
11 Regulations, title 10, sections 71.37 and 71.105.

12 Subp. 3. Type A quantity limits. Except as provided in
13 subpart 4, the general license issued under subpart 1 applies
14 only when a package contains no more than a Type A quantity of
15 radioactive material, including only one of the following:

16 A. up to 40 grams of uranium-235;

17 B. up to 30 grams of uranium-233;

18 C. up to 25 grams of the fissile radionuclides of
19 plutonium, except that for encapsulated plutonium-beryllium
20 neutron sources in special form, an A_1 quantity of plutonium may
21 be present; or

22 D. a combination of fissile radionuclides in which
23 the sum of the ratios of the amount of each radionuclide to the
24 corresponding maximum amounts in items A, B, and C does not
25 exceed unity.

26 Subp. 4. Fissile material mixed with other substances.
27 For packages where fissile material is mixed with substances

1 having an average hydrogen density greater than water, the
2 general license issued under subpart 1 applies only when a
3 package contains no more than a Type A quantity of radioactive
4 material, including only one of the following:

5 A. up to 29 grams of uranium-235;

6 B. up to 18 grams of uranium-233;

7 C. up to 18 grams of fissile radionuclides of
8 plutonium; or

9 D. a combination of fissile radionuclides in which
10 the sum of the ratios of the amount of each radionuclide to the
11 corresponding maximum amounts in items A, B, and C does not
12 exceed unity.

13 Subp. 5. Limited beryllium, graphite, or enriched
14 hydrogenous material. Except for the beryllium contained within
15 the special form plutonium-beryllium sources authorized in
16 subpart 3, the general license issued under subpart 1 applies
17 only when beryllium, graphite, or hydrogenous material enriched
18 in deuterium is not present in quantities exceeding 0.1 percent
19 of the fissile material mass.

20 Subp. 6. Transport index.

21 A. Except as specified in item B for encapsulated
22 plutonium-beryllium sources, the general license issued under
23 subpart 1 applies only when a package is labeled with a
24 transport index not less than the number given by the following
25 equation, where the package contains x grams of uranium-235, y
26 grams of uranium-233, and z grams of the fissile radionuclides
27 of plutonium:

1 Minimum Transport Index = $(0.25x + 0.33y + 0.4z)$.

2 B. For a package in which the only fissile material
3 is in the form of encapsulated plutonium-beryllium neutron
4 sources in special form, the transport index based on
5 criticality considerations may be taken as 0.025 times the
6 number of grams of the fissile radionuclides of plutonium.

7 C. Packages that have a transport index greater than
8 ten are not authorized under the general license provisions of
9 parts 4731.0400 to 4731.0424.

10 4731.0411 GENERAL LICENSE; FISSILE MATERIAL, LIMITED MODERATOR
11 PER PACKAGE.

12 Subpart 1. License for limited fissile material, limited
13 moderator per package. A general license is issued to any
14 licensee of the commissioner to transport fissile material, or
15 to deliver fissile material to a carrier for transport, without
16 complying with the package standards under Code of Federal
17 Regulations, title 10, sections 71.41 to 71.77, if the material
18 is shipped according to this part.

19 Subp. 2. Approved quality assurance program. The general
20 license issued under subpart 1 applies only to a licensee who
21 has a quality assurance program approved by the commissioner as
22 complying with parts 4731.0420 and 4731.0421 and Code of Federal
23 Regulations, title 10, part 71, subpart H.

24 Subp. 3. Limited quantity conditions. The general license
25 issued under subpart 1 applies only when:

26 A. the package contains no more than a Type A
27 quantity of radioactive material;

1 B. neither beryllium nor hydrogenous material
2 enriched in deuterium is present;

3 C. the total mass of graphite present does not exceed
4 7.7 times the total mass of uranium-235 plus plutonium;

5 D. substances having a higher hydrogen density than
6 water, for example, certain hydrocarbon oils, are not present,
7 except that polyethylene may be used for packing or wrapping;

8 E. uranium-233 is not present and the amount of
9 plutonium does not exceed one percent of the amount of
10 uranium-235;

11 F. the amount of uranium-235 is limited as follows:

12 (1) if the fissile radionuclides are not
13 uniformly distributed, the maximum amount of uranium-235 per
14 package may not exceed the value given in the following table:

15	Uranium enrichment	Permissible maximum
16	in weight percent of	grams of uranium-235
17	uranium-235 not exceeding	per package

18		
19	24	40
20	20	42
21	15	45
22	11	48
23	10	51
24	9.5	52
25	9	54
26	8.5	55
27	8	57
28	7.5	59
29	7	60
30	6.5	62
31	6	65
32	5.5	68
33	5	72
34	4.5	76
35	4	80
36	3.5	88
37	3	100
38	2.5	120
39	2	164
40	1.5	272

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1	1.35	320
2	1	680
3	0.92	1,200; or

4
5 (2) if the fissile radionuclides are distributed
6 uniformly, that is, cannot form a lattice arrangement within the
7 packaging, the maximum amount of uranium-235 per package may not
8 exceed the value given in the following table:

9	Uranium enrichment	Permissible maximum
10	in weight percent of	grams of uranium-235
11	uranium-235 not exceeding	per package
12		
13	4	84
14	3.5	92
15	3	112
16	2.5	148
17	2	240
18	1.5	560
19	1.35	800; and
20		

21 G. the transport index of each package, based on
22 criticality considerations, is taken as ten times the number of
23 grams of uranium-235 in the package divided by the maximum
24 allowable number of grams per package according to the tables in
25 item F, as applicable.

26 4731.0412 EXTERNAL RADIATION STANDARDS FOR ALL PACKAGES.

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

34 Subp. 2. Packages in excess of limit. A package that
35 exceeds the radiation level limits under subpart 1 must be

1 transported by exclusive use shipment only and the radiation
2 levels for such shipment must not exceed the following during
3 transportation:

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

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

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

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

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

20 C. ten millirems per hour (0.1 mSv/hr) at any point
21 80 inches (2 meters) from the outer lateral surfaces of the
22 vehicle, excluding the top and underside of the vehicle; or in
23 the case of a flat-bed style vehicle, at any point 6.6 feet (2
24 meters) from the vertical planes projected by the outer edges of
25 the vehicle, excluding the top and underside of the vehicle; and

26 D. two millirems per hour (0.02 mSv/hr) in any
27 normally occupied space, except that this item does not apply to

1 private carriers, if exposed personnel under their control wear
2 radiation dosimetry devices according to part 4731.2210.

3 Subp. 3. Written instructions.

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

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

15 4731.0413 ASSUMPTIONS AS TO UNKNOWN PROPERTIES.

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

22 4731.0414 PRELIMINARY DETERMINATIONS.

23 Before the first use of any packaging for the shipment of
24 licensed material:

25 A. a licensee must ascertain that there are no
26 cracks, pinholes, uncontrolled voids, or other defects that

1 could significantly reduce the effectiveness of the packaging;

2 B. where the maximum normal operating pressure will
3 exceed five pounds per square inch (35 kilopascal) gauge, a
4 licensee must test the containment system at an internal
5 pressure of at least 50 percent higher than the maximum normal
6 operating pressure, to verify the capability of that system to
7 maintain its structural integrity at that pressure; and

8 C. a licensee must conspicuously and durably mark the
9 packaging with its model number, serial number, gross weight,
10 and a package identification number assigned by the NRC. Before
11 applying the model number, a licensee must determine that the
12 packaging has been fabricated according to a design approved by
13 the NRC.

14 4731.0415 ROUTINE DETERMINATIONS.

15 Before each shipment of licensed material, a licensee must
16 ensure that the package with its contents satisfies the
17 applicable requirements of the license and parts 4731.0400 to
18 4731.0424. The licensee must determine that:

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

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

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

27 D. any system for containing liquid is adequately

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1 sealed and has adequate space or other specified provision for
2 expansion of the liquid;

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

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

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

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

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

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

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

27 4731.0416 AIR TRANSPORT OF PLUTONIUM.

1 Subpart 1. Limitations for plutonium transport.

2 Notwithstanding the provisions of any general license and
3 notwithstanding any exemptions stated directly in parts
4 4731.0400 to 4731.0424 or included indirectly by citation to
5 Code of Federal Regulations, title 49, chapter I, as may be
6 applicable, a licensee must ensure that plutonium in any form,
7 whether for import, export, or domestic shipment, is not
8 transported by air, or delivered to a carrier for air transport,
9 unless:

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

12 B. the plutonium is contained in a material in which
13 the specific activity is not greater than 0.002 microcurie per
14 gram (70 Bq/g) of material and in which the radioactivity is
15 essentially uniformly distributed;

16 C. the plutonium is shipped in a single package
17 containing no more than an A₂ quantity of plutonium in any
18 isotope or form and is shipped according to part 4731.0402; or

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

22 Subp. 2. Federal law.

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

26 B. For a shipment of plutonium by air that is subject
27 to subpart 1, item D, a licensee must, through special

1 arrangement with the carrier, require compliance with the DOT
2 regulations applicable to the air transport of plutonium under
3 Code of Federal Regulations, title 49, section 175.704.

4 4731.0417 OPENING INSTRUCTIONS.

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

10 4731.0418 REPORTS.

11 A licensee must report to the commissioner within 30 days:

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

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

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

21 4731.0419 ADVANCE NOTIFICATION OF SHIPMENT OF IRRADIATED REACTOR
22 FUEL AND NUCLEAR WASTE.

23 Subpart 1. Notice required. As specified in subparts 2 to
24 4, a licensee must provide advance notification to the
25 commissioner, the governor of the state or the governor's
26 designee, and the NRC of a shipment of licensed material through

1 or across the boundary of the state before the transport, or
2 delivery to a carrier for transport, of licensed material
3 outside the confines of the licensee's plant or other place of
4 use or storage.

5 Subp. 2. Shipments requiring notice. Advance notification
6 is required under this part for shipments of irradiated fuel in
7 quantities less than that subject to the advance notification
8 requirements of Code of Federal Regulations, title 10, section
9 73.37, paragraph (f). Advance notification is also required
10 under this part for shipments of licensed material, other than
11 irradiated fuel, meeting the following three conditions:

12 A. the licensed material is required by parts
13 4731.0400 to 4731.0424 to be in Type B packaging for
14 transportation;

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

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

20 (1) 3,000 times the A_1 value of radionuclides as
21 specified in part 4731.0422 for special form radioactive
22 material;

23 (2) 3,000 times the A_2 value of radionuclides as
24 specified in part 4731.0422 for normal form radioactive
25 material; or

26 (3) 1,000 TBq (27,000 Ci).

27 Subp. 3. Procedures for submitting notification.

1 A. The notification required under this part must:

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

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

9 (3) if delivered by messenger, reach the office
10 of the commissioner and the governor or governor's designee at
11 least four days before the beginning of the seven-day period
12 during which departure of the shipment is estimated to occur.

13 B. A list of the names and mailing addresses of the
14 governor's designees receiving advance notification of
15 transportation of nuclear waste is published annually in the
16 Federal Register on or about June 30 to reflect changes in
17 information. The list of the names and mailing addresses of the
18 governor's designees is available on request from the Director,
19 Office of State and Tribal Programs, United States Nuclear
20 Regulatory Commission, Washington, DC 20555-0001.

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

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

27 B. a description of the irradiated reactor fuel or

1 nuclear waste contained in the shipment according to DOT
2 regulations in Code of Federal Regulations, title 49, sections
3 172.202 and 172.203, paragraph (d);

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

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

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

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

14 Subp. 5. Revision notice. A licensee who finds that
15 schedule information, previously furnished under this part to
16 the commissioner and a governor or governor's designee, will not
17 be met must telephone a responsible individual in the
18 commissioner's office and the governor or governor's designee
19 and inform the individual of the extent of the delay beyond the
20 schedule originally reported. The licensee must maintain a
21 record of the name of the individual contacted for three years.

22 Subp. 6. Cancellation notice.

23 A. A licensee who cancels an irradiated reactor fuel
24 or nuclear waste shipment for which advance notification has
25 been sent must send a cancellation notice to the commissioner,
26 the governor of each state or the governor's designee previously
27 notified, and the director of the Division of Nuclear Security,

1 Office of Nuclear Security and Incident Response, NRC.

2 B. The licensee must state in the notice that it is a
3 cancellation and identify the advance notification that is being
4 canceled. The licensee must retain a copy of the notice as a
5 record for three years.

6 4731.0420 QUALITY ASSURANCE REQUIREMENTS.

7 Subpart 1. Program requirement.

8 A. A licensee must establish, maintain, and execute a
9 quality assurance program satisfying each of the applicable
10 criteria of this part and part 4731.0421 and Code of Federal
11 Regulations, title 10, part 71, subpart H, and satisfying any
12 specific provisions that are applicable to the licensee's
13 activities, including procurement of packaging. A licensee must
14 apply each of the applicable criteria in a graded approach, to
15 an extent that is consistent with the criteria's importance to
16 safety.

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

24 ~~Subp.-2.--Approval-of-program--Before-using-any-package~~
25 ~~for-the-shipment-of-licensed-material-subject-to-parts-4731-0400~~
26 ~~to-4731-0424,-a-licensee-must-obtain-commissioner-approval-of~~
27 ~~its-quality-assurance-program--A-licensee-must-file-a~~

1 ~~description-of-its-quality-assurance-program-with-the~~
2 ~~commissioner,-including-a-discussion-of-which-requirements-of~~
3 ~~parts-4731.0400-to-4731.0424-are-applicable-and-how-they-will-be~~
4 ~~satisfied.~~

5 Subp. 3- 2. Radiography containers. A program for
6 transport container inspection and maintenance limited to
7 radiographic exposure devices, source changers, or packages
8 transporting these devices and meeting the requirements of part
9 4731.4090, subpart 2, item A, or an equivalent requirement of
10 the NRC or an agreement state, is deemed to satisfy the
11 requirements of subpart 1 and part 4731.0406, subpart 2.

12 4731.0421 QUALITY ASSURANCE ORGANIZATION.

13 Subpart 1. Licensee duty. A licensee is responsible for
14 the establishment and execution of the quality assurance
15 program. While the term "licensee" is used in these criteria,
16 the requirements are applicable to whatever design, fabrication,
17 assembly, and testing of the package is accomplished with
18 respect to a package prior to the time a package approval is
19 issued.

20 Subp. 2. Delegation permitted. A licensee may delegate to
21 others, such as contractors, agents, or consultants, the work of
22 establishing and executing the quality assurance program, or any
23 part of the quality assurance program, but must retain
24 responsibility for the program.

25 Subp. 3. Delegation requirements. A licensee must clearly
26 establish and delineate, in writing, the authority and duties of
27 persons and organizations performing activities affecting the

1 safety-related functions of structures, systems, and
2 components. These activities include performing the functions
3 associated with attaining quality objectives and the quality
4 assurance functions.

5 Subp. 4. Quality assurance functions. The quality
6 assurance functions are:

7 A. ensuring that an appropriate quality assurance
8 program is established and effectively executed; and

9 B. verifying, by procedures such as checking,
10 auditing, and inspection, that activities affecting the
11 safety-related functions have been performed correctly.

12 Subp. 5. Required authority. The persons and
13 organizations performing quality assurance functions must have
14 sufficient authority and organizational freedom to:

15 A. identify quality problems;

16 B. initiate, recommend, or provide solutions; and

17 C. verify implementation of solutions.

18 Subp. 6. Management. The persons and organizations
19 performing quality assurance functions must report to a
20 management level that ensures that the required authority and
21 organizational freedom, including sufficient independence from
22 cost and schedule, when opposed to safety considerations, are
23 provided.

24 Subp. 7. Organizational structure. Because of many
25 variables involved, such as the number of personnel, the type of
26 activity being performed, and the location where activities are
27 performed, the organizational structure for executing the

1 quality assurance program may take various forms, provided that
 2 the persons and organizations assigned the quality assurance
 3 functions have the required authority and organizational freedom.

4 Subp. 8. Access to management. Irrespective of the
 5 organizational structure, the individuals assigned the
 6 responsibility for ensuring effective execution of any portion
 7 of the quality assurance program, at any location where
 8 activities subject to parts 4731.0400 to 4731.0424 are being
 9 performed, must have direct access to the levels of management
 10 necessary to perform this function.

11 4731.0422 A₁ AND A₂ VALUES FOR RADIONUCLIDES.

12 Subpart 1. A₁ and A₂ values. This subpart specifies
 13 A₁ and A₂ values for individual radionuclides.

14 Element and Atomic
 15 Number and
 16 Symbol of

17 Radionuclide	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)
18				
19 Actinium (89)				
20 Ac-225	0.6	16.2	1×10^{-2}	0.270
21 Ac-227	40	1,080	2×10^{-5}	5.41×10^{-4}
22 Ac-228	0.6	16.2	0.4	10.8
23				
24 Silver (47)				
25 Ag-105	2	54.1	2	54.1
26 Ag-108m	0.6	16.2	0.6	16.2
27 Ag-110m	0.4	10.8	0.4	10.8
28 Ag-111	0.6	16.2	0.5	13.5
29				
30 Aluminum (13)				
31 Al-26	0.4	10.8	0.4	10.8
32				
33 Americium (95)				
34 Am-241	2	54.1	2×10^{-4}	5.41×10^{-3}
35 Am-242m	2	54.1	2×10^{-4}	5.41×10^{-3}
36 Am-243	2	54.1	2×10^{-4}	5.41×10^{-3}
37				
38 Argon (18)				
39 Ar-37	40	1,080	40	1,080

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1	Ar-39	20	541	20	541
2	Ar-41	0.6	16.2	0.6	16.2
3	Ar-42	0.2	5.41	0.2	5.41
4					
5	Arsenic (33)				
6	As-72	0.2	5.41	0.2	5.41
7	As-73	40	1,080	40	1,080
8	As-74	1	27.0	0.5	13.5
9	As-76	0.2	5.41	0.2	5.41
10	As-77	20	541	0.5	13.5
11					
12	Astatine (85)				
13	At-211	30	811	2	54.1
14					
15	Gold (79)				
16	Au-193	6	162	6	162
17	Au-194	1	27.0	1	27.0
18	Au-195	10	270	10	270
19	Au-196	2	54.1	2	54.1
20	Au-198	3	81.1	0.5	13.5
21	Au-199	10	270	0.9	24.3
22					
23	Barium (56)				
24	Ba-131	2	54.1	2	54.1
25	Ba-133m	10	270	0.9	24.3
26	Ba-133	3	81.1	3	81.1
27	Ba-140	0.4	10.8	0.4	10.8
28					
29	Beryllium (4)				
30	Be-7	20	541	20	541
31	Be-10	20	541	0.5	13.5
32					
33	Bismuth (83)				
34	Bi-205	0.6	16.2	0.6	16.2
35	Bi-206	0.3	8.11	0.3	8.11
36	Bi-207	0.7	18.9	0.7	18.9
37	Bi-210m	0.3	8.11	3×10^{-2}	0.811
38	Bi-210	0.6	16.2	0.5	13.5
39	Bi-212	0.3	8.11	0.3	8.11
40					
41	Berkelium (97)				
42	Bk-247	2	54.1	2×10^{-4}	5.41×10^{-3}
43	Bk-249	40	1,080	8×10^{-2}	2.16
44					
45	Bromine (35)				
46	Br-76	0.3	8.11	0.3	8.11
47	Br-77	3	81.1	3	81.1
48	Br-82	0.4	10.8	0.4	10.8
49					
50	Carbon (6)				
51	C-11	1	27	0.5	13.5
52	C-14	40	1,080	2	54.1
53					
54	Calcium (20)				

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1	Ca-41	40	1,080	40	1,080
2	Ca-45	40	1,080	0.9	24.3
3	Ca-47	0.9	24.3	0.5	13.5
4					
5	Cadmium (48)				
6	Cd-109	40	1,080	1	27.0
7	Cd-113m	20	541	9 x 10	2.43
8	Cd-115m	0.3	8.11	0.3	8.11
9	Cd-115	4	108	0.5	13.5
10					
11	Cerium (58)				
12	Ce-139	6	162	6	162
13	Ce-141	10	270	0.5	13.5
14	Ce-143	0.6	16.2	0.5	13.5
15	Ce-144	0.2	5.41	0.2	5.41
16					
17	Californium (98)				
18	Cf-248	30	811	3 x 10 ⁻³	8.11 x 10 ⁻²
19	Cf-249	2	54.1	2 x 10 ⁻⁴	5.41 x 10 ⁻³
20	Cf-250	5	135	5 x 10 ⁻⁴	1.35 x 10 ⁻²
21	Cf-251	2	54.1	2 x 10 ⁻⁴	5.41 x 10 ⁻³
22	Cf-252	0.1	2.70	1 x 10 ⁻³	2.70 x 10 ⁻²
23	Cf-253	40	1,080	6 x 10 ⁻²	1.62
24	Cf-254	3 x 10 ⁻³	8.11 x 10 ⁻²	6 x 10 ⁻⁴	1.62 x 10 ⁻²
25					
26	Chlorine (17)				
27	Cl-36	20	541	0.5	13.5
28	Cl-38	0.2	5.41	0.2	5.41
29					
30	Curium (96)				
31	Cm-240	40	1,080	2 x 10 ⁻²	0.541
32	Cm-241	2	54.1	0.9	24.3
33	Cm-242	40	1,080	1 x 10 ⁻²	0.270
34	Cm-243	3	81.1	3 x 10 ⁻⁴	8.11 x 10 ⁻³
35	Cm-244	4	108	4 x 10 ⁻⁴	1.08 x 10 ⁻²
36	Cm-245	2	54.1	2 x 10 ⁻⁴	5.41 x 10 ⁻³
37	Cm-246	2	54.1	2 x 10 ⁻⁴	5.41 x 10 ⁻³
38	Cm-247	2	54.1	2 x 10 ⁻⁴	5.41 x 10 ⁻³
39	Cm-248	4 x 10 ⁻²	1.08	5 x 10 ⁻⁵	1.35 x 10 ⁻³
40					
41	Cobalt (27)				
42	Co-55	0.5	13.5	0.5	13.5
43	Co-56	0.3	8.11	0.3	8.11
44	Co-57	8	216	8	216
45	Co-58m	40	1,080	40	1,080
46	Co-58	1	27.0	1	27.0
47	Co-60	0.4	10.8	0.4	10.8
48					
49	Chromium (24)				
50	Cr-51	30	811	30	811
51					
52	Cesium (55)				
53	Cs-129	4	108	4	108
54	Cs-131	40	1,080	40	1,080

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1	Cs-132	1	27.0	1	27.0
2	Cs-134m	40	1,080	9	243
3	Cs-134	0.6	16.2	0.5	13.5
4	Cs-135	40	1,080	0.9	24.3
5	Cs-136	0.5	13.5	0.5	13.5
6	Cs-137	2	54.1	0.5	13.5
7					
8	Copper (29)				
9	Cu-64	5	135	0.9	24.3
10	Cu-67	9	243	0.9	24.3
11					
12	Dysprosium (66)				
13	Dy-159	20	541	20	541
14	Dy-165	0.6	16.2	0.5	13.5
15	Dy-166	0.3	8.11	0.3	8.11
16					
17	Erbium (68)				
18	Er-169	40	1,080	0.9	24.3
19	Er-171	0.6	16.2	0.5	13.5
20					
21	Einsteinium (99) ^a				
22	Es-253	200	5,400	2×10^{-2}	5.41×10^{-1}
23	Es-254	30	811	3×10^{-3}	8.11×10^{-2}
24	Es-254m	0.6	16.2	0.4	10.8
25	Es-255	---	---	---	---
26					
27	Europium (63)				
28	Eu-147	2	54.1	2	54.1
29	Eu-148	0.5	13.5	0.5	13.5
30	Eu-149	20	541	20	541
31	Eu-150	0.7	18.9	0.7	18.9
32	Eu-152m	0.6	16.2	0.5	13.5
33	Eu-152	0.9	24.3	0.9	24.3
34	Eu-154	0.8	21.6	0.5	13.5
35	Eu-155	20	541	2	54.1
36	Eu-156	0.6	16.2	0.5	13.5
37					
38	Fluorine (9)				
39	F-18	1	27.0	0.5	13.5
40					
41	Iron (26)				
42	Fe-52	0.2	5.41	0.2	5.41
43	Fe-55	40	1,080	40	1,080
44	Fe-59	0.8	21.6	0.8	21.6
45	Fe-60	40	1,080	0.2	5.41
46					
47	Fermium (100) ^b				
48	Fm-255	40	1,080	0.8	21.6
49	Fm-257	10	270	8×10^{-3}	2.16×10^{-1}
50					
51	Gallium (31)				
52	Ga-67	6	162	6	162
53	Ga-68	0.3	8.11	0.3	8.11
54	Ga-72	0.4	10.8	0.4	10.8

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1					
2	Gadolinium (64)				
3	Gd-146	0.4	10.8	0.4	10.8
4	Gd-148	3	81.1	3×10^{-4}	8.11×10^{-3}
5	Gd-153	10	270	5	135
6	Gd-159	4	108	0.5	13.5
7					
8	Germanium (32)				
9	Ge-68	0.3	8.11	0.3	8.11
10	Ge-71	40	1,080	40	1,080
11	Ge-77	0.3	8.11	0.3	8.11
12					
13	Hydrogen (1)				
14	H-3	See			
15		T-Tritium ---		---	---
16					
17	Hafnium (72)				
18	Hf-172	0.5	13.5	0.3	8.11
19	Hf-175	3	81.1	3	81.1
20	Hf-181	2	54.1	0.9	24.3
21	Hf-182	4	108	3×10^{-2}	0.811
22					
23	Mercury (80)				
24	Hg-194	1	27.0	1	27.0
25	Hg-195m	5	135	5	135
26	Hg-197m	10	270	0.9	24.3
27	Hg-197	10	270	10	270
28	Hg-203	4	108	0.9	24.3
29					
30	Holmium (67)				
31	Ho-163	40	1,080	40	1,080
32	Ho-166m	0.6	16.2	0.3	8.11
33	Ho-166	0.3	8.11	0.3	8.11
34					
35	Iodine (53)				
36	I-123	6	162	6	162
37	I-124	0.9	24.3	0.9	24.3
38	I-125	20	541	2	54.1
39	I-126	2	54.1	0.9	24.3
40	I-129	Unlimited	Unlimited	Unlimited	Unlimited
41	I-131	3	81.1	0.5	13.5
42	I-132	0.4	10.8	0.4	10.8
43	I-133	0.6	16.2	0.5	13.5
44	I-134	0.3	8.11	0.3	8.11
45	I-135	0.6	16.2	0.5	13.5
46					
47	Indium (49)				
48	In-111	2	54.1	2	54.1
49	In-113m	4	108	4	108
50	In-114m	0.3	8.11	0.3	8.11
51	In-115m	6	162	0.9	24.3
52					
53	Iridium (77)				
54	Ir-189	10	270	10	270

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1	Ir-190	0.7	18.9	0.7	18.9
2	Ir-192	1	27.0	0.5	13.5
3	Ir-193m	10	270	10	270
4	Ir-194	0.2	5.41	0.2	5.41
5					
6	Potassium (19)				
7	K-40	0.6	16.2	0.6	16.2
8	K-42	0.2	5.41	0.2	5.41
9	K-43	1.0	27.0	0.5	13.5
10					
11	Krypton (36)				
12	Kr-81	40	1,080	40	1,080
13	Kr-85m	6	162	6	162
14	Kr-85	20	541	10	270
15	Kr-87	0.2	5.41	0.2	5.41
16					
17	Lanthanum (57)				
18	La-137	40	1,080	2	54.1
19	La-140	0.4	10.8	0.4	10.8
20					
21	Lutetium (71)				
22	Lu-172	0.5	13.5	0.5	13.5
23	Lu-173	8	216	8	216
24	Lu-174m	20	541	8	216
25	Lu-174	8	216	4	108
26	Lu-177	30	811	0.9	24.3
27					
28	MFP (mixed				
29	fission				
30	products) ^c				
31					
32	Magnesium (12)				
33	Mg-28	0.2	5.41	0.2	5.41
34					
35	Manganese (25)				
36	Mn-52	0.3	8.11	0.3	8.11
37	Mn-53	Unlimited	Unlimited	Unlimited	Unlimited
38	Mn-54	1	27.0	1	27.0
39	Mn-56	0.2	5.41	0.2	5.41
40					
41	Molybdenum (42)				
42	Mo-93	40	1,080	7	189 ^d
43	Mo-99	0.6	16.2	0.5	13.5 ^d
44					
45	Nitrogen (7)				
46	N-13	0.6	16.2	0.5	13.5
47					
48	Sodium (11)				
49	Na-22	0.5	13.5	0.5	13.5
50	Na-24	0.2	5.41	0.2	5.41
51					
52	Niobium (41)				
53	Nb-92m	0.7	18.9	0.7	18.9
54	Nb-93m	40	1,080	6	162

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1	Nb-94	0.6	16.2	0.6	16.2
2	Nb-95	1	27.0	1	27.0
3	Nb-97	0.6	16.2	0.5	13.5
4					
5	Neodymium (60)				
6	Nd-147	4	108	0.5	13.5
7	Nd-149	0.6	16.2	0.5	13.5
8					
9	Nickel (28)				
10	Ni-59	40	1,080	40	1,080
11	Ni-63	40	1,080	30	811
12	Ni-65	0.3	8.11	0.3	8.11
13					
14	Neptunium (93)				
15	Np-235	40	1,080	40	1,080
16	Np-236	7	189	1×10^{-3}	2.70×10^{-2}
17	Np-237	2	54.1	2×10^{-4}	5.41×10^{-3}
18	Np-239	6	162	0.5	13.5
19					
20	Osmium (76)				
21	Os-185	1	27.0	1	27.0
22	Os-191m	40	1,080	40	1,080
23	Os-191	10	270	0.9	24.3
24	Os-193	0.6	16.2	0.5	13.5
25	Os-194	0.2	5.41	0.2	5.41
26					
27	Phosphorus (15)				
28	P-32	0.3	8.11	0.3	8.11
29	P-33	40	1,080	0.9	24.3
30					
31	Protactinium (91)				
32	Pa-230	2	54.1	0.1	2.70
33	Pa-231	0.6	16.2	6×10^{-5}	1.62×10^{-3}
34	Pa-233	5	135	0.9	24.3
35					
36	Lead (82)				
37	Pb-201	1	27.0	1	27.0
38	Pb-202	40	1,080	2	54.1
39	Pb-203	3	81.1	3	81.1
40	Pb-205	Unlimited	Unlimited	Unlimited	Unlimited
41	Pb-210	0.6	16.2	9×10^{-3}	0.243
42	Pb-212	0.3	8.11	0.3	8.11
43					
44	Palladium (46)				
45	Pd-103	40	1,080	40	1,080
46	Pd-107	Unlimited	Unlimited	Unlimited	Unlimited
47	Pd-109	0.6	16.2	0.5	13.5
48					
49	Promethium (61)				
50	Pm-143	3	81.1	3	81.1
51	Pm-144	0.6	16.2	0.6	16.2
52	Pm-145	30	811	7	189
53	Pm-147	40	1,080	0.9	24.3
54	Pm-148m	0.5	13.5	0.5	13.5

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1	Pm-149	0.6	16.2	0.5	13.5
2	Pm-151	3	81.1	0.5	13.5
3					
4	Polonium (84)				
5	Po-208	40	1,080	2×10^{-2}	0.541
6	Po-209	40	1,080	2×10^{-2}	0.541
7	Po-210	40	1,080	2×10^{-2}	0.541
8					
9	Praseodymium (59)				
10	Pr-142	0.2	5.41	0.2	5.41
11	Pr-143	4	108	0.5	13.5
12					
13	Platinum (78)				
14	Pt-188	0.6	16.2	0.6	16.2
15	Pt-191	3	81.1	3	81.1
16	Pt-193m	40	1,080	9	243
17	Pt-193	40	1,080	40	1,080
18	Pt-195m	10	270	2	54.1
19	Pt-197m	10	270	0.9	24.3
20	Pt-197	20	541	0.5	13.5
21					
22	Plutonium (94)				
23	Pu-236	7	189	7×10^{-4}	1.89×10^{-2}
24	Pu-237	20	541	20	541
25	Pu-238	2	54.1	2×10^{-4}	5.41×10^{-3}
26	Pu-239	2	54.1	2×10^{-4}	5.41×10^{-3}
27	Pu-240	2	54.1	2×10^{-4}	5.41×10^{-3}
28	Pu-241	40	1,080	1×10^{-2}	0.270
29	Pu-242	2	54.1	2×10^{-4}	5.41×10^{-3}
30	Pu-244	0.3	8.11	2×10^{-4}	5.41×10^{-3}
31					
32	Radium (88)				
33	Ra-223	0.6	16.2	3×10^{-2}	0.811
34	Ra-224	0.3	8.11	6×10^{-2}	1.62
35	Ra-225	0.6	16.2	2×10^{-2}	0.541
36	Ra-226	0.3	8.11	2×10^{-2}	0.541
37	Ra-228	0.6	16.2	4×10^{-2}	1.08
38					
39	Rubidium (37)				
40	Rb-81	2	54.1	0.9	24.3
41	Rb-83	2	54.1	2	54.1
42	Rb-84	1	27.0	0.9	24.3
43	Rb-86	0.3	8.11	0.3	8.11
44	Rb-87	Unlimited	Unlimited	Unlimited	Unlimited
45	Rb (natural)	Unlimited	Unlimited	Unlimited	Unlimited
46					
47	Rhenium (75)				
48	Re-183	5	135	5	135
49	Re-184m	3	81.1	3	81.1
50	Re-184	1	27.0	1	27.0
51	Re-186	4	108	0.5	13.5
52	Re-187	Unlimited	Unlimited	Unlimited	Unlimited
53	Re-188	0.2	5.41	0.2	5.41
54	Re-189	4	108	0.5	13.5

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1	Re (natural)	Unlimited	Unlimited	Unlimited	Unlimited
2					
3	Rhodium (45)				
4	Rh-99	2	54.1	2	54.1
5	Rh-101	4	108	4	108
6	Rh-102m	2	54.1	0.9	24.3
7	Rh-102	0.5	13.5	0.5	13.5
8	Rh-103m	40	1,080	40	1,080
9	Rh-105	10	270	0.9	24.3
10					
11	Radon (86)				
12	Rn-222	0.2	5.41	4×10^{-3}	0.108
13					
14	Ruthenium (44)				
15	Ru-97	4	108	4	108
16	Ru-103	2	54.1	0.9	24.3
17	Ru-105	0.6	16.2	0.5	13.5
18	Ru-106	0.2	5.41	0.2	5.41
19					
20	Sulfur (16)				
21	S-35	40	1,080	2	54.1
22					
23	Antimony (51)				
24	Sb-122	0.3	8.11	0.3	8.11
25	Sb-124	0.6	16.2	0.5	13.5
26	Sb-125	2	54.1	0.9	24.3
27	Sb-126	0.4	10.8	0.4	10.8
28					
29	Scandium (21)				
30	Sc-44	0.5	13.5	0.5	13.5
31	Sc-46	0.5	13.5	0.5	13.5
32	Sc-47	9	243	0.9	24.3
33	Sc-48	0.3	8.11	0.3	8.11
34					
35	Selenium (34)				
36	Se-75	3	81.1	3	81.1
37	Se-79	40	1,080	2	54.1
38					
39	Silicon (14)				
40	Si-31	0.6	16.2	0.5	13.5
41	Si-32	40	1,080	0.2	5.41
42					
43	Samarium (62)				
44	Sm-145	20	541	20	541
45	Sm-147	Unlimited	Unlimited	Unlimited	Unlimited
46	Sm-151	40	1,080	4	108
47	Sm-153	4	108	0.5	13.5
48					
49	Tin (50)				
50	Sn-113	4	108	4	108
51	Sn-117m	6	162	24	54.1
52	Sn-119m	40	1,080	40	1,080
53	Sn-121m	40	1,080	0.9	24.3
54	Sn-123	0.6	16.2	0.5	13.5

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1	Sn-125	0.2	5.41	0.2	5.41
2	Sn-126	0.3	8.11	0.3	8.11
3					
4	Strontium (38)				
5	Sr-82	0.2	5.41	0.2	5.41
6	Sr-85m	5	135	5	135
7	Sr-85	2	54.1	2	54.1
8	Sr-87m	3	81.1	3	81.1
9	Sr-89	0.6	16.2	0.5	13.5
10	Sr-90	0.2	5.41	0.1	2.70
11	Sr-91	0.3	8.11	0.3	8.11
12	Sr-92	0.8	21.6	0.5	13.5
13					
14	Tritium (1)				
15	T	40	1,080	40	1,080
16					
17	Tantalum (73)				
18	Ta-178	1	27.0	1	27.0
19	Ta-179	30	811	30	811
20	Ta-182	0.8	21.6	0.5	13.5
21					
22	Terbium (65)				
23	Tb-157	40	1,080	10	270
24	Tb-158	1	27.0	0.7	18.9
25	Tb-160	0.9	24.3	0.5	13.5
26					
27	Technetium (43)				
28	Tc-95m	2	54.1	2	54.1
29	Tc-96m	0.4	10.8	0.4	10.8
30	Tc-96	0.4	10.8	0.4	10.8
31	Tc-97m	40	1,080	40	1,080
32	Tc-97	Unlimited	Unlimited	Unlimited	Unlimited
33	Tc-98	0.7	18.9	0.7	18.9
34	Tc-99m	8	216	8	216
35	Tc-99	40	1,080	0.9	24.3
36					
37	Tellurium (52)				
38	Te-118	0.2	5.41	0.2	5.41
39	Te-121m	5	135	5	135
40	Te-121	2	5.41	2	5.41
41	Te-123m	7	189	7	189
42	Te-125m	30	811	9	243
43	Te-127m	20	541	0.5	13.5
44	Te-127	20	541	0.5	13.5
45	Te-129m	0.6	16.2	0.5	13.5
46	Te-129	0.6	16.2	0.5	13.5
47	Te-131m	0.7	18.9	0.5	13.5
48	Te-132	0.4	10.8	0.4	10.8
49					
50	Thorium (90)				
51	Th-227	9	243	1×10^{-2}	0.270
52	Th-228	0.3	8.11	4×10^{-4}	1.08×10^{-2}
53	Th-229	0.3	8.11	3×10^{-5}	8.11×10^{-3}
54	Th-230	2	54.1	2×10^{-4}	5.41×10^{-3}

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1	Th-231	40	1,080	0.9	24.3
2	Th-232	Unlimited	Unlimited	Unlimited	Unlimited
3	Th-234	0.2	5.41	0.2	5.41
4	Th (natural)	Unlimited	Unlimited	Unlimited	Unlimited
5					
6	Titanium (22)				
7	Ti-44	0.5	13.5	0.2	5.41
8					
9	Thallium (81)				
10	Tl-200	0.8	21.6	0.8	21.6
11	Tl-201	10	270	10	270
12	Tl-202	2	54.1	2	54.1
13	Tl-204	4	108	0.5	13.5
14					
15	Thulium (69)				
16	Tm-167	7	189	7	189
17	Tm-168	0.8	21.6	0.8	21.6
18	Tm-170	4	108	0.5	13.5
19	Tm-171	40	1,080	10	270
20					
21	Uranium (92)				
22	U-230	40	1,080	1×10^{-2}	0.270
23	U-232	3	81.1	3×10^{-4}	8.11×10^{-3}
24	U-233	10	270	1×10^{-3}	2.70×10^{-2}
25	U-234	10	270	1×10^{-3}	2.70×10^{-2}
26	U-235	Unlimited	Unlimited	Unlimited	Unlimited
27	U-236	10	270	1×10^{-3}	2.70×10^{-2}
28	U-238	Unlimited	Unlimited	Unlimited	Unlimited
29	U (natural)	Unlimited	Unlimited	Unlimited	Unlimited
30	U (enriched 5% or less)	Unlimited	Unlimited	Unlimited	Unlimited
31	U (enriched more than 5%)	10	270	1×10^{-3}	2.70×10^{-2}
32	U (depleted)	Unlimited	Unlimited	Unlimited	Unlimited
33					
34	Vanadium (23)				
35	V-48	0.3	8.11	0.3	8.11
36	V-49	40	1,080	40	1,080
37					
38	Tungsten (74)				
39	W-178	1	27.0	1	27.0
40	W-181	30	811	30	811
41	W-185	40	1,080	0.9	24.3
42	W-187	2	54.1	0.5	13.5
43	W-188	0.2	5.41	0.2	5.41
44					
45	Xenon (54)				
46	Xe-122	0.2	5.41	0.2	5.41
47	Xe-123	0.2	5.41	0.2	5.41
48	Xe-127	4	108	4	108
49	Xe-131m	40	1,080	40	1,080
50	Xe-133	20	541	20	541
51	Xe-135	4	108	4	108
52					
53					
54					

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1	Yttrium (39)				
2	Y-87	2	54.1	2	54.1
3	Y-88	0.4	10.8	0.4	10.8
4	Y-90	0.2	5.41	0.2	5.41
5	Y-91m	2	54.1	2	54.1
6	Y-91	0.3	8.11	0.3	8.11
7	Y-92	0.2	5.41	0.2	5.41
8	Y-93	0.2	5.41	0.2	5.41
9					
10	Ytterbium (70)				
11	Yb-169	3	81.1	3	81.1
12	Yb-175	30	811	.09	24.3
13					
14	Zinc (30)				
15	Zn-65	2	54.1	2	54.1
16	Zn-69m	2	54.1	0.5	13.5
17	Zn-69	4	108	0.5	13.5
18					
19	Zirconium (40)				
20	Zr-88	3	81.1	3	81.1
21	Zr-93	40	1,080	0.2	5.41
22	Zr-95	1	27.0	0.9	24.3
23	Zr-97	0.3	8.11	0.3	8.11

24
25 ^aInternational shipments of Einsteinium require

26 multilateral approval of A₁ and A₂ values.

27 ^bInternational shipments of Fermium require multilateral
28 approval of A₁ and A₂ values.

29 ^cFor mixed fission products, use formula for mixtures or
30 part 4731.0423.

31 ^d20 Ci for Mo-99 for domestic use.

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

34 Element and Atomic
35 Number and

36 Symbol of
37 Radionuclide Specific Activity
38 (Tbq/g) (Ci/g)

39	Actinium (89)		
40	Ac-225	2.1 x 10 ³	5.8 x 10 ⁴
41	Ac-227	2.7	7.2 x 10 ¹
42	Ac-228	8.4 x 10 ⁴	2.2 x 10 ⁶
43			
44	Silver (47)		

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1	Ag-105	1.1×10^3	3.0×10^4
2	Ag-108m	9.7×10^{-1}	2.6×10^1
3	Ag-110m	1.8×10^2	4.7×10^3
4	Ag-111	5.8×10^3	1.6×10^5
5			
6	Aluminum (13)		
7	Al-26	7.0×10^{-4}	1.9×10^{-2}
8			
9	Americium (95)		
10	Am-241	1.3×10^{-1}	3.4
11	Am-242m	3.6×10^{-1}	1.0×10^1
12	Am-243	7.4×10^{-3}	2.0×10^{-1}
13			
14	Argon (18)		
15	Ar-37	3.7×10^3	9.9×10^4
16	Ar-39	1.3	3.4×10^1
17	Ar-41	1.5×10^6	4.2×10^2
18	Ar-42	9.6	2.6×10^2
19			
20	Arsenic (33)		
21	As-72	6.2×10^4	1.7×10^6
22	As-73	8.2×10^2	2.2×10^4
23	As-74	3.7×10^3	9.9×10^4
24	As-76	5.8×10^4	1.6×10^6
25	As-77	3.9×10^4	1.0×10^6
26			
27	Astatine (85)		
28	At-211	7.6×10^4	2.1×10^6
29			
30	Gold (79)		
31	Au-193	3.4×10^4	9.2×10^5
32	Au-194	1.5×10^2	4.1×10^3
33	Au-195	1.4×10^3	3.7×10^5
34	Au-196	4.0×10^3	1.1×10^5
35	Au-198	9.0×10^3	2.4×10^5
36	Au-199	7.7×10^3	2.1×10^5
37			
38	Barium (56)		
39	Ba-131	3.1×10^3	8.4×10^4
40	Ba-133m	2.2×10^4	6.1×10^5
41	Ba-133	9.4	2.6×10^2
42	Ba-140	2.7×10^3	7.3×10^4
43			
44	Beryllium (4)		
45	Be-7	1.3×10^4	3.5×10^5
46	Be-10	8.3×10^{-4}	2.2×10^{-2}
47			
48	Bismuth (83)		
49	Bi-205	1.5×10^{-3}	4.2×10^4
50	Bi-206	3.8×10^3	1.0×10^5
51	Bi-207	1.9	5.2×10^1
52	Bi-210m	2.1×10^{-5}	5.7×10^{-4}
53	Bi-210	4.6×10^3	1.2×10^5
54	Bi-212	5.4×10^5	1.5×10^7

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1			
2	Berkelium (97)		
3	Bk-247	3.8×10^{-2}	1.0
4	Bk-249	6.1×10^{-1}	1.6×10^3
5			
6	Bromine (35)		
7	Br-76	9.4×10^4	2.5×10^6
8	Br-77	2.6×10^4	7.1×10^5
9	Br-82	4.0×10^4	1.1×10^6
10			
11	Carbon (6)		
12	C-11	3.1×10^{-7}	8.4×10^8
13	C-14	1.6×10^{-1}	4.5
14			
15	Calcium (20)		
16	Ca-41	3.1×10^{-3}	8.5×10^{-2}
17	Ca-45	6.6×10^2	1.8×10^4
18	Ca-47	2.3×10^4	6.1×10^5
19			
20	Cadmium (48)		
21	Cd-109	9.6×10^1	2.6×10^3
22	Cd-113m	8.3	2.2×10^2
23	Cd-115m	9.4×10^2	2.5×10^4
24	Cd-115	1.9×10^4	5.1×10^5
25			
26	Cerium (58)		
27	Ce-139	2.5×10^2	6.8×10^3
28	Ce-141	1.1×10^3	2.8×10^4
29	Ce-143	2.5×10^4	6.6×10^5
30	Ce-144	1.2×10^2	3.2×10^3
31			
32	Californium (98)		
33	Cf-248	5.8×10^1	1.6×10^3
34	Cf-249	1.5×10^{-1}	4.1
35	Cf-250	4.0	1.1×10^2
36	Cf-251	5.9×10^{-2}	1.6
37	Cf-252	2.0×10^1	5.4×10^2
38	Cf-253	1.1×10^3	2.9×10^4
39	Cf-254	3.1×10^2	8.5×10^3
40			
41	Chlorine (17)		
42	Cl-36	1.2×10^{-3}	3.3×10^{-2}
43	Cl-38	4.9×10^6	1.3×10^8
44			
45	Curium (96)		
46	Cm-240	7.5×10^2	2.0×10^4
47	Cm-241	6.1×10^2	1.7×10^4
48	Cm-242	1.2×10^2	3.3×10^3
49	Cm-243	1.9×10^{-3}	5.2×10^1
50	Cm-244	3.0	8.1×10^1
51	Cm-245	6.4×10^{-3}	1.7×10^{-1}
52	Cm-246	1.1×10^{-2}	3.1×10^{-1}
53	Cm-247	3.4×10^{-6}	9.3×10^{-5}
54	Cm-248	1.6×10^{-5}	4.2×10^{-3}

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1			
2	Cobalt (27)		
3	Co-55	1.1×10^5	3.1×10^6
4	Co-56	1.1×10^3	3.0×10^4
5	Co-57	3.1×10^2	8.4×10^3
6	Co-58m	2.2×10^5	5.9×10^6
7	Co-58	1.2×10^3	3.2×10^4
8	Co-60	4.2×10^1	1.1×10^3
9			
10	Chromium (24)		
11	Cr-51	3.4×10^3	9.2×10^4
12			
13	Cesium (55)		
14	Cs-129	2.8×10^4	7.6×10^5
15	Cs-131	3.8×10^3	1.0×10^5
16	Cs-132	5.7×10^3	1.5×10^5
17	Cs-134m	3.0×10^5	8.0×10^6
18	Cs-134	4.8×10^{-5}	1.3×10^{-3}
19	Cs-135	4.3×10^3	1.2×10^4
20	Cs-136	2.7×10^3	7.3×10^1
21	Cs-137	3.2	8.7×10^1
22			
23	Copper (29)		
24	Cu-64	1.4×10^5	3.9×10^6
25	Cu-67	2.8×10^4	7.6×10^5
26			
27	Dysprosium (66)		
28	Dy-159	2.1×10^2	5.7×10^3
29	Dy-165	3.0×10^5	8.2×10^6
30	Dy-166	8.6×10^3	2.3×10^5
31			
32	Erbium (68)		
33	Er-169	3.1×10^3	8.3×10^4
34	Er-171	9.0×10^4	2.4×10^6
35			
36	Einsteinium (99) ^a		
37	Es-253	---	---
38	Es-254	---	---
39	Es-254m	---	---
40	Es-255	---	---
41			
42	Europium (63)		
43	Eu-147	1.4×10^3	3.7×10^4
44	Eu-148	6.0×10^2	1.6×10^4
45	Eu-149	3.5×10^2	9.4×10^3
46	Eu-150	6.1×10^4	1.6×10^6
47	Eu-152m	8.2×10^4	2.2×10^6
48	Eu-152	6.5	1.8×10^2
49	Eu-154	9.8	2.6×10^2
50	Eu-155	1.8×10^1	4.9×10^2
51	Eu-156	2.0×10^3	5.5×10^4
52			
53	Fluorine (9)		
54	F-18	3.5×10^6	9.5×10^7

1			
2	Iron (26)		
3	Fe-52	2.7×10^5	7.3×10^6
4	Fe-55	8.8×10^1	2.4×10^3
5	Fe-59	1.8×10^3	5.0×10^4
6	Fe-60	7.4×10^{-4}	2.0×10^{-2}
7			
8	Fermium (100) ^b		
9	Fm-255	---	---
10	Fm-257	---	---
11			
12	Gallium (31)		
13	Ga-67	2.2×10^4	6.0×10^5
14	Ga-68	1.5×10^6	4.1×10^7
15	Ga-72	1.1×10^5	3.1×10^6
16			
17	Gadolinium (64)		
18	Gd-146	6.9×10^2	1.9×10^4
19	Gd-148	1.2	3.2×10^1
20	Gd-153	1.3×10^2	3.5×10^3
21	Gd-159	3.9×10^4	1.1×10^6
22			
23	Germanium (32)		
24	Ge-68	2.6×10^2	7.1×10^3
25	Ge-71	5.8×10^3	1.6×10^5
26	Ge-77	1.3×10^5	3.6×10^6
27			
28	Hydrogen (1)		
29	H-3	---	---
30			
31	Hafnium (72)		
32	Hf-172	4.1×10^1	1.1×10^3
33	Hf-175	3.9×10^2	1.1×10^4
34	Hf-181	6.3×10^2	1.7×10^4
35	Hf-182	8.1×10^{-6}	2.2×10^{-4}
36			
37	Mercury (80)		
38	Hg-194	1.3×10^{-1}	3.5
39	Hg-195m	1.5×10^4	4.0×10^5
40	Hg-197m	2.5×10^4	6.7×10^5
41	Hg-197	9.2×10^3	2.5×10^5
42	Hg-203	5.1×10^2	1.4×10^4
43			
44	Holmium (67)		
45	Ho-163	2.7	7.6×10^1
46	Ho-166m	6.6×10^{-2}	1.8
47	Ho-166	2.6×10^4	7.0×10^5
48			
49	Iodine (53)		
50	I-123	7.1×10^4	1.9×10^6
51	I-124	9.3×10^3	2.5×10^5
52	I-125	6.4×10^2	1.7×10^4
53	I-126	2.9×10^3	8.0×10^4
54	I-129	6.5×10^{-6}	1.8×10^{-4}

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1	I-131	4.6×10^3	1.2×10^5
2	I-132	3.8×10^5	1.0×10^7
3	I-133	4.2×10^4	1.1×10^6
4	I-134	9.9×10^5	2.7×10^7
5	I-135	1.3×10^5	3.5×10^6
6			
7	Indium (49)		
8	In-111	1.5×10^4	4.2×10^5
9	In-113m	6.2×10^5	1.7×10^7
10	In-114m	8.6×10^2	2.3×10^4
11	In-115m	2.2×10^5	6.1×10^6
12			
13	Iridium (77)		
14	Ir-189	1.9×10^3	5.2×10^4
15	Ir-190	2.3×10^3	6.2×10^4
16	Ir-192	3.4×10^2	9.2×10^3
17	Ir-193m	2.4×10^3	6.4×10^4
18	Ir-194	3.1×10^4	8.4×10^5
19			
20	Potassium (19)		
21	K-40	2.4×10^{-7}	6.4×10^{-6}
22	K-42	2.2×10^5	6.0×10^6
23	K-43	1.2×10^5	3.3×10^6
24			
25	Krypton (36)		
26	Kr-81	7.8×10^{-4}	2.1×10^{-2}
27	Kr-85m	3.0×10^5	8.2×10^6
28	Kr-85	1.5×10^1	3.9×10^2
29	Kr-87	1.0×10^6	2.8×10^7
30			
31	Lanthanum (57)		
32	La-137	1.6×10^{-3}	4.4×10^{-2}
33	La-140	2.1×10^4	5.6×10^5
34			
35	Lutetium (71)		
36	Lu-172	4.2×10^3	1.1×10^5
37	Lu-173	5.6×10^1	1.5×10^3
38	Lu-174m	2.0×10^2	5.3×10^3
39	Lu-174	2.3×10^1	6.2×10^2
40	Lu-177	4.1×10^3	1.1×10^5
41			
42	MFP (mixed		
43	fission		
44	products) ^c		
45			
46	Magnesium (12)		
47	Mg-28	2.0×10^5	5.4×10^6
48			
49	Manganese (25)		
50	Mn-52	1.6×10^4	4.4×10^5
51	Mn-53	6.8×10^{-5}	1.8×10^{-3}
52	Mn-54	2.9×10^2	7.7×10^3
53	Mn-56	8.0×10^5	2.2×10^7
54			

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1	Molybdenum (42)		
2	Mo-93	4.1×10^{-2}	1.1
3	Mo-99	1.8×10^4	4.8×10^5
4			
5	Nitrogen (7)		
6	N-13	5.4×10^7	1.5×10^9
7			
8	Sodium (11)		
9	Na-22	2.3×10^2	6.3×10^3
10	Na-24	3.2×10^5	8.7×10^6
11			
12	Niobium (41)		
13	Nb-92m	5.2×10^3	1.4×10^5
14	Nb-93m	8.8	2.4×10^2
15	Nb-94	6.9×10^{-3}	1.9×10^{-1}
16	Nb-95	1.5×10^3	3.9×10^4
17	Nb-97	9.9×10^5	2.7×10^7
18			
19	Neodymium (60)		
20	Nd-147	3.0×10^3	8.1×10^4
21	Nd-149	4.5×10^5	1.2×10^7
22			
23	Nickel (28)		
24	Ni-59	3.0×10^{-3}	8.0×10^{-2}
25	Ni-63	2.1	5.7×10^1
26	Ni-65	7.1×10^5	1.9×10^7
27			
28	Neptunium (93)		
29	Np-235	5.2×10^1	1.4×10^3
30	Np-236	4.7×10^{-4}	1.3×10^{-2}
31	Np-237	2.6×10^{-5}	7.1×10^{-4}
32	Np-239	8.6×10^3	2.3×10^5
33			
34	Osmium (76)		
35	Os-185	2.8×10^2	7.5×10^3
36	Os-191m	4.6×10^4	1.3×10^6
37	Os-191	1.6×10^3	4.4×10^4
38	Os-193	2.0×10^4	5.3×10^5
39	Os-194	1.1×10^1	3.1×10^2
40			
41	Phosphorus (15)		
42	P-32	1.1×10^4	2.9×10^5
43	P-33	5.8×10^3	1.6×10^5
44			
45	Protactinium (91)		
46	Pa-230	1.2×10^3	3.3×10^4
47	Pa-231	1.7×10^{-3}	4.7×10^{-2}
48	Pa-233	7.7×10^2	2.1×10^4
49			
50	Lead (82)		
51	Pb-201	6.2×10^4	1.7×10^6
52	Pb-202	1.2×10^{-4}	3.4×10^{-3}
53	Pb-203	1.1×10^4	3.0×10^5
54	Pb-205	4.5×10^{-6}	1.2×10^{-4}

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1	Pb-210	2.8	7.6×10^1
2	Pb-212	5.1×10^4	1.4×10^6
3			
4	Palladium (46)		
5	Pd-103	2.8×10^3	7.5×10^4
6	Pd-107	1.9×10^{-5}	5.1×10^{-4}
7	Pd-109	7.9×10^4	2.1×10^6
8			
9	Promethium (61)		
10	Pm-143	1.3×10^2	3.4×10^3
11	Pm-144	9.2×10^1	2.5×10^2
12	Pm-145	5.2	1.4×10^2
13	Pm-147	3.4×10^1	9.3×10^2
14	Pm-148m	7.9×10^2	2.1×10^4
15	Pm-149	1.5×10^4	4.0×10^5
16	Pm-151	2.7×10^4	7.3×10^5
17			
18	Polonium (84)		
19	Po-208	2.2×10^1	5.9×10^2
20	Po-209	6.2×10^{-1}	1.7×10^1
21	Po-210	1.7×10^2	4.5×10^3
22			
23	Praseodymium (59)		
24	Pr-142	4.3×10^4	1.2×10^6
25	Pr-143	2.5×10^3	6.7×10^4
26			
27	Platinum (78)		
28	Pt-188	2.5×10^3	6.8×10^4
29	Pt-191	8.7×10^3	2.4×10^5
30	Pt-193m	5.8×10^3	1.6×10^5
31	Pt-193	1.4	3.7×10^1
32	Pt-195m	6.2×10^3	1.7×10^5
33	Pt-197m	3.7×10^5	1.0×10^7
34	Pt-197	3.2×10^4	8.7×10^5
35			
36	Plutonium (94)		
37	Pu-236	2.0×10^1	5.3×10^2
38	Pu-237	4.5×10^2	1.2×10^4
39	Pu-238	6.3×10^{-1}	1.7×10^1
40	Pu-239	2.3×10^{-3}	6.2×10^{-2}
41	Pu-240	8.4×10^{-3}	2.3×10^{-1}
42	Pu-241	3.8	1.0×10^2
43	Pu-242	1.5×10^{-4}	3.9×10^{-3}
44	Pu-244	6.7×10^{-7}	1.8×10^{-5}
45			
46	Radium (88)		
47	Ra-223	1.9×10^3	5.1×10^4
48	Ra-224	5.9×10^3	1.6×10^5
49	Ra-225	1.5×10^3	3.9×10^4
50	Ra-226	3.7×10^{-2}	1.0
51	Ra-228	1.0×10^1	2.7×10^2
52			
53	Rubidium (37)		
54	Rb-81	3.1×10^5	8.4×10^6

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1	Rb-83	6.8×10^2	1.8×10^4
2	Rb-84	1.8×10^3	4.7×10^4
3	Rb-86	3.0×10^3	8.1×10^{-8}
4	Rb-87	3.2×10^{-9}	8.6×10^8
5	Rb (natural)	6.7×10^6	1.8×10^8
6			
7	Rhenium (75)		
8	Re-183	3.8×10^2	1.0×10^4
9	Re-184m	1.6×10^2	4.3×10^3
10	Re-184	6.9×10^2	1.9×10^4
11	Re-186	6.9×10^3	1.9×10^5
12	Re-187	1.4×10^{-9}	3.8×10^{-8}
13	Re-188	3.6×10^4	9.8×10^5
14	Re-189	2.5×10^4	6.8×10^5
15	Re (natural)	---	2.4×10^{-8}
16			
17	Rhodium (45)		
18	Rh-99	3.0×10^3	8.2×10^4
19	Rh-101	4.1×10^1	1.1×10^3
20	Rh-102m	2.3×10^2	6.2×10^3
21	Rh-102	4.5×10^1	1.2×10^3
22	Rh-103m	1.2×10^6	3.3×10^7
23	Rh-105	3.1×10^4	8.4×10^5
24			
25	Radon (86)		
26	Rn-222	5.7×10^3	1.5×10^5
27			
28	Ruthenium (44)		
29	Ru-97	1.7×10^4	4.6×10^5
30	Ru-103	1.2×10^3	3.2×10^4
31	Ru-105	2.5×10^5	6.7×10^6
32	Ru-106	1.2×10^2	3.3×10^3
33			
34	Sulfur (16)		
35	S-35	1.6×10^3	4.3×10^4
36			
37	Antimony (51)		
38	Sb-122	1.5×10^4	4.0×10^5
39	Sb-124	6.5×10^2	1.7×10^4
40	Sb-125	3.9×10^1	1.0×10^3
41	Sb-126	3.1×10^3	8.4×10^4
42			
43	Scandium (21)		
44	Sc-44	6.7×10^5	1.8×10^7
45	Sc-46	1.3×10^3	3.4×10^4
46	Sc-47	3.1×10^4	8.3×10^5
47	Sc-48	5.5×10^4	1.5×10^6
48			
49	Selenium (34)		
50	Se-75	5.4×10^2	1.5×10^4
51	Se-79	2.6×10^{-3}	7.0×10^{-2}
52			
53	Silicon (14)		
54	Si-31	1.4×10^6	3.9×10^7

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1	Si-32	3.9	1.1×10^2
2			
3	Samarium (62)		
4	Sm-145	9.8×10^{-1}	2.6×10^3
5	Sm-147	8.5×10^{-1}	2.3×10^{-8}
6	Sm-151	9.7×10^{-1}	2.6×10^1
7	Sm-153	1.6×10^4	4.4×10^5
8			
9	Tin (50)		
10	Sn-113	3.7×10^2	1.0×10^4
11	Sn-117m	3.0×10^3	8.2×10^3
12	Sn-119m	1.4×10^2	3.7×10^3
13	Sn-121m	2.0	5.4×10^1
14	Sn-123	3.0×10^2	8.2×10^3
15	Sn-125	4.0×10^3	1.1×10^5
16	Sn-126	1.0×10^{-3}	2.8×10^{-2}
17			
18	Strontium (38)		
19	Sr-82	2.3×10^3	6.2×10^4
20	Sr-85m	1.2×10^6	3.3×10^7
21	Sr-85	8.8×10^2	2.4×10^4
22	Sr-87m	4.8×10^5	1.3×10^7
23	Sr-89	1.1×10^3	2.9×10^4
24	Sr-90	5.1	1.4×10^2
25	Sr-91	1.3×10^5	3.6×10^6
26	Sr-92	4.7×10^5	1.3×10^7
27			
28	Tritium (1)		
29	T	3.6×10^2	9.7×10^3
30			
31	Tantalum (73)		
32	Ta-178	4.2×10^6	1.1×10^8
33	Ta-179	4.1×10^1	1.1×10^3
34	Ta-182	2.3×10^2	6.2×10^3
35			
36	Terbium (65)		
37	Tb-157	5.6×10^{-1}	1.5×10^1
38	Tb-158	5.6×10^{-1}	1.5×10^1
39	Tb-160	4.2×10^2	1.1×10^4
40			
41	Technetium (43)		
42	Tc-95m	8.3×10^2	2.2×10^4
43	Tc-96m	1.4×10^6	3.8×10^7
44	Tc-96	1.2×10^4	3.2×10^5
45	Tc-97m	5.6×10^2	1.5×10^4
46	Tc-97	5.2×10^{-5}	1.4×10^{-3}
47	Tc-98	3.2×10^{-5}	8.7×10^{-4}
48	Tc-99m	1.9×10^5	5.3×10^6
49	Tc-99	6.3×10^{-4}	1.7×10^{-2}
50			
51	Tellurium (52)		
52	Te-118	6.8×10^3	1.8×10^5
53	Te-121m	2.6×10^2	7.0×10^3
54	Te-121	2.4×10^3	6.4×10^4

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1	Te-123m	3.3×10^2	8.9×10^3
2	Te-125m	6.7×10^2	1.8×10^3
3	Te-127m	3.5×10^4	9.4×10^6
4	Te-127	9.8×10^3	2.6×10^4
5	Te-129m	1.1×10^5	3.0×10^7
6	Te-129	7.7×10^4	2.1×10^5
7	Te-131m	3.0×10^4	8.0×10^5
8	Te-132	1.1×10^4	8.0×10^5
9			
10	Thorium (90)		
11	Th-227	1.1×10^3	3.1×10^4
12	Th-228	3.0×10^1	8.2×10^2
13	Th-229	7.9×10^{-3}	2.1×10^{-1}
14	Th-230	7.6×10^{-4}	2.1×10^{-2}
15	Th-231	2.0×10^4	5.3×10^5
16	Th-232	4.0×10^{-9}	1.1×10^{-7}
17	Th-234	8.6×10^2	2.3×10^4
18	Th (natural)	8.1×10^{-9}	2.2×10^{-7}
19			
20	Titanium (22)		
21	Ti-44	6.4	1.7×10^2
22			
23	Thallium (81)		
24	Tl-200	2.2×10^4	6.0×10^5
25	Tl-201	7.9×10^3	2.1×10^5
26	Tl-202	2.0×10^3	5.3×10^4
27	Tl-204	1.7×10^1	4.6×10^2
28			
29	Thulium (69)		
30	Tm-167	3.1×10^3	8.5×10^4
31	Tm-168	3.1×10^2	8.3×10^3
32	Tm-170	2.2×10^2	6.0×10^3
33	Tm-171	4.0×10^1	1.1×10^3
34			
35	Uranium (92)		
36	U-230	1.0×10^3	2.7×10^4
37	U-232	8.3×10^{-1}	2.2×10^1
38	U-233	3.6×10^{-4}	9.7×10^{-3}
39	U-234	2.3×10^{-4}	6.2×10^{-3}
40	U-235	8.0×10^{-8}	2.2×10^{-6}
41	U-236	2.4×10^{-6}	6.5×10^{-5}
42	U-238	1.2×10^{-8}	3.4×10^{-7}
43	U (natural)	2.6×10^{-8}	7.1×10^{-7}
44	U (enriched 5%		(See part
45	or less)	---	4731.0424)
46	U (enriched		(See part
47	more than 5%)	---	4731.0424)
48	U (depleted)	---	(See part
49			4731.0424)
50			
51	Vanadium (23)		
52	V-48	6.3×10^3	1.7×10^5
53	V-49	3.0×10^2	8.1×10^3
54			

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1	Tungsten (74)		
2	W-178	1.3×10^3	3.4×10^4
3	W-181	2.2×10^2	6.0×10^3
4	W-185	3.5×10^2	9.4×10^3
5	W-187	2.6×10^4	7.0×10^5
6	W-188	3.7×10^2	1.0×10^4
7			
8	Xenon (54)		
9	Xe-122	4.8×10^4	1.3×10^6
10	Xe-123	4.4×10^5	1.2×10^7
11	Xe-127	1.0×10^3	2.8×10^4
12	Xe-131m	3.1×10^3	8.4×10^4
13	Xe-133	6.9×10^3	1.9×10^5
14	Xe-135	9.5×10^4	2.6×10^6
15			
16	Yttrium (39)		
17	Y-87	1.7×10^4	4.5×10^5
18	Y-88	5.2×10^2	1.4×10^4
19	Y-90	2.0×10^4	5.4×10^5
20	Y-91m	1.5×10^6	4.2×10^7
21	Y-91	9.1×10^2	2.5×10^4
22	Y-92	3.6×10^5	9.6×10^6
23	Y-93	1.2×10^5	3.3×10^6
24			
25	Ytterbium (70)		
26	Yb-169	8.9×10^2	2.4×10^4
27	Yb-175	6.6×10^3	1.8×10^5
28			
29	Zinc (30)		
30	Zn-65	3.0×10^2	8.2×10^3
31	Zn-69m	1.2×10^5	3.3×10^6
32	Zn-69	1.8×10^6	4.9×10^7
33			
34	Zirconium (40)		
35	Zr-88	6.6×10^2	1.8×10^4
36	Zr-93	9.3×10^{-5}	2.5×10^{-3}
37	Zr-95	7.9×10^2	2.1×10^4
38	Zr-97	7.1×10^4	1.9×10^6

39
40 ^aInternational shipments of Einsteinium require
41 multilateral approval of A₁ and A₂ values.

42 ^bInternational shipments of Fermium require multilateral
43 approval of A₁ and A₂ values.

44 ^cFor mixed fission products, use formula for mixtures or
45 part 4731.0423.

46 4731.0423 DETERMINATION OF A₁ AND A₂.

1 Subpart 1. Generally. Values of A_1 and A_2 for individual
2 radionuclides, which are the bases for many activity limits
3 elsewhere in this chapter, are given in part 4731.0422. The
4 curie (Ci) values specified are obtained by converting from the
5 Terabecquerel (TBq) figure. The curie values are expressed to
6 three significant figures to ensure that the difference in the
7 TBq and Ci quantities is one-tenth of one percent or less.
8 Where values of A_1 and A_2 are unlimited, it is for radiation
9 control purposes only. For nuclear criticality safety, some
10 materials are subject to controls placed on fissile material.

11 Subp. 2. Individual radionuclides; not listed. For
12 individual radionuclides whose identities are known, but which
13 are not listed in part 4731.0422, the determination of the
14 values of A_1 and A_2 requires commissioner approval, except that
15 the values of A_1 and A_2 in subpart 6 may be used without
16 obtaining commissioner approval.

17 Subp. 3. Radioactive decay chain. In the calculations of
18 A_1 and A_2 for a radionuclide not in part 4731.0422, a single
19 radioactive decay chain, in which radionuclides are present in
20 their naturally occurring proportions and in which no daughter
21 nuclide has a half-life longer than ten days or longer than that
22 of the parent nuclide, shall be considered as a single
23 radionuclide. The activity to be taken into account and the A_1
24 or A_2 value to be applied shall be those corresponding to the
25 parent nuclide of the chain. In the case of radioactive decay
26 chains in which any daughter nuclide has a half-life longer than
27 ten days or greater than that of the parent nuclide, the parent

1 and those daughter nuclides shall be considered as mixtures of
2 different nuclides.

3 Subp. 4. Radionuclide mixture. For mixtures of
4 radionuclides whose identities and respective activities are
5 known, the following conditions apply:

6 A. For special form radioactive material, the maximum
7 quantity transported in a Type A package:

$$\begin{array}{l} 8 \\ 9 \quad \sum B(i) \\ 10 \quad \quad \quad \text{less than or equal to } 1 \\ 11 \quad I \quad \overline{A_1(i)} \\ 12 \end{array}$$

13 where B(i) is the activity of radionuclide I and A₁(i) is the A₁
14 value for radionuclide I.

15 B. For normal form radioactive material, the maximum
16 quantity transported in a Type A package:

$$\begin{array}{l} 17 \\ 18 \quad \sum B(i) \\ 19 \quad \quad \quad \text{less than or equal to } 1 \\ 20 \quad I \quad \overline{A_2(i)} \\ 21 \end{array}$$

22 where B(i) is the activity of radionuclide I and A₂(i) is the A₂
23 value for radionuclide I.

24 C. Alternatively, an A₁ value for mixtures of special
25 form material may be determined as follows:

$$\begin{array}{l} 26 \\ 27 \quad \quad \quad 1 \\ 28 \\ 29 \quad A_1 \text{ for mixture} = \frac{\sum f(i)}{I \overline{A_1(i)}} \\ 30 \\ 31 \\ 32 \end{array}$$

33 where f(i) is the fraction of activity of nuclide I in the
34 mixture and A₁(i) is the appropriate A₁ value for nuclide I.

35 D. An A₂ value for mixtures of normal form material
36 may be determined as follows:

$$A_2 \text{ for mixture} = \frac{\sum f(i)}{\sum A_2(i)}$$

where $f(i)$ is the fraction of activity of nuclide I in the mixture and $A_2(i)$ is the appropriate A_2 value for nuclide I .

Subp. 5. Activities unknown. 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.

Subp. 6. General values for A_1 and A_2 .

Contents	A_1		A_2	
	(Tbq)	(Ci)	(Tbq)	(Ci)
Only beta- or gamma-emitting nuclides are known to be present	0.2	5	0.02	0.5
Alpha-emitting nuclides are known to be present, or no relevant data are available	0.10	2.70	2×10^{-5}	5.41×10^{-4}

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}

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1	0.72	2.6×10^{-8}	7.1×10^{-7}
2	1.0	2.8×10^{-8}	7.6×10^{-7}
3	1.5	3.7×10^{-8}	1.0×10^{-6}
4	5.0	1.0×10^{-7}	2.7×10^{-6}
5	10.0	1.8×10^{-7}	4.8×10^{-6}
6	20.0	3.7×10^{-7}	1.0×10^{-5}
7	35.0	7.4×10^{-7}	2.0×10^{-5}
8	50.0	9.3×10^{-7}	2.5×10^{-5}
9	90.0	2.2×10^{-6}	5.8×10^{-5}
10	93.0	2.6×10^{-6}	7.0×10^{-5}
11	95.0	3.4×10^{-6}	9.1×10^{-5}

12 ¹ The figures for uranium include representative values for
13 the activity of the uranium-234 that is concentrated during the
14 enrichment process.

15 DOMESTIC LICENSING OF SPECIAL NUCLEAR MATERIAL

16 4731.0525 DOMESTIC LICENSING OF SPECIAL NUCLEAR MATERIAL.

17 Subpart 1. Scope. Parts 4731.0525 to 4731.0630 establish
18 procedures and criteria for the issuance of licenses to receive
19 title to, own, acquire, deliver, receive, possess, use, and
20 transfer special nuclear material and establish and provide for
21 the terms and conditions upon which the commissioner will issue
22 such licenses.

23 Subp. 2. Applicability. Except as provided in part
24 4731.0535, parts 4731.0525 to 4731.0630 apply to all persons in
25 the United States. Parts 4731.0525 to 4731.0630 give notice to
26 all persons who knowingly provide to any licensee, applicant,

1 contractor, or subcontractor, components, equipment, materials,
2 or other goods or services that relate to a licensee's or
3 applicant's activities subject to parts 4731.0525 to 4731.0630,
4 that they may be individually subject to enforcement action for
5 violation of part 4731.0280.

6 4731.0530 LICENSE REQUIREMENT; SPECIAL NUCLEAR MATERIAL.

7 No person shall receive title to, own, acquire, deliver,
8 receive, possess, use, or transfer special nuclear material,
9 except as authorized in a license issued by the commissioner
10 according to parts 4731.0525 to 4731.0630.

11 4731.0535 EXEMPTION; CERTAIN FEDERAL CONTRACTS.

12 A. Except to the extent that United States Department
13 of Energy (DOE) facilities or activities of the types subject to
14 licensing under the federal Energy Reorganization Act of 1974,
15 United States Code, title 42, section 5842, are involved, a
16 prime contractor of the DOE is exempt from parts 4731.0525 to
17 4731.0630 to the extent that the contractor, under the prime
18 contract with the DOE, receives title to, owns, acquires,
19 delivers, receives, possesses, uses, or transfers special
20 nuclear material for:

21 (1) the performance of work for the DOE at a
22 United States government-owned or -controlled site, including
23 the transportation of special nuclear material to or from the
24 site and the performance of contract services during temporary
25 interruptions of such transportation;

26 (2) research in or development, manufacture,

1 storage, testing, or transportation of atomic weapons or
2 components thereof; or

3 (3) the use or operation of nuclear reactors or
4 other nuclear devices in a United States-owned vehicle or vessel.

5 B. Subject to the requirement for licensing of DOE
6 facilities and activities according to United States Code, title
7 42, section 5842, a prime contractor or subcontractor of the DOE
8 or the NRC is exempt from parts 4731.0525 to 4731.0630 to the
9 extent that the prime contractor or subcontractor receives title
10 to, owns, acquires, delivers, receives, possesses, uses, or
11 transfers special nuclear material under the prime contract or
12 subcontract when the NRC determines that the exemption is
13 authorized by law and that under the terms of the contract or
14 subcontract, there is adequate assurance that the work
15 thereunder can be accomplished without undue risk to the public
16 health and safety.

17 4731.0540 EXEMPTION; CARRIERS.

18 Common and contract carriers, freight forwarders,
19 warehousers, and the United States Postal Service are exempt
20 from parts 4731.0525 to 4731.0630 to the extent that they
21 transport special nuclear material in the regular course of
22 carriage for another or storage incident thereto. This
23 exemption does not apply to the storage in transit or transport
24 of material by persons covered by the general license issued
25 under Code of Federal Regulations, title 10, sections 70.20a and
26 70.20b.

1 4731.0550 TYPES OF LICENSES.

2 Licenses for special nuclear material are of two types:
3 general and specific. A general license issued under parts
4 4731.0525 to 4731.0630 is effective without the filing of an
5 application with the commissioner or the issuance of licensing
6 documents to particular persons. Specific licenses are issued
7 to named persons upon application filed according to parts
8 4731.0525 to 4731.0630.

9 4731.0555 GENERAL LICENSE; CALIBRATION OR REFERENCE SOURCES.

10 Subpart 1. Calibration or reference sources. Persons
11 listed in items A to C are issued a general license to receive
12 title to, own, acquire, deliver, receive, possess, use, and
13 transfer, according to subparts 2 to 4, plutonium in the form of
14 calibration or reference sources:

15 A. a person who holds a specific license issued by
16 the commissioner that authorizes the person to receive, possess,
17 use, and transfer radioactive material, including source
18 material and special nuclear material;

19 B. a person who holds a specific license issued by
20 the NRC or an agreement state that authorizes the person to
21 receive, possess, use, and transfer radioactive material,
22 including source and special nuclear material; and

23 C. a government agency that holds a specific license
24 issued by the NRC that authorizes the agency to receive,
25 possess, use, or transfer by-product material, source material,
26 or special nuclear material.

27 Subp. 2. Applicability. The general license issued under

1 subpart 1 applies only to calibration or reference sources that
2 have been manufactured or initially transferred according to a
3 specific license issued under part 4731.0605 or according to a
4 specific license issued by the commissioner, the NRC, or an
5 agreement state that authorizes manufacture of the sources for
6 distribution to persons generally licensed by the commissioner,
7 the NRC, or an agreement state.

8 Subp. 3. Other law. The general license issued under
9 subpart 1 is subject to the provisions of parts 4731.0260;
10 4731.0590; 4731.0620; 4731.0630; and 4731.1000 to 4731.2950 and
11 the provisions of Code of Federal Regulations, title 10, part
12 21, and sections 70.62, 74.11, and 74.19.

13 Subp. 4. Requirements. Persons who receive title to, own,
14 acquire, deliver, receive, possess, use, or transfer one or more
15 calibration or reference sources under the general license
16 issued under subpart 1:

17 A. shall not possess at any one time, at any one
18 location of storage or use, more than five microcuries (185 kBq)
19 of plutonium or five microcuries (185 kBq) of radium-226 in the
20 sources;

21 B. shall not receive, possess, use, or transfer the
22 source unless the source or storage container bears a label that
23 includes the following statement or a substantially similar
24 statement that contains the information called for in the
25 following statement:

26 "The receipt, possession, use, and transfer of this source,
27 Model No., Serial No., are subject to a general

1 license and the regulations of the Minnesota commissioner of
2 health, the Nuclear Regulatory Commission, or a state with which
3 the Nuclear Regulatory Commission has entered into an agreement
4 for the exercise of regulatory authority. Do not remove this
5 label.

6 CAUTION - RADIOACTIVE MATERIAL - THIS SOURCE CONTAINS
7 PLUTONIUM. DO NOT TOUCH RADIOACTIVE PORTION OF THIS
8 SOURCE.

9 (Name of manufacturer or initial transferor)";

10 C. shall not transfer, abandon, or dispose of the
11 source except by transfer to a person authorized by a license
12 from the commissioner, the NRC, the Atomic Energy Commission, or
13 an agreement state to receive the source;

14 D. shall store the source, except when the source is
15 being used, in a closed container adequately designed and
16 constructed to contain plutonium or radium-226, which might
17 otherwise escape during storage; and

18 E. shall not use the source for any purpose other
19 than the calibration of radiation detectors or the
20 standardization of other sources.

21 Subp. 5. Limitation. The general license issued under
22 subpart 1 does not authorize the manufacture, import, or export
23 of calibration or reference sources containing plutonium or
24 radium-226.

25 4731.0560 GENERAL LICENSE; OWNING SPECIAL NUCLEAR MATERIAL.

26 A general license is issued to receive title to and own
27 special nuclear material without regard to quantity.

1 Notwithstanding any other provision of this chapter, a general
2 licensee under this part is not authorized to acquire, deliver,
3 receive, possess, use, transfer, import, or export special
4 nuclear material, except as authorized in a specific license.

5 4731.0565 APPLICATION; FILING.

6 Subpart 1. Generally.

7 A. A person may apply for a specific license issued
8 under parts 4731.0525 to 4731.0630 by filing an application
9 according to part 4731.0200, subpart 5 4.

10 B. Information contained in previous applications,
11 statements, or reports filed with the commissioner may be
12 incorporated by reference if the references are clear and
13 specific.

14 C. A license application filed under this part will
15 be considered also to be an application for licenses authorizing
16 other activities for which licenses are required by the
17 commissioner, provided the application specifies the additional
18 activities for which licenses are requested and complies with
19 rules of the commissioner as to applications for such licenses.

20 D. Applications and documents submitted to the
21 commissioner in connection with applications may be made
22 available for public inspection according to part 4731.0240.

23 Subp. 2. Fees. An application for a special nuclear
24 material license must be accompanied by the fee prescribed in
25 Minnesota Statutes, section 144.1205.

26 4731.0570 APPLICATION; CONTENTS.

1 Subpart 1. Required information.

2 A. An application for a license under parts 4731.0525
3 to 4731.0630 must contain:

- 4 (1) the applicant's full name and address;
5 (2) the applicant's age, if an individual;
6 (3) the applicant's citizenship; and
7 (4) the names and addresses of three personal
8 references.

9 B. If the applicant is a corporation or other entity,
10 the application must contain:

- 11 (1) the state where the entity was incorporated
12 or organized;
13 (2) the location of the principal office;
14 (3) the names, addresses, and citizenship of the
15 entity's principal officers; and
16 (4) information known to the applicant concerning
17 the control or ownership, if any, exercised over the applicant
18 by any alien, foreign corporation, or foreign government.

19 C. All applications must contain:

- 20 (1) a description of the activity for which the
21 special nuclear material is requested, or in which special
22 nuclear material will be produced, the place at which the
23 activity is to be performed, and the general plan for carrying
24 out the activity;
25 (2) the period of time for which the license is
26 requested;
27 (3) the name, amount, and specifications,

1 including the chemical and physical form and, where applicable,
2 isotopic content, of the special nuclear material the applicant
3 proposes to use or produce;

4 (4) the technical qualifications, including
5 training and experience of the applicant and members of the
6 applicant's staff, to engage in the proposed activities
7 according to this chapter;

8 (5) a description of equipment and facilities
9 that will be used by the applicant to protect health and
10 minimize danger to life or property, such as handling devices,
11 working areas, shields, measuring and monitoring instruments,
12 devices for the disposal of radioactive effluents and wastes,
13 storage facilities, and criticality accident alarm systems; and

14 (6) proposed procedures to protect health and
15 minimize danger to life or property, such as procedures to avoid
16 accidental criticality, procedures for personnel monitoring and
17 waste disposal, and postcriticality accident emergency
18 procedures.

19 D. Where the nature of the proposed activities is
20 such as to require consideration of the applicant's financial
21 qualifications to engage in the proposed activities according to
22 this chapter, the commissioner may request the applicant to
23 submit information regarding the applicant's financial
24 qualifications.

25 E. As provided under part 4731.0580, certain
26 applications for specific licenses filed under parts 4731.0525
27 to 4731.0630 must contain a proposed decommissioning funding

1 plan or a certification of financial assurance for
2 decommissioning.

3 F. Each application and statement must contain
4 complete and accurate disclosure as to all matters and things
5 required to be disclosed.

6 Subp. 2. Additional information. The commissioner may, at
7 any time after the filing of the original application and before
8 the expiration of the license, require further statements to
9 enable the commissioner to determine whether an application
10 should be granted or denied or whether a license should be
11 modified or revoked. All applications and statements must be
12 signed by the applicant or licensee or a corporate officer
13 thereof.

14 4731.0575 APPLICATION APPROVAL REQUIREMENTS.

15 An application for a license under parts 4731.0525 to
16 4731.0630 shall be approved if the commissioner determines that:

17 A. the special nuclear material is to be used for the
18 conduct of research or development activities of a type
19 specified in parts 4731.3200 to 4731.3245, in activities
20 licensed by the commissioner, or for such other uses as the
21 commissioner determines to be appropriate to carry out the
22 purposes of this chapter. Types of research and development
23 activities specified in parts 4731.3200 to 4731.3245 are those
24 relating to:

25 (1) nuclear processes;

26 (2) the theory and production of atomic energy,
27 including processes, materials, and devices related to such

1 production;

2 (3) utilization of special nuclear material and
3 radioactive material for medical, biological, agricultural,
4 health, or military purposes;

5 (4) utilization of special nuclear material,
6 atomic energy, and radioactive material and processes entailed
7 in the utilization or production of atomic energy or such
8 material for all other purposes, including industrial use, the
9 generation of usable energy, and the demonstration of the
10 practical value of utilization or production facilities for
11 industrial or commercial purposes; and

12 (5) the protection of health and the promotion of
13 safety during research and production activities;

14 B. the applicant is qualified by reason of training
15 and experience to use the material for the purpose requested
16 according to this chapter;

17 C. the applicant's proposed equipment and facilities
18 are adequate to protect health and minimize danger to life or
19 property;

20 D. the applicant's proposed procedures to protect
21 health and to minimize danger to life or property are adequate;

22 E. where the nature of the proposed activities is
23 such as to require consideration by the commissioner, the
24 applicant appears to be financially qualified to engage in the
25 proposed activities according to parts 4731.0525 to 4731.0630.

26 4731.0580 APPLICATION; FINANCIAL ASSURANCE AND RECORD KEEPING
27 FOR DECOMMISSIONING.

1 Subpart 1. Requirements.

2 A. An applicant for a specific license authorizing
3 possession and use of unsealed special nuclear material in
4 quantities specified in subpart 3 must:

5 (1) submit a decommissioning funding plan
6 according to subpart 4; or

7 (2) submit a certification that financial
8 assurance for decommissioning has been provided in the amount
9 prescribed under subpart 3, using one of the methods described
10 in subpart 5. The certification may state that the appropriate
11 assurance will be obtained after the application has been
12 approved and the license issued, but before the receipt of
13 licensed material.

14 B. If an applicant defers execution of the financial
15 instrument until after the license has been issued, a signed
16 original of the financial instrument obtained to satisfy the
17 requirements of subpart 5 must be submitted to the commissioner
18 before receipt of licensed material.

19 C. If the applicant does not defer execution of the
20 financial instrument, the applicant must submit to the
21 commissioner, as part of the certification, a signed original of
22 the financial instrument obtained to satisfy the requirements of
23 subpart 5.

24 Subp. 2. Financial assurance required. A holder of a
25 specific license described in subpart 1 must provide financial
26 assurance for decommissioning according to the criteria set
27 forth in this part.

1 Subp. 3. Financial assurance; amounts. The following
2 amounts of financial assurance are required for decommissioning
3 by quantity of material:

4 Greater than 10^4 but less than
5 or equal to 10^5 times the
6 applicable quantities under part
7 4731.3160. For a combination
8 of isotopes, if R, as defined
9 in Code of Federal Regulations,
10 title 10, section 70.25,
11 paragraph (a), divided by
12 10^4 is greater than 1 but
13 R divided by 10^5 is less
14 than or equal to 1.

\$1,125,000

15
16 Greater than 10^3 but less than
17 or equal to 10^4 times the
18 applicable quantities under part
19 4731.3160. For a combination
20 of isotopes, if R, as defined
21 in Code of Federal Regulations,
22 title 10, section 70.25,
23 paragraph (a), divided by
24 10^3 is greater than 1 but
25 R divided by 10^4 is less
26 than or equal to 1.

\$225,000

1 Subp. 4. Funding plan requirements. A decommissioning
2 funding plan must contain:

3 A. a cost estimate for decommissioning and a
4 description of the method of assuring funds for decommissioning
5 from subpart 5, including means of adjusting cost estimates and
6 associated funding levels periodically over the life of the
7 facility. Cost estimates must be adjusted at intervals not to
8 exceed three years; and

9 B. a certification by the licensee that financial
10 assurance for decommissioning has been provided in the amount of
11 the cost estimate for decommissioning. A signed original of the
12 financial instrument obtained to satisfy the requirements of
13 subpart 5 must accompany the certification.

14 Subp. 5. Financial assurance requirements.

15 A. Financial assurance for decommissioning must be
16 provided by one of the methods described in items B to F.

17 B. Prepayment is the deposit prior to the start of
18 operation into an account segregated from licensee assets and
19 outside the licensee's administrative control of cash or liquid
20 assets such that the amount of funds would be sufficient to pay
21 decommissioning costs. Prepayment may be in the form of a
22 trust, escrow account, government fund, certificate of deposit,
23 or deposit of government securities.

24 C. A surety method, insurance, or other guarantee
25 method guarantees that decommissioning costs will be paid. A
26 surety method may be in the form of a surety bond, letter of
27 credit, or line of credit. A parent company guarantee of funds

1 for decommissioning costs based on a financial test may be used
2 if the guarantee and test comply with part 4731.3155, but may
3 not be used in combination with other financial methods to
4 satisfy the requirements of this part. For commercial
5 corporations that issue bonds, a guarantee of funds by the
6 applicant or licensee for decommissioning costs based on a
7 financial test may be used if the guarantee and test comply with
8 part 4731.3165. For commercial corporations that do not issue
9 bonds, a guarantee of funds by the applicant or licensee for
10 decommissioning costs may be used if the guarantee and test
11 comply with part 4731.3170. For nonprofit entities, such as
12 colleges, universities, and nonprofit hospitals, a guarantee of
13 funds by the applicant or licensee may be used if the guarantee
14 and test comply with part 4731.3175. A guarantee by the
15 applicant or licensee may not be used in combination with other
16 financial methods used to satisfy this part or in any situation
17 where the applicant or licensee has a parent company holding
18 majority control of the voting stock of the company. Any surety
19 method or insurance used to provide financial assurance for
20 decommissioning must:

21 (1) be open-ended or, if written for a specified
22 term, such as five years, must be renewed automatically unless
23 90 days or more before the renewal date, the issuer notifies the
24 commissioner, the beneficiary, and the licensee of its intention
25 not to renew;

26 (2) provide that the full face amount be paid to
27 the beneficiary automatically before the expiration without

1 proof of forfeiture if the licensee fails to provide a
2 replacement acceptable to the commissioner within 30 days after
3 receipt of notification of cancellation;

4 (3) be payable to a trust established for
5 decommissioning costs. The trustee and trust must be acceptable
6 to the commissioner. An acceptable trustee includes an
7 appropriate state or federal government agency or an entity that
8 has authority to act as a trustee and whose trust operations are
9 regulated and examined by a federal or state agency; and

10 (4) remain in effect until the commissioner
11 terminates the license.

12 D. An external sinking fund in which deposits are
13 made at least annually, coupled with a surety method or
14 insurance, the value of which may decrease by the amount being
15 accumulated in the sinking fund, may be used as a method of
16 financial assurance. The surety or insurance provisions must be
17 as stated in item C. An external sinking fund:

18 (1) is a fund established and maintained by
19 setting aside funds periodically in an account segregated from
20 licensee assets and outside the licensee's administrative
21 control in which the total amount of funds would be sufficient
22 to pay decommissioning costs at the time termination of
23 operation is expected; and

24 (2) may be in the form of a trust, escrow
25 account, government fund, certificate of deposit, or deposit of
26 government securities.

27 E. In the case of federal, state, or local government

1 licensees, a statement of intent containing a cost estimate for
2 decommissioning or an amount according to subpart 3 and
3 indicating that funds for decommissioning will be obtained when
4 necessary may be used as a method of financial assurance.

5 F. When a governmental entity assumes custody and
6 ownership of a site, an arrangement that is deemed acceptable by
7 the governmental entity may be used as a method of financial
8 assurance.

9 Subp. 6. Record keeping. A licensee must keep records of
10 information important to the decommissioning of a facility in an
11 identified location until the site is released for unrestricted
12 use. If records important to the decommissioning of a facility
13 are kept for other purposes, reference to the records and their
14 location may be used. Information the commissioner considers
15 important to decommissioning ~~include~~ includes:

16 A. records of spills or other unusual occurrences
17 involving the spread of contamination in and around the
18 facility, equipment, or site, which:

19 (1) may be limited to instances when
20 contamination remains after cleanup procedures or when there is
21 reasonable likelihood that contaminants may have spread to
22 inaccessible areas, as in the case of possible seepage into
23 porous materials such as concrete; and

24 (2) must include any known information on
25 identification of involved nuclides, quantities, forms, and
26 concentrations;

27 B. as-built drawings and modifications of structures

1 and equipment in restricted areas where radioactive materials
2 are used or stored and of locations of possible inaccessible
3 contamination, such as buried pipes, that may be subject to
4 contamination. If required drawings are referenced, each
5 relevant document need not be indexed individually. If drawings
6 are not available, the licensee must substitute appropriate
7 records of available information concerning these areas and
8 locations;

9 C. a list of the following, contained in a single
10 document and updated every two years. Areas containing only
11 sealed sources, if the sources have not leaked or no
12 contamination remains after cleanup of any leak, need not be
13 included:

14 (1) all areas designated and formerly designated
15 as restricted areas;

16 (2) all areas outside of restricted areas that
17 require documentation under item A;

18 (3) all areas outside of restricted areas where
19 current and previous wastes have been buried as documented under
20 part 4731.2560; and

21 (4) all areas outside of restricted areas that
22 contain material such that, if the license expired, the licensee
23 would be required to either decontaminate the area to meet the
24 criteria for decommissioning under part 4731.2100 or apply for
25 approval for disposal under part 4731.2410; and

26 D. records of:

27 (1) the cost estimate performed for the

1 decommissioning funding plan or of the amount certified for
2 decommissioning; and
3 (2) the funding method used for assuring funds if
4 either a funding plan or certification is used.

5 4731.0585 ISSUANCE OF LICENSES.

6 Subpart 1. Issuance. Upon a determination that an
7 application meets the requirements of this chapter, the
8 commissioner shall issue a license in such form and containing
9 such conditions and limitations as the commissioner deems
10 appropriate or necessary to effectuate the purposes of this
11 chapter.

12 Subp. 2. Denial. The commissioner shall not issue a
13 license to any person if the commissioner finds that the
14 issuance of the license would be inimical to the common defense
15 and security or would constitute an unreasonable risk to the
16 health and safety of the public.

17 4731.0590 LICENSE CONDITIONS.

18 Subpart 1. Required conditions. A specific license issued
19 under parts 4731.0525 to 4731.0630 must contain and be subject
20 to the following conditions:

21 A. no right to the special nuclear material shall be
22 conferred by the license except as defined by the license;

23 B. neither the license nor any right under the
24 license shall be assigned or otherwise transferred in violation
25 of this chapter; and

26 C. the license is subject to and the licensee must

1 observe, all applicable rules and orders of the commissioner.

2 Subp. 2. Bankruptcy.

3 A. A licensee under parts 4731.0525 to 4731.0630 must
4 notify the commissioner, in writing, immediately following the
5 filing of a voluntary or involuntary petition for bankruptcy
6 under any chapter of United States Code, title 11, by or against:

7 (1) the licensee;

8 (2) an entity, which includes a person, estate,
9 trust, governmental unit, or United States trustee, that
10 controls the licensee or lists the license or licensee as
11 property; or

12 (3) an affiliate of the licensee, as defined
13 under United States Code, chapter 11, section 101, clause (2).

14 B. The bankruptcy notification must indicate the
15 bankruptcy court in which the petition for bankruptcy was filed
16 and the date of the filing of the petition.

17 Subp. 3. Additional conditions. The commissioner may
18 incorporate in any license such additional conditions and
19 requirements with respect to the licensee's ownership, receipt,
20 possession, use, and transfer of special nuclear material as the
21 commissioner deems appropriate or necessary to protect health or
22 to minimize danger to life or property.

23 Subp. 4. Additional requirements. The commissioner may
24 require reports, record keeping, and inspections of activities
25 under the license as may be necessary or appropriate to
26 effectuate the purposes of this chapter.

27 4731.0595 LICENSE RENEWAL AND AMENDMENT.

1 Subpart 1. Renewal application. Applications for renewal
2 of a license must be filed according to parts 4731.0565 and
3 4731.0570. Information contained in previous applications,
4 statements, or reports filed with the commissioner under the
5 license may be incorporated by reference, if the references are
6 clear and specific.

7 Subp. 2. Extension; renewal pending. If a licensee
8 granted the extension under part 4731.0600, subpart 1, item B,
9 has a currently pending renewal application for the extended
10 license, the application is considered withdrawn by the licensee
11 and any renewal fees paid by the licensee for the application
12 shall be refunded.

13 Subp. 3. Amendment applications. Applications for
14 amendment of a license must be filed according to part
15 4731.0565, subpart 1, and must specify the respects in which the
16 licensee desires the license to be amended and the grounds for
17 the amendment.

18 Subp. 4. Consideration criteria. In considering an
19 application by a licensee to renew or amend a license, the
20 commissioner shall apply the criteria under part 4731.0575.

21 4731.0597 INALIENABILITY OF LICENSES.

22 No license granted under parts 4731.0525 to 4731.0630 and
23 no right to possess or utilize special nuclear material granted
24 by a license issued under parts 4731.0525 to 4731.0630 shall be
25 transferred, assigned, or in any manner disposed of, either
26 voluntarily or involuntarily, directly or indirectly, through
27 transfer of control of a license to a person unless the

1 commissioner, after securing full information, finds that the
2 transfer is in accordance with this chapter and gives consent in
3 writing.

4 4731.0600 LICENSE EXPIRATION AND TERMINATION; DECOMMISSIONING.

5 Subpart 1. Expiration.

6 A. Except as provided in this subpart, a specific
7 license issued under parts 4731.0525 to 4731.0630 expires at the
8 end of the specified day in the month and year stated in the
9 license.

10 B. A specific license that has an expiration date
11 after July 1, 1995, and that is not one of the licenses
12 described in item C is deemed to have an expiration date that is
13 five years after the expiration date stated on the license.

14 C. The following specific licenses are not subject
15 to, or otherwise affected, by subpart 2:

16 (1) a specific license for which, on February 15,
17 1996, an evaluation or an emergency plan is required under Code
18 of Federal Regulations, title 10, section 70.22, paragraph (i);

19 (2) a specific license whose holder is subject to
20 the financial assurance requirements under part 4731.0580 and
21 whose holder on February 15, 1996, either:

22 (a) has not submitted a decommissioning
23 funding plan or certification of financial assurance for
24 decommissioning; or

25 (b) has not received written notice that the
26 decommissioning funding plan or certification of financial
27 assurance for decommissioning is acceptable;

1 (3) a specific license whose holder is on the
2 list of contaminated sites maintained for the NRC's site
3 decommissioning management plan (SDMP) and published in Site
4 Decommissioning Management Plan, NUREG-1444, Supplement 1
5 (November 1995);

6 (4) a specific license whose issuance, amendment,
7 or renewal, as of February 15, 1996, is not a categorical
8 exclusion under Code of Federal Regulations, title 10, section
9 51.22, paragraph (c), clause (14), and, therefore, needs an
10 environmental assessment or environmental impact statement
11 according to Code of Federal Regulations, title 10, part 51,
12 subpart A; and

13 (5) a specific license issued according to part
14 4731.0585 that, as of February 15, 1996, is also subject to Code
15 of Federal Regulations, title 10, section 70.24.

16 D. A specific license revoked by the commissioner
17 expires at the end of the day on the date of the commissioner's
18 final determination to revoke the license, on the expiration
19 date stated in the determination, or as otherwise provided by a
20 commissioner's order.

21 E. A specific license continues in effect, beyond the
22 expiration date if necessary, with respect to possession of
23 special nuclear material until the commissioner notifies the
24 licensee in writing that the license is terminated. During this
25 time, the licensee must:

26 (1) limit actions involving special nuclear
27 material to those related to decommissioning; and

1 (2) continue to control entry to restricted areas
2 until they are suitable for release according to this chapter.

3 Subp. 2. Decommissioning.

4 A. Within 60 days of any of the occurrences
5 under item B, and consistent with the administrative directions
6 under part 4731.0200, subpart 4 3, a licensee must provide
7 notification to the commissioner in writing of such occurrence
8 and:

9 (1) begin decommissioning the licensee's site or
10 any separate building or outdoor area that contains residual
11 radioactivity so that the building or outdoor area is suitable
12 for release according to this chapter; or

13 (2) submit within 12 months of notification a
14 decommissioning plan, if required under item E, and begin
15 decommissioning upon approval of that plan.

16 B. Notice under item A is required when:

17 (1) the license has expired under subpart 1, item
18 A or C;

19 (2) the licensee has decided to permanently cease
20 principal activities at the entire site or in any separate
21 building or outdoor area;

22 (3) no principal activities have been conducted
23 under the license for a period of 24 months; or

24 (4) no principal activities have been conducted
25 for a period of 24 months in any separate building or outdoor
26 area that contains residual radioactivity such that the building
27 or outdoor area is unsuitable for release according to this

1 chapter.

2 C. Coincident with the notification required under
3 this subpart, the licensee must maintain in effect all
4 decommissioning financial assurances established by the licensee
5 under part 4731.0580 in conjunction with license issuance or
6 renewal or as required under this part. The amount of the
7 financial assurance must be increased, or may be decreased, as
8 appropriate, to cover the detailed cost estimate for
9 decommissioning established under item H, subitem (5). A
10 licensee who has not provided financial assurance to cover the
11 detailed cost estimate submitted with the decommissioning plan
12 must do so when this chapter becomes effective. Following
13 approval of the decommissioning plan, a licensee may reduce the
14 amount of the financial assurance as decommissioning proceeds
15 and radiological contamination is reduced at the site with the
16 approval of the commissioner.

17 D. The commissioner may grant a request to delay or
18 postpone initiation of the decommissioning process if the
19 commissioner determines that this relief is not detrimental to
20 the public health and safety and is otherwise in the public
21 interest. The request must be submitted no later than 30 days
22 before notification under this subpart. The schedule for
23 decommissioning in this subpart may not commence until the
24 commissioner has made a determination on the request.

25 E. A decommissioning plan must be submitted if:
26 (1) required by a license condition; or
27 (2) the procedures and activities necessary to

1 carry out decommissioning of the site or separate building or
2 outdoor area have not been previously approved by the
3 commissioner and the procedures could increase potential health
4 and safety impacts to workers or the public, such as in any of
5 the following cases:

6 (a) procedures would involve techniques not
7 routinely applied during cleanup and maintenance operations;

8 (b) workers would be entering areas not
9 normally occupied where surface contamination and radiation
10 levels are significantly higher than routinely encountered
11 during operation;

12 (c) procedures could result in significantly
13 greater airborne concentrations of radioactive materials than
14 are present during operation; or

15 (d) procedures could result in significantly
16 greater releases of radioactive material to the environment than
17 those associated with operation.

18 F. The commissioner may approve an alternate schedule
19 for submittal of a decommissioning plan required under this
20 subpart if the commissioner determines that the alternative
21 schedule is necessary to the effective conduct of
22 decommissioning operations and presents no undue risk from the
23 radiation to the public health and safety and is otherwise in
24 the public interest.

25 G. The procedures under item E, subitem (2), may not
26 be performed before approval of the decommissioning plan.

27 H. The proposed decommissioning plan for the site or

1 separate building or outdoor area must include:

2 (1) a description of the conditions of the site
3 or separate building or outdoor area sufficient to evaluate the
4 acceptability of the plan;

5 (2) a description of planned decommissioning
6 activities;

7 (3) a description of the methods used to ensure
8 protection of workers and the environment against radiation
9 hazards during decommissioning;

10 (4) a description of the planned final radiation
11 survey;

12 (5) an updated detailed cost estimate for
13 decommissioning, comparison of that estimate with present funds
14 set aside for decommissioning, and a plan for ensuring the
15 availability of adequate funds for completion of
16 decommissioning;

17 (6) a description of the physical security plan
18 and material control and accounting plan provisions in place
19 during decommissioning; and

20 (7) for decommissioning plans calling for
21 completion of decommissioning later than 24 months after plan
22 approval, a justification for the delay based on the criteria in
23 item K.

24 I. The commissioner shall approve a proposed
25 decommissioning plan if the information in the plan demonstrates
26 that the decommissioning will be completed as soon as
27 practicable and that the health and safety of workers and the

1 public will be adequately protected.

2 J. Except as provided in item K, a licensee must:

3 (1) complete decommissioning of the site or
4 separate building or outdoor area as soon as practicable but no
5 later than 24 months following the initiation of
6 decommissioning; and

7 (2) request license termination as soon as
8 practicable but no later than 24 months following the initiation
9 of decommissioning, when decommissioning involves the entire
10 site.

11 K. The commissioner may approve a request for an
12 alternative schedule for completion of decommissioning of the
13 site or separate building or outdoor area, and license
14 termination if appropriate, if the commissioner determines that
15 the alternative is warranted by consideration of:

16 (1) whether it is technically feasible to
17 complete decommissioning within the allotted 24-month period;

18 (2) whether sufficient waste disposal capacity is
19 available to allow completion of decommissioning within the
20 allotted 24-month period;

21 (3) whether a significant volume reduction in
22 wastes requiring disposal will be achieved by allowing
23 short-lived radionuclides to decay;

24 (4) whether a significant reduction in radiation
25 exposure to workers can be achieved by allowing short-lived
26 radionuclides to decay; and

27 (5) other site-specific factors that the

1 commissioner may consider appropriate on a case-by-case basis,
2 such as the regulatory requirements of other governmental
3 agencies, lawsuits, groundwater treatment activities, monitored
4 natural groundwater restoration, actions that could result in
5 more environmental harm than deferring clean up, and other
6 factors beyond the control of the licensee.

7 L. As the final step in decommissioning, the licensee
8 must:

9 (1) certify the disposition of all licensed
10 material, including accumulated wastes, by submitting a
11 completed Form 314 or equivalent information; and

12 (2) conduct a radiation survey of the premises
13 where the licensed activities were carried out and submit a
14 report of the results of the survey, unless the licensee
15 demonstrates in some other manner that the premises are suitable
16 for release according to parts 4731.2100 and 4731.2150. The
17 licensee must, as appropriate:

18 (a) for gamma radiation, report levels of
19 radiation in units of microroentgens (millisieverts) per hour at
20 one meter from surfaces;

21 (b) for radioactivity, including alpha and
22 beta radiation, report levels of radiation in units of
23 disintegrations per minute or microcuries (megabecquerels) per
24 100 square centimeters removable and fixed for surfaces,
25 microcuries (megabecquerels) per milliliter for water, and
26 picocuries (becquerels) per gram for solids such as soils or
27 concrete; and

1 (c) specify the survey instruments used and
2 certify that each instrument is properly calibrated and tested.

3 M. Specific licenses, including expired licenses,
4 shall be terminated by written notice to the licensee when the
5 commissioner determines that:

6 (1) special nuclear material has been properly
7 disposed of;

8 (2) reasonable effort has been made to eliminate
9 residual radioactive contamination, if present; and

10 (3) a radiation survey has been performed that
11 demonstrates, or other information submitted by the licensee is
12 sufficient to demonstrate, that the premises are suitable for
13 release according to parts 4731.2100 and 4731.2150.

14 Subp. 3. Required records. Prior to license termination,
15 any reports required by part 4731.0625 must have been received
16 by the commissioner.

17 4731.0605 SPECIFIC LICENSE; MANUFACTURE OR INITIAL TRANSFER OF
18 CALIBRATION OR REFERENCE SOURCES.

19 Subpart 1. Manufacture or initial transfer of certain
20 calibration sources. An application for a specific license to
21 manufacture or initially transfer calibration and reference
22 sources containing plutonium for distribution to persons
23 generally licensed under part 4731.0555 shall be approved if:

24 A. the applicant satisfies the general requirements
25 of part 4731.0575;

26 B. the applicant submits sufficient information
27 regarding each type of calibration or reference source pertinent

1 to evaluation of the potential radiation exposure, including:

2 (1) chemical and physical form and maximum
3 quantity of plutonium in the source;

4 (2) details of construction and design;

5 (3) details of the method of incorporation and
6 binding of the plutonium in the source;

7 (4) procedures for and results of prototype
8 testing of sources that are designed to contain more than 0.005
9 microcurie of plutonium to demonstrate that the plutonium
10 contained in each source will not be released or be removed from
11 the source under normal conditions of use;

12 (5) details of quality control procedures to be
13 followed in manufacture of the source;

14 (6) a description of labeling to be affixed to
15 the source or the storage container for the source; and

16 (7) any additional information, including
17 experimental studies and tests, required by the commissioner to
18 facilitate a determination of the safety of the source;

19 C. each source contains no more than five microcuries
20 of plutonium;

21 D. the commissioner determines, with respect to any
22 type of source containing more than 0.005 microcurie of
23 plutonium that:

24 (1) the method of incorporation and binding of
25 the plutonium in the source is such that the plutonium will not
26 be released or be removed from the source under normal
27 conditions of use and handling of the source; and

1 (2) the source has been subjected to and has
2 satisfactorily passed the prototype tests prescribed by item E;
3 and

4 E. for any type of source that is designed to contain
5 more than 0.005 microcurie of plutonium, the applicant has
6 conducted prototype tests, in the order listed, on each of five
7 prototypes of such source, which contains more than 0.005
8 microcurie of plutonium, as follows:

9 (1) an initial measurement. The quantity of
10 radioactive material deposited on the source must be measured by
11 direct counting of the source;

12 (2) a dry wipe test. The entire radioactive
13 surface of the source must be wiped with filter paper with the
14 application of moderate finger pressure. Removal of radioactive
15 material from the source must be determined by measuring the
16 radioactivity on the filter paper or by direct measurement of
17 the radioactivity on the source following the dry wipe;

18 (3) a wet wipe test. The entire radioactive
19 surface of the source must be wiped with filter paper, moistened
20 with water, with the application of moderate finger pressure.
21 Removal of radioactive material from the source must be
22 determined by measuring the radioactivity on the filter paper
23 after it has dried or by direct measurement of the radioactivity
24 on the source following the wet wipe;

25 (4) a water soak test. The source must be
26 immersed in water at room temperature for a period of 24
27 consecutive hours. The source must then be removed from the

1 water. Removal of radioactive material from the source must be
2 determined by direct measurement of the radioactivity on the
3 source after it has dried or by measuring the radioactivity in
4 the residue obtained by evaporation of the water in which the
5 source was immersed;

6 (5) a dry wipe test. On completion of the
7 preceding tests under subitems (1) to (4), the dry wipe test
8 described in subitem (2) must be repeated; and

9 (6) observations. Removal of more than 0.005
10 microcurie of radioactivity in any test prescribed by this item
11 is cause for rejection of the source design. Results of
12 prototype tests submitted to the commissioner must be given in
13 terms of radioactivity in microcuries and percent of removal
14 from the total amount of radioactive material deposited on the
15 source.

16 Subp. 2. Labeling. A person licensed under this part must
17 affix to each source or storage container for the source a label
18 that:

19 (1) contains sufficient information relative to
20 safe use and storage of the source; and

21 (2) includes the following statement or a
22 substantially similar statement containing the information
23 called for:

24 "The receipt, possession, use, and transfer of this
25 source, Model ..., Serial No. ..., are subject to a
26 general license and the regulations of the Minnesota
27 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.

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

1 title to, own, acquire, receive, possess, and use special
2 nuclear material. Preparation for shipment and transport of
3 special nuclear material must be according to parts 4731.0400 to
4 4731.0424.

5 Subp. 2. Material produced under license. The possession,
6 use, and transfer of any special nuclear material produced by a
7 licensee, in connection with or as a result of use of special
8 nuclear material received under the license, is subject to the
9 provisions of the license and this chapter.

10 4731.0615 TRANSFER OF SPECIAL NUCLEAR MATERIAL.

11 Subpart 1. Authorization required. No licensee shall
12 transfer special nuclear material except as authorized under
13 this part.

14 Subp. 2. Approved transfer. Except as otherwise provided
15 in a license and subject to subpart 3, a licensee may transfer
16 special nuclear material:

17 A. to the commissioner after approval from the
18 commissioner;

19 B. to the United States Department of Energy;

20 C. to the agency in an agreement state that regulates
21 radioactive material according to an agreement with the NRC, if
22 the quantity transferred is not sufficient to form critical
23 mass;

24 D. to a person exempt from this chapter to the extent
25 permitted under the exemption;

26 E. to a person in an agreement state, subject to the
27 jurisdiction of that state, who has been exempted from licensing

1 requirements of that state, to the extent permitted under the
2 exemption;

3 F. to a person authorized to receive such material
4 under terms of a specific license or a general license or their
5 equivalents issued by the commissioner, the NRC, an agreement
6 state, or a licensing state; or

7 G. as otherwise authorized by the commissioner in
8 writing.

9 Subp. 3. Verification for transfer.

10 A. Before transferring special nuclear material to a
11 specific licensee of the commissioner, the NRC, an agreement
12 state, or a licensing state or to a general licensee who is
13 required to register with the commissioner, the NRC, an
14 agreement state, or a licensing state before receipt of the
15 special nuclear material, the licensee transferring radioactive
16 material must verify that the transferee's license authorizes
17 the receipt of the type, form, and quantity of special nuclear
18 material to be transferred.

19 B. Any of the following methods of verification are
20 acceptable:

21 (1) the transferor may possess and read a current
22 copy of the transferee's specific license or general license
23 registration certificate. The transferor must retain a copy of
24 each license or certificate until the next inspection;

25 (2) the transferor may possess a written
26 certification by the transferee that the transferee is
27 authorized by license or registration certificate to receive the

1 type, form, and quantity of special nuclear material to be
2 transferred, specifying:

3 (a) the license or registration certificate
4 number;

5 (b) the issuing agency; and

6 (c) the expiration date.

7 The transferor must retain the written certification as a record
8 for three years from the date of receipt of the certification;
9 or

10 (3) for emergency shipments, the transferor may
11 accept oral certification by the transferee that the transferee
12 is authorized by license or registration certificate to receive
13 the type, form, and quantity of special nuclear material to be
14 transferred, specifying:

15 (a) the license or registration certificate
16 number;

17 (b) the issuing agency; and

18 (c) the expiration date.

19 The oral certification must be confirmed in writing within ten
20 days. The transferor must retain the written confirmation of
21 the oral certification for three years from the date of receipt
22 of the confirmation.

23 Subp. 4. Other sources of information. The transferor may
24 obtain other information compiled by a reporting service from
25 official records of the commissioner, the NRC, or the licensing
26 agency of an agreement state regarding the identity of licensees
27 or registrants and the scope and expiration dates of the

1 licenses and registrations. The transferor must retain the
2 compilation of information as a record for three years from the
3 date that it was obtained.

4 Subp. 5. Confirmation. The transferor may obtain and
5 record confirmation from the commissioner, the NRC, or the
6 licensing agency of an agreement state or licensing state that
7 the transferee is licensed to receive the special nuclear
8 material:

9 A. when none of the methods of verification described
10 in subparts 3 and 4 are readily available; or

11 B. when a transferor desires to verify that
12 information received by one of the verification methods is
13 correct or up-to-date.

14 The transferor must retain the record of confirmation for three
15 years from the date the record is made.

16 4731.0620 REPORTING REQUIREMENTS.

17 Subpart 1. Immediate notification required. A licensee
18 must notify the commissioner as soon as possible but not later
19 than four hours after the discovery of an event that prevents
20 immediate protective actions necessary to avoid exposures to
21 radiation and radioactive materials that could exceed regulatory
22 limits or releases of licensed material that could exceed
23 regulatory limits. Reportable events under this subpart include
24 fires, explosions, toxic gas release, or similar hazards.

25 Subp. 2. 24-hour notification required. A licensee must
26 notify the commissioner within 24 hours after discovery of any
27 of the following events involving licensed material:

1 A. an unplanned contamination event that:

2 (1) requires access to the contaminated area, by
3 workers or the public, to be restricted for more than 24 hours
4 by imposing additional radiological controls or by prohibiting
5 entry into the areas;

6 (2) involves a quantity of material greater than
7 five times the lowest annual limit on intake specified in part
8 4731.2750 for the material; and

9 (3) restricts access to the area for a reason
10 other than to allow isotopes with a half-life of less than 24
11 hours to decay prior to decontamination;

12 B. an event in which equipment is disabled or fails
13 to function as designed when:

14 (1) the equipment is required by rule or license
15 condition to prevent releases exceeding regulatory limits, to
16 prevent exposure to radiation and radioactive materials
17 exceeding regulatory limits, or to mitigate the consequences of
18 an accident;

19 (2) the equipment is required to be available and
20 operable when it is disabled or fails to function; and

21 (3) no redundant equipment is available and
22 operable to perform the required safety function;

23 C. an event that requires unplanned medical treatment
24 at a medical facility of an individual with spreadable
25 radioactive contamination on the individual's clothing or body;
26 and or

27 D. an unplanned fire or explosion that damages any

1 licensed material or any device, container, or equipment
2 containing licensed materials when:

3 (1) the quantity of material involved is greater
4 than five times the lowest annual limit on intake under part
5 4731.2750 for the material; and

6 (2) the damage affects the integrity of the
7 licensed material or its container.

8 Subp. 3. Preparation and submission of reports.

9 A. A licensee must make reports required under
10 subparts 1 and 2 and Code of Federal Regulations, title 10,
11 section 70.74, and part 70, Appendix A, if applicable, by
12 telephone to the commissioner. To the extent that the
13 information is available at the time of notification, the
14 information provided in the report must include:

15 (1) the caller's name, position, title, and
16 call-back telephone number;

17 (2) the date, time, and exact location of the
18 event;

19 (3) a description of the event, including:

20 (a) the radiological or chemical hazards
21 involved, including isotopes, quantities, and chemical and
22 physical form of any material released;

23 (b) the actual or potential health and
24 safety consequences to the workers, the public, and the
25 environment, including relevant chemical and radiation data for
26 actual personnel exposures to radiation or radioactive materials
27 or hazardous chemicals produced from licensed materials, for

1 example, level of radiation exposure, concentration of
2 chemicals, and duration of exposure;

3 (c) the sequence of occurrences leading to
4 the event, including degradation or failure of structures,
5 systems, equipment, components, and activities of personnel
6 relied on to prevent potential accidents or mitigate their
7 consequences; and

8 (d) whether the remaining structures,
9 systems, equipment, components, and activities of personnel
10 relied on to prevent potential accidents or mitigate their
11 consequences are available and reliable to perform their
12 function;

13 (4) any external conditions affecting the event;

14 (5) any additional actions taken by the licensee
15 in response to the event;

16 (6) the status of the event, for example, whether
17 the event is ongoing or was terminated;

18 (7) the current and planned site status,
19 including any declared emergency class;

20 (8) any notifications related to the event that
21 were made or are planned to be made to the commissioner or any
22 local, state, or federal agencies; and

23 (9) the status of any press releases related to
24 the event that were made or are planned.

25 B. A licensee that makes a report required under
26 subpart 1 or 2 or Code of Federal Regulations, title 10, section
27 70.74, and part 70, Appendix A, if applicable, must submit a

1 written follow-up report within 30 days of the initial
2 notification. Written reports prepared as required by other
3 rules may be submitted to fulfill this requirement if the
4 reports contain all of the necessary information. The written
5 reports must be sent to the commissioner. The reports must
6 include:

7 (1) the probable cause of the event, including
8 all factors that contributed to the event, and the manufacturer
9 and model number, if applicable, of any equipment that failed or
10 malfunctioned;

11 (2) the exact location of the event;

12 (3) the isotopes, quantities, and chemical and
13 physical form of the licensed involved;

14 (4) the date and time of the event;

15 (5) corrective actions taken or planned to
16 prevent the occurrence of similar or identical events in the
17 future and the results of any evaluations or assessments; and

18 (6) the extent of exposure of individuals to
19 radiation or to radioactive materials, without identification of
20 the individuals by name.

21 4731.0625 RECORD TRANSFER REQUIREMENTS.

22 Subpart 1. Transfer to commissioner. Prior to license
23 termination, a licensee authorized to possess radioactive
24 materials must forward the following records to the commissioner:

25 A. records of disposal of licensed material made
26 under parts 4731.2410 to 4731.2440;

27 B. records required under part 4731.2510; and

1 C. records required under part 4731.0580.

2 Subp. 2. Transfer to new licensee. If licensed activities
3 are transferred or assigned according to part 4731.0597, the
4 licensee must transfer the following records to the new licensee
5 and the new licensee is responsible for maintaining the records
6 until the license is terminated:

7 A. records of disposal of licensed material made
8 under parts 4731.2410 to 4731.2440;

9 B. records required under part 4731.2510; and

10 C. records required under part 4731.0580.

11 4731.0630 INSPECTIONS AND TESTS.

12 Subpart 1. Material and premises inspection. A licensee
13 must afford to the commissioner at all reasonable times
14 opportunity to inspect special nuclear material and the premises
15 and facilities wherein special nuclear material is used,
16 produced, or stored.

17 Subp. 2. Record inspection. A licensee must make
18 available to the commissioner for inspection, upon reasonable
19 notice, records kept by the licensee pertaining to the
20 licensee's receipt, possession, use, acquisition, import,
21 export, or transfer of special nuclear material.

22 Subp. 3. Testing. A licensee must perform, or permit the
23 commissioner to perform, such tests as the commissioner deems
24 appropriate or necessary for the administration of parts
25 4731.0525 to 4731.0630, including tests of:

26 A. special nuclear material;

27 B. facilities wherein special nuclear material is

1 utilized, produced, or stored;

2 C. radiation detection and monitoring instruments;

3 and

4 D. other equipment and devices used in connection
5 with the production, utilization, or storage of special nuclear
6 material.

7 DOMESTIC LICENSING OF SOURCE MATERIAL

8 4731.0700 PURPOSE AND SCOPE.

9 Subpart 1. Scope. The purpose of parts 4731.0700 to
10 4731.0840 is to establish procedures and criteria for the
11 issuance of licenses to receive title to, receive, possess, use,
12 transfer, or deliver source and by-product materials and
13 establish and provide for the terms and conditions upon which
14 the commissioner will issue such licenses. Parts 4731.0700 to
15 4731.0840 also provide for the disposal of by-product material
16 and for the long-term care and custody of by-product material
17 and residual radioactive material.

18 Subp. 2. Applicability; enforcement notice. Except as
19 provided in parts 4731.0715 to 4731.0730, parts 4731.0700 to
20 4731.0840 apply to all persons in the area in which the
21 Department of Health maintains jurisdiction. Parts 4731.0700 to
22 4731.0840 give notice to all persons who knowingly provide to
23 any licensee, applicant, contractor, or subcontractor,
24 components, equipment, materials, or other goods or services
25 that relate to a licensee's or applicant's activities subject to
26 parts 4731.0700 to 4731.0840 that they may be individually
27 subject to the commissioner's enforcement action for violation

1 of part 4731.0260, subpart 3.

2 4731.0705 INACTIVE TAILINGS SITES.

3 The NRC regulates by-product material that is located at a
4 site where milling operations are no longer active, if the site
5 is not covered by the remedial action program of title I of the
6 Uranium Mill Tailings Radiation Control Act of 1978, Public Law
7 95-604. Code of Federal Regulations, title 10, part 40,
8 Appendix A, applies to such sites.

9 4731.0710 LICENSE REQUIREMENT.

10 A person subject to parts 4731.0700 to 4731.0840 may not
11 receive title to, own, receive, possess, use, transfer, provide
12 for long-term care, deliver, or dispose of any source material
13 after removal from its place of deposit in nature, unless
14 authorized in a specific or general license issued by the
15 commissioner under parts 4731.0700 to 4731.0840.

16 4731.0715 EXEMPTION; USE OF SOURCE MATERIAL UNDER CERTAIN
17 FEDERAL CONTRACTS.

18 A. Except to the extent that United States Department
19 of Energy (DOE) facilities or activities of the types subject to
20 licensing under United States Code, title 42, section 5842, the
21 Energy Reorganization Act of 1974, or the Uranium Mill Tailings
22 Radiation Control Act of 1978, Public Law 95-604, are involved,
23 a prime contractor of the DOE is exempt from parts 4731.0700 to
24 4731.0840 to the extent that the contractor, under the prime
25 contract with the DOE, receives, possesses, uses, transfers, or
26 delivers source material for:

1 (1) the performance of work for the DOE at a
2 United States government-owned or -controlled site, including
3 the transportation of source material to or from such site and
4 the performance of contract services during temporary
5 interruptions of such transportation;

6 (2) research in or development, manufacture,
7 storage, testing, or transportation of atomic weapons or
8 components thereof; or

9 (3) the use or operation of nuclear reactors or
10 other nuclear devices in United States government-owned vehicles
11 or vessels.

12 B. In addition to the exemptions under item A, and
13 subject to the requirement for licensing of DOE facilities and
14 activities under the Energy Reorganization Act of 1974 or the
15 Uranium Mill Tailings Radiation Control Act of 1980, a prime
16 contractor or subcontractor of the DOE or the NRC is exempt from
17 parts 4731.0700 to 4731.0840 to the extent that:

18 (1) the prime contractor or subcontractor
19 receives, possesses, uses, transfers, or delivers source
20 material under the prime contract or subcontract; and

21 (2) the NRC determines that:

22 (a) the exemption is authorized by law; and

23 (b) under the terms of the contract or
24 subcontract, there is adequate assurance that the work
25 thereunder can be accomplished without undue risk to the public
26 health and safety.

27 4731.0720 EXEMPTION; CARRIERS.

1 Common and contract carriers, freight forwarders,
2 warehousemen, and the United States Postal Service are exempt
3 from parts 4731.0700 to 4731.0840, to the extent that they
4 transport or store source material in the regular course of the
5 carriage for another or storage incident thereto.

6 4731.0725 EXEMPTION; UNIMPORTANT QUANTITIES OF SOURCE MATERIAL.

7 Subpart 1. Low percentage source material. A person is
8 exempt from parts 4731.0700 to 4731.0840 to the extent that the
9 person receives, possesses, uses, transfers, or delivers source
10 material in any chemical mixture, compound, solution, or alloy
11 in which the source material is by weight less than 1/20 of one
12 percent (0.05%) of the mixture, compound, solution, or alloy.

13 Subp. 2. Ores containing source material. A person is
14 exempt from parts 4731.0700 to 4731.0840 to the extent that the
15 person receives, possesses, uses, or transfers unrefined and
16 unprocessed ore containing source material, provided that,
17 except as authorized in a specific license, the person does not
18 refine or process the ore.

19 Subp. 3. Certain items and materials.

20 A. A person is exempt from parts 4731.0700 to
21 4731.0840 to the extent that the person receives, possesses,
22 uses, or transfers:

23 (1) any quantities of thorium contained in:

24 (a) incandescent gas mantles;

25 (b) vacuum tubes;

26 (c) welding rods;

27 (d) electric lamps for illuminating

1 purposes, provided that each lamp does not contain more than 50
2 milligrams of thorium;

3 (e) germicidal lamps, sunlamps, and lamps
4 for outdoor or industrial lighting, provided that each lamp does
5 not contain more than two grams of thorium;

6 (f) rare earth metals and compounds,
7 mixtures, and products containing not more than 0.25 percent by
8 weight thorium, uranium, or any combination of these; or

9 (g) personnel neutron dosimeters, provided
10 that each dosimeter does not contain more than 50 milligrams of
11 thorium;

12 (2) source material contained in the following
13 products:

14 (a) glazed ceramic tableware, provided that
15 the glaze contains not more than 20 percent by weight source
16 material;

17 (b) piezoelectric ceramic containing not
18 more than two percent by weight source material;

19 (c) glassware containing not more than ten
20 percent by weight source material, but not including
21 commercially manufactured glass brick, pane glass, ceramic tile,
22 or other glass or ceramic used in construction; or

23 (d) glass enamel or glass enamel frit
24 containing not more than ten percent by weight source material
25 imported or ordered for importation into the United States, or
26 initially distributed by manufacturers in the United States,
27 before July 25, 1983;

1 (3) photographic film, negatives, and prints
2 containing uranium or thorium;

3 (4) any finished product or part fabricated of or
4 containing tungsten or magnesium-thorium alloys, provided that
5 the thorium content of the alloy does not exceed four percent by
6 weight and that the exemption in this subitem shall not be
7 deemed to authorize the chemical, physical, or metallurgical
8 treatment of any such product or part;

9 (5) uranium contained in counterweights installed
10 in aircraft, rockets, projectiles, and missiles or stored or
11 handled in connection with installation or removal of such
12 counterweights, provided that:

13 (a) the counterweights are manufactured
14 according to a specific license issued by the NRC or the Atomic
15 Energy Commission authorizing distribution by the licensee
16 according to parts 4731.0700 to 4731.0840;

17 (b) each counterweight has been impressed
18 with the following legend clearly legible through any plating or
19 other covering: "Depleted Uranium." This subunit does not
20 apply to counterweights manufactured before December 31, 1969,
21 if the counterweights were manufactured under a specific license
22 issued by the Atomic Energy Commission and were impressed with
23 the legend required under Code of Federal Regulations, title 10,
24 section 40.13, paragraph (c), clause (5), subclause (ii), in
25 effect June 30, 1969;

26 (c) each counterweight is durably and
27 legibly labeled or marked with the identification of the

1 manufacturer and the statement: "Unauthorized Alterations
2 Prohibited." This subunit does not apply to counterweights
3 manufactured before December 31, 1969, if the counterweights
4 were manufactured under a specific license issued by the Atomic
5 Energy Commission and were impressed with the legend required
6 under Code of Federal Regulations, title 10, section 40.13,
7 paragraph (c), clause (5), subclause (ii), in effect June 30,
8 1969; and

9 (d) the exemption contained in this subitem
10 shall not be deemed to authorize the chemical, physical, or
11 metallurgical treatment or processing of any such counterweights
12 other than repair or restoration of any plating or other
13 covering;

14 (6) natural or depleted uranium metal used as
15 shielding constituting part of a shipping container, provided
16 that:

17 (a) the shipping container is conspicuously
18 and legibly impressed with the legend "CAUTION - RADIOACTIVE
19 SHIELDING - URANIUM"; and

20 (b) the uranium metal is encased in mild
21 steel or equally fire-resistant metal of minimum wall thickness
22 of one-eighth inch (3.2 mm);

23 (7) thorium contained in finished optical lenses,
24 provided that each does not contain more than 30 percent by
25 weight of thorium. The exemption in this subitem shall not be
26 deemed to authorize:

27 (a) the shaping, grinding, or polishing of

1 such lens or manufacturing processes other than the assembly of
2 such lens into optical systems and devices without any
3 alteration of the lens; or

4 (b) the receipt, possession, use, or
5 transfer of thorium contained in contact lenses, spectacles, or
6 eyepieces of binoculars or other optical instruments; or

7 (8) thorium contained in any finished aircraft
8 engine part containing nickel-thoria alloy, provided that:

9 (a) the thorium is dispersed in the
10 nickel-thoria alloy in the form of finely divided thoria
11 (thorium dioxide); and

12 (b) the thorium content in the nickel-thoria
13 alloy does not exceed four percent by weight.

14 B. The exemptions in this subpart do not authorize
15 the manufacture of any of the products described.

16 Subp. 4. Fire detection units. A person is exempt from
17 parts 4731.0700 to 4731.0840 to the extent that the person
18 receives, possesses, uses, or transfers uranium contained in
19 detector heads for use in fire detection units, provided that
20 each detector head contains not more than 0.005 microcurie of
21 uranium. The exemption in this subpart does not authorize the
22 manufacture of any detector head containing uranium.

23 4731.0730 OTHER EXEMPTIONS.

24 A. The commissioner may, upon application of any
25 interested person or upon the commissioner's own initiative,
26 grant exemptions from parts 4731.0700 to 4731.0840 as the
27 commissioner determines are authorized by law and will not

1 endanger life or property and are otherwise in the public
2 interest.

3 B. The United States Department of Energy is exempt
4 from parts 4731.0700 to 4731.0840.

5 C. Except as specifically provided in Code of Federal
6 Regulations, title 10, part 61, a licensee is exempt from parts
7 4731.0700 to 4731.0840 to the extent that the licensee's
8 activities are subject to Code of Federal Regulations, title 10,
9 part 61.

10 4731.0735 TYPES OF LICENSES.

11 A. Licenses for radioactive material are of two
12 types: general and specific.

13 B. Licenses for long-term care and custody of
14 residual radioactive material at disposal sites are general
15 licenses. The general licenses provided under parts 4731.0700
16 to 4731.0840 are effective without the filing of applications
17 with the commissioner or the issuance of licensing documents to
18 particular persons.

19 C. Licenses issued to named persons upon applications
20 filed according to parts 4731.0700 to 4731.0840 are specific
21 licenses.

22 4731.0740 GENERAL LICENSE; TITLE TO SOURCE OR RADIOACTIVE
23 MATERIAL.

24 A general license is issued authorizing the receipt of
25 title to source or radioactive material without regard to
26 quantity. This general license does not authorize any person to

1 receive, possess, deliver, use, or transfer source or
2 radioactive material.

3 4731.0745 GENERAL LICENSE; SMALL QUANTITIES OF SOURCE MATERIAL.

4 Subpart 1. General license issued. A general license is
5 issued authorizing commercial and industrial firms; research,
6 educational, and medical institutions; and state and local
7 government agencies to use and transfer not more than 15 pounds
8 of source material at any one time for research, development,
9 educational, commercial, or operational purposes. A person
10 authorized to use or transfer source material under this general
11 license may not receive more than a total of 150 pounds of
12 source material in any one calendar year.

13 Subp. 2. Other law. A person who receives, possesses,
14 uses, or transfers source material under the general license
15 issued under subpart 1 is exempt from parts 4731.1000 to
16 4731.2950, to the extent that the receipt, possession, use, or
17 transfer is within the terms of the general license. This
18 exemption does not apply to a person who is also in possession
19 of source material under a specific license issued under parts
20 4731.0700 to 4731.0840.

21 Subp. 3. Prohibition. A person who receives, possesses,
22 uses, or transfers source material under the general license
23 issued under subpart 1 is prohibited from administering source
24 material, or the radiation therefrom, either externally or
25 internally, to human beings except as may be authorized by the
26 commissioner, the NRC, or an agreement state in a specific
27 license.

1 4731.0750 GENERAL LICENSE; USE OF CERTAIN INDUSTRIAL PRODUCTS OR
2 DEVICES.

3 Subpart 1. General license issued. A general license is
4 issued to receive, acquire, possess, use, or transfer, according
5 to this part, depleted uranium contained in industrial products
6 or devices for the purpose of providing a concentrated mass in a
7 small volume of the product or device.

8 Subp. 2. Scope. The general license issued under subpart
9 1 applies only to industrial products or devices that have been
10 manufactured or initially transferred according to a specific
11 license issued under part 4731.0770 or according to a specific
12 license issued to by the NRC or an agreement state that
13 authorizes manufacture of the products or devices for
14 distribution to persons generally licensed by the NRC or an
15 agreement state.

16 Subp. 3. Registration certificate.

17 A. A person who receives, acquires, possesses, or
18 uses depleted uranium under the general license issued under
19 subpart 1 must submit to the commissioner a form for a
20 registration certificate for use of depleted uranium under a
21 general license, as prescribed by the commissioner. The form
22 must be submitted within 30 days after the first receipt or
23 acquisition of the depleted uranium.

24 B. A registrant must furnish the following
25 information on the form and any other information as may be
26 prescribed by the commissioner:

27 (1) the name and address of the registrant;

1 (2) a statement that the registrant has developed
2 and will maintain procedures designed to establish physical
3 control over the depleted uranium described in subpart 1 and to
4 prevent transfer of the depleted uranium in any form, including
5 metal scrap, to persons not authorized to receive the depleted
6 uranium; and

7 (3) the name, title, address, and telephone
8 number of the individual duly authorized to act for and on
9 behalf of the registrant in supervising the procedures
10 identified in subitem (2).

11 C. A registrant possessing or using depleted uranium
12 under the general license issued under subpart 1 must report in
13 writing to the commissioner any changes in information furnished
14 by the registrant under item B. The report must be submitted
15 within 30 days after the effective date of the change.

16 Subp. 4. License requirements.

17 A. A person who receives, acquires, possesses, or
18 uses depleted uranium under the general license issued in
19 subpart 1:

20 (1) must not introduce the depleted uranium, in
21 any form, into a chemical, physical, or metallurgical treatment
22 or process, except a treatment or process for repair or
23 restoration of any plating or other covering of the depleted
24 uranium;

25 (2) must not abandon the depleted uranium;

26 (3) must transfer or dispose of the depleted
27 uranium only by transfer according to part 4731.0815 and:

1 (a) when the transferee receives the
2 depleted uranium under the general license issued under subpart
3 1, the transferor must furnish the transferee a copy of this
4 part and a copy of the registration certificate form required
5 under subpart 3; or

6 (b) when the transferee receives the
7 depleted uranium under a general license issued under an NRC or
8 agreement state regulation equivalent to this part, the
9 transferor must furnish the transferee a copy of this part and a
10 copy of the registration certificate form required under subpart
11 3, accompanied by a note explaining that use of the product or
12 device is regulated by the NRC or an agreement state under
13 requirements substantially the same as those in this part; and

14 (4) within 30 days of any transfer, must report
15 in writing to the commissioner the name and address of the
16 person receiving the source material pursuant to the transfer.

17 B. A person receiving, acquiring, possessing, using,
18 or transferring depleted uranium under the general license
19 issued under subpart 1 is exempt from parts 4731.1000 to
20 4731.2950 with respect to the depleted uranium covered by the
21 general license.

22 4731.0760 SPECIFIC LICENSE; APPLICATION.

23 Subpart 1. Application generally.

24 A. An application for a specific license must be
25 filed on an application for radioactive material license form
26 prescribed by the commissioner.

27 B. An applicant may incorporate by reference

1 A. An application to possess uranium hexafluoride in
2 excess of 50 kilograms in a single container or 1,000 kilograms
3 total must contain:

4 (1) an evaluation showing that the maximum intake
5 of uranium by a member of the public due to release would not
6 exceed two milligrams; or

7 (2) an emergency plan for responding to the
8 radiological hazards of an accidental release of source material
9 and to any associated chemical hazards directly incident thereto.

10 B. One or more of the following factors may be used
11 to support an evaluation submitted under item A, subitem (1):

12 (1) all or part of the radioactive material is
13 not subject to release during an accident because of the way it
14 is stored or packaged;

15 (2) facility design or engineered safety features
16 in the facility would reduce the amount of the release; or

17 (3) other factors appropriate for the specific
18 facility.

19 C. An emergency plan submitted under item A, subitem
20 (2), must include:

21 (1) a brief description of the licensee's
22 facility and area near the site;

23 (2) identification of each type of accident for
24 which protective actions may be needed;

25 (3) a classification system for classifying
26 accidents as alert or site area emergencies;

27 (4) identification of the means of detecting each

1 type of accident in a timely manner;

2 (5) a brief description of the means and
3 equipment for mitigating the consequences of each type of
4 accident, including those provided to protect workers on-site,
5 and a description of the program for maintaining the equipment;

6 (6) a brief description of the methods and
7 equipment to assess releases of radioactive materials;

8 (7) a brief description of the responsibilities
9 of licensee personnel should an accident occur, including
10 identification of personnel responsible for promptly notifying
11 off-site response organizations and the commissioner, and the
12 responsibilities for developing, maintaining, and updating the
13 plan;

14 (8) a commitment to and a brief description of
15 the means to promptly notify the commissioner and off-site
16 response personnel and request assistance, including medical
17 assistance for the treatment of contaminated injured on-site
18 workers when appropriate. A control point must be established.
19 The notification and coordination must be planned so that
20 unavailability of some personnel, parts of the facility, and
21 equipment does not prevent notification and coordination. The
22 licensee must also commit to notifying the commissioner
23 immediately after the licensee has notified the off-site
24 response organizations and not later than one hour after the
25 licensee declares an emergency;

26 (9) a brief description of the types of
27 information on facility status, radioactive releases, and

1 recommended protective actions, if necessary, to be given to
2 off-site response organizations and to the commissioner;

3 (10) a brief description of the frequency,
4 performance objectives, and plans for the training that the
5 licensee will provide workers on how to respond to an emergency,
6 including any special instructions and orientation tours the
7 licensee would offer to fire, police, medical, and other
8 emergency personnel. The training must:

9 (a) familiarize personnel with site-specific
10 emergency procedures;

11 (b) prepare site personnel for their
12 responsibilities in the event of an accident; and

13 (c) use team training for accident scenarios
14 postulated as the most probable accidents for the specific site;

15 (11) a brief description of the means of
16 restoring the facility to a safe condition after an accident;

17 (12) provisions for conducting quarterly
18 communications checks with off-site response organizations and
19 biennial on-site exercises to test response to simulated
20 emergencies. A quarterly communications check with off-site
21 response organizations must include checking and updating all
22 necessary telephone numbers. The licensee must invite off-site
23 response organizations to participate in the biennial exercises.
24 Participation of off-site response organizations in biennial
25 exercises, although recommended, is not required. Exercises
26 must use accident scenarios postulated as most probable for the
27 specific site and the scenarios must not be known to most

1 exercise participants. The licensee must critique each exercise
2 using individuals not having direct implementation
3 responsibility for the plan. Critiques of exercises must
4 evaluate the appropriateness of the plan, emergency procedures,
5 facilities, equipment, training of personnel, and overall
6 effectiveness of the response. Deficiencies found by the
7 critiques must be corrected; and

8 (13) a certification that the applicant has met
9 its responsibilities under the Emergency Planning and Community
10 Right-to-Know Act of 1986, title III, Public Law 99-499, if
11 applicable to the applicant's activities at the proposed place
12 of use of the source material.

13 Subp. 4. Comments. A licensee must:

14 A. allow the off-site response organizations expected
15 to respond in case of an accident 60 days to comment on the
16 licensee's emergency plan before submitting it to the
17 commissioner; and

18 B. provide any comments received within the 60 days
19 to the commissioner along with the emergency plan.

20 4731.0765 SPECIFIC LICENSE; APPROVAL.

21 The commissioner shall approve an application for a
22 specific license if:

23 A. the application is for a purpose authorized under
24 this chapter;

25 B. the applicant is qualified by reason of training
26 and experience according to this chapter to use the source
27 material for the purpose requested in such manner as to protect

1 health and minimize danger to life and property;

2 C. the applicant's proposed equipment, facilities,
3 and procedures are in accordance with this chapter and are
4 adequate to protect health and minimize danger to life and
5 property; and

6 D. the applicant satisfies any applicable special
7 requirements under part 4731.0770.

8 4731.0770 SPECIFIC LICENSE; CERTAIN INDUSTRIAL PRODUCTS AND
9 DEVICES.

10 Subpart 1. License requirements. An application for a
11 specific license to manufacture industrial products and devices
12 containing depleted uranium or to initially transfer such
13 products and devices, for use according to part 4731.0750 or
14 equivalent regulations of the NRC or an agreement state, shall
15 be approved if the applicant:

16 A. satisfies the general requirements under part
17 4731.0765;

18 B. submits sufficient information relating to the
19 design, manufacture, prototype testing, quality control
20 procedures, labeling or marking, proposed uses, and potential
21 hazards of the industrial product or device to provide
22 reasonable assurance that possession, use, or transfer of the
23 depleted uranium in the product or device is not likely to cause
24 any individual to receive in one year a radiation dose in excess
25 of ten percent of the annual limits specified in part 4731.2020,
26 subpart 1; and

27 C. submits sufficient information regarding the

1 industrial product or device and the presence of depleted
2 uranium for a mass-volume application in the product or device
3 to provide reasonable assurance that unique benefits will accrue
4 to the public because of the usefulness of the product or device.

5 Subp. 2. Questionable benefits. In the case of an
6 industrial product or device whose unique benefits are
7 questionable, the commissioner shall approve an application for
8 a specific license under this part only if the product or device
9 is found to combine a high degree of utility and low probability
10 of uncontrolled disposal and dispersal of significant quantities
11 of depleted uranium into the environment.

12 Subp. 3. End uses unforeseeable. The commissioner may
13 deny an application for a specific license under this part if
14 the end uses of the industrial product or device cannot be
15 reasonably foreseen.

16 Subp. 4. License conditions. A person licensed under this
17 part must:

18 A. maintain the level of quality control required by
19 the license in the manufacture of the industrial product or
20 device and in the installation of the depleted uranium into the
21 product or device;

22 B. label or mark each unit to:

23 (1) identify:

24 (a) the manufacturer or initial transferor
25 of the product or device;

26 (b) the number of the license under which
27 the product or device was manufactured or initially transferred;

1 (c) the fact that the product or device
2 contains depleted uranium; and

3 (d) the quantity of depleted uranium in each
4 product or device; and

5 (2) state that receipt, possession, use, and
6 transfer of the product or device are subject to a general
7 license or the equivalent and to the regulations of the NRC or
8 an agreement state;

9 C. ensure that the depleted uranium, before being
10 installed in each product or device, has been impressed with the
11 following legend clearly legible through any plating or other
12 covering: "Depleted Uranium";

13 D. furnish a copy of:

14 (1) the general license issued under part
15 4731.0750 and a copy of NRC Form 244 to each person to whom the
16 licensee transfers source material in a product or device for
17 use according to the general license issued under part
18 4731.0750;

19 (2) the general license issued under an NRC or
20 agreement state regulation equivalent to part 4731.0750 and a
21 copy of the NRC or agreement state certificate; or

22 (3) the general license issued under part
23 4731.0750 and a copy of NRC Form 244 to each person to whom the
24 licensee transfers source material in a product or device for
25 use according to a general license of the NRC or an agreement
26 state, accompanied by a note explaining that use of the product
27 or device is regulated by the NRC or an agreement state under

1 requirements substantially the same as those in part 4731.0750;
2 and

3 E. report to the commissioner all transfers of
4 industrial products or devices to persons for use under the
5 general license issued under part 4731.0750. The report must be
6 submitted within 30 days after the end of each calendar quarter
7 in which the product or device is transferred to a generally
8 licensed person. If no transfers have been made to a person
9 generally licensed under part 4731.0750 during the reporting
10 period, the report must so indicate. The report must identify:

11 (1) each general licensee by name and address;

12 (2) an individual by name or position who may
13 constitute a point of contact between the commissioner and the
14 general licensee;

15 (3) the type and model number of the device
16 transferred; and

17 (4) the quantity of depleted uranium contained in
18 the product or device.

19 Subp. 5. Record keeping. A licensee must keep records for
20 three years from the date of transfer showing:

21 A. the name, address, and point of contact for each
22 general licensee to whom the licensee transfers depleted uranium
23 in industrial products or devices for use according to the
24 general license issued under part 4731.0750 or equivalent
25 regulations of the NRC or an agreement state;

26 B. the date of each transfer;

27 C. the quantity of depleted uranium in each product

1 or device transferred; and

2 D. compliance with the report requirements of this
3 part.

4 Subp. 6. Emergency plan. A licensee that is required to
5 submit an emergency plan under part 4731.0760 must follow the
6 emergency plan approved by the commissioner. The licensee:

7 A. may change the plan without commissioner approval
8 if the changes do not decrease the effectiveness of the plan;

9 B. must furnish the change to the commissioner within
10 six months after the change is made; and

11 C. may not implement proposed changes that decrease
12 the effectiveness of the approved emergency plan without prior
13 application to and prior approval by the commissioner.

14 4731.0780 FINANCIAL ASSURANCE AND RECORD KEEPING FOR
15 DECOMMISSIONING.

16 Subpart 1. Applicability. This part establishes criteria
17 for providing financial assurance for decommissioning, except
18 for licenses authorizing the receipt, possession, and use of
19 source material for uranium or thorium milling or radioactive
20 material at sites formerly associated with such milling, for
21 which financial assurance requirements are set forth in part
22 4731.0580.

23 Subp. 2. More than 100 mCi. An applicant for a specific
24 license authorizing the possession and use of more than 100
25 millicuries (3.7 GBq) of source material in a readily
26 dispersible form must submit a decommissioning funding plan
27 according to subpart 4.

1 Subp. 3. Between ten mCi and 100 mCi.

2 A. An applicant for a specific license authorizing
3 possession and use of quantities of source material greater than
4 ten millicuries (370 MBq) but less than or equal to 100
5 millicuries (3.7 GBq) in a readily dispersible form must:

6 (1) submit a decommissioning funding plan
7 according to subpart 4; or

8 (2) submit a certification that financial
9 assurance for decommissioning has been provided in the amount of
10 \$225,000, using one of the methods described under subpart 5.

11 The certification must state that the appropriate assurance will
12 be obtained after the application has been approved and the
13 license issued but before the receipt of licensed material.

14 B. An applicant may:

15 (1) defer execution of the financial instrument
16 until after the license has been issued, at which time a signed
17 original of the financial instrument obtained to satisfy the
18 requirements of subpart 5 must be submitted to the commissioner
19 before receipt of licensed material; or

20 (2) not defer execution of the financial
21 instrument and, at the time of application, must submit to the
22 commissioner, as part of the certification, a signed original of
23 the financial instrument obtained to satisfy the requirements of
24 subpart 5.

25 C. A holder of a specific license:

26 (1) issued on or after July 27, 1990, which is
27 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 decommissioning funding plan must contain:

A. a cost estimate for decommissioning and a description of the method of assuring funds for decommissioning from subpart 5, including means of adjusting cost estimates and associated funding levels periodically over the life of the facility. Cost estimates must be adjusted at intervals not to exceed three years; and

B. a certification by the licensee that financial assurance for decommissioning has been provided in the amount of the cost estimate for decommissioning. A signed original of the financial instrument obtained to satisfy the requirements of subpart 5 must accompany the certification.

Subp. 5. Financial assurance requirements.

A. Financial assurance for decommissioning must be provided by one of the methods described in items B to F.

1 B. Prepayment is the deposit prior to the start of
2 operation into an account segregated from licensee assets and
3 outside the licensee's administrative control of cash or liquid
4 assets such that the amount of funds would be sufficient to pay
5 decommissioning costs. Prepayment may be in the form of a
6 trust, escrow account, government fund, certificate of deposit,
7 or deposit of government securities.

8 C. A surety method, insurance, or other guarantee
9 method guarantees that decommissioning costs will be paid. A
10 surety method may be in the form of a surety bond, letter of
11 credit, or line of credit. A parent company guarantee of funds
12 for decommissioning costs based on a financial test may be used
13 if the guarantee and test comply with part 4731.3155, but may
14 not be used in combination with other financial methods to
15 satisfy the requirements of this part. For commercial
16 corporations that issue bonds, a guarantee of funds by the
17 applicant or licensee for decommissioning costs based on a
18 financial test may be used if the guarantee and test comply with
19 part 4731.3165. For commercial corporations that do not issue
20 bonds, a guarantee of funds by the applicant or licensee for
21 decommissioning costs may be used if the guarantee and test
22 comply with part 4731.3170. For nonprofit entities, such as
23 colleges, universities, and nonprofit hospitals, a guarantee of
24 funds by the applicant or licensee may be used if the guarantee
25 and test comply with part 4731.3175. A guarantee by the
26 applicant or licensee may not be used in combination with other
27 financial methods used to satisfy this part or in any situation

1 where the applicant or licensee has a parent company holding
2 majority control of the voting stock of the company. Any surety
3 method or insurance used to provide financial assurance for
4 decommissioning must:

5 (1) be open-ended or, if written for a specified
6 term, such as five years, must be renewed automatically unless
7 90 days or more before the renewal date, the issuer notifies the
8 commissioner, the beneficiary, and the licensee of its intention
9 not to renew;

10 (2) provide that the full face amount be paid to
11 the beneficiary automatically before the expiration without
12 proof of forfeiture if the licensee fails to provide a
13 replacement acceptable to the commissioner within 30 days after
14 receipt of notification of cancellation;

15 (3) be payable to a trust established for
16 decommissioning costs. The trustee and trust must be acceptable
17 to the commissioner. An acceptable trustee includes an
18 appropriate state or federal government agency or an entity that
19 has authority to act as a trustee and whose trust operations are
20 regulated and examined by a federal or state agency; and

21 (4) remain in effect until the commissioner
22 terminates the license.

23 D. An external sinking fund in which deposits are
24 made at least annually, coupled with a surety method or
25 insurance, the value of which may decrease by the amount being
26 accumulated in the sinking fund, may be used as a method of
27 financial assurance. The surety or insurance provisions must be

1 as stated in item C. An external sinking fund:

2 (1) is a fund established and maintained by
3 setting aside funds periodically in an account segregated from
4 licensee assets and outside the licensee's administrative
5 control in which the total amount of funds would be sufficient
6 to pay decommissioning costs at the time termination of
7 operation is expected; and

8 (2) may be in the form of a trust, escrow
9 account, government fund, certificate of deposit, or deposit of
10 government securities.

11 E. In the case of federal, state, or local government
12 licensees, a statement of intent containing a cost estimate for
13 decommissioning or an amount according to subpart 3 and
14 indicating that funds for decommissioning will be obtained when
15 necessary may be used as a method of financial assurance.

16 F. When a governmental entity assumes custody and
17 ownership of a site, an arrangement that is deemed acceptable by
18 the governmental entity may be used as a method of financial
19 assurance.

20 Subp. 6. Record keeping.

21 A. A licensee must keep records of information
22 important to the decommissioning of a facility in an identified
23 location until the site is released for unrestricted use.

24 B. Before licensed activities are transferred or
25 assigned according to part 4731.0785, subpart 1, item A, a
26 licensee must transfer all records described in this subpart to
27 the new licensee. The new licensee is responsible for

1 maintaining the records until the license is terminated.

2 C. If records important to the decommissioning of a
3 facility are kept for other purposes, reference to the records
4 and their location may be used.

5 D. Information the commissioner considers important
6 to decommissioning are:

7 (1) records of spills or other unusual
8 occurrences involving the spread of contamination in and around
9 the facility, equipment, or site, which:

10 (a) may be limited to instances when
11 contamination remains after cleanup procedures or when there is
12 reasonable likelihood that contaminants may have spread to
13 inaccessible areas, as in the case of possible seepage into
14 porous materials such as concrete; and

15 (b) must include any known information on
16 identification of involved nuclides, quantities, forms, and
17 concentrations;

18 (2) as-built drawings and modifications of
19 structures and equipment in restricted areas where radioactive
20 materials are used or stored and of locations of possible
21 inaccessible contamination, such as buried pipes, that may be
22 subject to contamination. If required drawings are referenced,
23 each relevant document need not be indexed individually. If
24 drawings are not available, the licensee must substitute
25 appropriate records of available information concerning these
26 areas and locations;

27 (3) a list of the following, contained in a

1 single document and updated every two years:

2 (a) all areas designated and formerly
3 designated as restricted areas;

4 (b) all areas outside of restricted areas
5 that require documentation under subitem (1);

6 (c) all areas outside of restricted areas
7 where current and previous wastes have been buried as documented
8 under part 4731.2560; and

9 (d) all areas outside of restricted areas
10 that contain material such that, if the license expired, the
11 licensee would be required to either decontaminate the area to
12 meet the criteria for decommissioning under part 4731.2100 or
13 apply for approval for disposal under part 4731.2410; and

14 (4) records of:

15 (a) the cost estimate performed for the
16 decommissioning funding plan or of the amount certified for
17 decommissioning; and

18 (b) the funding method used for assuring
19 funds if either a funding plan or certification is used.

20 4731.0785 LICENSE CONDITIONS.

21 Subpart 1. Required conditions. A specific license issued
22 under parts 4731.0700 to 4731.0840 must contain and be subject
23 to the following conditions:

24 A. neither the license nor any right under the
25 license shall be assigned or otherwise transferred in violation
26 of this chapter; and

27 B. the license is subject to and the licensee must

1 observe, all applicable rules and orders of the commissioner.

2 Subp. 2. Scope of license. A person licensed by the
3 commissioner under parts 4731.0700 to 4731.0840 must confine the
4 licensee's possession and use of radioactive material to the
5 locations and purposes authorized in the license. Except as
6 otherwise provided in the license, a license issued under parts
7 4731.0700 to 4731.0840 carries with it the right to receive,
8 possess, and use radioactive material. Preparation for shipment
9 and transport of radioactive material must be according to this
10 chapter.

11 Subp. 3. Bankruptcy.

12 A. A licensee under parts 4731.0700 to 4731.0840 must
13 notify the commissioner, in writing, immediately following the
14 filing of a voluntary or involuntary petition for bankruptcy
15 under any chapter of United States Code, title 11, by or against:

16 (1) the licensee;

17 (2) an entity, which includes a person, estate,
18 trust, governmental unit, or United States trustee, that
19 controls the licensee or lists the license or licensee as
20 property; or

21 (3) an affiliate of the licensee, as defined
22 under United States Code, chapter 11, section 101, clause (2).

23 B. The bankruptcy notification must indicate the
24 bankruptcy court in which the petition for bankruptcy was filed
25 and the date of the filing of the petition.

26 Subp. 4. Additional conditions. The commissioner may
27 incorporate in any license, at the time of issuance or

1 thereafter by appropriate rule or order, such additional
2 conditions and requirements with respect to the licensee's
3 receipt, possession, use, and transfer of source or radioactive
4 material as the commissioner deems appropriate or necessary to
5 protect health or to minimize danger to life or property.

6 Subp. 5. Additional requirements. The commissioner may
7 require reports, record keeping, and inspections of activities
8 under the license as may be necessary or appropriate to
9 effectuate the purposes of this chapter.

10 4731.0790 LICENSE EXPIRATION AND TERMINATION; DECOMMISSIONING.

11 Subpart 1. Expiration. Except as provided in this
12 subpart, a specific license issued under parts 4731.0700 to
13 4731.0840 expires at the end of the day on the expiration date
14 stated in the license, unless the licensee has filed an
15 application for renewal not less than 30 days before the
16 expiration date stated in the existing license. If an
17 application for renewal has been filed at least 30 days before
18 the expiration date stated in the existing license, the existing
19 license expires at the end of the day on which the commissioner
20 makes a final determination to deny the renewal application or,
21 if the determination states an expiration date, the expiration
22 date stated in the determination.

23 Subp. 2. Revocation. A specific license revoked by the
24 commissioner expires at the end of the day on the date of the
25 commissioner's final determination to revoke the license, on the
26 expiration date stated in the determination, or as otherwise
27 provided by a commissioner's order.

1 Subp. 3. Termination notice. A specific license continues
2 in effect, beyond the expiration date if necessary, with respect
3 to possession of source material, until the commissioner
4 notifies the licensee in writing that the license is
5 terminated. During this time, the licensee must:

6 A. limit actions involving source material to those
7 related to decommissioning; and

8 B. continue to control entry to restricted areas
9 until they are suitable for release according to this chapter.

10 Subp. 4. Decommissioning.

11 A. Within 60 days of any of the occurrences
12 under item B, a licensee must provide notification to the
13 commissioner in writing of such occurrence and:

14 (1) begin decommissioning the licensee's site or
15 any separate building or outdoor area that contains residual
16 radioactivity so that the building or outdoor area is suitable
17 for release according to this chapter; or

18 (2) submit within 12 months of notification a
19 decommissioning plan, if required under item E or F, and begin
20 decommissioning upon approval of that plan.

21 B. Notice under item A is required when:

22 (1) the license has expired under subpart 1 or 2;

23 (2) the licensee has decided to permanently cease
24 principal activities at the entire site or in any separate
25 building or outdoor area;

26 (3) no principal activities have been conducted
27 under the license for a period of 24 months; or

1 (4) no principal activities have been conducted
2 for a period of 24 months in any separate building or outdoor
3 area that contains residual radioactivity such that the building
4 or outdoor area is unsuitable for release according to this
5 chapter.

6 C. Coincident with the notification required under
7 item A, the licensee must maintain in effect all decommissioning
8 financial assurances established by the licensee under part
9 4731.0780 in conjunction with license issuance or renewal or as
10 required under this part. The amount of the financial assurance
11 must be increased, or may be decreased, as appropriate, to cover
12 the detailed cost estimate for decommissioning established under
13 item H, subitem (5). Following approval of the decommissioning
14 plan, a licensee may reduce the amount of the financial
15 assurance as decommissioning proceeds and radiological
16 contamination is reduced at the site with the approval of the
17 commissioner.

18 D. The commissioner may grant a request to delay or
19 postpone initiation of the decommissioning process if the
20 commissioner determines that this relief is not detrimental to
21 the public health and safety and is otherwise in the public
22 interest. The request must be submitted no later than 30 days
23 before notification under item A. The schedule for
24 decommissioning in this subpart may not commence until the
25 commissioner has made a determination on the request.

26 E. A decommissioning plan must be submitted if:

27 (1) required by a license condition; or

1 (2) the procedures and activities necessary to
2 carry out decommissioning of the site or separate building or
3 outdoor area have not been previously approved by the
4 commissioner and the procedures could increase potential health
5 and safety impacts to workers or the public, such as in any of
6 the following cases:

7 (a) procedures would involve techniques not
8 routinely applied during cleanup and maintenance operations;

9 (b) workers would be entering areas not
10 normally occupied where surface contamination and radiation
11 levels are significantly higher than routinely encountered
12 during operation;

13 (c) procedures could result in significantly
14 greater airborne concentrations of radioactive materials than
15 are present during operation; or

16 (d) procedures could result in significantly
17 greater releases of radioactive material to the environment than
18 those associated with operation.

19 F. The commissioner may approve an alternate schedule
20 for submittal of a decommissioning plan required under this
21 subpart if the commissioner determines that the alternative
22 schedule is necessary to the effective conduct of
23 decommissioning operations and presents no undue risk from the
24 radiation to the public health and safety and is otherwise in
25 the public interest.

26 G. The procedures under item E, subitem (2), may not
27 be performed before approval of the decommissioning plan.

1 H. The proposed decommissioning plan for the site or
2 separate building or outdoor area must include:

3 (1) a description of the conditions of the site
4 or separate building or outdoor area sufficient to evaluate the
5 acceptability of the plan;

6 (2) a description of planned decommissioning
7 activities;

8 (3) a description of the methods used to ensure
9 protection of workers and the environment against radiation
10 hazards during decommissioning;

11 (4) a description of the planned final radiation
12 survey;

13 (5) an updated detailed cost estimate for
14 decommissioning, comparison of that estimate with present funds
15 set aside for decommissioning, and a plan for ensuring the
16 availability of adequate funds for completion of
17 decommissioning; and

18 (6) for decommissioning plans calling for
19 completion of decommissioning later than 24 months after plan
20 approval, a justification for the delay based on the criteria in
21 item K.

22 I. The commissioner shall approve a proposed
23 decommissioning plan if the information in the plan demonstrates
24 that the decommissioning will be completed as soon as
25 practicable and that the health and safety of workers and the
26 public will be adequately protected.

27 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

1 agencies, lawsuits, groundwater treatment activities, monitored
2 natural groundwater restoration, actions that could result in
3 more environmental harm than deferring clean up, and other
4 factors beyond the control of the licensee.

5 L. As the final step in decommissioning, the licensee
6 must:

7 (1) certify the disposition of all licensed
8 material, including accumulated wastes, by submitting a
9 completed NRC Form 314 or equivalent information; and

10 (2) conduct a radiation survey of the premises
11 where the licensed activities were carried out and submit a
12 report of the results of the survey, unless the licensee
13 demonstrates in some other manner that the premises are suitable
14 for release according to part 4731.2100. The licensee must, as
15 appropriate:

16 (a) for gamma radiation, report levels of
17 radiation in units of microroentgens (millisieverts) per hour at
18 one meter from surfaces;

19 (b) for radioactivity, including alpha and
20 beta radiation, report levels of radiation in units of
21 disintegrations per minute or microcuries (megabecquerels) per
22 100 square centimeters removable and fixed for surfaces,
23 microcuries (megabecquerels) per milliliter for water, and
24 picocuries (becquerels) per gram for solids such as soils or
25 concrete; and

26 (c) specify the survey instruments used and
27 certify that each instrument is properly calibrated and tested.

1 M. Specific licenses, including expired licenses,
2 shall be terminated by written notice to the licensee when the
3 commissioner determines that:

4 (1) source material has been properly disposed
5 of;

6 (2) reasonable effort has been made to eliminate
7 residual radioactive contamination, if present;

8 (3) a radiation survey has been performed that
9 demonstrates, or other information submitted by the licensee is
10 sufficient to demonstrate, that the premises are suitable for
11 release according to part 4731.2100; and

12 (4) records required under part 4731.0825,
13 subparts 4 and 6, have been received.

14 Subp. 5. Exemptions. Specific licenses for uranium and
15 thorium milling are ~~except~~ exempt from subpart 4, items B,
16 subitem (4), and D to I, with respect to reclamation of tailings
17 impoundments and waste disposal areas.

18 4731.0795 LICENSE RENEWAL AND AMENDMENT.

19 Subpart 1. Renewal application. Applications for renewal
20 of a specific license must be filed on an application for
21 radioactive material license form, as prescribed by the
22 commissioner, according to part 4731.0760.

23 Subp. 2. Amendment applications. Applications for
24 amendment of a license must be filed on an application for
25 radioactive material license form, as prescribed by the
26 commissioner, according to part 4731.0760 and must specify the
27 respects in which the licensee desires the license to be amended

1 and the grounds for the amendment.

2 Subp. 3. Consideration criteria. In considering an
3 application by a licensee to renew or amend a license, the
4 commissioner shall apply the criteria under part 4731.0765.

5 4731.0810 INALIENABILITY OF LICENSES.

6 No license issued or granted under parts 4731.0700 to
7 4731.0840 shall be transferred, assigned, or in any manner
8 disposed of, either voluntarily or involuntarily, directly or
9 indirectly, through transfer of control of a license to a person
10 unless the commissioner, after securing full information, finds
11 that the transfer is in accordance with this chapter and gives
12 consent in writing.

13 4731.0815 TRANSFER OF RADIOACTIVE MATERIAL.

14 Subpart 1. Authorization required. No licensee shall
15 transfer radioactive material except as authorized under this
16 part.

17 Subp. 2. Approved transfer. Except as otherwise provided
18 in a license and subject to subpart 3, a licensee may transfer
19 radioactive material:

20 A. to the United States Department of Energy;

21 B. to the agency in an agreement state that regulates
22 radioactive material;

23 C. to a person exempt from parts 4731.0700 to
24 4731.0840, to the extent permitted under the exemption;

25 D. to a person in an agreement state, subject to the
26 jurisdiction of that state, who has been exempted from licensing

1 requirements of that state, to the extent permitted under the
2 exemption;

3 E. to a person authorized to receive radioactive
4 material under terms of a specific license or a general license
5 or their equivalents issued by the commissioner, the NRC, or an
6 agreement state; or

7 F. as otherwise authorized by the commissioner in
8 writing.

9 Subp. 3. Verification for transfer.

10 A. Before transferring radioactive material to a
11 specific licensee of the commissioner, the NRC, an agreement
12 state, or a licensing state or to a general licensee who is
13 required to register with the commissioner, the NRC, an
14 agreement state, or a licensing state before receipt of the
15 radioactive material, the licensee transferring radioactive
16 material must verify that the transferee's license authorizes
17 the receipt of the type, form, and quantity of radioactive
18 material to be transferred.

19 B. Any of the following methods of verification are
20 acceptable:

21 (1) the transferor may possess and read a current
22 copy of the transferee's specific license or general license
23 registration certificate. The transferor must retain a copy of
24 each license or certificate until the next inspection;

25 (2) the transferor may possess a written
26 certification by the transferee that the transferee is
27 authorized by license or registration certificate to receive the

1 type, form, and quantity of radioactive material to be
2 transferred, specifying:

3 (a) the license or registration certificate
4 number;

5 (b) the issuing agency; and

6 (c) the expiration date.

7 The transferor must retain the written certification as a record
8 for three years from the date of receipt of the certification;
9 or

10 (3) for emergency shipments, the transferor may
11 accept oral certification by the transferee that the transferee
12 is authorized by license or registration certificate to receive
13 the type, form, and quantity of radioactive material to be
14 transferred, specifying:

15 (a) the license or registration certificate
16 number;

17 (b) the issuing agency; and

18 (c) the expiration date.

19 The oral certification must be confirmed in writing within ten
20 days. The transferor must retain the written confirmation of
21 the oral certification for three years from the date of receipt
22 of the confirmation.

23 Subp. 4. Other sources of information. The transferor may
24 obtain other information compiled by a reporting service from
25 official records of the commissioner, the NRC, or the licensing
26 agency of an agreement state or licensing state regarding the
27 identity of licensees or registrants and the scope and

1 expiration dates of the licenses and registrations, to verify
2 that the transferee is licensed or registered to receive the
3 radioactive material.

4 Subp. 5. Confirmation. The transferor may obtain and
5 record confirmation from the commissioner, the NRC, or the
6 licensing agency of an agreement state or licensing state that
7 the transferee is licensed to receive the radioactive material:

8 A. when none of the methods of verification described
9 in subparts 3 and 4 are readily available; or

10 B. when a transferor desires to verify that
11 information received by one of the verification methods is
12 correct or up-to-date.

13 4731.0820 REPORTING REQUIREMENTS.

14 Subpart 1. Immediate notification required. A licensee
15 must notify the commissioner as soon as possible but not later
16 than four hours after the discovery of an event that prevents
17 immediate protective actions necessary to avoid exposures to
18 radiation or radioactive materials that could exceed regulatory
19 limits or releases of licensed material that could exceed
20 regulatory limits. Reportable events under this subpart include
21 fires, explosions, toxic gas release, or similar hazards.

22 Subp. 2. 24-hour notification required. A licensee must
23 notify the commissioner within 24 hours after discovery of any
24 of the following events involving licensed material:

25 A. an unplanned contamination event that:

26 (1) requires access to the contaminated area, by
27 workers or the public, to be restricted for more than 24 hours

1 by imposing additional radiological controls or by prohibiting
2 entry into the areas;

3 (2) involves a quantity of material greater than
4 five times the lowest annual limit on intake specified in part
5 4731.2750 for the material; and

6 (3) restricts access to the area for a reason
7 other than to allow isotopes with a half-life of less than 24
8 hours to decay prior to decontamination;

9 B. an event in which equipment is disabled or fails
10 to function as designed when:

11 (1) the equipment is required by rule or license
12 condition to prevent releases exceeding regulatory limits, to
13 prevent exposure to radiation and radioactive materials
14 exceeding regulatory limits, or to mitigate the consequences of
15 an accident;

16 (2) the equipment is required to be available and
17 operable when it is disabled or fails to function; and

18 (3) no redundant equipment is available and
19 operable to perform the required safety function;

20 C. an event that requires unplanned medical treatment
21 at a medical facility of an individual with spreadable
22 radioactive contamination on the individual's clothing or body;
23 or

24 D. an unplanned fire or explosion that damages any
25 licensed material or any device, container, or equipment
26 containing licensed materials when:

27 (1) the quantity of material involved is greater

1 than five times the lowest annual limit on intake under part
2 4731.2750 for the material; and

3 (2) the damage affects the integrity of the
4 licensed material or its container.

5 Subp. 3. Preparation and submission of reports.

6 A. A licensee must make reports required under
7 subparts 1 and 2 by telephone to the commissioner. To the
8 extent that the information is available at the time of
9 notification, the information provided in the report must
10 include:

11 (1) the caller's name and call-back telephone
12 number;

13 (2) a description of the event, including date
14 and time;

15 (3) the exact location of the event;

16 (4) the isotopes, quantities, and chemical and
17 physical form of the licensed material involved; and

18 (5) any personnel radiation exposure data
19 available.

20 B. A licensee that makes a report required under
21 subpart 1 or 2 must submit a written follow-up report within 30
22 days of the initial notification. Written reports prepared as
23 required by other rules may be submitted to fulfill this
24 requirement if the reports contain all of the necessary
25 information and the appropriate distribution is made. The
26 written reports must be sent to the commissioner. The reports
27 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.

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.

1 D. A licensee must retain each record of disposal of
2 radioactive material until the commissioner terminates each
3 license that authorizes the activity that is subject to the
4 record-keeping requirement.

5 E. If radioactive material is combined or mixed with
6 other licensed material and subsequently treated in a manner
7 that makes direct correlation of a receipt record with a
8 transfer, export, or disposition record impossible, a licensee
9 may use evaluative techniques, such as first-in-first-out, to
10 make the records that are required by this part account for 100
11 percent of the material received.

12 Subp. 2. Retention.

13 A. A licensee must retain each record that is
14 required by this part or by license condition for the period
15 specified by the appropriate rule or license condition. If a
16 retention period is not otherwise specified by rule or license
17 condition, each record must be maintained until the commissioner
18 terminates the license that authorizes the activity that is
19 subject to the record-keeping requirement.

20 B. If there is a conflict between this chapter, a
21 license condition, or other written commissioner approval or
22 authorization pertaining to the retention period for the same
23 type of record, the retention period specified in this chapter
24 applies unless the commissioner, under part 4731.0730, has
25 granted a specific exemption from the record retention
26 requirements specified in this chapter.

27 Subp. 3. Format.

1 A. Records that must be maintained according to this
2 chapter may be the original or a reproduced copy or microform if
3 the reproduced copy or microform is duly authenticated by
4 authorized personnel and the microform is capable of producing a
5 clear and legible copy after storage for the period specified by
6 this chapter.

7 B. Records may also be stored in electronic media
8 with the capability for producing legible, accurate, and
9 complete records during the required retention period.

10 C. Records such as letters, drawings, or
11 specifications must include all pertinent information such as
12 stamps, initials, and signatures.

13 D. A licensee must maintain adequate safeguards
14 against tampering with and loss of records.

15 Subp. 4. Transfer to commissioner. Prior to license
16 termination, a licensee authorized to possess source material,
17 in an unsealed form, must forward the following records to the
18 commissioner:

19 A. records of disposal of licensed material made
20 under parts 4731.2410 to 4731.2440; and

21 B. records required under part 4731.2510, subpart 2,
22 item D.

23 Subp. 5. Transfer to new licensee. If licensed activities
24 are transferred or assigned under part 4731.0785, a licensee
25 authorized to possess source material in an unsealed form must
26 transfer the following records to the new licensee and the new
27 licensee is responsible for maintaining the records until the

1 license is terminated:

2 A. records of disposal of licensed material made
3 under parts 4731.2410 to 4731.2440; and

4 B. records required under part 4731.2510, subpart 2,
5 item D.

6 Subp. 6. Decommissioning records. Prior to license
7 termination, a licensee must forward the records required under
8 part 4731.0780, subpart 6, to the commissioner.

9 4731.0830 INSPECTIONS AND TESTS.

10 Subpart 1. Material and premises inspection. A licensee
11 or registrant must afford to the commissioner at all reasonable
12 times opportunity to inspect radioactive material and the
13 premises and facilities wherein radioactive material is used or
14 stored.

15 Subp. 2. Record inspection. A licensee or registrant must
16 make available to the commissioner for inspection, upon
17 reasonable notice, records kept by the licensee as required
18 under this chapter.

19 Subp. 3. Radioactive materials inspection. The
20 commissioner shall perform inspections to ensure the radiation
21 sources and radioactive materials are used only as specified in
22 this chapter. Inspections for radioactive materials may be
23 announced or unannounced.

24 Subp. 4. Testing.

25 A. A licensee or registrant must perform, or permit
26 the commissioner to perform, such tests as the commissioner
27 deems appropriate or necessary for the administration of parts

1 4731.0700 to 4731.0840, including tests of:

2 (1) radioactive material;

3 (2) facilities wherein radioactive material is
4 utilized or stored;

5 (3) radiation detection and monitoring
6 instruments; and

7 (4) other equipment and devices used in
8 connection with the utilization or storage of radioactive
9 material.

10 B. A licensee or registrant must also permit the
11 commissioner to perform such tests as are deemed necessary to
12 determine compliance with this chapter.

13 4731.0840 MODIFICATION AND REVOCATION OF LICENSES.

14 The terms and conditions of each license issued under parts
15 4731.0700 to 4731.0840 are subject to amendment, revision, or
16 modification by reason of this chapter or orders issued by the
17 commissioner, according to part 4731.0270.

18 STANDARDS FOR PROTECTION AGAINST RADIATION

19 4731.1000 SCOPE; NOTICES, INSTRUCTIONS, REPORTS.

20 Parts 4731.1000 to 4731.1090 apply to all persons who
21 receive, possess, use, or transfer material licensed by the
22 commissioner under this chapter. Parts 4731.1000 to 4731.1090
23 establish requirements for notices, instructions, and reports by
24 licensees to individuals participating in licensed activities
25 and options available to these individuals in connection with
26 commissioner inspections of licensees to ascertain compliance

1 with this chapter and orders and licenses issued thereunder
2 regarding radiological working conditions. Parts 4731.1000 to
3 4731.1090 also establish the rights and responsibilities of the
4 commissioner and individuals during interviews, inspections, or
5 investigations according to part 4731.1060 on any matter within
6 the commissioner's jurisdiction.

7 4731.1010 POSTING WORKER NOTICES.

8 Subpart 1. Required postings.

9 A. A licensee must post current copies of the
10 following documents:

11 (1) parts 4731.2000 to 4731.2900;

12 (2) the license, license conditions, and
13 documents incorporated into the license by reference and
14 amendments thereto;

15 (3) the operating procedures applicable to
16 licensed activities; and

17 (4) any notice of violation involving
18 radiological working conditions, proposed imposition of civil
19 penalty, or order issued under part 4731.1090 and any response
20 from the licensee.

21 B. If posting of a document specified in item A,
22 subitems (1) to (3), is not practicable, a licensee may post a
23 notice that describes the document and states where it may be
24 examined.

25 Subp. 2. Notice to employees. Each licensee and each
26 applicant for a specific license must prominently post a MDH
27 Form 3, "Notice to Employees," provided by the commissioner. A

1 copy of any revision of the Notice to Employees must be posted
2 within 30 days of receiving the revised notice from the
3 commissioner. Copies of the Notice to Employees may be obtained
4 by writing to the Radioactive Materials Unit, Minnesota
5 Department of Health, or found on-line at
6 [http://www.health.state.mn/divs/eh/radiation/radioactive/](http://www.health.state.mn/divs/eh/radiation/radioactive/index.html)
7 [index.html](http://www.health.state.mn/divs/eh/radiation/radioactive/index.html).

8 Subp. 3. Posting locations. Documents, notices, or forms
9 posted according to this part must:

10 A. appear in a sufficient number of places to permit
11 individuals engaged in licensed activities to observe them on
12 the way to or from any particular licensed activity location to
13 which the document applies;

14 B. be conspicuous; and

15 C. be replaced if defaced or altered.

16 Subp. 4. Notice of violation. Documents posted according
17 to subpart 1, item A, subitem (4), must be posted within two
18 working days after receipt of the documents from the
19 commissioner. A licensee's response, if any, must be posted
20 within two working days after dispatch by the licensee. The
21 documents must remain posted for a minimum of five working days
22 or until action correcting the violation is completed, whichever
23 is later.

24 4731.1020 WORKER INSTRUCTIONS.

25 Subpart 1. Required instruction. All individuals who, in
26 the course of employment, are likely to receive in a year an
27 occupational dose in excess of 100 millirems (1 mSv) must be:

1 A. kept informed of the storage, transfer, or use of
2 radiation and radioactive material;

3 B. instructed in the health protection problems
4 associated with exposure to radiation and radioactive material,
5 in precautions or procedures to minimize exposure, and in the
6 purposes and functions of protective devices employed;

7 C. instructed in and required to observe, to the
8 extent within the worker's control, the applicable provisions of
9 this chapter and the license that protect personnel from
10 exposure to radiation and radioactive material;

11 D. instructed of their responsibility to report
12 promptly to the licensee any condition that may lead to or cause
13 a violation of this chapter or the license or any unnecessary
14 exposure to radiation or radioactive material;

15 E. instructed in the appropriate response to warnings
16 made in the event of any unusual occurrence or malfunction that
17 may involve exposure to radiation or radioactive material; and

18 F. advised as to the radiation exposure reports that
19 workers may request according to part 4731.1030.

20 Subp. 2. Applicability. In determining which individuals
21 are subject to subpart 1, a licensee must take into
22 consideration an individual's assigned activities during normal
23 and abnormal situations involving exposure to radiation or
24 radioactive material that can reasonably be expected to occur
25 during the life of a licensed facility. The extent of the
26 instructions must be commensurate with potential radiological
27 health protection problems present in the workplace.

1 4731.1030 EXPOSURE NOTIFICATIONS AND REPORTS.

2 Subpart 1. Exposure data notification.

3 A. Radiation exposure data for an individual and the
4 results of any measurements, analyses, and calculations of
5 radioactive material deposited or retained in the body of an
6 individual must be reported to the individual as specified in
7 this part.

8 B. The information reported must include data and
9 results obtained pursuant to this chapter, commissioner's
10 orders, or license conditions, as shown in records maintained by
11 the licensee according to this chapter.

12 C. Each notification and report to the individual
13 must:

14 (1) be in writing;

15 (2) include appropriate identifying data such as
16 the name of the licensee, the name of the individual, and the
17 individual's social security number;

18 (3) include the individual's exposure
19 information; and

20 (4) contain the following statement: "This
21 report is furnished to you under Minnesota Rules, chapter 4731.
22 You should preserve this report for further reference."

23 Subp. 2. Frequency of report. A licensee must annually
24 advise each worker of the worker's dose as shown in records
25 maintained by the licensee according to part 4731.2540.

26 Subp. 3. Report to former employee; report to commissioner.

27 A. At the request of a worker formerly engaged in

1 licensed activities controlled by the licensee, a licensee must
2 furnish to the worker a report of the worker's exposure to
3 radiation and radioactive material:

4 (1) as shown in records maintained by the
5 licensee according to part 4731.2540 for each year the worker
6 was required to be monitored under part 4731.2210; and

7 (2) for each year the worker was required to be
8 monitored under the monitoring requirements in effect before
9 January 1, 1994.

10 B. The report under item A must:

11 (1) be furnished within 30 days from the time the
12 request is made or within 30 days after the exposure of the
13 individual has been determined by the licensee, whichever is
14 later;

15 (2) cover the period of time that the worker's
16 activities involved exposure to radiation from radioactive
17 material licensed by the commissioner; and

18 (3) include the dates and locations of licensed
19 activities in which the worker participated during this period.

20 C. When a licensee is required under part 4731.2610,
21 4731.2620, 4731.2630, or 4731.2650 to report to the commissioner
22 any exposure of an individual to radiation or radioactive
23 material, the licensee must also provide the individual a report
24 on the individual's exposure data contained therein. The report
25 must be transmitted to the individual no later than the
26 transmittal to the commissioner.

27 Subp. 4. Report upon termination. At the request of a

1 worker who is terminating employment with the licensee that
2 involved exposure to radiation or radioactive materials during
3 the current calendar quarter or the current year, a licensee
4 must provide at termination to each worker, or to the worker's
5 designee, a written report regarding the radiation dose received
6 by that worker from operations of the licensee during the
7 current year or fraction thereof. If the most recent individual
8 monitoring results are not available at that time, a written
9 estimate of the dose must be provided together with a clear
10 indication that this is an estimate.

11 4731.1040 INSPECTIONS; PRESENCE OF REPRESENTATIVES.

12 A. A licensee must afford to the commissioner at all
13 reasonable times opportunity to inspect materials, activities,
14 facilities, premises, and records according to this chapter.

15 B. During an inspection, the commissioner's
16 inspectors may consult privately with workers according to part
17 4731.1050. The licensee or licensee's representative may
18 accompany the commissioner's inspectors during other phases of
19 an inspection.

20 C. If, at the time of inspection, an individual has
21 been authorized by the workers to represent them during
22 commissioner's inspections, the licensee must notify the
23 inspectors of such authorization and must give the workers'
24 representative an opportunity to accompany the inspectors during
25 the inspection of physical working conditions.

26 D. Each workers' representative must be routinely
27 engaged in licensed activities under control of the licensee and

1 must have received instruction according to part 4731.1020.

2 E. Different representatives of licensees and workers
3 may accompany the inspectors during different phases of an
4 inspection if there is no resulting interference with the
5 conduct of the inspection. Only one workers' representative at
6 a time may accompany the inspectors.

7 F. With the approval of the licensee and the workers'
8 representative, an individual who is not routinely engaged in
9 licensed activities under control of the licensee, for example,
10 a consultant to the licensee or workers' representative, must be
11 afforded the opportunity to accompany the commissioner's
12 inspectors during the inspection of physical working conditions.

13 G. Notwithstanding other provisions of this part,
14 inspectors may refuse to permit accompaniment by an individual
15 who deliberately interferes with a fair and orderly inspection.

16 H. With regard to areas containing information
17 classified by an agency of the federal government in the
18 interest of national security, an individual who accompanies an
19 inspector must be authorized to have access to such information.

20 I. With regard to an area containing proprietary
21 information, the workers' representative for that area must be
22 an individual previously authorized by the licensee to enter the
23 area.

24 4731.1050 INSPECTIONS; CONSULTATION WITH WORKERS.

25 Subpart 1. Consultation permitted. The commissioner's
26 inspectors may consult privately with workers concerning matters
27 of occupational radiation protection and other matters related

1 to this chapter and to licenses to the extent the inspectors
2 deem necessary for the conduct of an effective and thorough
3 inspection.

4 Subp. 2. Worker allegations and complaints. During the
5 course of an inspection, a worker may privately bring to the
6 attention of the inspectors, either orally or in writing, any
7 past or present condition that the worker has reason to believe
8 may have contributed to or caused a violation of this chapter or
9 a license condition or any unnecessary exposure of an individual
10 to radiation from licensed radioactive material under the
11 licensee's control. A written notice under this subpart must
12 comply with part 4731.1060, subparts 1 and 2. This subpart must
13 not be interpreted as authorization to disregard instructions
14 under part 4731.1020.

15 4731.1060 INSPECTIONS; REQUESTS BY WORKERS.

16 Subpart 1. Worker request for inspection. A worker or
17 representative of workers who believes that a violation of this
18 chapter or a license condition exists or has occurred in
19 licensed activities with regard to radiological working
20 conditions in which the worker is engaged may request an
21 inspection by giving notice of the alleged violation to the
22 supervisor of the Radioactive Materials Unit of the Department
23 of Health or to the commissioner's inspectors.

24 Subp. 2. Requirements. A notice under subpart 1 must be
25 in writing, must set forth the specific grounds for the notice,
26 and must be signed by the worker or workers' representative. A
27 copy of the notice must be provided to the licensee by the

1 Radioactive Materials Unit supervisor or the inspector no later
2 than at the time of inspection, except that upon the request of
3 the worker giving the notice, the worker's name and the name of
4 individuals referred to in the notice must not appear in the
5 copy or on any record published, released, or made available by
6 the commissioner, except for good cause shown.

7 Subp. 3. Inspection required. If, upon receipt of a
8 notice, the Radioactive Materials Unit supervisor determines
9 that the complaint meets the requirements of subparts 1 and 2,
10 and that there are reasonable grounds to believe that the
11 alleged violation exists or has occurred, the supervisor must
12 require an inspection to be made as soon as practicable to
13 determine if the alleged violation exists or has occurred.
14 Inspections under this subpart need not be limited to matters
15 referred to in the complaint.

16 4731.1070 INSPECTION NOT WARRANTED; INFORMAL REVIEW.

17 Subpart 1. Review of inspection denial.

18 A. If the Radioactive Materials Unit supervisor
19 determines, with respect to a complaint under part 4731.1060,
20 that an inspection is not warranted because there are no
21 reasonable grounds to believe that a violation exists or has
22 occurred, the supervisor must notify the complainant in writing
23 of the determination.

24 B. The complainant may obtain review of the
25 determination under item A by submitting a written statement of
26 position to the commissioner, who shall provide the licensee
27 with a copy of the statement by certified mail, excluding at the

1 request of the complainant the name of the complainant. The
2 licensee may submit an opposing written statement of position to
3 the commissioner, who shall provide the complainant with a copy
4 of the statement by certified mail.

5 C. Upon the request of the complainant, the
6 commissioner may hold an informal conference in which the
7 complainant and the licensee may orally present their views.

8 D. An informal conference may also be held at the
9 request of the licensee, but disclosure of the identity of the
10 complainant shall be made only following receipt of written
11 authorization from the complainant.

12 E. After considering all written and oral views
13 presented, the commissioner must affirm, modify, or reverse the
14 determination of the supervisor of the Radioactive Materials
15 Unit and furnish the complainant and the licensee a written
16 notification of the commissioner's decision and the reason
17 therefore.

18 Subp. 2. Procedural defects. If the commissioner
19 determines that an inspection is not warranted because the
20 requirements of part 4731.1060, subparts 1 and 2, have not been
21 met, the commissioner must notify the complainant in writing of
22 the determination. The determination must be without prejudice
23 to the filing of a new complaint meeting the requirements of
24 part 4731.1060, subparts 1 and 2.

25 4731.1080 VARIANCES.

26 The commissioner may grant a variance to this chapter,
27 except parts 4731.3000 to 4731.3175, only according to parts

1 4717.7000 to 4717.7050.

2 4731.1090 DISCRIMINATION PROHIBITED.

3 No person, on the grounds of sex, race, or other
4 discriminations, may color, creed, religion, national origin,
5 sex, disability, sexual orientation, or age, shall be excluded
6 from participation in; denied the benefits of; or subjected to
7 discrimination under any program or activity licensed by the
8 commissioner. This part shall be enforced according to
9 Minnesota Statutes, sections 181.931 to 181.935.

10 4731.2000 GENERAL PROVISIONS.

11 Subpart 1. Scope. Parts 4731.2000 to 4731.2950 establish
12 standards for protection against ionizing radiation resulting
13 from activities conducted under licenses issued by the
14 commissioner. Parts 4731.2000 to 4731.2950 apply to persons
15 licensed by the commissioner to receive, possess, use, transfer,
16 or dispose of radioactive, source, or special nuclear material
17 under this chapter.

18 Subp. 2. Purpose. It is the purpose of parts 4731.2000 to
19 4731.2950 to control the receipt, possession, use, transfer, and
20 disposal of licensed material by a licensee so that the total
21 dose to an individual, including doses resulting from licensed
22 and unlicensed radioactive material and from radiation sources
23 other than background radiation, does not exceed the standards
24 for protection against radiation prescribed in parts 4731.2000
25 to 4731.2950.

26 Subp. 3. Exclusions. The limits in parts 4731.2000 to

1 4731.2950 do not apply to doses due to background radiation,
2 exposure of patients to radiation for the purpose of medical
3 diagnosis or therapy, exposure from individuals administered
4 radioactive material and released under part 4731.4427, or
5 exposure from voluntary participation in medical research
6 programs.

7 4731.2010 RADIATION PROTECTION PROGRAMS.

8 Subpart 1. General requirements. A licensee must develop,
9 document, and implement a radiation protection program
10 commensurate with the scope and extent of licensed activities
11 and sufficient to ensure compliance with parts 4731.2000 to
12 4731.2950. Records of the program must be kept according to
13 part 4731.2500.

14 Subp. 2. Protection methods. A licensee must use, to the
15 extent practicable, procedures and engineering controls based
16 upon sound radiation protection principles to achieve
17 occupational doses and doses to members of the public that are
18 as low as reasonably achievable (ALARA).

19 Subp. 3. Review. A licensee must periodically, at least
20 annually, review the radiation protection program content and
21 implementation.

22 Subp. 4. Air emissions.

23 A. To implement the ALARA requirement of subpart 2,
24 and notwithstanding part 4731.2090, a constraint on air
25 emissions of radioactive material to the environment, excluding
26 radon-222 and its daughter, must be established by the licensee,
27 other than those subject to Code of Federal Regulations, title

1 10, section 50.34a, such that the individual member of the
2 public likely to receive the highest dose is not expected to
3 receive a total effective dose equivalent in excess of ten
4 millirems (0.1 mSv) per year from these emissions.

5 B. If a licensee exceeds the dose constraint under
6 item A, the licensee must report the exceedance according to
7 part 4731.2620 and promptly take appropriate corrective action
8 to ensure against recurrence.

9 4731.2020 OCCUPATIONAL DOSE LIMITS FOR ADULTS.

10 Subpart 1. Dose limits. Except for planned special
11 exposures according to part 4731.2060, a licensee must control
12 the occupational dose to individual adults to the following dose
13 limits:

14 A. an annual limit, which is the more limiting of:

15 (1) the total effective dose equivalent being
16 equal to five rems (0.05 Sv); or

17 (2) the sum of the deep dose equivalent and the
18 committed dose equivalent to any individual organ or tissue
19 other than the lens of the eye being equal to 50 rems (0.5 Sv);
20 and

21 B. the annual limits to the lens of the eye, to the
22 skin of the whole body, and to the skin of the extremities,
23 which are:

24 (1) a lens dose equivalent of 15 rems (0.15 Sv);
25 and

26 (2) a shallow dose equivalent of 50 rems (0.5 Sv)
27 to the skin of the whole body or to the skin of any extremity.

1 Subp. 2. Excess doses. Doses received in excess of the
2 annual limits, including doses received during accidents,
3 emergencies, and planned special exposures, must be subtracted
4 from the limits for planned special exposures that the
5 individual may receive during the current year as specified
6 under part 4731.2060, item E, subitem (1), and during the
7 individual's lifetime as specified under part 4731.2060, item E,
8 subitem (2).

9 Subp. 3. Assessing dose. The assigned deep dose
10 equivalent must be for the part of the body receiving the
11 highest exposure. The assigned shallow dose equivalent must be
12 the dose averaged over the contiguous ten square centimeters of
13 skin receiving the highest exposure. The deep dose equivalent,
14 lens dose equivalent, and shallow dose equivalent may be
15 assessed from surveys or other radiation measurements to
16 demonstrate compliance with the occupational dose limits if the
17 individual monitoring device was not in the region of highest
18 potential exposure or if the results of individual monitoring
19 are unavailable.

20 Subp. 4. DAC and ALI values. Derived air concentration
21 (DAC) and annual limit on intake (ALI) values in part 4731.2750
22 may be used by the licensee to determine an individual's dose
23 according to part 4731.2540 and to demonstrate compliance with
24 the occupational dose limits.

25 Subp. 5. Soluble uranium intake. In addition to the
26 annual dose limits, a licensee must limit the soluble uranium
27 intake by an individual to ten milligrams in a week in

1 consideration of chemical toxicity according to part 4731.2750,
2 subpart 7, footnote 3.

3 Subp. 6. Other employment. A licensee must reduce the
4 dose that an individual may be allowed to receive in the current
5 year by the amount of occupational dose received while employed
6 by any other person according to part 4731.2520, subpart 5.

7 4731.2030 SUMMATION OF EXTERNAL AND INTERNAL DOSES.

8 Subpart 1. Summation required. If a licensee is required
9 to monitor under part 4731.2210, subparts 2 and 3, the licensee
10 must demonstrate compliance with the dose limits by summing
11 external and internal doses.

12 Subp. 2. Summation not required. If a licensee is
13 required to monitor only under part 4731.2210, subpart 2, or
14 only under part 4731.2210, subpart 3, then summation is not
15 required to demonstrate compliance with the dose limits. The
16 licensee may demonstrate compliance with the requirements for
17 summation of external and internal doses by meeting one of the
18 conditions specified under subpart 3 and the conditions
19 specified under subparts 4 and 5. The dose equivalents for the
20 lens of the eye, the skin, and the extremities are not included
21 in the summation, but are subject to separate limits.

22 Subp. 3. Intake by inhalation. If the only intake of
23 radionuclides is by inhalation, the total effective dose
24 equivalent (TEDE) limit is not exceeded if the sum of the deep
25 dose equivalent divided by the total effective dose equivalent
26 limit, and one of the following, does not exceed unity:

27 A. the sum of the fractions of the inhalation ALI for

1 each radionuclide;

2 B. the total number of derived air
3 concentration-hours (DAC-hours) for all radionuclides divided by
4 2,000; or

5 C. the sum of the calculated committed effective dose
6 equivalents to all significantly irradiated organs or tissues
7 (T) calculated from bioassay data using appropriate biological
8 models and expressed as a fraction of the annual limit. For
9 purposes of this item, an organ or tissue is considered
10 significantly irradiated if, for that organ or tissue, the
11 product of the weighting factors, W_T , and the committed dose
12 equivalent, $H_{T,50}$, per unit intake is greater than ten percent
13 of the maximum weighted value of $H_{T,50}$ per unit intake for any
14 organ or tissue.

15 Subp. 4. Intake by oral ingestion. If the occupationally
16 exposed individual also receives an intake of radionuclides by
17 oral ingestion greater than ten percent of the applicable oral
18 ALI, a licensee must account for this intake and include it in
19 demonstrating compliance with the limits.

20 Subp. 5. Intake by wound or absorption. A licensee must
21 evaluate and, to the extent practical, account for intakes
22 through wounds or skin absorption. The intake through intact
23 skin is included in the calculation of DAC for hydrogen-3 and
24 does not need to be further evaluated.

25 4731.2040 DETERMINATION OF EXTERNAL DOSE; AIRBORNE RADIOACTIVE
26 MATERIAL.

27 A. When determining the dose from airborne

1 radioactive material, a licensee must include the contribution
2 to the deep dose equivalent, lens dose equivalent, and shallow
3 dose equivalent from external exposure to the radioactive cloud
4 according to part 4731.2750, subpart 7, footnotes 1 and 2.

5 B. Airborne radioactivity measurements and DAC values
6 must not be used as the primary means to assess the deep dose
7 equivalent when the airborne radioactive material includes
8 radionuclides other than noble gases or if the cloud of airborne
9 radioactive material is not relatively uniform. The
10 determination of the deep dose equivalent to an individual must
11 be based upon measurements using instruments or individual
12 monitoring devices.

13 4731.2050 DETERMINATION OF INTERNAL EXPOSURE.

14 Subpart 1. Required measurements. For purposes of
15 assessing dose used to determine compliance with occupational
16 dose equivalent limits, a licensee must, when required under
17 part 4731.2210, take suitable and timely measurements of:

18 A. concentrations of radioactive materials in air in
19 work areas;

20 B. quantities of radionuclides in the body;

21 C. quantities of radionuclides excreted from the
22 body; or

23 D. a combination of the measurements in items A to C.

24 Subp. 2. Assumption. Unless respiratory protective
25 equipment is used according to part 4731.2260 or the assessment
26 of intake is based on bioassays, a licensee must assume that an
27 individual inhales radioactive material at the airborne

1 concentration in which the individual is present.

2 Subp. 3. Alternative assessment. When specific
3 information on the physical and biochemical properties of the
4 radionuclides taken into the body or the behavior or the
5 material in an individual is known, a licensee may:

6 A. use that information to calculate the committed
7 effective dose equivalent and, if used, the licensee must
8 document that information in the individual's record;

9 B. upon prior approval of the commissioner, adjust
10 the DAC or ALI values to reflect the actual physical and
11 chemical characteristics of airborne radioactive material, for
12 example, aerosol size distribution or density; and

13 C. separately assess the contribution of fractional
14 intakes of Class D, W, or Y compounds of a given radionuclide as
15 listed in part 4731.2750 to the committed effective dose
16 equivalent.

17 Subp. 4. Delayed recording. If a licensee chooses to
18 assess intakes of Class Y material using the measurements given
19 in subpart 1, item B or C, the licensee may delay the recording
20 and reporting of the assessments for periods up to seven months,
21 unless otherwise required under part 4731.2610 or 4731.2620, to
22 permit the licensee to make additional measurements basic to the
23 assessments.

24 Subp. 5. Mixture; identity and concentration known. If
25 the identity and concentration of each radionuclide in a mixture
26 are known, the fraction of the DAC applicable to the mixture for
27 use in calculating DAC-hours must be:

1 A. the sum of the ratios of the concentration to the
2 appropriate DAC value, for example, D, W, Y, from part
3 4731.2750, for each radionuclide in the mixture; or

4 B. the ratio of the total concentration for all
5 radionuclides in the mixture to the most restrictive DAC value
6 for any radionuclide in the mixture.

7 Subp. 6. Mixture; identity known. If the identity of each
8 radionuclide in a mixture is known, but the concentration of one
9 or more of the radionuclides in the mixture is not known, the
10 DAC for the mixture must be the most restrictive DAC of any
11 radionuclide in the mixture.

12 Subp. 7. Mixture in air. When a mixture of radionuclides
13 in air exists, a licensee may disregard certain radionuclides in
14 the mixture if:

15 A. the licensee uses the total activity of the
16 mixture in demonstrating compliance with the dose limits in part
17 4731.2020 and in complying with the monitoring requirements in
18 part 4731.2210, subpart 2;

19 B. the concentration of any radionuclide disregarded
20 is less than ten percent of its DAC; and

21 C. the sum of these percentages for all of the
22 radionuclides disregarded in the mixture does not exceed 30
23 percent.

24 Subp. 8. Committed effective dose equivalent
25 considerations. When determining the committed effective dose
26 equivalent, the following information may be considered:

27 A. to calculate the committed effective dose

1 equivalent, the licensee may assume that the inhalation of one
2 ALI, or an exposure of 2,000 DAC-hours, results in a committed
3 effective dose equivalent of five rems (0.05 Sv) for
4 radionuclides that have their ALIs or DACs based on the
5 committed effective dose equivalent; and

6 B. when the ALI and the associated DAC are determined
7 by the nonstochastic organ dose limit of 50 rems (0.5 Sv), the
8 intake of radionuclides that would result in a committed
9 effective dose equivalent of five rems (0.05 Sv), the stochastic
10 ALI, is listed in parentheses in part 4731.2750, subpart 7,
11 Table 1. In this case, the licensee may, as a simplifying
12 assumption, use the stochastic ALIs to determine committed
13 effective dose equivalent. However, if the licensee uses the
14 stochastic ALIs, the licensee must also demonstrate that the
15 limit in part 4731.2020, subpart 1, item A, subitem (2), is met.

16 4731.2060 PLANNED SPECIAL EXPOSURES.

17 A licensee may authorize an adult worker to receive doses
18 in addition to, and accounted for separately from, the doses
19 received under the limits specified in part 4731.2020, provided
20 that each of the following conditions is satisfied:

21 A. the licensee authorizes a planned special exposure
22 only in an exceptional situation when alternatives that might
23 avoid the dose estimated to result from the planned special
24 exposure are unavailable or impractical;

25 B. the licensee and employer, if the employer is not
26 the licensee, specifically authorizes the planned special
27 exposure, in writing, before the exposure occurs;

1 C. before a planned special exposure, the licensee
2 ensures that the individuals involved are:

3 (1) informed of the purpose of the planned
4 operation;

5 (2) informed of the estimated doses and
6 associated potential risks and specific radiation levels or
7 other conditions that might be involved in performing the task;
8 and

9 (3) instructed in the measures to be taken to
10 keep the dose ALARA considering other risks that may be present;

11 D. before permitting an individual to participate in
12 a planned special exposure, the licensee ascertains prior doses
13 as required under part 4731.2520, subpart 2, during the lifetime
14 of the individual for each individual involved;

15 E. subject to part 4731.2020, subpart 2, the licensee
16 does not authorize a planned special exposure that would cause
17 an individual to receive a dose from all planned exposures and
18 all doses in excess of the limits to exceed:

19 (1) the numerical values of any of the dose
20 limits under part 4731.2020, subpart 1, in any year; and

21 (2) five times the annual dose limits under part
22 4731.2020, subpart 1, during the individual's lifetime;

23 F. the licensee maintains records of the conduct of a
24 planned special exposure according to part 4731.2530 and submits
25 a written report according to part 4731.2630; and

26 G. the licensee records the best estimate of the dose
27 resulting from the planned special exposure in the individual's

1 record and informs the individual, in writing, of the dose
2 within 30 days from the date of the planned special exposure.
3 The dose from planned special exposures is not to be considered
4 in controlling future occupational dose of the individual under
5 part 4731.2020, subpart 1, but is to be included in evaluations
6 required under items D and E.

7 4731.2070 OCCUPATIONAL DOSE LIMITS FOR MINORS.

8 The annual occupational dose limits for minors are ten
9 percent of the annual dose limits specified for adult workers
10 under part 4731.2020.

11 4731.2080 DOSE EQUIVALENT TO EMBRYO/FETUS.

12 Subpart 1. Dose limit. A licensee must ensure that the
13 dose equivalent to an embryo/fetus during the entire pregnancy
14 due to occupational exposure of a declared pregnant woman does
15 not exceed 0.5 rem (5 mSv). Records must be kept according to
16 part 4731.2540.

17 Subp. 2. Uniform exposure. A licensee must make efforts
18 to avoid substantial variation above a uniform monthly exposure
19 rate to a declared pregnant woman so as to satisfy the limit in
20 subpart 1.

21 Subp. 3. Dose equivalent. The dose to an embryo/fetus is
22 the sum of:

23 (1) the deep dose equivalent to the declared
24 pregnant woman; and

25 (2) the dose equivalent to the embryo/fetus from
26 radionuclides in the embryo/fetus and radionuclides in the

1 declared pregnant woman.

2 Subp. 4. Dose after pregnancy declaration. If the dose
3 equivalent to the embryo/fetus is found to have exceeded 0.5 rem
4 (5 mSv), or is within 0.05 rem (0.5 mSv) of this dose, by the
5 time the woman declares the pregnancy to the licensee, the
6 licensee shall be deemed to be in compliance with subpart 1 if
7 the additional dose equivalent to the embryo/fetus does not
8 exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

9 4731.2090 RADIATION DOSE LIMITS FOR THE PUBLIC.

10 Subpart 1. Dose limits. A licensee must conduct
11 operations so that:

12 A. the total effective dose equivalent to individual
13 members of the public from the licensed operation does not
14 exceed 0.1 rem (1 mSv) in a year, exclusive of the dose
15 contributions from background radiation, from any medical
16 administration the individual has received, from exposure to
17 individuals administered radioactive material and released
18 according to part 4731.4427, from voluntary participation in
19 medical research programs, and from the licensee's disposal of
20 radioactive material into sanitary sewerage according to part
21 4731.2420; and

22 B. the dose in any unrestricted area from external
23 sources, exclusive of the dose contributions from patients
24 administered radioactive material and released according to part
25 4731.4427, does not exceed 0.002 rem (0.02 mSv) in any one hour.

26 Subp. 2. Access to controlled areas. If a licensee
27 permits members of the public to have access to controlled

1 areas, the limits for members of the public continue to apply to
2 those individuals.

3 Subp. 3. Exception. Notwithstanding subpart 1, item A, a
4 licensee may permit visitors to an individual who cannot be
5 released under part 4731.4427 to receive a radiation dose
6 greater than 0.1 rem (1 mSv) if:

7 A. the radiation dose received does not exceed 0.5
8 rem (5 mSv); and

9 B. the authorized user under part 4731.4427 has
10 determined before the visit that the visit is appropriate.

11 Subp. 4. Prior authorization. A licensee or license
12 applicant may apply for prior authorization from the
13 commissioner to operate up to an annual dose limit for an
14 individual member of the public of 0.5 rem (5 mSv). The
15 licensee or applicant must include in the application for prior
16 authorization:

17 A. a demonstration of the need for and the expected
18 duration of operations in excess of the limit under subpart 1;

19 B. a description of the licensee's program to assess
20 and control the dose within the 0.5 rem (5 mSv) annual limit;
21 and

22 C. the procedures to be followed to maintain the dose
23 as low as is reasonably achievable.

24 Subp. 5. Federal law. In addition to the requirements of
25 this part, a licensee subject to Code of Federal Regulations,
26 title 40, part 190, must comply with those standards.

27 Subp. 6. Additional restrictions. The commissioner may

1 impose additional restrictions on radiation levels in
2 unrestricted areas and on the total quantity of radionuclides
3 that a licensee may release in effluents in order to restrict
4 the collective dose to individual members of the public.

5 4731.2095 COMPLIANCE; DOSE LIMITS FOR THE PUBLIC.

6 Subpart 1. Surveys required. A licensee must make or
7 cause to be made, as appropriate, surveys of radiation levels in
8 unrestricted and controlled areas and radioactive materials in
9 effluents released to unrestricted and controlled areas to
10 demonstrate compliance with the dose limits for individual
11 members of the public under part 4731.2090.

12 Subp. 2. Showing compliance. A licensee must show
13 compliance with the annual dose limit under part 4731.2090 by:

14 A. demonstrating by measurement or calculation that
15 the total effective dose equivalent to the individual likely to
16 receive the highest dose from the licensed operation does not
17 exceed the annual dose limit; or

18 B. demonstrating that:

19 (1) the annual average concentrations of
20 radioactive material released in gaseous and liquid effluents at
21 the boundary of the unrestricted area do not exceed the values
22 under part 4731.2750, subpart 7, Table 2; and

23 (2) if an individual were continuously present in
24 an unrestricted area, the dose from external sources would not
25 exceed 0.002 rem (0.02 mSv) in an hour and 0.05 rem (0.5 mSv) in
26 a year.

27 Subp. 3. Adjustments. Upon approval from the

1 commissioner, a licensee may adjust the effluent concentration
2 values under part 4731.2750, subpart 7, Table 2, for members of
3 the public, to take into account the actual physical and
4 chemical characteristics of the effluents, for example, aerosol
5 size distribution, solubility, density, radioactive decay
6 equilibrium, or chemical form.

7 4731.2100 RADIOLOGICAL CRITERIA FOR LICENSE TERMINATION.

8 Subpart 1. General provisions and applicability.

9 A. This part applies to the decommissioning of
10 facilities licensed under this chapter and to facilities subject
11 to the NRC's jurisdiction under the Atomic Energy Act of 1954,
12 as amended, and the Energy Reorganization Act of 1974, as
13 amended. This part does not apply to uranium and thorium
14 recovery facilities already subject to Code of Federal
15 Regulations, title 10, part 40, Appendix A, or to uranium
16 solution extraction facilities.

17 B. This part does not apply to sites that:

18 (1) have been decommissioned before the effective
19 date of this part according to criteria identified in the Site
20 Decommissioning Management Plan (SDMP) Action Plan of April 16,
21 1992, as listed in the Federal Register, volume 57, page 13389;

22 (2) have previously submitted and received the
23 commissioner's approval on a license termination plan or
24 decommissioning plan that is compatible with the SDMP Action
25 Plan criteria; or

26 (3) submit a sufficient license termination plan
27 or decommissioning plan before August 20, 1998, that is approved

1 by the commissioner before August 20, 1999, and is according to
2 the criteria identified in the SDMP Action Plan, except that if
3 an environmental impact statement is required in the submittal,
4 there will be a provision for day-for-day extension.

5 C. After a site has been decommissioned and the
6 license terminated according to this part, the commissioner
7 shall require additional cleanup only if, based on new
8 information, the commissioner determines that the criteria of
9 this part were not met and residual radioactivity remaining at
10 the site could result in a significant threat to public health
11 and safety.

12 D. When calculating the TEDE to the average member of
13 the critical group, the licensee must determine the peak annual
14 TEDE expected within the first 1,000 years after decommissioning.

15 Subp. 2. Radiological criteria for unrestricted use. A
16 site is considered acceptable for unrestricted use if:

17 A. the residual radioactivity that is distinguishable
18 from background radiation results in a TEDE to an average member
19 of the critical group that does not exceed 25 millirems (0.25
20 mSv) per year, including that from groundwater sources of
21 drinking water; and

22 B. the residual radioactivity has been reduced to
23 levels that are ALARA. Determination of levels that are ALARA
24 must take into account consideration of any detriments, such as
25 deaths from transportation accidents, expected to potentially
26 result from decontamination and waste disposal.

27 Subp. 3. Criteria for termination under restricted

1 conditions. A site is considered acceptable for license
2 termination under restricted conditions, if the licensee:

3 A. can demonstrate that further reductions in
4 residual radioactivity necessary to comply with subpart 2:

5 (1) would result in net public or environmental
6 harm; or

7 (2) are not being made because the residual
8 levels associated with restricted conditions are ALARA.

9 Determination of the levels that are ALARA must take into
10 account consideration of any detriments, such as traffic
11 accidents, expected to potentially result from decontamination
12 and waste disposal;

13 B. has made provisions for legally enforceable
14 institutional controls that provide reasonable assurance that
15 the TEDE from residual radioactivity, distinguishable from
16 background radiation, will not exceed 25 millirems (0.25 mSv)
17 per year to the average member of the critical group;

18 C. has provided sufficient financial assurance to
19 enable an independent third party, including a governmental
20 custodian of a site, to assume and carry out responsibilities
21 for any necessary control and maintenance of the site.

22 Acceptable financial assurance mechanisms are:

23 (1) funds placed into an account segregated from
24 the licensee's assets and outside the licensee's administrative
25 control as described under part 4731.3080, subpart 6, item B;

26 (2) surety method, insurance, or other guarantee
27 method as described under part 4731.3080, subpart 6, item C;

1 (3) a statement of intent, in the case of
2 federal, state, or local government licensees, as described
3 under part 4731.3080, subpart 6, item E; or

4 (4) when a governmental entity is assuming
5 custody and ownership of a site, an arrangement that is deemed
6 acceptable by the governmental entity;

7 D. has submitted a decommissioning plan or a license
8 termination plan to the commissioner indicating the licensee's
9 intent to decommission according to part 4731.0600, subpart 2,
10 4731.0790, subpart 4, or 4731.3085, subpart 4, or Code of
11 Federal Regulations, title 10, section 50.82, paragraphs (a) and
12 (b), or 72.54, and specifying that the licensee intends to
13 decommission by restricting use of the site. The licensee must
14 document in the license termination plan or decommissioning plan
15 how the advice of individuals and institutions in the community
16 has been sought according to items E and F and incorporated, as
17 appropriate, following analysis of that advice;

18 E. if proposing to decommission by restricting use of
19 the site, seeks advice from individuals and institutions in the
20 community who may be affected by the decommissioning regarding
21 whether:

22 (1) institutional controls proposed by the
23 licensee:

24 (a) will provide reasonable assurance that
25 the TEDE from residual radioactivity distinguishable from
26 background radiation to the average member of the critical group
27 will not exceed 25 millirems (0.25 mSv) TEDE per year;

1 (b) will be enforceable; and

2 (c) will not impose undue burdens on the
3 local community or other affected parties; and

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

9 F. while seeking advice under item E, provides for:

10 (1) participation by representatives of a broad
11 cross section of community interests who may be affected by the
12 decommissioning;

13 (2) an opportunity for a comprehensive,
14 collective discussion on the issues by the participants
15 represented; and

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

21 G. reduces residual radioactivity at the site so that
22 if the institutional controls were no longer in effect, there is
23 reasonable assurance that the TEDE from residual radioactivity
24 distinguishable from background radiation to the average member
25 of the critical group is as low as reasonably achievable and
26 would not exceed:

27 (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,

1 restrictions on site use according to subpart 3, in minimizing
2 exposures at the site;

3 (3) reduces doses to ALARA levels, taking into
4 consideration any detriments, such as traffic accidents,
5 expected to potentially result from decontamination and waste
6 disposal; and

7 (4) submits a decommissioning plan or license
8 termination plan to the commissioner indicating the licensee's
9 intent to decommission according to part 4731.0600, subpart 2;
10 4731.0790, subpart 4; or 4731.3085, subpart 4, or Code of
11 Federal Regulations, title 10, section 50.82, paragraphs (a) and
12 (b), or 72.54, and specifying that the licensee proposes to
13 decommission by use of alternate criteria. The licensee must
14 document in the decommissioning plan or license termination plan
15 how the advice of individuals and institutions in the community
16 who may be affected by the decommissioning has been sought and
17 addressed, as appropriate, following analysis of that advice.
18 In seeking such advice, the licensee must provide for:

19 (a) participation by representatives of a
20 broad cross section of community interests who may be affected
21 by the decommissioning;

22 (b) an opportunity for a comprehensive,
23 collective discussion on the issues by the participants
24 represented; and

25 (c) a publicly available summary of the
26 results of all such discussions, including a description of the
27 individual viewpoints of the participants on the issues and the

1 extent of agreement and disagreement among the participants on
2 the issues.

3 B. The use of alternate criteria to terminate a
4 license requires the approval of the commissioner after
5 consideration of staff recommendations of the Radioactive
6 Materials Unit of the Department of Health that address any
7 comments provided by the Environmental Protection Agency or the
8 Pollution Control Agency and any public comments submitted under
9 subpart 5.

10 Subp. 5. Public notification and public participation.

11 Upon receipt of a license termination plan or decommissioning
12 plan from a licensee or a proposal by a licensee for release of
13 a site according to subpart 3 or 4, or whenever the commissioner
14 deems such notice to be in the public interest, the commissioner
15 must:

16 A. notify and solicit comments from:

17 (1) local and state governments in the vicinity
18 of the site and any Indian nation or other indigenous people
19 that have treaty or statutory rights that could be affected by
20 the decommissioning; and

21 (2) the Environmental Protection Agency for cases
22 when the licensee proposes to release a site according to
23 subpart 4; and

24 B. publish a notice in the State Register and in a
25 forum, such as local newspapers, letters to state and local
26 organizations, or other appropriate forum, that is readily
27 accessible to individuals in the vicinity of the site and

1 solicit comments from affected parties.

2 4731.2150 MINIMIZATION OF CONTAMINATION.

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

9 4731.2200 SURVEYS AND MONITORING.

10 Subpart 1. Required surveys. A licensee must make or
11 cause to be made, surveys that:

12 A. may be necessary for the licensee to comply with
13 this chapter; and

14 B. are reasonable under the circumstances to evaluate:

15 (1) the magnitude and extent of radiation levels;

16 (2) concentrations or quantities of radioactive
17 material; and

18 (3) potential radiological hazards.

19 Subp. 2. Calibration required. A licensee must ensure
20 that instruments and equipment used for quantitative radiation
21 measurements, for example, dose rate and effluent monitoring,
22 are calibrated periodically for the radiation measured.

23 Subp. 3. Dosimeter processing. All personnel dosimeters,
24 except for direct and indirect reading pocket ionization
25 chambers and those dosimeters used to measure the dose to the
26 extremities, that require processing to determine the radiation

1 dose and that are used by a licensee to comply with part
2 4731.2020, with other applicable provisions of this chapter, or
3 with conditions specified in a license, must be processed and
4 evaluated by a dosimetry processor that:

5 A. holds current personnel dosimetry accreditation
6 from the National Voluntary Laboratory Accreditation Program
7 (NVLAP) of the National Institute of Standards and Technology;
8 and

9 B. is approved in the accreditation process for the
10 type of radiation or radiations included in the NVLAP program
11 that most closely approximates the type of radiation or
12 radiations for which the individual wearing the dosimeter is
13 monitored.

14 4731.2210 INDIVIDUAL MONITORING; EXTERNAL AND INTERNAL
15 OCCUPATIONAL DOSE.

16 Subpart 1. General requirement. A licensee must monitor
17 exposures to radiation and radioactive material at levels
18 sufficient to demonstrate compliance with the occupational dose
19 limits of parts 4731.2000 to 4731.2950. At a minimum, a
20 licensee must comply with this part.

21 Subp. 2. External dose. A licensee must monitor
22 occupational exposure to radiation from licensed and unlicensed
23 radiation sources under the control of the licensee and must
24 supply and require the use of individual monitoring devices by:

25 A. adults likely to receive, in one year from sources
26 external to the body, a dose in excess of ten percent of the
27 limits in part 4731.2020, subpart 1;

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

6 C. declared pregnant women likely to receive, during
7 the entire pregnancy from radiation sources external to the
8 body, a deep dose equivalent in excess of 0.1 rem (1 mSv). All
9 of the occupational doses under part 4731.2020 continue to be
10 applicable to the declared pregnant worker as long as the
11 embryo/fetus dose limit is not exceeded; and

12 D. individuals entering a high or very high radiation
13 area.

14 Subp. 3. Internal dose. A licensee must monitor, as
15 required under part 4731.2050, the occupational intake of
16 radioactive material by and assess the committed effective dose
17 equivalent to:

18 A. adults likely to receive, in one year, an intake
19 in excess of ten percent of the applicable ALIs in part
20 4731.2750, subpart 7, Table 1, columns 1 and 2;

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

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

26 4731.2220 HIGH RADIATION AREAS; CONTROL OF ACCESS.

27 Subpart 1. Entrance controls required.

1 A. A licensee must ensure that each entrance or
2 access point to a high radiation area has one or more of the
3 following features:

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

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

14 (3) entryways that are locked, except during
15 periods when access to the areas is required, with positive
16 control over each individual entry.

17 B. In place of the controls required under item A for
18 a high radiation area, a licensee may substitute continuous
19 direct or electronic surveillance that is capable of preventing
20 unauthorized entry.

21 C. A licensee may apply to the commissioner for
22 approval of alternative methods for controlling access to high
23 radiation areas.

24 Subp. 2. Egress required. A licensee must establish the
25 controls required under subpart 1 in a way that does not prevent
26 individuals from leaving a high radiation area.

27 Subp. 3. Exception; package for transport. Control is not

1 required for each entrance or access point to a room or other
2 area that is a high radiation area solely because of the
3 presence of radioactive materials prepared for transport and
4 packaged and labeled according to the regulations of the DOT,
5 provided that:

6 A. the packages do not remain in the area longer than
7 three days; and

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

11 Subp. 4. Exception; hospitals. Control of entrance or
12 access to rooms or other areas in hospitals is not required
13 solely because of the presence of patients containing
14 radioactive materials, provided that there are personnel in
15 attendance who will take the necessary precautions to:

16 A. prevent the exposure of individuals to radiation
17 or radioactive material in excess of the limits established
18 under parts 4731.2000 to 4731.2950; and

19 B. operate within the ALARA provisions of the
20 licensee's radiation protection program.

21 4731.2230 VERY HIGH RADIATION AREAS; CONTROL OF ACCESS.

22 In addition to the requirements under part 4731.2220, a
23 licensee must institute additional measures to ensure that an
24 individual is not able to gain unauthorized or inadvertent
25 access to areas in which radiation levels could be encountered
26 at 500 rads (5 Gy) or more in one hour at one meter from a
27 radiation source or any surface through which the radiation

1 penetrates.

2 4731.2240 CONTROLLING CONCENTRATION OF RADIOACTIVE MATERIAL IN
3 AIR.

4 Subpart 1. Process or other engineering controls. A
5 licensee must use, to the extent practical, process or other
6 engineering controls, such as containment, decontamination, or
7 ventilation, to control the concentrations of radioactive
8 material in air.

9 Subp. 2. Other controls.

10 A. When it is not practical to apply process or other
11 engineering controls to control the concentrations of
12 radioactive material in air to values below those that define an
13 airborne radioactivity area, a licensee must, consistent with
14 maintaining the total effective dose equivalent ALARA, increase
15 monitoring and limit intakes by one or more of the following
16 means:

- 17 (1) control of access;
18 (2) limitation of exposure times;
19 (3) use of respiratory protection equipment; or
20 (4) other controls.

21 B. If a licensee performs an ALARA analysis to
22 determine whether or not respirators should be used, the
23 licensee may consider safety factors other than radiological
24 factors. The licensee must also consider the impact of
25 respirator use on workers' industrial health and safety.

26 4731.2260 USE OF INDIVIDUAL RESPIRATORY PROTECTION EQUIPMENT.

1 Subpart 1. Applicability. This part applies if a licensee
2 assigns or permits the use of respiratory protection equipment
3 to limit intake of radioactive material.

4 Subp. 2. NIOSH certification. A licensee must use only
5 respiratory protection equipment that is tested and certified by
6 the National Institute for Occupational Safety and Health
7 (NIOSH), except as otherwise noted in this part.

8 Subp. 3. Alternative equipment. If a licensee wishes to
9 use equipment that has not been tested or certified by NIOSH, or
10 for which there is no schedule for testing or certification, the
11 licensee must submit an application to the commissioner for
12 authorized use of the equipment, except as provided in this
13 part. The application must include evidence that the material
14 and performance characteristics of the equipment are capable of
15 providing the proposed degree of protection under anticipated
16 conditions of use. This must be demonstrated by licensee
17 testing or on the basis of reliable test information.

18 Subp. 4. Respiratory protection program. A licensee must
19 implement and maintain a respiratory protection program that
20 includes:

21 A. air sampling sufficient to identify a potential
22 hazard, permit proper equipment selection, and estimate doses;

23 B. surveys and bioassays, as necessary, to evaluate
24 actual intakes;

25 C. testing of respirators for operability and user
26 seal check for face sealing devices and functional check for
27 others immediately prior to each use;

1 D. written procedures regarding:

- 2 (1) monitoring, including air sampling and
3 bioassays;
4 (2) supervision and training of respirator users;
5 (3) fit testing;
6 (4) respirator selection;
7 (5) breathing air quality;
8 (6) inventory and control;
9 (7) storage, issuance, maintenance, repair,
10 testing, and quality assurance of respiratory protection
11 equipment;
12 (8) record keeping; and
13 (9) limitations on periods of respirator use and
14 relief from respirator use;

15 E. a determination by a physician that an individual
16 user is medically fit to use the respiratory protection
17 equipment:

- 18 (1) before the initial fitting of a face sealing
19 respirator;
20 (2) before the first field use of nonface sealing
21 respirators; and
22 (3) either every 12 months thereafter or
23 periodically at a frequency determined by a physician; and

24 F. fit testing, with a fit factor greater than or
25 equal to 10 times the APF for negative pressure devices and a
26 fit factor greater than or equal to 500 for any positive
27 pressure, continuous flow, and pressure-demand devices, before

1 the first field use of tight fitting, face-sealing respirators
2 and periodically thereafter at a frequency not to exceed one
3 year. Fit testing must be performed with the facepiece
4 operating in the negative pressure mode.

5 Subp. 5. User advise. A licensee must advise each
6 respirator user that the user may leave the area at any time for
7 relief from respirator use in the event of equipment
8 malfunction, physical or psychological distress, procedural or
9 communication failure, significant deterioration of operating
10 conditions, or any other conditions that might require such
11 relief.

12 Subp. 6. Equipment limitations. A licensee must consider
13 limitations appropriate to the type and mode of use. When
14 selecting respiratory devices, a licensee must provide for
15 vision correction, adequate communication, low temperature work
16 environments, and the concurrent use of other safety or
17 radiological protection equipment. A licensee must use the
18 equipment in such a way as not to interfere with the proper
19 operation of the respirator.

20 Subp. 7. Standby rescue persons.

21 A. Standby rescue persons are required whenever
22 one-piece atmosphere-supplying suits or any combination of
23 supplied-air respiratory protection device and personnel
24 protective equipment are used from which an unaided individual
25 would have difficulty extricating himself or herself.

26 B. The standby persons must be equipped with
27 respiratory protection devices or other apparatus appropriate

1 for the potential hazards.

2 C. The standby rescue persons must observe or
3 otherwise maintain continuous communication with the workers, by
4 voice, visual, signal line, telephone, radio, or other suitable
5 means, and be immediately available to assist them in case of a
6 failure of the air supply or for any other reason that requires
7 relief from distress.

8 D. A sufficient number of standby rescue persons must
9 be immediately available to assist all users of this type of
10 equipment and to provide effective emergency rescue if needed.

11 Subp. 8. Respirator requirements.

12 A. Atmosphere-supplying respirators must be supplied
13 with respirable air of Grade D quality or better as defined in
14 "Commodity Specification for Air G-7.1," Compressed Gas
15 Association (1997), as included in Code of Federal Regulations,
16 title 29, section 1910.134. Grade D quality air criteria
17 include:

18 (1) oxygen content (v/v) of 19.5 to 23.5 percent;

19 (2) hydrocarbon (condensed) content of five
20 milligrams per cubic meter of air or less;

21 (3) carbon monoxide content of ten parts per
22 million or less;

23 (4) carbon dioxide content of 1,000 parts per
24 million or less; and

25 (5) lack of noticeable odor.

26 B. A licensee must ensure that no objects, materials
27 or substances, such as facial hair, or conditions that interfere

1 with the face-facepiece seal or valve function and that are
2 under the control of the respirator wearer are present between
3 the skin of the wearer's face and the sealing surface of a
4 tight-fitting respirator facepiece.

5 Subp. 9. Dose calculation. In estimating the dose to
6 individuals from intake of airborne radioactive materials, the
7 concentration of radioactive material in the air that is inhaled
8 when respirators are worn is initially assumed to be the ambient
9 concentration in air without respiratory protection, divided by
10 the assigned protection factor. If the dose is later found to
11 be greater than the estimated dose, the corrected value must be
12 used. If the dose is later found to be less than the estimated
13 dose, the corrected value may be used.

14 4731.2270 RESPIRATORY PROTECTION EQUIPMENT RESTRICTIONS.

15 The commissioner may impose restrictions in addition to
16 those under parts 4731.2240, 4731.2260, and 4731.2700 to:

17 A. ensure that the respiratory protection program of
18 the licensee is adequate to limit doses to individuals from
19 intakes of airborne radioactive materials, consistent with
20 maintaining total effective dose equivalent ALARA; and

21 B. limit the extent to which a licensee may use
22 respiratory protection equipment instead of process or other
23 engineering controls.

24 4731.2280 USE OF HIGHER ASSIGNED PROTECTION FACTORS.

25 A licensee must obtain authorization from the commissioner
26 before using assigned protection factors in excess of those

1 specified in part 4731.2700. The commissioner may authorize a
2 licensee to use higher assigned protection factors on receipt of
3 an application that:

4 A. describes the situation for which a need exists
5 for higher protection factors; and

6 B. demonstrates that the respiratory protection
7 equipment provides these higher protection factors under the
8 proposed conditions of use.

9 4731.2290 STORAGE AND CONTROL OF LICENSED MATERIAL.

10 Subpart 1. Security of stored material. A licensee must
11 secure from unauthorized removal or access licensed materials
12 that are stored in controlled or unrestricted areas.

13 Subp. 2. Control of material not in storage. A licensee
14 must control and maintain constant surveillance of licensed
15 material that is in a controlled or unrestricted area and that
16 is not in storage.

17 4731.2300 CAUTION SIGNS.

18 Subpart 1. Radiation symbol. Unless otherwise authorized
19 by the commissioner, the standard radiation symbol used to
20 designate a radiation hazard is as prescribed in this subpart.
21 The radiation symbol is the three-bladed design:

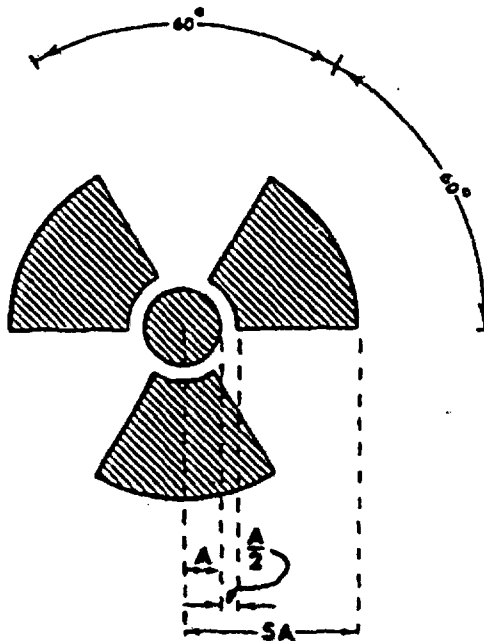
22 4731.2300 T=1: 20 picas - Insert radiation hazard symbol here.

23

24

25

26



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,

1 additional information, as appropriate, to make individuals
2 aware of potential radiation exposures and to minimize the
3 exposures.

4 4731.2310 POSTING REQUIREMENTS.

5 Subpart 1. Radiation area. A licensee must post each
6 radiation area with a conspicuous sign or signs bearing the
7 radiation symbol and the words "CAUTION, RADIATION AREA."

8 Subp. 2. High radiation area. A licensee must post each
9 high radiation area with a conspicuous sign or signs bearing the
10 radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or
11 "DANGER, HIGH RADIATION AREA."

12 Subp. 3. Very high radiation area. A licensee must post
13 each very high radiation area with a conspicuous sign or signs
14 bearing the radiation symbol and the words "GRAVE DANGER, VERY
15 HIGH RADIATION AREA."

16 Subp. 4. Airborne radioactivity area. A licensee must
17 post each airborne radioactivity area with a conspicuous sign or
18 signs bearing the radiation symbol and the words "CAUTION,
19 AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY
20 AREA."

21 Subp. 5. Use or storage area. A licensee must post each
22 area or room in which there is used or stored an amount of
23 licensed material exceeding ten times the quantity of such
24 material specified in part 4731.2800 with a conspicuous sign or
25 signs bearing the radiation symbol and the words "CAUTION,
26 RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL."

1 4731.2320 EXCEPTIONS TO POSTING REQUIREMENTS.

2 Subpart 1. Short-term storage. A licensee is not required
3 to post a caution sign in areas or rooms containing radioactive
4 materials for periods of less than eight hours, if:

5 A. the materials are constantly attended during these
6 periods by an individual who takes the precautions necessary to
7 prevent the exposure of individuals to radiation or radioactive
8 materials in excess of the limits established in parts 4731.2000
9 to 4731.2950; and

10 B. the area or room is subject to the licensee's
11 control.

12 Subp. 2. Hospital; patient room. A room or other area in
13 a hospital that is occupied by a patient is not required to be
14 posted with a caution sign if the patient could be released from
15 licensee control under part 4731.4427.

16 Subp. 3. Sealed sources. A room or area is not required
17 to be posted with a caution sign because of the presence of a
18 sealed source if the radiation level at 30 centimeters from the
19 surface of the source container or housing does not exceed 0.005
20 rem (0.05 mSv) per hour.

21 Subp. 4. Hospital; teletherapy. A room in a hospital or
22 clinic that is used for teletherapy is exempt from the
23 requirement to post a caution sign if:

24 A. access to the room is controlled according to part
25 4731.4467; and

26 B. personnel in attendance take necessary precautions
27 to prevent the inadvertent exposure of workers, other patients,

1 and members of the public to radiation in excess of the limits
2 established in parts 4731.2000 to 4731.2950.

3 4731.2330 LABELING CONTAINERS.

4 Subpart 1. Label requirements. A licensee must ensure
5 that each container of licensed material bears a durable,
6 clearly visible label bearing the radiation symbol and the words
7 "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE
8 MATERIAL." The label must provide sufficient information, such
9 as the radionuclides present, an estimate of the quantity of
10 radioactivity, the date for which the activity is estimated,
11 radiation levels, kinds of materials, and mass enrichment, to
12 permit individuals handling or using the containers or working
13 in the vicinity of the containers to take precautions to avoid
14 or minimize exposures.

15 Subp. 2. Label removal. A licensee must, prior to removal
16 or disposal of empty uncontaminated containers to unrestricted
17 areas, remove or deface the radioactive material label or
18 otherwise clearly indicate that the container no longer contains
19 radioactive materials.

20 4731.2340 LABELING REQUIREMENTS; EXEMPTIONS.

21 A licensee is not required to label:

22 A. containers holding licensed material in quantities
23 less than the quantities listed in part 4731.2800;

24 B. containers holding licensed material in
25 concentrations less than those specified in part 4731.2750,
26 subpart 7, Table 3;

1 C. containers attended to by an individual who takes
2 the precautions necessary to prevent the exposure of individuals
3 in excess of the limits established by parts 4731.2000 to
4 4731.2950;

5 D. containers when they are in transport and packaged
6 and labeled according to DOT regulations. Labeling of packages
7 containing radioactive materials is required by the DOT if the
8 amount and type of radioactive material exceeds the limits for
9 an excepted quantity or article as defined and limited under
10 Code of Federal Regulations, title 49, sections 173.403 and
11 173.421 to 173.424;

12 E. containers that are accessible only to individuals
13 authorized to handle or use them or to work in the vicinity of
14 the containers, if the contents are identified to the
15 individuals by a readily available written record. Containers
16 of this type include containers in water-filled canals, storage
17 vaults, or hot cells. The record must be retained as long as
18 the containers are in use for the purpose indicated on the
19 record; or

20 F. installed manufacturing or process equipment, such
21 as reactor components, piping, or tanks.

22 4731.2350 PROCEDURES FOR RECEIVING AND OPENING PACKAGES.

23 Subpart 1. Package receipt. A licensee who expects to
24 receive a package containing quantities of radioactive material
25 in excess of a Type A quantity must make arrangements to receive:

26 A. the package when the carrier offers it for
27 delivery; or

1 B. notification of the arrival of the package at the
2 carrier's terminal and to take possession of the package
3 expeditiously.

4 Subp. 2. Monitoring requirements. A licensee must:

5 A. monitor the external surfaces of a package with a
6 Radioactive White I, Yellow II, or Yellow III label as specified
7 in Code of Federal Regulations, title 49, sections 172.403 and
8 172.436 to 172.440, for radioactive contamination unless the
9 package contains only radioactive material in the form of a gas
10 or in special form;

11 B. monitor the external surfaces of a package with a
12 Radioactive White I, Yellow II, or Yellow III label as specified
13 in Code of Federal Regulations, title 49, sections 172.403 and
14 172.436 to 172.440, for radiation levels unless the package
15 contains quantities of radioactive material that are less than
16 or equal to a Type A quantity; and

17 C. monitor all packages known to contain radioactive
18 material for radioactive contamination and radiation levels if
19 there is evidence of degradation of package integrity, such as
20 packages that are crushed, wet, or damaged.

21 Subp. 3. Timing. A licensee must perform the monitoring
22 required under subpart 2 as soon as practical after receipt of
23 the package, but not later than three hours after the package is
24 received at the licensee's facility if it is received during the
25 licensee's normal working hours, or not later than three hours
26 from the beginning of the next working day if it is received
27 after working hours.

1 Subp. 4. Immediate notification. A licensee must
2 immediately notify the final delivery carrier and the
3 commissioner, by telephone, when:

4 A. removable radioactive surface contamination
5 exceeds the limits of part 4731.0415, item I; or

6 B. external radiation levels exceed the limits under
7 part 4731.0412.

8 Subp. 5. Procedures required. A licensee must:

9 A. establish, maintain, and retain written procedures
10 for safely opening packages in which radioactive material is
11 received; and

12 B. ensure that the procedures are followed and that
13 due consideration is given to special instructions for the type
14 of package being opened.

15 Subp. 6. Exemption. A licensee transferring special form
16 sources in licensee-owned or licensee-operated vehicles to and
17 from a work site is exempt from the contamination monitoring
18 requirements under subpart 2, but is not exempt from the survey
19 requirement under subpart 2 for measuring radiation levels that
20 is required to ensure that the source is still properly lodged
21 in its shield.

22 4731.2400 WASTE DISPOSAL.

23 Subpart 1. General requirements. A licensee must dispose
24 of licensed material only:

25 A. by transfer to an authorized recipient as provided
26 under parts 4731.0525 to 4731.0840, 4731.2450, and 4731.3000 to
27 4731.3175 or in Code of Federal Regulations, title 10, parts 60,

1 63, and 72;

2 B. by decay in storage;

3 C. by release in effluents within the limits under
4 part 4731.2090; or

5 D. as authorized under parts 4731.2410 to 4731.2440.

6 Subp. 2. Waste receipt. A person must be specifically
7 licensed to receive waste containing licensed material from
8 other persons for:

9 A. treatment prior to disposal;

10 B. treatment or disposal by incineration; or

11 C. decay in storage.

12 4731.2410 APPROVAL OF PROPOSED DISPOSAL PROCEDURES.

13 A licensee or applicant for a license may apply to the
14 commissioner for approval of proposed procedures, not otherwise
15 authorized in this chapter, to dispose of licensed material
16 generated in the licensee's or applicant's activities. An
17 application must include:

18 A. a description of the waste containing licensed
19 material to be disposed of, including the physical and chemical
20 properties important to risk evaluation, and the proposed manner
21 and conditions of waste disposal;

22 B. an analysis and evaluation of pertinent
23 information on the nature of the environment;

24 C. the nature and location of other potentially
25 affected licensed and unlicensed facilities; and

26 D. analyses and procedures to ensure that doses are
27 maintained ALARA and within the dose limits under parts

1 4731.2000 to 4731.2950.

2 4731.2420 DISPOSAL BY RELEASE INTO SANITARY SEWERAGE.

3 Subpart 1. Discharge limitations. A licensee may
4 discharge licensed material into sanitary sewerage if:

5 A. the material is readily soluble in water or is a
6 biological material that readily disperses in water;

7 B. the quantity of licensed or other radioactive
8 material that the licensee releases into the sewer in one month
9 divided by the average monthly volume of water released into the
10 sewer by the licensee does not exceed the concentration listed
11 in part 4731.2750, subpart 7, Table 3;

12 C. if more than one radionuclide is released, the
13 following conditions are also satisfied:

14 (1) the licensee determines the fraction of the
15 limit in part 4731.2750, subpart 7, Table 3, represented by
16 discharges into sanitary sewerage by dividing the actual monthly
17 average concentration of each radionuclide released by the
18 licensee into the sewer by the concentration of that
19 radionuclide in part 4731.2750, subpart 7, Table 3; and

20 (2) the sum of the fractions for each
21 radionuclide under subitem (1) does not exceed unity; and

22 D. the total quantity of licensed and other
23 radioactive material that the licensee releases into the
24 sanitary sewerage system in a year does not exceed five curies
25 (185 GBq) of hydrogen-3, one curie (37 GBq) of carbon-14, and
26 one curie (37 GBq) of all other radioactive materials combined.

27 Subp. 2. Excreta exemption. Excreta from individuals

1 undergoing medical diagnosis or therapy with radioactive
2 material are not subject to subpart 1.

3 4731.2430 TREATMENT OR DISPOSAL BY INCINERATION.

4 A licensee may treat or dispose of licensed material by
5 incineration only:

6 A. if the material is in a form and concentration
7 specified in part 4731.2440; or

8 B. as specifically approved by the commissioner
9 according to part 4731.2410.

10 4731.2440 DISPOSAL OF SPECIFIC WASTES.

11 A. A licensee may dispose of the following licensed
12 material as if it were not radioactive:

13 (1) 0.05 microcurie (1.85 kBq) or less of
14 hydrogen-3 or carbon-14 per gram of medium used for liquid
15 scintillation counting; and

16 (2) 0.05 microcurie (1.85 kBq) or less of
17 hydrogen-3 or carbon-14 per gram of animal tissue, averaged over
18 the weight of the entire animal.

19 B. A licensee may not dispose of tissue under item A,
20 subitem (2), in a manner that would permit its use as food for
21 humans or as animal feed.

22 C. A licensee must maintain records of disposal under
23 this part according to part 4731.2560.

24 4731.2450 TRANSFER FOR DISPOSAL; MANIFESTS.

25 Subpart 1. Purpose. The requirements of this part and
26 part 4731.2950 are designed to:

1 A. control transfers of low-level radioactive waste
2 by any waste generator, waste collector, or waste processor
3 licensee who ships low-level waste directly or indirectly
4 through a waste collector or waste processor to a licensed
5 low-level waste land disposal facility;

6 B. establish a manifest tracking system; and

7 C. supplement existing requirements concerning
8 transfers and record keeping for those wastes.

9 Subp. 2. Manifest required.

10 A. A licensee shipping radioactive waste intended for
11 ultimate disposal at a licensed land disposal facility must
12 document the information required by the NRC's Uniform Low-Level
13 Radioactive Waste Manifest and transfer the manifest information
14 to the intended consignee according to part 4731.2950.

15 B. A shipment manifest must include a certification
16 by the waste generator according to part 4731.2950, subpart 9.

17 Subp. 3. Control and tracking. A person involved in the
18 transfer for disposal and disposal of waste, including a waste
19 generator, waste collector, waste processor, and disposal
20 facility operator, must comply with part 4731.2950, subparts 10
21 to 14.

22 4731.2500 RECORDS; RADIATION PROTECTION PROGRAMS.

23 A. A licensee must maintain records of the radiation
24 protection program, including:

25 (1) the provisions of the program; and

26 (2) audits and other reviews of the program
27 content and implementation.

1 B. A licensee must retain the records under item A,
2 subitem (1), until the commissioner terminates each pertinent
3 license requiring the record. The licensee must retain the
4 records under item A, subitem (2), for three years after the
5 record is made.

6 4731.2510 RECORDS; SURVEYS.

7 Subpart 1. Record maintenance; three years. A licensee
8 must maintain records showing the results of surveys and
9 calibrations required under parts 4731.2200 and 4731.2350,
10 subpart 2, for three years after the record is made.

11 Subp. 2. Record maintenance; license termination. A
12 licensee must retain the following records until the
13 commissioner terminates each pertinent license requiring the
14 record:

15 A. records of the results of surveys to determine the
16 dose from external sources and used, in the absence of or in
17 combination with individual monitoring data, in the assessment
18 of the individual dose equivalents. This includes those records
19 of results of surveys to determine the dose from external
20 sources and used, in the absence of or in combination with
21 individual monitoring data, in the assessment of individual dose
22 equivalents required under the standards for protection against
23 radiation in effect prior to January 1, 1994;

24 B. records of the results of measurements and
25 calculations used to determine individual intakes of radioactive
26 material and used in the assessment of internal dose. This
27 includes those records of the results of measurements and

1 calculations used to determine individual intakes of radioactive
2 material and used in the assessment of internal dose required
3 under the standards for protection against radiation in effect
4 prior to January 1, 1994;

5 C. records showing the results of air sampling,
6 surveys, and bioassays required under part 4731.2260, subpart 4,
7 items A and B. This includes those records showing the results
8 of air sampling, surveys, and bioassays required under the
9 standards for protection against radiation in effect prior to
10 January 1, 1994; and

11 D. records of the results of measurements and
12 calculations used to evaluate the release of radioactive
13 effluents to the environment. This includes the records of the
14 results of measurements and calculations used to evaluate the
15 release of radioactive effluents to the environment required
16 under the standards for protection against radiation in effect
17 before January 1, 1994.

18 4731.2520 DETERMINATION OF PRIOR OCCUPATIONAL DOSE.

19 Subpart 1. Determining occupational dose. For each
20 individual who is likely to receive in a year an occupational
21 dose requiring monitoring under part 4731.2210, a licensee must:

22 A. determine the occupational radiation dose received
23 during the current year; and

24 B. attempt to obtain the records of cumulative
25 occupational radiation dose.

26 Subp. 2. Planned special exposures. Before permitting an
27 individual to participate in a planned special exposure, a

1 licensee must determine:

2 A. the internal and external doses from all previous
3 planned special exposures; and

4 B. all doses in excess of the limits, including doses
5 received during accidents and emergencies, received during the
6 lifetime of the individual.

7 Subp. 3. Compliance methods. In complying with the
8 requirements of subpart 1, a licensee may:

9 A. accept, as a record of the occupational dose that
10 the individual received during the current year, a written
11 signed statement from the individual, or from the individual's
12 most recent employer for work involving radiation exposure, that
13 discloses the nature and the amount of any occupational dose
14 that the individual may have received during the current year;

15 B. accept, as the record of cumulative radiation
16 dose, an up-to-date cumulative occupational exposure form as
17 described under subpart 4, or its equivalent, signed by the
18 individual and countersigned by an appropriate official of the
19 most recent employer for work involving radiation exposure, or
20 the individual's current employer if the individual is not
21 employed by the licensee; and

22 C. obtain reports of the individual's dose equivalent
23 from the most recent employer for work involving radiation
24 exposure, or the individual's current employer if the individual
25 is not employed by the licensee, by telephone, telegram,
26 electronic media, or letter. The licensee must request a
27 written verification of the dose data if the authenticity of the

1 transmitted report cannot be established.

2 Subp. 4. Record keeping.

3 A. A licensee must record the exposure history of
4 each individual, as required by subpart 1, on a cumulative
5 occupational exposure record form prescribed by the
6 commissioner, or other clear and legible record including all of
7 the information required by the commissioner's form.

8 B. A licensee is not required to partition historical
9 dose between external dose equivalents and internal committed
10 dose equivalents. Occupational exposure histories obtained and
11 recorded on the cumulative occupational exposure record form, or
12 its equivalent, before January 1, 1994, might not have included
13 effective dose equivalents, but may be used in the absence of
14 specific information on the intake of radionuclides by the
15 individual.

16 C. The form or record must:

17 (1) show each period in which the individual
18 received occupational exposure to radiation or radioactive
19 material; and

20 (2) be signed by the individual who received the
21 exposure.

22 D. For each period for which a licensee obtains
23 reports, the licensee must use the dose shown in the report in
24 preparing the form or its equivalent.

25 E. For any period in which a licensee does not obtain
26 a report, the licensee must place a notation on the form or its
27 equivalent, indicating the periods of time for which data are

1 not available.

2 Subp. 5. Assumptions. If a licensee is unable to obtain a
3 complete record of an individual's current and previously
4 accumulated occupational dose, the licensee must assume:

5 (1) in establishing administrative controls under part
6 4731.2020, subpart 6, for the current year, that the allowable
7 dose limit for the individual is reduced by 1.25 rems (12.5 mSv)
8 for each quarter for which records are unavailable and the
9 individual was engaged in activities that could have resulted in
10 occupational radiation exposure; and

11 (2) that the individual is not available for planned
12 special exposures.

13 Subp. 6. Record retention. A licensee must retain the
14 records under subpart 4 until the commissioner terminates each
15 pertinent license requiring the records. A licensee must retain
16 records used in preparing the cumulative occupational exposure
17 record form, or its equivalent, for three years after the record
18 was made. This includes records required under the standards
19 for protection against radiation in effect prior to January 1,
20 1994.

21 4731.2530 RECORDS; PLANNED SPECIAL EXPOSURES.

22 Subpart 1. Required records. For each planned special
23 exposure under part 4731.2060, a licensee must maintain records
24 that describe:

25 A. the exceptional circumstances requiring the use of
26 a planned special exposure;

27 B. the name of the management official who authorized

1 the planned special exposure and a copy of the signed
2 authorization;

3 C. what actions were necessary;

4 D. why the actions were necessary;

5 E. how doses were maintained ALARA; and

6 F. what individual and collective doses were expected
7 to result and the doses actually received in the planned special
8 exposure.

9 Subp. 2. Retention period. A licensee must retain records
10 under this part until the commissioner terminates each pertinent
11 license requiring the records.

12 4731.2540 RECORDS; INDIVIDUAL MONITORING RESULTS.

13 Subpart 1. Required records. A licensee must maintain
14 records of doses received by all individuals for whom monitoring
15 is required under part 4731.2210 and records of doses received
16 during planned special exposures, accidents, and emergency
17 conditions. Assessments of dose equivalent and records made
18 using units in effect before the effective date of this part
19 need not be changed. The records must include, when applicable:

20 A. the deep dose equivalent to the whole body, lens
21 dose equivalent, shallow dose equivalent to the skin, and
22 shallow dose equivalent to the extremities;

23 B. the estimated intake of radionuclides according to
24 part 4731.2030;

25 C. the committed effective dose equivalent assigned
26 to the intake of radionuclides;

27 D. the specific information used to assess the

1 committed effective dose equivalent according to part 4731.2050,
2 subparts 1 and 3, and, when required, part 4731.2210;

3 E. the total effective dose equivalent, when required
4 under part 4731.2030; and

5 F. the total of the deep dose equivalent and the
6 committed dose to the organ receiving the highest total dose.

7 Subp. 2. Record keeping frequency. A licensee must make
8 entries of the records required under subpart 1 at least
9 annually.

10 Subp. 3. Record format. A licensee must maintain the
11 records required under subpart 1 on the NRC's Form 5, or its
12 equivalent, according to the instructions for the form, or in
13 clear and legible records containing all the information
14 required by the NRC form.

15 Subp. 4. Privacy protection. The records required under
16 this part must be protected from public disclosure because of
17 their personal privacy nature. The records are protected by
18 most state privacy laws and, when transferred to the
19 commissioner, are protected by the Minnesota Data Practices Act,
20 Minnesota Statutes, chapter 13.

21 Subp. 5. Embryo/fetus records. A licensee must maintain
22 the records of dose to an embryo/fetus with the records of dose
23 to the declared pregnant woman. The declaration of pregnancy
24 must be kept on file, but may be maintained separately from the
25 dose records.

26 Subp. 6. Retention period. A licensee must retain the
27 records required under this part until the commissioner

1 terminates each pertinent license requiring the record. This
2 includes records required under the standards for protection
3 against radiation in effect prior to January 1, 1994.

4 4731.2550 RECORDS; DOSE TO INDIVIDUAL MEMBERS OF THE PUBLIC.

5 A licensee must maintain records sufficient to demonstrate
6 compliance with the dose limit for individual members of the
7 public under part 4731.2090. A licensee must retain the records
8 required under this part until the commissioner terminates each
9 pertinent license requiring the record.

10 4731.2560 RECORDS; WASTE DISPOSAL.

11 A. A licensee must maintain records of:

12 (1) the disposal of licensed materials made under
13 part 4731.2410, 4731.2420, 4731.2430, or 4731.2440; and

14 (2) disposal by burial in soil, including burials
15 authorized before January 28, 1981.

16 B. A licensee must retain the records required under
17 this part until the commissioner terminates each pertinent
18 license requiring the record. Requirements for disposition of
19 the records, before license termination, are found in parts
20 4731.0625, 4731.0825, and 4731.3115, and in Code of Federal
21 Regulations, title 10, section 72.80, for activities licensed
22 under this chapter.

23 4731.2600 REPORTS; THEFT OR LOSS OF LICENSED MATERIAL.

24 Subpart 1. Telephone reports.

25 A. A licensee must report by telephone as follows:

26 (1) immediately after its occurrence becomes

1 known to the licensee, any lost, stolen, or missing licensed
2 material in an aggregate quantity equal to or greater than 1,000
3 times the quantity under part 4731.2800, under such
4 circumstances that it appears to the licensee that an exposure
5 could result to persons in unrestricted areas; or

6 (2) thirty days after an occurrence under subitem
7 (1) becomes known to the licensee, all licensed material in a
8 quantity greater than ten times the quantity under part
9 4731.2800 that is still missing at the time of the report.

10 B. Licensees having an installed emergency
11 notification system must make reports to the NRC Operations
12 Center according to Code of Federal Regulations, title 10,
13 section 50.72, the commissioner, and the state duty officer at
14 1-800-422-0798, according to part 4731.0200. All other
15 licensees must make reports by telephone to the state duty
16 officer at 1-800-422-0798.

17 Subp. 2. Written reports. A licensee required to make a
18 report under subpart 1 must, within 30 days after making the
19 telephone report, make a written report to the commissioner that
20 includes:

21 A. a description of the licensed material involved,
22 including kind, quantity, and chemical and physical form;

23 B. a description of the circumstances under which the
24 loss or theft occurred;

25 C. a statement of disposition, or probable
26 disposition, of the licensed material involved;

27 D. exposures of individuals to radiation,

1 circumstances under which the exposures occurred, and the
2 possible total effective dose equivalent to persons in
3 unrestricted areas;

4 E. actions that have been taken, or will be taken, to
5 recover the material; and

6 F. procedures or measures that have been, or will be,
7 adopted to ensure against a recurrence of the loss or theft of
8 licensed material.

9 Subp. 3. Exemption. A report is not required under
10 subpart 2 if the licensee is also required to submit a report
11 under Code of Federal Regulations, title 10, section 40.64,
12 paragraph (c).

13 Subp. 4. Additional information. Subsequent to filing a
14 written report, a licensee must report any additional
15 substantive information on the loss or theft within 30 days
16 after the licensee learns of the information.

17 Subp. 5. Individual names. A licensee must prepare any
18 report filed with the commissioner under this part so that names
19 of individuals who may have received exposure to radiation are
20 stated in a separate and detachable part of the report.

21 4731.2610 NOTIFICATION OF INCIDENTS.

22 Subpart 1. Immediate notification required.

23 Notwithstanding any other requirements for notification, a
24 licensee must immediately report any event involving radioactive
25 material possessed by the licensee that may have caused or
26 threatens to cause:

27 A. an individual to receive:

1 (1) a total effective dose equivalent of 25 rems
2 (0.25 Sv) or more;

3 (2) a lens dose equivalent of 75 rems (0.75 Sv)
4 or more; or

5 (3) a shallow dose equivalent to the skin or
6 extremities of 250 rads (2.5 Gy) or more; or

7 B. the release of radioactive material, inside or
8 outside of a restricted area, so that, had an individual been
9 present for 24 hours, the individual could have received an
10 intake of five times the annual limit on intake. This item does
11 not apply to locations where personnel are not normally
12 stationed during routine operations, such as hot cells or
13 process enclosures.

14 Subp. 2. 24-hour notification required. A licensee must,
15 within 24 hours of discovery of the event, report any event
16 involving loss of control of a licensed material possessed by
17 the licensee that may have caused or threatens to cause:

18 A. an individual to receive in a period of 24 hours:

19 (1) a total effective dose equivalent exceeding
20 five rems (0.05 Sv);

21 (2) a lens dose equivalent exceeding 15 rems
22 (0.15 Sv); or

23 (3) a shallow dose equivalent to the skin or
24 extremities exceeding 50 rems (0.5 Sv); or

25 B. the release of radioactive material, inside or
26 outside of a restricted area, so that, had an individual been
27 present for 24 hours, the individual could have received an

1 intake in excess of one occupational annual limit on intake.
2 This item does not apply to locations where personnel are not
3 normally stationed during routine operation, such as hot cells
4 or process enclosures.

5 Subp. 3. Individual names. A licensee must prepare any
6 report filed with the commissioner under this part so that names
7 of individuals who have received exposure to radiation or
8 radioactive material are stated in a separate and detachable
9 part of the report.

10 Subp. 4. Reporting method. Licensees having an installed
11 emergency notification system must make the reports required
12 under this part to the NRC Operations Center according to Code
13 of Federal Regulations, title 10, section 50.72. All other
14 licensees must make the reports required under this part by
15 telephone to the commissioner or state duty officer at
16 1-800-422-0798.

17 Subp. 5. Exception. This part does not apply to doses
18 that result from planned special exposures, that are within the
19 limits for planned special exposures, and that are reported
20 under part 4731.2630.

21 4731.2620 REPORTS; RADIATION EXPOSURES, LEVELS, AND
22 CONCENTRATIONS EXCEEDING CONSTRAINTS OR LIMITS.

23 Subpart 1. Reportable events. In addition to the
24 notification required under part 4731.2610, a licensee must
25 submit a written report within 30 days after learning of:

26 A. an incident for which notification is required
27 under part 4731.2610;

1 B. doses in excess of:

2 (1) the occupational dose limits for adults under
3 part 4731.2020;

4 (2) the occupational dose limits for a minor
5 under part 4731.2070;

6 (3) the limits for an embryo/fetus of a declared
7 pregnant woman under part 4731.2080;

8 (4) the limits for an individual member of the
9 public under part 4731.2090;

10 (5) any applicable limit in the license; or

11 (6) the ALARA constraints for air emissions
12 established under part 4731.2010, subpart 4;

13 C. levels of radiation or concentrations of
14 radioactive material in:

15 (1) a restricted area in excess of applicable
16 limits in the license; or

17 (2) an unrestricted area in excess of ten times
18 any applicable limit under this chapter or in the license,
19 whether or not involving exposure of any individual in excess of
20 the limits under part 4731.2090; or

21 D. for licensees subject to the provisions of the
22 Environmental Protection Agency's generally applicable
23 environmental radiation standards under Code of Federal
24 Regulations, title 40, part 190, levels of radiation or releases
25 of radioactive material in excess of those standards or of
26 license conditions related to those standards.

27 Subp. 2. Contents of reports. A report required under

1 subpart 1 must describe the extent of exposure of individuals to
2 radiation and radioactive material, including, as appropriate:

3 A. estimates of each individual's dose;

4 B. the levels of radiation and concentrations of
5 radioactive material involved;

6 C. the cause of the elevated exposures, dose rates,
7 or concentrations; and

8 D. corrective steps taken or planned to ensure
9 against a recurrence, including the schedule for achieving
10 conformance with applicable limits, ALARA constraints, generally
11 applicable environmental standards, and associated license
12 conditions.

13 Subp. 3. Individual information.

14 A. A report filed under subpart 1 must include, for
15 each occupationally overexposed individual:

16 (1) the name;

17 (2) social security number; and

18 (3) date of birth.

19 B. With respect to the limit for the embryo/fetus
20 under part 4731.2080, the identifiers must be those of the
21 declared pregnant woman.

22 C. The report must be prepared so that the
23 information under this subpart is stated in a separate and
24 detachable part of the report.

25 Subp. 4. Reporting method. All licensees, other than
26 those holding an operating license for a nuclear power plant,
27 who make reports according to this part must submit the report

1 in writing to the commissioner according to part 4731.2610.

2 4731.2630 REPORTS; PLANNED SPECIAL EXPOSURES.

3 A licensee must submit a written report to the commissioner
4 within 30 days following any planned special exposure conducted
5 according to part 4731.2060. The report must inform the
6 commissioner that a planned special exposure was conducted,
7 indicate the date the planned special exposure occurred, and
8 provide the information required under part 4731.2530.

9 4731.2640 REPORTS TO INDIVIDUALS; DOSE LIMITS EXCEEDED.

10 When a licensee is required, under part 4731.2620,
11 4731.2630, or 4731.2650, to report to the commissioner any
12 exposure of an identified occupationally exposed individual or
13 an identified member of the public to radiation or radioactive
14 material, the licensee must also provide a copy of the report
15 submitted to the commissioner to the individual. The report
16 must be transmitted at a time no later than the transmittal to
17 the commissioner.

18 4731.2650 REPORTS; INDIVIDUAL MONITORING.

19 A. This part applies to a person licensed by the
20 commissioner to:

21 (1) possess or use radioactive material for
22 purposes of radiography according to parts 4731.3000 to
23 4731.3175 and 4731.4000 to 4731.4360; or

24 (2) possess or use at any time for processing or
25 manufacturing for distribution according to parts 4731.3000 to
26 4731.3175, 4731.3300 to 4731.3580, or 4731.4400 to 4731.4527,

1 radioactive material in quantities exceeding any one of the
2 following quantities:

3	Radionuclide	Quantity of Radionuclide
4		in curies
5		
6	Cesium-137	1
7	Cobalt-60	1
8	Gold-198	100
9	Iodine-131	1
10	Iridium-192	10
11	Krypton-85	1,000
12	Promethium-147	10
13	Technetium-99m	1,000
14		

15 B. The commissioner may require as a license
16 condition or by order according to part 4731.0200, reports from
17 licensees who are licensed to use radionuclides not listed under
18 item A, subitem (2), in quantities sufficient to cause
19 comparable radiation levels.

20 C. A licensee under item A must submit an annual
21 report of the results of individual monitoring carried out by
22 the licensee for each individual for whom monitoring was
23 required under part 4731.2210 during that year. The licensee
24 may include additional data for individuals for whom monitoring
25 was provided but not required. The licensee must use an NRC
26 Form 5, or its equivalent, or electronic media containing all
27 the information required by the NRC form, to file the report.

28 D. A licensee must file the report required under
29 item C, covering the preceding year, on or before April 30 of
30 each year. A licensee must submit the report to the
31 commissioner.

32 4731.2700 ASSIGNED PROTECTION FACTORS FOR RESPIRATORS.

33 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
(3) Facepiece, full	Negative pressure
(4) Facepiece, half	Powered air-purifying respirators
(5) Facepiece, full	Powered air-purifying respirators
(6) Helmet/hood	Powered air-purifying respirators
(7) Facepiece,	
loose-fitting	Powered air-purifying respirators

B. Atmosphere supplying respirators [particulate, gases and vapors]:

(1) Air-line respirator:

1	(a) Facepiece, half	Demand	10
2	(b) Facepiece, half	Continuous flow	50
3	(c) Facepiece, half	Pressure demand	50
4	(d) Facepiece, full	Demand	100
5	(e) Facepiece, full	Continuous flow	1000
6	(f) Facepiece, full	Pressure demand	1000
7	(g) Helmet/hood	Continuous flow	1000
8	(h) Facepiece,		
9	loose-fitting	Continuous flow	25
10	(i) Suit	Continuous flow	-

(2) Self-contained breathing apparatus (SCBA):

13	(a) Facepiece, full	Demand	100
14	(b) Facepiece, full	Pressure demand	10,000
15	(c) Facepiece, full	Demand, recirculating	100
16	(d) Facepiece, full	Positive pressure recirculating	10,000

C. Combination respirators:

19	Any combination	Assigned
20	of air-purifying	protection
21	and atmosphere-	factor for
22	supplying	type and
23	respirators	mode of
24		operation
25		as listed
26		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

1 permit individuals to use this type of respirator who have not
2 been medically screened or fit tested on the device, provided
3 that no credit be taken for their use in estimating intake or
4 dose. It is also recognized that it is difficult to perform an
5 effective positive or negative pressure pre-use user seal check
6 on this type of device. All other respiratory protection
7 program requirements under part 4731.2260 apply. An assigned
8 protection factor has not been assigned for these devices.
9 However, an APF equal to ten may be used if the licensee can
10 demonstrate a fit factor of at least 100 by use of a validated
11 or evaluated, qualitative or quantitative fit test.

12 D. Subpart 2, item A, subitem (2): Under-chin type
13 only. No distinction is made in this part between elastomeric
14 half-masks with replaceable cartridges and those designed with
15 the filter medium as an integral part of the facepiece, for
16 example, disposable or reusable disposable. Both types are
17 acceptable so long as the seal area of the latter contains some
18 substantial type of seal-enhancing material such as rubber or
19 plastic, the two or more suspension straps are adjustable, the
20 filter medium is at least 95 percent efficient, and all other
21 requirements of this chapter are met.

22 E. Subpart 2, item B: The assigned protection
23 factors for gases and vapors are not applicable to radioactive
24 contaminants that present an absorption or submersion hazard.
25 For tritium oxide vapor, approximately one-third of the intake
26 occurs by absorption through the skin so that an overall
27 protection factor of 3 is appropriate when atmosphere-supplying

1 respirators are used to protect against tritium oxide. Exposure
2 to radioactive noble gases is not considered a significant
3 respiratory hazard and protective actions for these contaminants
4 should be based on external (submersion) dose considerations.

5 F. Subpart 2, item B, subitem (1), unit (i): A
6 National Institute for Occupational Safety and Health approval
7 schedule is currently not available for atmosphere supplying
8 suits. This equipment may be used in an acceptable respiratory
9 protection program as long as all the other minimum program
10 requirements under part 4731.2260, with the exception of fit
11 testing, are met.

12 G. Subpart 2, item B, subitem (2), units (a) and (c):
13 A licensee should implement institutional controls to ensure
14 that these devices are not used in areas immediately dangerous
15 to life or health.

16 H. Subpart 2, item B, subitem (2), units (b) and
17 (d): This type of respirator may be used as an emergency device
18 in unknown concentrations for protection against inhalation
19 hazards. External radiation hazards and other limitations to
20 permitted exposure such as skin absorption must be taken into
21 account in these circumstances. The device may not be used by
22 any individual who experiences perceptible outward leakage of
23 breathing gas while wearing the device.

24 4731.2750 ANNUAL LIMITS ON INTAKE AND DERIVED AIR CONCENTRATIONS.

25 Subpart 1. General explanation. For each radionuclide,
26 subpart 7, Table 1, indicates the chemical form that is to be
27 used for selecting the appropriate annual limit on intake (ALI)

1 or derived air concentration (DAC) value. The ALIs and DACs for
2 inhalation are given for an aerosol with an activity median
3 aerodynamic diameter (AMAD) of 1 μm and for three classes (D,W,Y)
4 of radioactive material, which refer to their retention
5 (approximately days, weeks, or years) in the pulmonary region of
6 the lung. This classification applies to a range of clearance
7 half-times for D of less than ten days, for W from ten to 100
8 days, and for Y greater than 100 days. The class (D, W, or Y)
9 given in the column headed "Atomic Number (AN), Radionuclide,
10 and Class" applies only to the inhalation ALIs and DACs given in
11 subpart 7, Table 1, columns 2 and 3. Subpart 7, Table 2,
12 provides concentration limits for airborne and liquid effluents
13 released to the general environment. Subpart 7, Table 3,
14 provides concentration limits for discharges to sanitary sewer
15 systems.

16 Subp. 2. Notation. The values in subpart 7, Tables 1, 2,
17 and 3, are presented in the computer "E" notation. In this
18 notation, a value of 6E-02 represents a value of 6×10^{-2} or
19 0.06, 6E+2 represents 6×10^2 or 600, and 6E+0 represents $6 \times$
20 10^0 or 6.

21 Subp. 3. Table 1 explanation; occupational values.

22 A. The columns in subpart 7, Table 1, are applicable
23 to occupational exposure to radioactive material. Column 1 is
24 the oral ingestion ALI, expressed in μCi . Column 2 is the
25 inhalation ALI, expressed in μCi . Column 3 is the inhalation
26 DAC, expressed in $\mu\text{Ci/ml}$.

27 B. The ALIs in this part are the annual intakes of a

1 given radionuclide by reference man that would result in:

2 (1) a committed effective dose equivalent of five
3 rems (stochastic ALI); or

4 (2) a committed dose equivalent of 50 rems to an
5 organ or tissue (nonstochastic ALI).

6 C. The stochastic ALIs were derived to result in a
7 risk, due to irradiation of organs and tissues, comparable to
8 the risk associated with deep dose equivalent to the whole body
9 of five rems.

10 D. The derivation includes multiplying the committed
11 dose equivalent to an organ or tissue by a weighting factor,
12 W_T . This weighting factor is the proportion of the risk of
13 stochastic effects resulting from irradiation of the organ or
14 tissue, T , to the total risk of stochastic effects when the
15 whole body is irradiated uniformly. The values of W_T are listed
16 under part 4731.0100, subpart 261. The nonstochastic ALIs were
17 derived to avoid nonstochastic effects, such as prompt damage to
18 tissue or reduction in organ function.

19 E. A value of $W_T=0.06$ is applicable to each of the
20 five organs or tissues in the "remainder" category receiving the
21 highest dose equivalents and the dose equivalents of all other
22 remaining tissues may be disregarded.

23 F. The following parts of the gastrointestinal tract
24 are to be treated as four separate organs: stomach, small
25 intestine, upper large intestine, and lower large intestine.

26 G. The dose equivalents for extremities (hands and
27 forearms, feet and lower legs), skin, and lens of the eye are

1 not considered in computing the committed effective dose
2 equivalent, but are subject to limits that must be met
3 separately.

4 H. When an ALI is defined by the stochastic dose
5 limit, this value alone is given. When an ALI is determined by
6 the nonstochastic dose limit to an organ, the organ or tissue to
7 which the limit applies is shown, and the ALI for the stochastic
8 limit is shown in parentheses. Abbreviated organ or tissue
9 designations are used:

10 LLI = lower large intestine wall;

11 Stom = stomach wall;

12 Blad = bladder wall;

13 Bone = bone surface;

14 Kid = kidneys; and

15 Thyr = thyroid.

16 I. The use of the ALIs listed first, the more
17 limiting of the stochastic and nonstochastic ALIs, will ensure
18 that nonstochastic effects are avoided and that the risk of
19 stochastic effects is limited to an acceptably low value. If,
20 in a particular situation involving a radionuclide for which the
21 nonstochastic ALI is limiting, use of that nonstochastic ALI is
22 considered unduly conservative, a licensee may use the
23 stochastic ALI to determine the committed effective dose
24 equivalent. However, the licensee must also ensure that the
25 50-rem dose equivalent limit for any organ or tissue is not
26 exceeded by the sum of the external deep dose equivalent plus
27 the internal committed dose to that organ (not the effective

1 dose). For the case where there is no external dose
2 contribution, this would be demonstrated if the sum of the
3 fractions of the nonstochastic ALIs (ALI_{ns}) that contribute to
4 the committed dose equivalent to the organ receiving the highest
5 dose does not exceed unity: $\sum (\text{intake (in } \mu\text{Ci) of each}$
6 $\text{radionuclide}/ALI_{ns}) < 1.0$. If there is an external deep dose
7 equivalent contribution of H_d , then this sum must be less than
8 $1-(H_d/50)$ instead of being less than 1.0.

9 J. The DAC values are derived limits intended to
10 control chronic occupational exposures. The relationship
11 between the DAC and the ALI is given by:

$$12 \text{ DAC} = \text{ALI (in } \mu\text{Ci)}/(2000 \text{ hours per working year} \times 60 \text{ minutes/hour} \\ 13 \times 2 \times 10^4 \text{ ml per minute}) = [\text{ALI}/2.4 \times 10^9] \mu\text{Ci/ml}$$

14 where 2×10^4 ml is the volume of air breathed per minute at
15 work by reference man under working conditions of light work.

16 K. The DAC values relate to one of two modes of
17 exposure: either external submersion or the internal committed
18 dose equivalents resulting from inhalation of radioactive
19 materials. Derived air concentrations based upon submersion are
20 for immersion in a semi-infinite cloud of uniform concentration
21 and apply to each radionuclide separately.

22 L. The ALI and DAC values relate to exposure to the
23 single radionuclide named, but also include contributions from
24 the in-growth of any daughter radionuclide produced in the body
25 by the decay of the parent. However, intakes that include both
26 the parent and daughter radionuclides should be treated by the
27 general method appropriate for mixtures.

1 M. The ~~value~~ values of ALI and DAC do not apply
2 directly when the individual both ingests and inhales a
3 radionuclide, when the individual is exposed to a mixture of
4 radionuclides by either inhalation or ingestion or both, or when
5 the individual is exposed to both internal and external
6 irradiation.

7 N. When an individual is exposed to radioactive
8 materials that fall under several of the translocation
9 classifications (Class D, W, or Y) of the same radionuclide, the
10 exposure may be evaluated as if it were a mixture of different
11 radionuclides.

12 O. The classification of a compound as Class D, W, or
13 Y is based on the chemical form of the compound and does not
14 take into account the radiological half-life of different
15 radioisotopes. For this reason, values are given for Class D,
16 W, and Y compounds, even for very short-lived radionuclides.

17 Subp. 4. Table 2 explanation; effluent concentrations.

18 A. The columns in subpart 7, Table 2, are applicable
19 to the assessment and control of dose to the public,
20 particularly in the implementation of part 4731.2095. Column 1
21 is the effluent concentration limit for air, expressed in $\mu\text{Ci/ml}$.
22 Column 2 is the effluent concentration limit for water,
23 expressed in $\mu\text{Ci/ml}$. The concentration values given in subpart
24 7, Table 2, columns 1 and 2, are equivalent to the radionuclide
25 concentrations that, if inhaled or ingested continuously over
26 the course of a year, would produce a total effective dose
27 equivalent of 0.05 rem (50 mrem or 0.5 mSv).

1 B. Consideration of nonstochastic limits has not been
2 included in deriving the air and water effluent concentration
3 limits because nonstochastic effects are presumed not to occur
4 at the dose levels established for individual members of the
5 public. For radionuclides, where the nonstochastic limit was
6 governing in deriving the occupational DAC, the stochastic ALI
7 was used in deriving the corresponding airborne effluent limit
8 in subpart 7, Table 2. For this reason, the DAC and airborne
9 effluent limits are not always proportional as they were in
10 previous Code of Federal Regulations, title 10, sections 20.1 to
11 20.602, Appendix B.

12 C. The air concentration values in subpart 7, Table
13 2, column 1, were derived by one of two methods. For those
14 radionuclides for which the stochastic limit is governing, the
15 occupational stochastic inhalation ALI was divided by 2.4×10^9
16 (ml), relating the inhalation ALI to the DAC, and then divided
17 by a factor of 300. The factor of 300 includes the following
18 components: a factor of 50 to relate the five-rem annual
19 occupational dose limit to the 0.1-rem limit for members of the
20 public; a factor of three to adjust for the difference in
21 exposure time and inhalation rate for a worker and for members
22 of the public; and a factor of two to adjust the occupational
23 values derived for adults so that they are applicable to other
24 age groups.

25 D. For those radionuclides for which submersion
26 (external dose) is limiting, the occupational DAC in subpart 7,
27 Table 1, column 3, was divided by 219. The factor of 219 is

1 composed of a factor of 50, according to item C, and a factor of
2 4.38 relating occupational exposure for 2,000 hours per year to
3 full-time exposure (8,760 hours per year). An additional factor
4 of two for age considerations is not warranted in the submersion
5 case.

6 E. The water concentrations were derived by taking
7 the most restrictive occupational stochastic oral ingestion ALI
8 and dividing by 7.3×10^7 . The factor of 7.3×10^7 (ml) includes
9 the following components: the factors of 50 and two, according
10 to item C, and a factor of 7.3×10^5 (ml), which is the annual
11 water intake of reference man.

12 F. Subpart 8 provides groupings of radionuclides that
13 are applicable to unknown mixtures of radionuclides. These
14 groupings, including occupational inhalation ALIs and DACs, air
15 and water effluent concentrations and sewerage, require
16 demonstrating that the most limiting radionuclides in successive
17 classes are absent. The limit for the unknown mixture is
18 defined when the presence of one of the listed radionuclides
19 cannot be definitely excluded, either from knowledge of the
20 radionuclide composition of the source or from actual
21 measurements.

22 Subp. 5. Table 3 explanation; releases to sewers. Subpart
23 7, Table 3, gives the monthly average concentrations for release
24 to sanitary sewers, expressed in $\mu\text{Ci/ml}$. The monthly average
25 concentrations for release to sanitary sewers are applicable to
26 part 4731.2420. The concentration values were derived by taking
27 the most restrictive occupational stochastic oral ingestion ALI

1 and dividing by 7.3×10^6 (ml). The factor of 7.3×10^6 (ml) is
2 composed of a factor of 7.3×10^5 (ml), the annual water intake
3 by reference man, and a factor of ten, such that the
4 concentrations, if the sewage released by the licensee were the
5 only source of water ingested by a reference man during a year,
6 would result in a committed effective dose equivalent of 0.5 rem.

7 Subp. 6. List of elements.

8	Name	Symbol	Atomic Number (AN)
9			
10	Actinium	Ac	89
11	Aluminum	Al	13
12	Americium	Am	95
13	Antimony	Sb	51
14	Argon	Ar	18
15	Arsenic	As	33
16	Astatine	At	85
17			
18	Barium	Ba	56
19	Berkelium	Bk	97
20	Beryllium	Be	4
21	Bismuth	Bi	83
22	Bromine	Br	35
23			
24	Cadmium	Cd	48
25	Calcium	Ca	20
26	Californium	Cf	98
27	Carbon	C	6
28	Cerium	Ce	58
29	Cesium	Cs	55
30	Chlorine	Cl	17
31	Chromium	Cr	24
32	Cobalt	Co	27
33	Copper	Cu	29
34	Curium	Cm	96
35			
36	Dysprosium	Dy	66
37			
38	Einsteinium	Es	99
39	Erbium	Er	68
40	Europium	Eu	63
41			
42	Fermium	Fm	100
43	Fluorine	F	9
44	Francium	Fr	87
45			
46	Gadolinium	Gd	64
47	Gallium	Ga	31

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1	Germanium	Ge	32
2	Gold	Au	79
3			
4	Hafnium	Hf	72
5	Holmium	Ho	67
6	Hydrogen	H	1
7			
8	Indium	In	49
9	Iodine	I	53
10	Iridium	Ir	77
11	Iron	Fe	26
12			
13	Krypton	Kr	36
14			
15	Lanthanum	La	57
16	Lead	Pb	82
17	Lutetium	Lu	71
18			
19	Magnesium	Mg	12
20	Manganese	Mn	25
21	Mendelevium	Md	101
22	Mercury	Hg	80
23	Molybdenum	Mo	42
24			
25	Neodymium	Nd	60
26	Neptunium	Np	93
27	Nickel	Ni	28
28	Niobium	Nb	41
29			
30	Osmium	Os	76
31			
32	Palladium	Pd	46
33	Phosphorus	P	15
34	Platinum	Pt	78
35	Plutonium	Pu	94
36	Polonium	Po	84
37	Potassium	K	19
38	Praseodymium	Pr	59
39	Promethium	Pm	61
40	Protactinium	Pa	91
41			
42	Radium	Ra	88
43	Radon	Rn	86
44	Rhenium	Re	75
45	Rhodium	Rh	45
46	Rubidium	Rb	37
47	Ruthenium	Ru	44
48			
49	Samarium	Sm	62
50	Scandium	Sc	21
51	Selenium	Se	34
52	Silicon	Si	14
53	Silver	Ag	47
54	Sodium	Na	11

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1	Strontium	Sr	38
2	Sulfur	S	16
3			
4	Tantalum	Ta	73
5	Technetium	Tc	43
6	Tellurium	Te	52
7	Terbium	Tb	65
8	Thallium	Tl	81
9	Thorium	Th	90
10	Thulium	Tm	69
11	Tin	Sn	50
12	Titanium	Ti	22
13	Tungsten	W	74
14			
15	Uranium	U	92
16			
17	Vanadium	V	23
18			
19	Xenon	Xe	54
20			
21	Ytterbium	Yb	70
22	Yttrium	Y	39
23			
24	Zinc	Zn	30
25	Zirconium	Zr	40
26	Subp. 7. Table of ALIs and DACs.		

27		Table 1			Table 2		Table 3
28	Atomic Number (AN),						
29	Radionuclide,						
30	and Class	1	2	3	1	2	
31							

32	AN 1						
33	Hydrogen-3						
34							
35	Water, DAC includes						
36	skin absorption	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
37							

38 Gas (HT or T_2)
 39 submersion: Use
 40 above values as
 41 HT and T_2 oxidize
 42 in air and in the
 43 body to HTO.

44							
45	AN 4						
46	Beryllium-7						
47							
48	W, all compounds						
49	except those						
50	given for Y	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
51							
52	Y, oxides,						

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1	halides, and						
2	nitrates	---	2E+4	8E-6	3E-8	---	---
3							
4	Beryllium-10						
5							
6	W, see ⁷ Be	1E+3	2E+2	6E-8	2E-10	---	---
7		LLI					
8		(1E+3)	---	---	2E-5	2E-4	---
9	Y, see ⁷ Be	---	1E+1	6E-9	2E-11	---	---
10							
11	AN 6						
12	Carbon-11 ²						
13							
14	Monoxide	---	1E+6	5E-4	2E-6	---	---
15	Dioxide	---	6E+5	3E-4	9E-7	---	---
16	Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2
17							
18	Carbon-14						
19							
20	Monoxide	---	2E+6	7E-4	2E-6	---	---
21	Dioxide	---	2E+5	9E-5	3E-7	---	---
22	Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
23							
24	AN 9						
25	Fluorine-18 ²						
26							
27	D, fluorides of H,						
28	Li, Na, K, Rb, Cs,						
29	and Fr	5E+4	7E+4	3E-5	1E-7	---	---
30		Stom					
31		(5E+4)	---	---	---	7E-4	7E-3
32	W, fluorides of Be,						
33	Mg, Ca, Sr, Ba, Ra,						
34	Al, Ga, In, Tl, As,						
35	Sb, Bi, Fe, Ru, Os,						
36	Co, Ni, Pd, Pt, Cu,						
37	Ag, Au, Zn, Cd, Hg,						
38	Sc, Y, Ti, Zr, V,						
39	Nb, Ta, Mn, Tc,						
40	and Re	---	9E+4	4E-5	1E-7	---	---
41							
42	Y, lanthanum						
43	fluoride	---	8E+4	3E-5	1E-7	---	---
44							
45	AN 11						
46	Sodium-22						
47							
48	D, all compounds	4E+2	6E+2	3E-7	9E-10	6E-6	6E-5
49							
50	Sodium-24						
51							
52	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
53							
54	AN 12						

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1	Magnesium-28						
2							
3	D, all compounds						
4	except those						
5	given for W	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
6							
7	W, oxides,						
8	hydroxides,						
9	carbides, halides,						
10	and nitrates	---	1E+3	5E-7	2E-9	---	---
11							
12	AN 13						
13	Aluminum-26						
14							
15	D, all compounds						
16	except those						
17	given for W	4E+2	6E+1	3E-8	9E-11	6E-6	6E-5
18							
19	W, oxides,						
20	hydroxides,						
21	carbides, halides,						
22	and nitrates	---	9E+1	4E-8	1E-10	---	---
23							
24	AN 14						
25	Silicon-31						
26							
27	D, all compounds						
28	except those						
29	given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
30							
31	W, oxides,						
32	hydroxides,						
33	carbides, and						
34	nitrates	---	3E+4	1E-5	5E-8	---	---
35							
36	Y, aluminosilicate						
37	glass	---	3E+4	1E-5	4E-8	---	---
38							
39	Silicon-32						
40							
41	D, see ³¹ Si	2E+3	2E+2	1E-7	3E-10	---	---
42		LLI					
43		(3E+3)	---	---	---	4E-5	4E-4
44	W, see ³¹ Si	---	1E+2	5E-8	2E-10	---	---
45	Y, see ³¹ Si	---	5E+0	2E-9	7E-12	---	---
46							
47	AN 15						
48	Phosphorus-32						
49							
50	D, all compounds						
51	except phosphates						
52	given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
53							
54	W, phosphates of						

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1	Zn ²⁺ , S ³⁺ , Mg ²⁺ ,						
2	Fe ³⁺ , Bi ³⁺ , and						
3	lanthanides	---	4E+2	2E-7	5E-10	---	---
4							
5	Phosphorus-33						
6							
7	D, see ³² P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
8	W, see ³² P	---	3E+3	1E-6	4E-9	---	---
9							
10	AN 16						
11	Sulfur-35						
12							
13	Vapor	1E+4	6E-6	2E-8	---	---	---
14							
15	D, sulfides and						
16	sulfates except						
17	those given for W	1E+4	2E+4	7E-6	2E-8	---	---
18		LLI					
19		(8E+3)	---	---	---	1E-4	1E-3
20	W, elemental sulfur,	6E+3	---	---	---	---	---
21	sulfides of Sr, Ba,						
22	Ge, Sn, Pb, As, Sb,						
23	Bi, Cu, Ag, Au, Zn,						
24	Cd, Hg, W, and Mo.						
25	Sulfates of Ca, Sr,						
26	Ba, Ra, As, Sb,						
27	and Bi	---	2E+3	9E-7	3E-9	---	---
28							
29	AN 17						
30	Chlorine-36						
31							
32	D, chlorides of H,						
33	Li, Na, K, Rb, Cs,						
34	and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
35							
36	W, chlorides of						
37	lanthanides, Be,						
38	Mg, Ca, Sr, Ba, Ra,						
39	Al, Ga, In, Tl, Ge,						
40	Sn, Pb, As, Sb, Bi,						
41	Fe, Ru, Os, Co, Rh,						
42	Ir, Ni, Pd, Pt, Cu,						
43	Ag, Au, Zn, Cd, Hg,						
44	Sc, Y, Ti, Zr, Hf,						
45	V, Nb, Ta, Cr, Mo,						
46	W, Mn, Tc, and Re	---	2E+2	1E-7	3E-10	---	---
47							
48	Chlorine-38 ²						
49							
50	D, see ³⁶ Cl	2E+4	4E+4	2E-5	6E-8	---	---
51		Stom					
52		(3E+4)	---	---	---	3E-4	3E-3
53	W, see ³⁶ Cl	---	5E+4	2E-5	6E-8	---	---
54							

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1	Chlorine-39 ²						
2							
3	D, see ³⁶ Cl	2E+4	5E+4	2E-5	7E-8	---	---
4		Stom					
5		(4E+4)	---	---	---	5E-4	5E-3
6	W, see ³⁶ Cl	---	6E+4	2E-5	8E-8	---	---
7							
8	AN 18						
9	Argon-37						
10							
11	Submersion ¹	---	---	1E+0	6E-3	---	---
12							
13	Argon-39						
14							
15	Submersion ¹	---	---	2E-4	8E-7	---	---
16							
17	Argon-41						
18							
19	Submersion ¹	---	---	3E-6	1E-8	---	---
20							
21	AN 19						
22	Potassium-40						
23							
24	D, all compounds	3E+2	4E+2	2E-7	6E-10	4E-6	4E-5
25							
26	Potassium-42						
27							
28	D, all compounds	5E+3	5E+3	2E-6	7E-9	6E-5	6E-4
29							
30	Potassium-43						
31							
32	D, all compounds	6E+3	9E+3	4E-6	1E-8	9E-5	9E-4
33							
34	Potassium-44 ²						
35							
36	D, all compounds	2E+4	7E+4	3E-5	9E-8	---	---
37		Stom					
38		(4E+4)	---	---	5E-4	5E-3	---
39							
40	Potassium-45 ²						
41							
42	D, all compounds	3E+4	1E+5	5E-5	2E-7	---	---
43		Stom					
44		(5E+4)	---	---	---	7E-4	7E-3
45							
46	AN 20						
47	Calcium-41						
48							
49	W, all compounds	3E+3	4E+3	2E-6	---	---	---
50		Bone	Bone				
51		(4E+3)	(4E+3)	---	5E-9	6E-5	6E-4
52							
53	Calcium-45						
54							

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1	W, all compounds	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
2							
3	Calcium-47						
4							
5	W, all compounds	8E+2	9E+2	4E-7	1E-9	1E-5	1E-4
6							
7	AN 21						
8	Scandium-43						
9							
10	Y, all compounds	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
11							
12	Scandium-44m						
13							
14	Y, all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
15							
16	Scandium-44						
17							
18	Y, all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
19							
20	Scandium-46						
21							
22	Y, all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4
23							
24	Scandium-47						
25							
26	Y, all compounds	2E+3	3E+3	1E-6	4E-9	---	---
27		LLI					
28		(3E+3)	---	---	---	4E-5	4E-4
29							
30	Scandium-48						
31							
32	Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
33							
34	Scandium-49 ²						
35							
36	Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
37							
38	AN 22						
39	Titanium-44						
40							
41	D, all compounds						
42	except those						
43	given for W and Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
44							
45	W, oxides,						
46	hydroxides,						
47	carbides, halides,						
48	and nitrates	---	3E+1	1E-8	4E-11	---	---
49							
50	Y, SrTiO ₃	---	6E+0	2E-9	8E-12	---	---
51							
52	Titanium-45						
53							
54	D, see ⁴⁴ Ti	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3

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1	W, see ⁴⁴ Ti	---	4E+4	1E-5	5E-8	---	---
2	Y, see ⁴⁴ Ti	---	3E+4	1E-5	4E-8	---	---
3							
4	AN 23						
5	Vanadium-47 ²						
6							
7	D, all compounds						
8	except those						
9	given for W	3E+4	8E+4	3E-5	1E-7	---	---
10		Stom					
11		(3E+4)	---	---	---	4E-4	4E-3
12	W, oxides						
13	hydroxides,						
14	carbides,						
15	and halides	---	1E+5	4E-5	1E-7	---	---
16							
17	Vanadium-48						
18							
19	D, see ⁴⁷ V	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
20	W, see ⁴⁷ V	---	6E+2	3E-7	9E-10	---	---
21							
22	Vanadium-49						
23							
24	D, see ⁴⁷ V	7E+4	3E+4	1E-5	---	---	---
25		LLI	Bone				
26		(9E+4)	(3E+4)	---	5E-8	1E-3	1E-2
27	W, see ⁴⁷ V	---	2E+4	8E-6	2E-8	---	---
28							
29	AN 24						
30	Chromium-48						
31							
32	D, all compounds						
33	except those						
34	given for W and Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
35							
36	W, halides and						
37	nitrates	---	7E+3	3E-6	1E-8	---	---
38							
39	Y, oxides						
40	hydroxides	---	7E+3	3E-6	1E-8	---	---
41							
42	Chromium-49 ²						
43							
44	D, see ⁴⁸ Cr	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
45	W, see ⁴⁸ Cr	---	1E+5	4E-5	1E-7	---	---
46	Y, see ⁴⁸ Cr	---	9E+4	4E-5	1E-7	---	---
47							
48	Chromium-51						
49							
50	D, see ⁴⁸ Cr	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
51	W, see ⁴⁸ Cr	---	2E+4	1E-5	3E-8	---	---
52	Y, see ⁴⁸ Cr	---	2E+4	8E-6	3E-8	---	---
53							
54	AN 25						

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1	Manganese-51 ²						
2							
3	D, all compounds						
4	except those						
5	given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
6							
7	W, oxides,						
8	hydroxides						
9	halides, and						
10	nitrates	---	6E+4	3E-5	8E-8	---	---
11							
12	Manganese-52m ²						
13							
14	D, see ⁵¹ Mn	3E+4	9E+4	4E-5	1E-7	---	---
15		Stom					
16		(4E+4)	---	---	---	5E-4	5E-3
17	W, see ⁵¹ Mn	---	1E+5	4E-5	1E-7	---	---
18							
19	Manganese-52						
20							
21	D, see ⁵¹ Mn	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
22	W, see ⁵¹ Mn	---	9E+2	4E-7	1E-9	---	---
23							
24	Manganese-53						
25							
26	D, see ⁵¹ Mn	5E+4	1E+4	5E-6	---	7E-4	7E-3
27			Bone				
28		---	(2E+4)	---	3E-8	---	---
29	W, see ⁵¹ Mn	---	1E+4	5E-6	2E-8	---	---
30							
31	Manganese-54						
32							
33	D, see ⁵¹ Mn	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
34	W, see ⁵¹ Mn	---	8E+2	3E-7	1E-9	---	---
35							
36	Manganese-56						
37							
38	D, see ⁵¹ Mn	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
39	W, see ⁵¹ Mn	---	2E+4	9E-6	3E-8	---	---
40							
41	AN 26						
42	Iron-52						
43							
44	D, all compounds						
45	except those						
46	given for W	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
47							
48	W, oxides,						
49	hydroxides, and						
50	halides	---	2E+3	1E-6	3E-9	---	---
51							
52	Iron-55						
53							
54	D, see ⁵² Fe	9E+3	2E+3	8E-7	3E-9	1E-4	1E-3

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1	W, see ⁵² Fe	---	4E+3	2E-6	6E-9	---	---
2							
3	Iron-59						
4							
5	D, see ⁵² Fe	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
6	W, see ⁵² Fe	---	5E+2	2E-7	7E-10	---	---
7							
8	Iron-60						
9							
10	D, see ⁵² Fe	3E+1	6E+0	3E-9	9E-12	4E-7	4E-6
11	W, see ⁵² Fe	---	2E+1	8E-9	3E-11	---	---
12							
13	AN 27						
14	Cobalt-55						
15							
16	W, all compounds						
17	except those						
18	given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
19							
20	Y, oxides,						
21	hydroxides,						
22	halides, and						
23	nitrates	---	3E+3	1E-6	4E-9	---	---
24							
25	Cobalt-56						
26							
27	W, see ⁵⁵ Co	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
28	Y, see ⁵⁵ Co	4E+2	2E+2	8E-8	3E-10	---	---
29							
30	Cobalt-57						
31							
32	W, see ⁵⁵ Co	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
33	Y, see ⁵⁵ Co	4E+3	7E+2	3E-7	9E-10	---	---
34							
35	Cobalt-58m						
36							
37	W, see ⁵⁵ Co	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
38	Y, see ⁵⁵ Co	---	6E+4	3E-5	9E-8	---	---
39							
40	Cobalt-58						
41							
42	W, see ⁵⁵ Co	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4
43	Y, see ⁵⁵ Co	1E+3	7E+2	3E-7	1E-9	---	---
44							
45	Cobalt-60m ²						
46							
47	W, see ⁵⁵ Co	1E+6	4E+6	2E-3	6E-6	---	---
48		Stom					
49		(1E+6)	---	---	---	2E-2	2E-1
50	Y, see ⁵⁵ Co	---	3E+6	1E-3	4E-6	---	---
51							
52	Cobalt-60						
53							
54	W, see ⁵⁵ Co	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5

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1	Y, see ⁵⁵ Co	2E+2	3E+1	1E-8	5E-11	---	---
2							
3	Cobalt-61 ²						
4							
5	W, see ⁵⁵ Co	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
6	Y, see ⁵⁵ Co	2E+4	6E+4	2E-5	8E-8	---	---
7							
8	Cobalt-62m ²						
9							
10	W, see ⁵⁵ Co	4E+4	2E+5	7E-5	2E-7	---	---
11		Stom					
12		(5E+4)	---	---	---	7E-4	7E-3
13	Y, see ⁵⁵ Co	---	2E+5	6E-5	2E-7	---	---
14							
15	AN 28						
16	Nickel-56						
17							
18	D, all compounds						
19	except those						
20	given for W	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
21							
22	W, oxides,						
23	hydroxides,						
24	and carbides	---	1E+3	5E-7	2E-9	---	---
25							
26	Vapor	---	1E+3	5E-7	2E-9	---	---
27							
28	Nickel-57						
29							
30	D, see ⁵⁶ Ni	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
31	W, see ⁵⁶ Ni	---	3E+3	1E-6	4E-9	---	---
32	Vapor	---	6E+3	3E-6	9E-9	---	---
33							
34	Nickel-59						
35							
36	D, see ⁵⁶ Ni	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
37	W, see ⁵⁶ Ni	---	7E+3	3E-6	1E-8	---	---
38	Vapor	---	2E+3	8E-7	3E-9	---	---
39							
40	Nickel-63						
41							
42	D, see ⁵⁶ Ni	9E+3	2E+3	7E-7	2E-9	1E-4	1E-3
43	W, see ⁵⁶ Ni	---	3E+3	1E-6	4E-9	---	---
44	Vapor	---	8E+2	3E-7	1E-9	---	---
45							
46	Nickel-65						
47							
48	D, see ⁵⁶ Ni	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
49	W, see ⁵⁶ Ni	---	3E+4	1E-5	4E-8	---	---
50	Vapor	---	2E+4	7E-6	2E-8	---	---
51							
52	Nickel-66						
53							
54	D, see ⁵⁶ Ni	4E+2	2E+3	7E-7	2E-9	---	---

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1		LLI					
2		(5E+2)	---	---	---	6E-6	6E-5
3	W, see ⁵⁶ Ni	---	6E+2	3E-7	9E-10	---	---
4	Vapor	---	3E+3	1E-6	4E-9	---	---
5							
6	AN 29						
7	Copper-60 ²						
8							
9	D, all compounds						
10	except those						
11	given for W and Y	3E+4	9E+4	4E-5	1E-7	---	---
12		Stom					
13		(3E+4)	---	---	---	4E-4	4E-3
14	W, sulfides,						
15	halides,						
16	and nitrates	---	1E+5	5E-5	2E-7	---	---
17							
18	Y, oxides and						
19	hydroxides	---	1E+5	4E-5	1E-7	---	---
20							
21	Copper-61						
22							
23	D, see ⁶⁰ Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
24	W, see ⁶⁰ Cu	---	4E+4	2E-5	6E-8	---	---
25	Y, see ⁶⁰ Cu	---	4E+4	1E-5	5E-8	---	---
26							
27	Copper-64						
28							
29	D, see ⁶⁰ Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
30	W, see ⁶⁰ Cu	---	2E+4	1E-5	3E-8	---	---
31	Y, see ⁶⁰ Cu	---	2E+4	9E-6	3E-8	---	---
32							
33	Copper-67						
34							
35	D, see ⁶⁰ Cu	5E+3	8E+3	3E-6	1E-8	6E-5	6E-4
36	W, see ⁶⁰ Cu	---	5E+3	2E-6	7E-9	---	---
37	Y, see ⁶⁰ Cu	---	5E+3	2E-6	6E-9	---	---
38							
39	AN 30						
40	Zinc-62						
41							
42	Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
43							
44	Zinc-63 ²						
45							
46	Y, all compounds	2E+4	7E+4	3E-5	9E-8	---	---
47		Stom					
48		(3E+4)	---	---	---	3E-4	3E-3
49							
50	Zinc-65						
51							
52	Y, all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5
53							
54	Zinc-69m						

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1							
2	Y, all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4
3							
4	Zinc-69 ²						
5							
6	Y, all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
7							
8	Zinc-71m						
9							
10	Y, all compounds	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
11							
12	Zinc-72						
13							
14	Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
15							
16	AN 31						
17	Gallium-65 ²						
18							
19	D, all compounds						
20	except those						
21	given for W	5E+4	2E+5	7E-5	2E-7	---	---
22		Stom					
23		(6E+4)	---	---	---	9E-4	9E-3
24							
25	W, oxides,						
26	hydroxides,						
27	carbides,						
28	halides, and						
29	nitrates	---	2E+5	8E-5	3E-7	---	---
30							
31	Gallium-66						
32							
33	D, see ⁶⁵ Ga	1E+3	4E+3	1E-6	5E-9	1E-5	1E-4
34	W, see ⁶⁵ Ga	---	3E+3	1E-6	4E-9	---	---
35							
36	Gallium-67						
37							
38	D, see ⁶⁵ Ga	7E+3	1E+4	6E-6	2E-8	1E-4	1E-3
39	W, see ⁶⁵ Ga	---	1E+4	4E-6	1E-8	---	---
40							
41	Gallium-68 ²						
42							
43	D, see ⁶⁵ Ga	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
44	W, see ⁶⁵ Ga	---	5E+4	2E-5	7E-8	---	---
45							
46	Gallium-70 ²						
47							
48	D, see ⁶⁵ Ga	5E+4	2E+5	7E-5	2E-7	---	---
49		Stom					
50		(7E+4)	---	---	---	1E-3	1E-2
51	W, see ⁶⁵ Ga	---	2E+5	8E-5	3E-7	---	---
52							
53	Gallium-72						
54							

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1	D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
2	W, see ^{65}Ga	---	3E+3	1E-6	4E-9	---	---
3							
4	Gallium-73						
5							
6	D, see ^{65}Ga	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
7	W, see ^{65}Ga	---	2E+4	6E-6	2E-8	---	---
8							
9	AN 32						
10	Germanium-66						
11							
12	D, all compounds						
13	except those						
14	given for W	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
15							
16	W, oxides,						
17	sulfides, and						
18	halides	---	2E+4	8E-6	3E-8	---	---
19							
20	Germanium-67 ²						
21							
22	D, see ^{66}Ge	3E+4	9E+4	4E-5	1E-7	---	---
23		Stom					
24		(4E+4)	---	---	6E-4	6E-3	---
25	W, see ^{66}Ge	---	1E+5	4E-5	1E-7	---	---
26							
27	Germanium-68						
28							
29	D, see ^{66}Ge	5E+3	4E+3	2E-6	5E-9	6E-5	6E-4
30	W, see ^{66}Ge	---	1E+2	4E-8	1E-10	---	---
31							
32	Germanium-69						
33							
34	D, see ^{66}Ge	1E+4	2E+4	6E-6	2E-8	2E-4	2E-3
35	W, see ^{66}Ge	---	8E+3	3E-6	1E-8	---	---
36							
37	Germanium-71						
38							
39	D, see ^{66}Ge	5E+5	4E+5	2E-4	6E-7	7E-3	7E-2
40	W, see ^{66}Ge	---	4E+4	2E-5	6E-8	---	---
41							
42	Germanium-75 ²						
43							
44	D, see ^{66}Ge	4E+4	8E+4	3E-5	1E-7	---	---
45		Stom					
46		(7E+4)	---	---	---	9E-4	9E-3
47	W, see ^{66}Ge	---	8E+4	4E-5	1E-7	---	---
48							
49	Germanium-77						
50							
51	D, see ^{66}Ge	9E+3	1E+4	4E-6	1E-8	1E-4	1E-3
52	W, see ^{66}Ge	---	6E+3	2E-6	8E-9	---	---
53							
54	Germanium-78 ²						

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1							
2	D, see ^{66}Ge	2E+4	2E+4	9E-6	3E-8	---	---
3		Stom					
4		(2E+4)	---	---	---	3E-4	3E-3
5	W, see ^{66}Ge	---	2E+4	9E-6	3E-8	---	---
6							
7	AN 33						
8	Arsenic-69 ²						
9							
10	W, all compounds	3E+4	1E+5	5E-5	2E-7	---	---
11		Stom					
12		(4E+4)	---	---	---	6E-4	6E-3
13							
14	Arsenic-70 ²						
15							
16	W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3
17							
18	Arsenic-71						
19							
20	W, all compounds	4E+3	5E+3	2E-6	6E-9	5E-5	5E-4
21							
22	Arsenic-72						
23							
24	W, all compounds	9E+2	1E+3	6E-7	2E-9	1E-5	1E-4
25							
26	Arsenic-73						
27							
28	W, all compounds	8E+3	2E+3	7E-7	2E-9	1E-4	1E-3
29							
30	Arsenic-74						
31							
32	W, all compounds	1E+3	8E+2	3E-7	1E-9	2E-5	2E-4
33							
34	Arsenic-76						
35							
36	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
37							
38	Arsenic-77						
39							
40	W, all compounds	4E+3	5E+3	2E-6	7E-9	---	---
41		LLI					
42		(5E+3)	---	---	---	6E-5	6E-4
43							
44	Arsenic-78 ²						
45							
46	W, all compounds	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
47							
48	AN 34						
49	Selenium-70 ²						
50							
51	D, all compounds						
52	except those						
53	given for W	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
54							

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1	W, oxides,						
2	hydroxides,						
3	carbides, and						
4	elemental Se	1E+4	4E+4	2E-5	6E-8	---	---
5							
6	Selenium-73m ²						
7							
8	D, see ⁷⁰ Se	6E+4	2E+5	6E-5	2E-7	4E-4	4E-3
9	W, see ⁷⁰ Se	3E+4	1E+5	6E-5	2E-7	---	---
10							
11	Selenium-73						
12							
13	D, see ⁷⁰ Se	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
14	W, see ⁷⁰ Se	---	2E+4	7E-6	2E-8	---	---
15							
16	Selenium-75						
17							
18	D, see ⁷⁰ Se	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
19	W, see ⁷⁰ Se	---	6E+2	3E-7	8E-10	---	---
20							
21	Selenium-79						
22							
23	D, see ⁷⁰ Se	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
24	W, see ⁷⁰ Se	---	6E+2	2E-7	8E-10	---	---
25							
26	Selenium-81m ²						
27							
28	D, see ⁷⁰ Se	4E+4	7E+4	3E-5	9E-8	3E-4	3E-3
29	W, see ⁷⁰ Se	2E+4	7E+4	3E-5	1E-7	---	---
30							
31	Selenium-81 ²						
32							
33	D, see ⁷⁰ Se	6E+4	2E+5	9E-5	3E-7	---	---
34	Stom						
35	(8E+4)	---	---	---	---	1E-3	1E-2
36	W, see ⁷⁰ Se	---	2E+5	1E-4	3E-7	---	---
37							
38	Selenium-83 ²						
39							
40	D, see ⁷⁰ Se	4E+4	1E+5	5E-5	2E-7	4E-4	4E-3
41	W, see ⁷⁰ Se	3E+4	1E+5	5E-5	2E-7	---	---
42							
43	AN 35						
44	Bromine-74m ²						
45							
46	D, bromides of						
47	H, Li, Na, K,						
48	Rb, Cs, and Fr	1E+4	4E+4	2E-5	5E-8	---	---
49		Stom					
50	(2E+4)	---	---	---	---	3E-4	3E-3
51	W, bromides of						
52	lanthanides,						
53	Be, Mg, Ca, Sr,						
54	Ba, Ra, Al, Ga, In,						

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1	Tl, Ge, Sn, Pb, As,						
2	Sb, Bi, Fe, Ru, Os,						
3	Co, Rh, Ir, Ni, Pd,						
4	Pt, Cu, Ag, Au, Zn,						
5	Cd, Hg, Sc, Y, Ti,						
6	Zr, Hf, V, Nb, Ta,						
7	Mn, Tc, and Re	---	4E+4	2E-5	6E-8	---	---
8							
9	Bromine-74 ²						
10							
11	D, see ^{74m} Br	2E+4	7E+4	3E-5	1E-7	---	---
12		Stom					
13		(4E+4)	---	---	---	5E-4	5E-3
14	W, see ^{74m} Br	---	8E+4	4E-5	1E-7	---	---
15							
16	Bromine-75 ²						
17							
18	D, see ^{74m} Br	3E+4	5E+4	2E-5	7E-8	---	---
19		Stom					
20		(4E+4)	---	---	---	5E-4	5E-3
21	W, see ^{74m} Br	---	5E+4	2E-5	7E-8	---	---
22							
23	Bromine-76						
24							
25	D, see ^{74m} Br	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
26	W, see ^{74m} Br	---	4E+3	2E-6	6E-9	---	---
27							
28	Bromine-77						
29							
30	D, see ^{74m} Br	2E+4	2E+4	1E-5	3E-8	2E-4	2E-3
31	W, see ^{74m} Br	---	2E+4	8E-6	3E-8	---	---
32							
33	Bromine-80m						
34							
35	D, see ^{74m} Br	2E+4	2E+4	7E-6	2E-8	3E-4	3E-3
36	W, see ^{74m} Br	---	1E+4	6E-6	2E-8	---	---
37							
38	Bromine-80 ²						
39							
40	D, see ^{74m} Br	5E+4	2E+5	8E-5	3E-7	---	---
41		Stom					
42		(9E+4)	---	---	---	1E-3	1E-2
43	W, see ^{74m} Br	---	2E+5	9E-5	3E-7	---	---
44							
45	Bromine-82						
46							
47	D, see ^{74m} Br	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
48	W, see ^{74m} Br	---	4E+3	2E-6	5E-9	---	---
49							
50	Bromine-83						
51							
52	D, see ^{74m} Br	5E+4	6E+4	3E-5	9E-8	---	---
53		Stom					
54		(7E+4)	---	---	---	9E-4	9E-3

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1	W, see ^{74m} Br	---	6E+4	3E-5	9E-8	---	---
2							
3	Bromine-84 ²						
4							
5	D, see ^{74m} Br	2E+4	6E+4	2E-5	8E-8	---	---
6		Stom					
7		(3E+4)	---	---	---	4E-4	4E-3
8	W, see ^{74m} Br	---	6E+4	3E-5	9E-8	---	---
9							
10	AN 36						
11	Krypton-74 ²						
12							
13	Submersion ¹	---	---	3E-6	1E-8	---	---
14							
15	Krypton-76						
16							
17	Submersion ¹	---	---	9E-6	4E-8	---	---
18							
19	Krypton-77 ²						
20							
21	Submersion ¹	---	---	4E-6	2E-8	---	---
22							
23	Krypton-79						
24							
25	Submersion ¹	---	---	2E-5	7E-8	---	---
26							
27	Krypton-81						
28							
29	Submersion ¹	---	---	7E-4	3E-6	---	---
30							
31	Krypton-83m ²						
32							
33	Submersion ¹	---	---	1E-2	5E-5	---	---
34							
35	Krypton-85m						
36							
37	Submersion ¹	---	---	2E-5	1E-7	---	---
38							
39	Krypton-85						
40							
41	Submersion ¹	---	---	1E-4	7E-7	---	---
42							
43	Krypton-87 ²						
44							
45	Submersion ¹	---	---	5E-6	2E-8	---	---
46							
47	Krypton-88						
48							
49	Submersion ¹	---	---	2E-6	9E-9	---	---
50							
51	AN 37						
52	Rubidium-79 ²						
53							
54	D, all compounds	4E+4	1E+5	5E-5	2E-7	---	---

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1		Stom					
2		(6E+4)	---	---	---	8E-4	8E-3
3							
4	Rubidium-81m ²						
5							
6	D, all compounds	2E+5	3E+5	1E-4	5E-7	---	---
7		Stom					
8		(3E+5)	---	---	---	4E-3	4E-2
9							
10	Rubidium-81						
11							
12	D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
13							
14	Rubidium-82m						
15							
16	D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
17							
18	Rubidium-83						
19							
20	D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
21							
22	Rubidium-84						
23							
24	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
25							
26	Rubidium-86						
27							
28	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
29							
30	Rubidium-87						
31							
32	D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
33							
34	Rubidium-88 ²						
35							
36	D, all compounds	2E+4	6E+4	3E-5	9E-8	---	---
37		Stom					
38		(3E+4)	---	---	---	4E-4	4E-3
39							
40	Rubidium-89 ²						
41							
42	D, all compounds	4E+4	1E+5	6E-5	2E-7	---	---
43		Stom					
44		(6E+4)	---	---	---	9E-4	9E-3
45							
46	AN 38						
47	Strontium-80 ²						
48							
49	D, all soluble						
50	compounds						
51	except SrTiO ₃	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
52							
53	Y, all insoluble						
54	compounds						

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1	and SrTiO ₃	---	1E+4	5E-6	2E-8	---	---
2							
3	Strontium-81 ²						
4							
5	D, see ⁸⁰ Sr	3E+4	8E+4	3E-5	1E-7	3E-4	3E-3
6	Y, see ⁸⁰ Sr	2E+4	8E+4	3E-5	1E-7	---	---
7							
8	Strontium-82						
9							
10	D, see ⁸⁰ Sr	3E+2	4E+2	2E-7	6E-10	---	---
11		LLI					
12		(2E+2)	---	---	---	3E-6	3E-5
13	Y, see ⁸⁰ Sr	2E+2	9E+1	4E-8	1E-10	---	---
14							
15	Strontium-83						
16							
17	D, see ⁸⁰ Sr	3E+3	7E+3	3E-6	1E-8	3E-5	3E-4
18	Y, see ⁸⁰ Sr	2E+3	4E+3	1E-6	5E-9	---	---
19							
20	Strontium-85m ²						
21							
22	D, see ⁸⁰ Sr	2E+5	6E+5	3E-4	9E-7	3E-3	3E-2
23	Y, see ⁸⁰ Sr	---	8E+5	4E-4	1E-6	---	---
24							
25	Strontium-85						
26							
27	D, see ⁸⁰ Sr	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
28	Y, see ⁸⁰ Sr	---	2E+3	6E-7	2E-9	---	---
29							
30	Strontium-87m						
31							
32	D, see ⁸⁰ Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
33	Y, see ⁸⁰ Sr	4E+4	2E+5	6E-5	2E-7	---	---
34							
35	Strontium-89						
36							
37	D, see ⁸⁰ Sr	6E+2	8E+2	4E-7	1E-9	---	---
38		LLI					
39		(6E+2)	---	---	---	8E-6	8E-5
40	Y, see ⁸⁰ Sr	5E+2	1E+2	6E-8	2E-10	---	---
41							
42	Strontium-90						
43							
44	D, see ⁸⁰ Sr	3E+1	2E+1	8E-9	---	---	---
45		Bone	Bone				
46		(4E+1)	(2E+1)	---	3E-11	5E-7	5E-6
47	Y, see ⁸⁰ Sr	---	4E+0	2E-9	6E-12	---	---
48							
49	Strontium-91						
50							
51	D, see ⁸⁰ Sr	2E+3	6E+3	2E-6	8E-9	2E-5	2E-4
52	Y, see ⁸⁰ Sr	---	4E+3	1E-6	5E-9	---	---
53							
54	Strontium-92						

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1							
2	D, see ^{80}Sr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
3	Y, see ^{80}Sr	---	7E+3	3E-6	9E-9	---	---
4							
5	AN 39						
6	Yttrium-86m ²						
7							
8	W, all compounds						
9	except those						
10	given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
11							
12	Y, oxides and						
13	hydroxides	---	5E+4	2E-5	8E-8	---	---
14							
15	Yttrium-86						
16							
17	W, see ^{86m}Y	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
18	Y, see ^{86m}Y	---	3E+3	1E-6	5E-9	---	---
19							
20	Yttrium-87						
21							
22	W, see ^{86m}Y	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
23	Y, see ^{86m}Y	---	3E+3	1E-6	5E-9	---	---
24							
25	Yttrium-88						
26							
27	W, see ^{86m}Y	1E+3	3E+2	1E-7	3E-10	1E-5	1E-4
28	Y, see ^{86m}Y	---	2E+2	1E-7	3E-10	---	---
29							
30	Yttrium-90m						
31							
32	W, see ^{86m}Y	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
33	Y, see ^{86m}Y	---	1E+4	5E-6	2E-8	---	---
34							
35	Yttrium-90						
36							
37	W, see ^{86m}Y	4E+2	7E+2	3E-7	9E-10	---	---
38		LLI					
39		(5E+2)	---	---	---	7E-6	7E-5
40	Y, see ^{86m}Y	---	6E+2	3E-7	9E-10	---	---
41							
42	Yttrium-91m ²						
43							
44	W, see ^{86m}Y	1E+5	2E+5	1E-4	3E-7	2E-3	2E-2
45	Y, see ^{86m}Y	---	2E+5	7E-5	2E-7	---	---
46							
47	Yttrium-91						
48							
49	W, see ^{86m}Y	5E+2	2E+2	7E-8	2E-10	---	---
50		LLI					
51		(6E+2)	---	---	---	8E-6	8E-5
52	Y, see ^{86m}Y	---	1E+2	5E-8	2E-10	---	---
53							
54	Yttrium-92						

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1							
2	W, see $^{86}\text{m}_\text{Y}$	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
3	Y, see $^{86}\text{m}_\text{Y}$	---	8E+3	3E-6	1E-8	---	---
4							
5	Yttrium-93						
6							
7	W, see $^{86}\text{m}_\text{Y}$	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
8	Y, see $^{86}\text{m}_\text{Y}$	---	2E+3	1E-6	3E-9	---	---
9							
10	Yttrium-94 ²						
11							
12	W, see $^{86}\text{m}_\text{Y}$	2E+4	8E+4	3E-5	1E-7	---	---
13		Stom					
14		(3E+4)	---	---	---	4E-4	4E-3
15	Y, see $^{86}\text{m}_\text{Y}$	---	8E+4	3E-5	1E-7	---	---
16							
17	Yttrium-95 ²						
18							
19	W, see $^{86}\text{m}_\text{Y}$	4E+4	2E+5	6E-5	2E-7	---	---
20		Stom					
21		(5E+4)	---	---	---	7E-4	7E-3
22	Y, see $^{86}\text{m}_\text{Y}$	---	1E+5	6E-5	2E-7	---	---
23							
24	AN 40						
25	Zirconium-86						
26							
27	D, all compounds						
28	except those						
29	given for W and Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
30							
31	W, oxides,						
32	hydroxides,						
33	halides, and						
34	nitrates.	---	3E+3	1E-6	4E-9	---	---
35							
36	Y, carbide	---	2E+3	1E-6	3E-9	---	---
37							
38	Zirconium-88						
39							
40	D, see ^{86}Zr	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4
41	W, see ^{86}Zr	---	5E+2	2E-7	7E-10	---	---
42	Y, see ^{86}Zr	---	3E+2	1E-7	4E-10	---	---
43							
44	Zirconium-89						
45							
46	D, see ^{86}Zr	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
47	W, see ^{86}Zr	---	2E+3	1E-6	3E-9	---	---
48	Y, see ^{86}Zr	---	2E+3	1E-6	3E-9	---	---
49							
50	Zirconium-93						
51							
52	D, see ^{86}Zr	1E+3	6E+0	3E-9	---	---	---
53		Bone	Bone				
54		(3E+3)	(2E+1)	---	2E-11	4E-5	4E-4

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1	W, see ^{86}Zr	---	2E+1	1E-8	---	---	---
2			Bone				
3		---	(6E+1)	---	9E-11	---	---
4	Y, see ^{86}Zr	---	6E+1	2E-8	---	---	---
5			Bone				
6		---	(7E+1)	---	9E-11	---	---
7							
8	Zirconium-95						
9							
10	D, see ^{86}Zr	1E+3	1E+2	5E-8	---	2E-5	2E-4
11			Bone				
12		---	(3E+2)	---	4E-10	---	---
13	W, see ^{86}Zr	---	4E+2	2E-7	5E-10	---	---
14	Y, see ^{86}Zr	---	3E+2	1E-7	4E-10	---	---
15							
16	Zirconium-97						
17							
18	D, see ^{86}Zr	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
19	W, see ^{86}Zr	---	1E+3	6E-7	2E-9	---	---
20	Y, see ^{86}Zr	---	1E+3	5E-7	2E-9	---	---
21							
22	AN 41						
23	Niobium-88 ²						
24							
25	W, all compounds						
26	except those						
27	given for Y	5E+4	2E+5	9E-5	3E-7	---	---
28		Stom					
29		(7E+4)	---	---	---	1E-3	1E-2
30	Y, oxides and						
31	hydroxides	---	2E+5	9E-5	3E-7	---	---
32							
33	Niobium-89 ²						
34	(66 min)						
35							
36	W, see ^{88}Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3
37	Y, see ^{88}Nb	---	4E+4	2E-5	5E-8	---	---
38							
39	Niobium-89						
40	(122 min)						
41							
42	W, see ^{88}Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
43	Y, see ^{88}Nb	---	2E+4	6E-6	2E-8	---	---
44							
45	Niobium-90						
46							
47	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
48	Y, see ^{88}Nb	---	2E+3	1E-6	3E-9	---	---
49							
50	Niobium-93m						
51							
52	W, see ^{88}Nb	9E+3	2E+3	8E-7	3E-9	---	---
53		LLI					
54		(1E+4)	---	---	---	2E-4	2E-3

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1	Y, see ⁸⁸ Nb	---	2E+2	7E-8	2E-10	---	---
2							
3	Niobium-94						
4							
5	W, see ⁸⁸ Nb	9E+2	2E+2	8E-8	3E-10	1E-5	1E-4
6	Y, see ⁸⁸ Nb	---	2E+1	6E-9	2E-11	---	---
7							
8	Niobium-95m						
9							
10	W, see ⁸⁸ Nb	2E+3	3E+3	1E-6	4E-9	---	---
11		LLI					
12		(2E+3)	---	---	---	3E-5	3E-4
13	Y, see ⁸⁸ Nb	---	2E+3	9E-7	3E-9	---	---
14							
15	Niobium-95						
16							
17	W, see ⁸⁸ Nb	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
18	Y, see ⁸⁸ Nb	---	1E+3	5E-7	2E-9	---	---
19							
20	Niobium-96						
21							
22	W, see ⁸⁸ Nb	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
23	Y, see ⁸⁸ Nb	---	2E+3	1E-6	3E-9	---	---
24							
25	Niobium-97 ²						
26							
27	W, see ⁸⁸ Nb	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
28	Y, see ⁸⁸ Nb	---	7E+4	3E-5	1E-7	---	---
29							
30	Niobium-98 ²						
31							
32	W, see ⁸⁸ Nb	1E+4	5E+4	2E-5	8E-8	2E-4	2E-3
33	Y, see ⁸⁸ Nb	---	5E+4	2E-5	7E-8	---	---
34							
35	AN 42						
36	Molybdenum-90						
37							
38	D, all compounds						
39	except those						
40	given for Y	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
41							
42	Y, oxides,						
43	hydroxides,						
44	and MoS ₂	2E+3	5E+3	2E-6	6E-9	---	---
45							
46	Molybdenum-93m						
47							
48	D, see ⁹⁰ Mo	9E+3	2E+4	7E-6	2E-8	6E-5	6E-4
49	Y, see ⁹⁰ Mo	4E+3	1E+4	6E-6	2E-8	---	---
50							
51	Molybdenum-93						
52							
53	D, see ⁹⁰ Mo	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
54	Y, see ⁹⁰ Mo	2E+4	2E+2	8E-8	2E-10	---	---

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1							
2	Molybdenum-99						
3							
4	D, see ⁹⁰ Mo	2E+3	3E+3	1E-6	4E-9	---	---
5		LLI					
6		(1E+3)	---	---	---	2E-5	2E-4
7	Y, see ⁹⁰ Mo	1E+3	1E+3	6E-7	2E-9	---	---
8							
9	Molybdenum-101 ²						
10							
11	D, see ⁹⁰ Mo	4E+4	1E+5	6E-5	2E-7	---	---
12		Stom					
13		(5E+4)	---	---	---	7E-4	7E-3
14	Y, see ⁹⁰ Mo	---	1E+5	6E-5	2E-7	---	---
15							
16	AN 43						
17	Technetium-93m ²						
18							
19	D, all compounds						
20	except those						
21	given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
22							
23	W, oxides,						
24	hydroxides,						
25	halides, and						
26	nitrates	---	3E+5	1E-4	4E-7	---	---
27							
28	Technetium-93						
29							
30	D, see ^{93m} Tc	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
31	W, see ^{93m} Tc	---	1E+5	4E-5	1E-7	---	---
32							
33	Technetium-94m ²						
34							
35	D, see ^{93m} Tc	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
36	W, see ^{93m} Tc	---	6E+4	2E-5	8E-8	---	---
37							
38	Technetium-94						
39							
40	D, see ^{93m} Tc	9E+3	2E+4	8E-6	3E-8	1E-4	1E-3
41	W, see ^{93m} Tc	---	2E+4	1E-5	3E-8	---	---
42							
43	Technetium-95m						
44							
45	D, see ^{93m} Tc	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
46	W, see ^{93m} Tc	---	2E+3	8E-7	3E-9	---	---
47							
48	Technetium-95						
49							
50	D, see ^{93m} Tc	1E+4	2E+4	9E-6	3E-8	1E-4	1E-3
51	W, see ^{93m} Tc	---	2E+4	8E-6	3E-8	---	---
52							
53	Technetium-96m ²						
54							

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1	D, see ^{93m}Tc	2E+5	3E+5	1E-4	4E-7	2E-3	2E-2
2	W, see ^{93m}Tc	---	2E+5	1E-4	3E-7	---	---
3							
4	Technetium-96						
5							
6	D, see ^{93m}Tc	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
7	W, see ^{93m}Tc	---	2E+3	9E-7	3E-9	---	---
8							
9	Technetium-97m						
10							
11	D, see ^{93m}Tc	5E+3	7E+3	3E-6	---	6E-5	6E-4
12			Stom				
13		---	(7E+3)	---	1E-8	---	---
14	W, see ^{93m}Tc	---	1E+3	5E-7	2E-9	---	---
15							
16	Technetium-97						
17							
18	D, see ^{93m}Tc	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
19	W, see ^{93m}Tc	---	6E+3	2E-6	8E-9	---	---
20							
21	Technetium-98						
22							
23	D, see ^{93m}Tc	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
24	W, see ^{93m}Tc	---	3E+2	1E-7	4E-10	---	---
25							
26	Technetium-99m						
27							
28	D, see ^{93m}Tc	8E+4	2E+5	6E-5	2E-7	1E-3	1E-2
29	W, see ^{93m}Tc	---	2E+5	1E-4	3E-7	---	---
30							
31	Technetium-99						
32							
33	D, see ^{93m}Tc	4E+3	5E+3	2E-6	---	6E-5	6E-4
34			Stom				
35		---	(6E+3)	---	8E-9	---	---
36	W, see ^{93m}Tc	---	7E+2	3E-7	9E-10	---	---
37							
38	Technetium-101 ²						
39							
40	D, see ^{93m}Tc	9E+4	3E+5	1E-4	5E-7	---	---
41		Stom					
42		(1E+5)	---	---	---	2E-3	2E-2
43	W, see ^{93m}Tc	---	4E+5	2E-4	5E-7	---	---
44							
45	Technetium-104 ²						
46							
47	D, see ^{93m}Tc	2E+4	7E+4	3E-5	1E-7	---	---
48		Stom					
49		(3E+4)	---	---	---	4E-4	4E-3
50	W, see ^{93m}Tc	---	9E+4	4E-5	1E-7	---	---
51							
52	AN 44						
53	Ruthenium-94 ²						
54							

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1	D, all compounds						
2	except those						
3	given for W and Y	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
4							
5	W, halides	---	6E+4	3E-5	9E-8	---	---
6							
7	Y, oxides and						
8	hydroxides	---	6E+4	2E-5	8E-8	---	---
9							
10	Ruthenium-97						
11							
12	D, see ⁹⁴ Ru	8E+3	2E+4	8E-6	3E-8	1E-4	1E-3
13	W, see ⁹⁴ Ru	---	1E+4	5E-6	2E-8	---	---
14	Y, see ⁹⁴ Ru	---	1E+4	5E-6	2E-8	---	---
15							
16	Ruthenium-103						
17							
18	D, see ⁹⁴ Ru	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
19	W, see ⁹⁴ Ru	---	1E+3	4E-7	1E-9	---	---
20	Y, see ⁹⁴ Ru	---	6E+2	3E-7	9E-10	---	---
21							
22	Ruthenium-105						
23							
24	D, see ⁹⁴ Ru	5E+3	1E+4	6E-6	2E-8	7E-5	7E-4
25	W, see ⁹⁴ Ru	---	1E+4	6E-6	2E-8	---	---
26	Y, see ⁹⁴ Ru	---	1E+4	5E-6	2E-8	---	---
27							
28	Ruthenium-106						
29							
30	D, see ⁹⁴ Ru	2E+2	9E+1	4E-8	1E-10	---	---
31		LLI					
32		(2E+2)	---	---	---	3E-6	3E-5
33	W, see ⁹⁴ Ru	---	5E+1	2E-8	8E-11	---	---
34	Y, see ⁹⁴ Ru	---	1E+1	5E-9	2E-11	---	---
35							
36	AN 45						
37	Rhodium-99m						
38							
39	D, all compounds						
40	except those						
41	given for W and Y	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
42							
43	W, halides	---	8E+4	3E-5	1E-7	---	---
44							
45	Y, oxides and						
46	hydroxides	---	7E+4	3E-5	9E-8	---	---
47							
48	Rhodium-99						
49							
50	D, see ^{99m} Rh	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
51	W, see ^{99m} Rh	---	2E+3	9E-7	3E-9	---	---
52	Y, see ^{99m} Rh	---	2E+3	8E-7	3E-9	---	---
53							
54	Rhodium-100						

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1								
2	D, see	^{99m} Rh	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
3	W, see	^{99m} Rh	---	4E+3	2E-6	6E-9	---	---
4	Y, see	^{99m} Rh	---	4E+3	2E-6	5E-9	---	---
5								
6	Rhodium-101m							
7								
8	D, see	^{99m} Rh	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
9	W, see	^{99m} Rh	---	8E+3	4E-6	1E-8	---	---
10	Y, see	^{99m} Rh	---	8E+3	3E-6	1E-8	---	---
11								
12	Rhodium-101							
13								
14	D, see	^{99m} Rh	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
15	W, see	^{99m} Rh	---	8E+2	3E-7	1E-9	---	---
16	Y, see	^{99m} Rh	---	2E+2	6E-8	2E-10	---	---
17								
18	Rhodium-102m							
19								
20	D, see	^{99m} Rh	1E+3	5E+2	2E-7	7E-10	---	---
21			LLI					
22			(1E+3)	---	---	---	2E-5	2E-4
23	W, see	^{99m} Rh	---	4E+2	2E-7	5E-10	---	---
24	Y, see	^{99m} Rh	---	1E+2	5E-8	2E-10	---	---
25								
26	Rhodium-102							
27								
28	D, see	^{99m} Rh	6E+2	9E+1	4E-8	1E-10	8E-6	8E-5
29	W, see	^{99m} Rh	---	2E+2	7E-8	2E-10	---	---
30	Y, see	^{99m} Rh	---	6E+1	2E-8	8E-11	---	---
31								
32	Rhodium-103m ²							
33								
34	D, see	^{99m} Rh	4E+5	1E+6	5E-4	2E-6	6E-3	6E-2
35	W, see	^{99m} Rh	---	1E+6	5E-4	2E-6	---	---
36	Y, see	^{99m} Rh	---	1E+6	5E-4	2E-6	---	---
37								
38	Rhodium-105							
39								
40	D, see	^{99m} Rh	4E+3	1E+4	5E-6	2E-8	---	---
41			LLI					
42			(4E+3)	---	---	---	5E-5	5E-4
43	W, see	^{99m} Rh	---	6E+3	3E-6	9E-9	---	---
44	Y, see	^{99m} Rh	---	6E+3	2E-6	8E-9	---	---
45								
46	Rhodium-106m							
47								
48	D, see	^{99m} Rh	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
49	W, see	^{99m} Rh	---	4E+4	2E-5	5E-8	---	---
50	Y, see	^{99m} Rh	---	4E+4	1E-5	5E-8	---	---
51								
52	Rhodium-107 ²							
53								
54	D, see	^{99m} Rh	7E+4	2E+5	1E-4	3E-7	---	---

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1		Stom					
2		(9E+4)	---	---	---	1E-3	1E-2
3	W, see ^{99m} Rh	---	3E+5	1E-4	4E-7	---	---
4	Y, see ^{99m} Rh	---	3E+5	1E-4	3E-7	---	---
5							
6	AN 46						
7	Palladium-100						
8							
9	D, all compounds						
10	except those						
11	given for W and Y	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
12							
13	W, nitrates	---	1E+3	5E-7	2E-9	---	---
14							
15	Y, oxides and						
16	hydroxides	---	1E+3	6E-7	2E-9	---	---
17							
18	Palladium-101						
19							
20	D, see ¹⁰⁰ Pd	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
21	W, see ¹⁰⁰ Pd	---	3E+4	1E-5	5E-8	---	---
22	Y, see ¹⁰⁰ Pd	---	3E+4	1E-5	4E-8	---	---
23							
24	Palladium-103						
25							
26	D, see ¹⁰⁰ Pd	6E+3	6E+3	3E-6	9E-9	---	---
27		LLI					
28		(7E+3)	---	---	---	1E-4	1E-3
29	W, see ¹⁰⁰ Pd	---	4E+3	2E-6	6E-9	---	---
30	Y, see ¹⁰⁰ Pd	---	4E+3	1E-6	5E-9	---	---
31							
32	Palladium-107						
33							
34	D, see ¹⁰⁰ Pd	3E+4	2E+4	9E-6	---	---	---
35		LLI	Kid				
36		(4E+4)	(2E+4)	---	3E-8	5E-4	5E-3
37	W, see ¹⁰⁰ Pd	---	7E+3	3E-6	1E-8	---	---
38	Y, see ¹⁰⁰ Pd	---	4E+2	2E-7	6E-10	---	---
39							
40	Palladium-109						
41							
42	D, see ¹⁰⁰ Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
43	W, see ¹⁰⁰ Pd	---	5E+3	2E-6	8E-9	---	---
44	Y, see ¹⁰⁰ Pd	---	5E+3	2E-6	6E-9	---	---
45							
46	AN 47						
47	Silver-102 ²						
48							
49	D, all compounds						
50	except those						
51	given for W and Y	5E+4	2E+5	8E-5	2E-7	---	---
52		Stom					
53		(6E+4)	---	---	---	9E-4	9E-3
54	W, nitrates and						

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1	sulfides	---	2E+5	9E-5	3E-7	---	---
2							
3	Y, oxides and						
4	hydroxides	---	2E+5	8E-5	3E-7	---	---
5							
6	Silver-103 ²						
7							
8	D, see 102Ag	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
9	W, see 102Ag	---	1E+5	5E-5	2E-7	---	---
10	Y, see 102Ag	---	1E+5	5E-5	2E-7	---	---
11							
12	Silver-104m ²						
13							
14	D, see 102Ag	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
15	W, see 102Ag	---	1E+5	5E-5	2E-7	---	---
16	Y, see 102Ag	---	1E+5	5E-5	2E-7	---	---
17							
18	Silver-104 ²						
19							
20	D, see 102Ag	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
21	W, see 102Ag	---	1E+5	6E-5	2E-7	---	---
22	Y, see 102Ag	---	1E+5	6E-5	2E-7	---	---
23							
24	Silver-105						
25							
26	D, see 102Ag	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
27	W, see 102Ag	---	2E+3	7E-7	2E-9	---	---
28	Y, see 102Ag	---	2E+3	7E-7	2E-9	---	---
29							
30	Silver-106m						
31							
32	D, see 102Ag	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
33	W, see 102Ag	---	9E+2	4E-7	1E-9	---	---
34	Y, see 102Ag	---	9E+2	4E-7	1E-9	---	---
35							
36	Silver-106 ²						
37							
38	D, see 102Ag	6E+4	2E+5	8E-5	3E-7	---	---
39		Stom					
40		(6E+4)	---	---	---	9E-4	9E-3
41	W, see 102Ag	---	2E+5	9E-5	3E-7	---	---
42	Y, see 102Ag	---	2E+5	8E-5	3E-7	---	---
43							
44	Silver-108m						
45							
46	D, see 102Ag	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5
47	W, see 102Ag	---	3E+2	1E-7	4E-10	---	---
48	Y, see 102Ag	---	2E+1	1E-8	3E-11	---	---
49							
50	Silver-110m						
51							
52	D, see 102Ag	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5
53	W, see 102Ag	---	2E+2	8E-8	3E-10	---	---
54	Y, see 102Ag	---	9E+1	4E-8	1E-10	---	---

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1							
2	Silver-111						
3							
4	D, see ^{102}Ag	9E+2	2E+3	6E-7	---	---	---
5		LLI	Liver				
6		(1E+3)	(2E+3)	---	2E-9	2E-5	2E-4
7	W, see ^{102}Ag	---	9E+2	4E-7	1E-9	---	---
8	Y, see ^{102}Ag	---	9E+2	4E-7	1E-9	---	---
9							
10	Silver-112						
11							
12	D, see ^{102}Ag	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
13	W, see ^{102}Ag	---	1E+4	4E-6	1E-8	---	---
14	Y, see ^{102}Ag	---	9E+3	4E-6	1E-8	---	---
15							
16	Silver-115 ²						
17							
18	D, see ^{102}Ag	3E+4	9E+4	4E-5	1E-7	---	---
19		Stom					
20		(3E+4)	---	---	---	4E-4	4E-3
21	W, see ^{102}Ag	---	9E+4	4E-5	1E-7	---	---
22	Y, see ^{102}Ag	---	8E+4	3E-5	1E-7	---	---
23							
24	AN 48						
25	Cadmium-104 ²						
26							
27	D, all compounds						
28	except those						
29	given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
30							
31	W, sulfides,						
32	halides, and						
33	nitrates	---	1E+5	5E-5	2E-7	---	---
34							
35	Y, oxides and						
36	hydroxides	---	1E+5	5E-5	2E-7	---	---
37							
38	Cadmium-107						
39							
40	D, see ^{104}Cd	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
41	W, see ^{104}Cd	---	6E+4	2E-5	8E-8	---	---
42	Y, see ^{104}Cd	---	5E+4	2E-5	7E-8	---	---
43							
44	Cadmium-109						
45							
46	D, see ^{104}Cd	3E+2	4E+1	1E-8	---	---	---
47		Kid	Kid				
48		(4E+2)	(5E+1)	---	7E-11	6E-6	6E-5
49	W, see ^{104}Cd	---	1E+2	5E-8	---	---	---
50			Kid				
51		---	(1E+2)	---	2E-10	---	---
52	Y, see ^{104}Cd	---	1E+2	5E-8	2E-10	---	---
53							
54	Cadmium-113m						

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1							
2	D, see ^{104}Cd	2E+1	2E+0	1E-9	---	---	---
3		Kid	Kid				
4		(4E+1)	(4E+0)	---	5E-12	5E-7	5E-6
5	W, see ^{104}Cd	---	8E+0	4E-9	---	---	---
6			Kid				
7		---	(1E+1)	---	2E-11	---	---
8	Y, see ^{104}Cd	---	1E+1	5E-9	2E-11	---	---
9							
10	Cadmium-113						
11							
12	D, see ^{104}Cd	2E+1	2E+0	9E-10	---	---	---
13		Kid	Kid				
14		(3E+1)	(3E+0)	---	5E-12	4E-7	4E-6
15	W, see ^{104}Cd	---	8E+0	3E-9	---	---	---
16			Kid				
17		---	(1E+1)	---	2E-11	---	---
18	Y, see ^{104}Cd	---	1E+1	6E-9	2E-11	---	---
19							
20	Cadmium-115m						
21							
22	D, see ^{104}Cd	3E+2	5E+1	2E-8	---	4E-6	4E-5
23			Kid				
24		---	(8E+1)	---	1E-10	---	---
25	W, see ^{104}Cd	---	1E+2	5E-8	2E-10	---	---
26	Y, see ^{104}Cd	---	1E+2	6E-8	2E-10	---	---
27							
28	Cadmium-115						
29							
30	D, see ^{104}Cd	9E+2	1E+3	6E-7	2E-9	---	---
31		LLI					
32		(1E+3)	---	---	---	1E-5	1E-4
33	W, see ^{104}Cd	---	1E+3	5E-7	2E-9	---	---
34	Y, see ^{104}Cd	---	1E+3	6E-7	2E-9	---	---
35							
36	Cadmium-117m						
37							
38	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
39	W, see ^{104}Cd	---	2E+4	7E-6	2E-8	---	---
40	Y, see ^{104}Cd	---	1E+4	6E-6	2E-8	---	---
41							
42	Cadmium-117						
43							
44	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
45	W, see ^{104}Cd	---	2E+4	7E-6	2E-8	---	---
46	Y, see ^{104}Cd	---	1E+4	6E-6	2E-8	---	---
47							
48	AN 49						
49	Indium-109						
50							
51	D, all compounds						
52	except those						
53	given for W	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
54							

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1	W, oxides,						
2	hydroxides,						
3	halides, and						
4	nitrates	---	6E+4	3E-5	9E-8	---	---
5							
6	Indium-110 ²						
7	(69.1 min)						
8							
9	D, see ¹⁰⁹ In	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
10	W, see ¹⁰⁹ In	---	6E+4	2E-5	8E-8	---	---
11							
12	Indium-110						
13	(4.9 h)						
14							
15	D, see ¹⁰⁹ In	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
16	W, see ¹⁰⁹ In	---	2E+4	8E-6	3E-8	---	---
17							
18	Indium-111						
19							
20	D, see ¹⁰⁹ In	4E+3	6E+3	3E-6	9E-9	6E-5	6E-4
21	W, see ¹⁰⁹ In	---	6E+3	3E-6	9E-9	---	---
22							
23	Indium-112 ²						
24							
25	D, see ¹⁰⁹ In	2E+5	6E+5	3E-4	9E-7	2E-3	2E-2
26	W, see ¹⁰⁹ In	---	7E+5	3E-4	1E-6	---	---
27							
28	Indium-113m ²						
29							
30	D, see ¹⁰⁹ In	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
31	W, see ¹⁰⁹ In	---	2E+5	8E-5	3E-7	---	---
32							
33	Indium-114m						
34							
35	D, see ¹⁰⁹ In	3E+2	6E+1	3E-8	9E-11	---	---
36		LLI					
37		(4E+2)	---	---	---	5E-6	5E-5
38	W, see ¹⁰⁹ In	---	1E+2	4E-8	1E-10	---	---
39							
40	Indium-115m						
41							
42	D, see ¹⁰⁹ In	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
43	W, see ¹⁰⁹ In	---	5E+4	2E-5	7E-8	---	---
44							
45	Indium-115						
46							
47	D, see ¹⁰⁹ In	4E+1	1E+0	6E-10	2E-12	5E-7	5E-6
48	W, see ¹⁰⁹ In	---	5E+0	2E-9	8E-12	---	---
49							
50	Indium-116m ²						
51							
52	D, see ¹⁰⁹ In	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
53	W, see ¹⁰⁹ In	---	1E+5	5E-5	2E-7	---	---
54							

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1	Indium-117m ²						
2							
3	D, see ¹⁰⁹ In	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
4	W, see ¹⁰⁹ In	---	4E+4	2E-5	6E-8	---	---
5							
6	Indium-117 ²						
7							
8	D, see ¹⁰⁹ In	6E+4	2E+5	7E-5	2E-7	8E-4	8E-3
9	W, see ¹⁰⁹ In	---	2E+5	9E-5	3E-7	---	---
10							
11	Indium-119m ²						
12							
13	D, see ¹⁰⁹ In	4E+4	1E+5	5E-5	2E-7	---	---
14		Stom					
15		(5E+4)	---	---	---	7E-4	7E-3
16	W, see ¹⁰⁹ In	---	1E+5	6E-5	2E-7	---	---
17							
18	AN 50						
19	Tin-110						
20							
21	D, all compounds						
22	except those						
23	given for W	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
24							
25	W, sulfides,						
26	oxides, hydroxides,						
27	halides, nitrates,						
28	and stannic						
29	phosphate	---	1E+4	5E-6	2E-8	---	---
30							
31	Tin-111 ²						
32							
33	D, see ¹¹⁰ Sn	7E+4	2E+5	9E-5	3E-7	1E-3	1E-2
34	W, see ¹¹⁰ Sn	---	3E+5	1E-4	4E-7	---	---
35							
36	Tin-113						
37							
38	D, see ¹¹⁰ Sn	2E+3	1E+3	5E-7	2E-9	---	---
39		LLI					
40		(2E+3)	---	---	---	3E-5	3E-4
41	W, see ¹¹⁰ Sn	---	5E+2	2E-7	8E-10	---	---
42							
43	Tin-117m						
44							
45	D, see ¹¹⁰ Sn	2E+3	1E+3	5E-7	---	---	---
46		LLI	Bone				
47		(2E+3)	(2E+3)	---	3E-9	3E-5	3E-4
48	W, see ¹¹⁰ Sn	---	1E+3	6E-7	2E-9	---	---
49							
50	Tin-119m						
51							
52	D, see ¹¹⁰ Sn	3E+3	2E+3	1E-6	3E-9	---	---
53		LLI					
54		(4E+3)	---	---	---	6E-5	6E-4

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1	W, see ¹¹⁰ Sn	---	1E+3	4E-7	1E-9	---	---
2							
3	Tin-121m						
4							
5	D, see ¹¹⁰ Sn	3E+3	9E+2	4E-7	1E-9	---	---
6		LLI					
7		(4E+3)	---	---	---	5E-5	5E-4
8	W, see ¹¹⁰ Sn	---	5E+2	2E-7	8E-10	---	---
9							
10	Tin-121						
11							
12	D, see ¹¹⁰ Sn	6E+3	2E+4	6E-6	2E-8	---	---
13		LLI					
14		(6E+3)	---	---	---	8E-5	8E-4
15	W, see ¹¹⁰ Sn	---	1E+4	5E-6	2E-8	---	---
16							
17	Tin-123m ²						
18							
19	D, see ¹¹⁰ Sn	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
20	W, see ¹¹⁰ Sn	---	1E+5	6E-5	2E-7	---	---
21							
22	Tin-123						
23							
24	D, see ¹¹⁰ Sn	5E+2	6E+2	3E-7	9E-10	---	----
25		LLI					
26		(6E+2)	---	---	---	9E-6	9E-5
27	W, see ¹¹⁰ Sn	---	2E+2	7E-8	2E-10	---	---
28							
29	Tin-125						
30							
31	D, see ¹¹⁰ Sn	4E+2	9E+2	4E-7	1E-9	---	---
32		LLI					
33		(5E+2)	---	---	---	6E-6	6E-5
34	W, see ¹¹⁰ Sn	---	4E+2	1E-7	5E-10	---	---
35							
36	Tin-126						
37							
38	D, see ¹¹⁰ Sn	3E+2	6E+1	2E-8	8E-11	4E-6	4E-5
39	W, see ¹¹⁰ Sn	---	7E+1	3E-8	9E-11	---	---
40							
41	Tin-127						
42							
43	D, see ¹¹⁰ Sn	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
44	W, see ¹¹⁰ Sn	---	2E+4	8E-6	3E-8	---	---
45							
46	Tin-128 ²						
47							
48	D, see ¹¹⁰ Sn	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
49	W, see ¹¹⁰ Sn	---	4E+4	1E-5	5E-8	---	---
50							
51	AN 51						
52	Antimony-115 ²						
53							
54	D, all compounds						

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1	except those						
2	given for W	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
3							
4	W, oxides,						
5	hydroxides,						
6	halides, sulfides,						
7	sulfates, and						
8	nitrates	---	3E+5	1E-4	4E-7	---	---
9							
10	Antimony-116m ²						
11							
12	D, see ¹¹⁵ Sb	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
13	W, see ¹¹⁵ Sb	---	1E+5	6E-5	2E-7	---	---
14							
15	Antimony-116 ²						
16							
17	D, see ¹¹⁵ Sb	7E+4	3E+5	1E-4	4E-7	---	---
18		Stom					
19		(9E+4)	---	---	---	1E-3	1E-2
20	W, see ¹¹⁵ Sb	---	3E+5	1E-4	5E-7	---	---
21							
22	Antimony-117						
23							
24	D, see ¹¹⁵ Sb	7E+4	2E+5	9E-5	3E-7	9E-4	9E-3
25	W, see ¹¹⁵ Sb	---	3E+5	1E-4	4E-7	---	---
26							
27	Antimony-118m						
28							
29	D, see ¹¹⁵ Sb	6E+3	2E+4	8E-6	3E-8	7E-5	7E-4
30	W, see ¹¹⁵ Sb	5E+3	2E+4	9E-6	3E-8	---	---
31							
32	Antimony-119						
33							
34	D, see ¹¹⁵ Sb	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
35	W, see ¹¹⁵ Sb	2E+4	3E+4	1E-5	4E-8	---	---
36							
37	Antimony-120 ²						
38	(16 min)						
39							
40	D, see ¹¹⁵ Sb	1E+5	4E+5	2E-4	6E-7	---	---
41		Stom					
42		(2E+5)	---	---	---	2E-3	2E-2
43	W, see ¹¹⁵ Sb	---	5E+5	2E-4	7E-7	---	---
44							
45	Antimony-120						
46	(5.76 d)						
47							
48	D, see ¹¹⁵ Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
49	W, see ¹¹⁵ Sb	9E+2	1E+3	5E-7	2E-9	---	---
50							
51	Antimony-122						
52							
53	D, see ¹¹⁵ Sb	8E+2	2E+3	1E-6	3E-9	---	---
54		LLI					

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1		(8E+2)	---	---	---	1E-5	1E-4
2	W, see ^{115}Sb	7E+2	1E+3	4E-7	2E-9	---	---
3							
4	Antimony-124m ²						
5							
6	D, see ^{115}Sb	3E+5	8E+5	4E-4	1E-6	3E-3	3E-2
7	W, see ^{115}Sb	2E+5	6E+5	2E-4	8E-7	---	---
8							
9	Antimony-124						
10							
11	D, see ^{115}Sb	6E+2	9E+2	4E-7	1E-9	7E-6	7E-5
12	W, see ^{115}Sb	5E+2	2E+2	1E-7	3E-10	---	---
13							
14	Antimony-125						
15							
16	D, see ^{115}Sb	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
17	W, see ^{115}Sb	---	5E+2	2E-7	7E-10	---	---
18							
19	Antimony-126m ²						
20							
21	D, see ^{115}Sb	5E+4	2E+5	8E-5	3E-7	---	---
22		Stom					
23		(7E+4)	---	---	---	9E-4	9E-3
24	W, see ^{115}Sb	---	2E+5	8E-5	3E-7	---	---
25							
26	Antimony-126						
27							
28	D, see ^{115}Sb	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5
29	W, see ^{115}Sb	5E+2	5E+2	2E-7	7E-10	---	---
30							
31	Antimony-127						
32							
33	D, see ^{115}Sb	8E+2	2E+3	9E-7	3E-9	---	---
34		LLI					
35		(8E+2)	---	---	---	1E-5	1E-4
36	W, see ^{115}Sb	7E+2	9E+2	4E-7	1E-9	---	---
37							
38	Antimony-128 ²						
39	(10.4 min)						
40							
41	D, see ^{115}Sb	8E+4	4E+5	2E-4	5E-7	---	---
42		Stom					
43		(1E+5)	---	---	---	1E-3	1E-2
44	W, see ^{115}Sb	---	4E+5	2E-4	6E-7	---	---
45							
46	Antimony-128						
47	(9.01 h)						
48							
49	D, see ^{115}Sb	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
50	W, see ^{115}Sb	---	3E+3	1E-6	5E-9	---	---
51							
52	Antimony-129						
53							
54	D, see ^{115}Sb	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4

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1	W, see ¹¹⁵ Sb	---	9E+3	4E-6	1E-8	---	---
2							
3	Antimony-130 ²						
4							
5	D, see ¹¹⁵ Sb	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
6	W, see ¹¹⁵ Sb	---	8E+4	3E-5	1E-7	---	---
7							
8	Antimony-131 ²						
9							
10	D, see ¹¹⁵ Sb	1E+4	2E+4	1E-5	---	---	---
11		Thyr	Thyr				
12		(2E+4)	(4E+4)	---	6E-8	2E-4	2E-3
13	W, see ¹¹⁵ Sb	---	2E+4	1E-5	---	---	---
14			Thyr				
15		---	(4E+4)	---	6E-8	---	---
16							
17	AN 52						
18	Tellurium-116						
19							
20	D, all compounds						
21	except those						
22	given for W	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
23							
24	W, oxides,						
25	hydroxides,						
26	and nitrates	---	3E+4	1E-5	4E-8	---	---
27							
28	Tellurium-121m						
29							
30	D, see ¹¹⁶ Te	5E+2	2E+2	8E-8	---	---	---
31		Bone	Bone				
32		(7E+2)	(4E+2)	---	5E-10	1E-5	1E-4
33	W, see ¹¹⁶ Te	---	4E+2	2E-7	6E-10	---	---
34							
35	Tellurium-121						
36							
37	D, see ¹¹⁶ Te	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
38	W, see ¹¹⁶ Te	---	3E+3	1E-6	4E-9	---	---
39							
40	Tellurium-123m						
41							
42	D, see ¹¹⁶ Te	6E+2	2E+2	9E-8	---	---	---
43		Bone	Bone				
44		(1E+3)	(5E+2)	---	8E-10	1E-5	1E-4
45	W, see ¹¹⁶ Te	---	5E+2	2E-7	8E-10	---	---
46							
47	Tellurium-123						
48							
49	D, see ¹¹⁶ Te	5E+2	2E+2	8E-8	---	---	---
50		Bone	Bone				
51		(1E+3)	(5E+2)	---	7E-10	2E-5	2E-4
52	W, see ¹¹⁶ Te	---	4E+2	2E-7	---	---	---
53			Bone				
54		---	(1E+3)	---	2E-9	---	---

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1	Tellurium-125m						
2							
3	D, see ^{116}Te	1E+3	4E+2	2E-7	---	---	---
4		Bone	Bone				
5		(1E+3)	(1E+3)	---	1E-9	2E-5	2E-4
6	W, see ^{116}Te	---	7E+2	3E-7	1E-9	---	---
7							
8	Tellurium-127m						
9							
10	D, see ^{116}Te	6E+2	3E+2	1E-7	---	9E-6	9E-5
11			Bone				
12		---	(4E+2)	---	6E-10	---	---
13	W, see ^{116}Te	---	3E+2	1E-7	4E-10	---	---
14							
15	Tellurium-127						
16							
17	D, see ^{116}Te	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
18	W, see ^{116}Te	---	2E+4	7E-6	2E-8	---	---
19							
20	Tellurium-129m						
21							
22	D, see ^{116}Te	5E+2	6E+2	3E-7	9E-10	7E-6	7E-5
23	W, see ^{116}Te	---	2E+2	1E-7	3E-10	---	---
24							
25	Tellurium-129 ²						
26							
27	D, see ^{116}Te	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
28	W, see ^{116}Te	---	7E+4	3E-5	1E-7	---	---
29							
30	Tellurium-131m						
31							
32	D, see ^{116}Te	3E+2	4E+2	2E-7	---	---	---
33		Thyr	Thyr				
34		(6E+2)	(1E+3)	---	2E-9	8E-6	8E-5
35	W, see ^{116}Te	---	4E+2	2E-7	---	---	---
36			Thyr				
37		---	(9E+2)	---	1E-9	---	---
38							
39	Tellurium-131 ²						
40							
41	D, see ^{116}Te	3E+3	5E+3	2E-6	---	---	---
42		Thyr	Thyr				
43		(6E+3)	(1E+4)	---	2E-8	8E-5	8E-4
44	W, see ^{116}Te	---	5E+3	2E-6	---	---	---
45			Thyr				
46		---	(1E+4)	---	2E-8	---	---
47							
48	Tellurium-132						
49							
50	D, see ^{116}Te	2E+2	2E+2	9E-8	---	---	---
51		Thyr	Thyr				
52		(7E+2)	(8E+2)	---	1E-9	9E-6	9E-5
53	W, see ^{116}Te	---	2E+2	9E-8	---	---	---
54			Thyr				

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1		---	(6E+2)	---	9E-10	---	---
2							
3	Tellurium-133m ²						
4							
5	D, see ¹¹⁶ Te	3E+3	5E+3	2E-6	---	---	---
6		Thyr	Thyr				
7		(6E+3)	(1E+4)	---	2E-8	9E-5	9E-4
8	W, see ¹¹⁶ Te	---	5E+3	2E-6	---	---	---
9			Thyr				
10		---	(1E+4)	---	2E-8	---	---
11							
12	Tellurium-133 ²						
13							
14	D, see ¹¹⁶ Te	1E+4	2E+4	9E-6	---	---	---
15		Thyr	Thyr				
16		(3E+4)	(6E+4)	---	8E-8	4E-4	4E-3
17	W, see ¹¹⁶ Te	---	2E+4	9E-6	---	---	---
18			Thyr				
19		---	(6E+4)	---	8E-8	---	---
20							
21	Tellurium-134 ²						
22							
23	D, see ¹¹⁶ Te	2E+4	2E+4	1E-5	---	---	---
24		Thyr	Thyr				
25		(2E+4)	(5E+4)	---	7E-8	3E-4	3E-3
26	W, see ¹¹⁶ Te	---	2E+4	1E-5	---	---	---
27			Thyr				
28		---	(5E+4)	---	7E-8	---	---
29							
30	AN 53						
31	Iodine-120m ²						
32							
33	D, all compounds	1E+4	2E+4	9E-6	3E-8	---	---
34		Thyr					
35		(1E+4)	---	---	---	2E-4	2E-3
36							
37	Iodine-120 ²						
38							
39	D, all compounds	4E+3	9E+3	4E-6	---	---	---
40		Thyr	Thyr				
41		(8E+3)	(1E+4)	---	2E-8	1E-4	1E-3
42							
43	Iodine-121						
44							
45	D, all compounds	1E+4	2E+4	8E-6	---	---	---
46		Thyr	Thyr				
47		(3E+4)	(5E+4)	---	7E-8	4E-4	4E-3
48							
49	Iodine-123						
50							
51	D, all compounds	3E+3	6E+3	3E-6	---	---	---
52		Thyr	Thyr				
53		(1E+4)	(2E+4)	---	2E-8	1E-4	1E-3
54							

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1	Iodine-124						
2							
3	D, all compounds	5E+1	8E+1	3E-8	---	---	---
4		Thyr	Thyr				
5		(2E+2)	(3E+2)	---	4E-10	2E-6	2E-5
6							
7	Iodine-125						
8							
9	D, all compounds	4E+1	6E+1	3E-8	---	---	---
10		Thyr	Thyr				
11		(1E+2)	(2E+2)	---	3E-10	2E-6	2E-5
12							
13	Iodine-126						
14							
15	D, all compounds	2E+1	4E+1	1E-8	---	---	---
16		Thyr	Thyr				
17		(7E+1)	(1E+2)	---	2E-10	1E-6	1E-5
18							
19	Iodine-128 ²						
20							
21	D, all compounds	4E+4	1E+5	5E-5	2E-7	---	---
22		Stom					
23		(6E+4)	---	---	---	8E-4	8E-3
24							
25	Iodine-129						
26							
27	D, all compounds	5E+0	9E+0	4E-9	---	---	---
28		Thyr	Thyr				
29		(2E+1)	(3E+1)	---	4E-11	2E-7	2E-6
30							
31	Iodine-130						
32							
33	D, all compounds	4E+2	7E+2	3E-7	---	---	---
34		Thyr	Thyr				
35		(1E+3)	(2E+3)	---	3E-9	2E-5	2E-4
36							
37	Iodine-131						
38							
39	D, all compounds	3E+1	5E+1	2E-8	---	---	---
40		Thyr	Thyr				
41		(9E+1)	(2E+2)	---	2E-10	1E-6	1E-5
42							
43	Iodine-132m ²						
44							
45	D, all compounds	4E+3	8E+3	4E-6	---	---	---
46		Thyr	Thyr				
47		(1E+4)	(2E+4)	---	3E-8	1E-4	1E-3
48							
49	Iodine-132						
50							
51	D, all compounds	4E+3	8E+3	3E-6	---	---	---
52		Thyr	Thyr				
53		(9E+3)	(1E+4)	---	2E-8	1E-4	1E-3
54							

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1	Iodine-133						
2							
3	D, all compounds	1E+2	3E+2	1E-7	---	---	---
4		Thyr	Thyr				
5		(5E+2)	(9E+2)	---	1E-9	7E-6	7E-5
6							
7	Iodine-134 ²						
8							
9	D, all compounds	2E+4	5E+4	2E-5	6E-8	---	---
10		Thyr					
11		(3E+4)	---	---	---	4E-4	4E-3
12							
13	Iodine-135						
14							
15	D, all compounds	8E+2	2E+3	7E-7	---	---	---
16		Thyr	Thyr				
17		(3E+3)	(4E+3)	---	6E-9	3E-5	3E-4
18							
19	AN 54						
20	Xenon-120 ²						
21							
22	Submersion ¹	---	---	1E-5	4E-8	---	---
23							
24	Xenon-121 ²						
25							
26	Submersion ¹	---	---	2E-6	1E-8	---	---
27							
28	Xenon-122						
29							
30	Submersion ¹	---	---	7E-5	3E-7	---	---
31							
32	Xenon-123						
33							
34	Submersion ¹	---	---	6E-6	3E-8	---	---
35							
36	Xenon-125						
37							
38	Submersion ¹	---	---	2E-5	7E-8	---	---
39							
40	Xenon-127						
41							
42	Submersion ¹	---	---	1E-5	6E-8	---	---
43							
44	Xenon-129m						
45							
46	Submersion ¹	---	---	2E-4	9E-7	---	---
47							
48	Xenon-131m						
49							
50	Submersion ¹	---	---	4E-4	2E-6	---	---
51							
52	Xenon-133m						
53							
54	Submersion ¹	---	---	1E-4	6E-7	---	---

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1							
2	Xenon-133						
3							
4	Submersion ¹	---	---	1E-4	5E-7	---	---
5							
6	Xenon-135m ²						
7							
8	Submersion ¹	---	---	9E-6	4E-8	---	---
9							
10	Xenon-135						
11							
12	Submersion ¹	---	---	1E-5	7E-8	---	---
13							
14	Xenon-138 ²						
15							
16	Submersion ¹	---	---	4E-6	2E-8	---	---
17							
18	AN 55						
19	Cesium-125 ²						
20							
21	D, all compounds	5E+4	1E+5	6E-5	2E-7	---	---
22		Stom					
23		(9E+4)	---	---	---	1E-3	1E-2
24							
25	Cesium-127						
26							
27	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3
28							
29	Cesium-129						
30							
31	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
32							
33	Cesium-130 ²						
34							
35	D, all compounds	6E+4	2E+5	8E-5	3E-7	---	---
36		Stom					
37		(1E+5)	---	---	---	1E-3	1E-2
38							
39	Cesium-131						
40							
41	D, all compounds	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
42							
43	Cesium-132						
44							
45	D, all compounds	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
46							
47	Cesium-134m						
48							
49	D, all compounds	1E+5	1E+5	6E-5	2E-7	---	---
50		Stom					
51		(1E+5)	---	---	---	2E-3	2E-2
52							
53	Cesium-134						
54							

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1	D, all compounds	7E+1	1E+2	4E-8	2E-10	9E-7	9E-6
2							
3	Cesium-135m ²						
4							
5	D, all compounds	1E+5	2E+5	8E-5	3E-7	1E-3	1E-2
6							
7	Cesium-135						
8							
9	D, all compounds	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
10							
11	Cesium-136						
12							
13	D, all compounds	4E+2	7E+2	3E-7	9E-10	6E-6	6E-5
14							
15	Cesium-137						
16							
17	D, all compounds	1E+2	2E+2	6E-8	2E-10	1E-6	1E-5
18							
19	Cesium-138 ²						
20							
21	D, all compounds	2E+4	6E+4	2E-5	8E-8	---	---
22		Stom					
23		(3E+4)	---	---	---	4E-4	4E-3
24							
25	AN 56						
26	Barium-126 ²						
27							
28	D, all compounds	6E+3	2E+4	6E-6	2E-8	8E-5	8E-4
29							
30	Barium-128						
31							
32	D, all compounds	5E+2	2E+3	7E-7	2E-9	7E-6	7E-5
33							
34	Barium-131m ²						
35							
36	D, all compounds	4E+5	1E+6	6E-4	2E-6	---	---
37		Stom					
38		(5E+5)	---	---	---	7E-3	7E-2
39							
40	Barium-131						
41							
42	D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
43							
44	Barium-133						
45							
46	D, all compounds	2E+3	9E+3	4E-6	1E-8	---	---
47		LLI					
48		(3E+3)	---	---	---	4E-5	4E-4
49							
50	Barium-133						
51							
52	D, all compounds	2E+3	7E+2	3E-7	9E-10	2E-5	2E-4
53							
54	Barium-135m						

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1							
2	D, all compounds	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
3							
4	Barium-139 ²						
5							
6	D, all compounds	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
7							
8	Barium-140						
9							
10	D, all compounds	5E+2	1E+3	6E-7	2E-9	---	---
11	LLI						
12	(6E+2)	---	---	---	---	8E-6	8E-5
13							
14	Barium-141 ²						
15							
16	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
17							
18	Barium-142 ²						
19							
20	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
21							
22	AN 57						
23	Lanthanum-131 ²						
24							
25	D, all compounds						
26	except those						
27	given for W	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
28							
29	W, oxides and						
30	hydroxides	---	2E+5	7E-5	2E-7	---	---
31							
32	Lanthanum-132						
33							
34	D, see ¹³¹ La	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
35	W, see ¹³¹ La	---	1E+4	5E-6	2E-8	---	---
36							
37	Lanthanum-135						
38							
39	D, see ¹³¹ La	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
40	W, see ¹³¹ La	---	9E+4	4E-5	1E-7	---	---
41							
42	Lanthanum-137						
43							
44	D, see ¹³¹ La	1E+4	6E+1	3E-8	---	2E-4	2E-3
45			Liver				
46		---	(7E+1)	---	1E-10	---	---
47	W, see ¹³¹ La	---	3E+2	1E-7	---	---	---
48			Liver				
49		---	(3E+2)	---	4E-10	---	---
50							
51	Lanthanum-138						
52							
53	D, see ¹³¹ La	9E+2	4E+0	1E-9	5E-12	1E-5	1E-4
54	W, see ¹³¹ La	---	1E+1	6E-9	2E-11	---	---

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1							
2	Lanthanum-140						
3							
4	D, see ¹³¹ La	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
5	W, see ¹³¹ La	---	1E+3	5E-7	2E-9	---	---
6							
7	Lanthanum-141						
8							
9	D, see ¹³¹ La	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
10	W, see ¹³¹ La	---	1E+4	5E-6	2E-8	---	---
11							
12	Lanthanum-142 ²						
13							
14	D, see ¹³¹ La	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
15	W, see ¹³¹ La	---	3E+4	1E-5	5E-8	---	---
16							
17	Lanthanum-143 ²						
18							
19	D, see ¹³¹ La	4E+4	1E+5	4E-5	1E-7	---	---
20		Stom					
21		(4E+4)	---	---	---	5E-4	5E-3
22	W, see ¹³¹ La	---	9E+4	4E-5	1E-7	---	---
23							
24	AN 58						
25	Cerium-134						
26							
27	W, all compounds						
28	except those						
29	given for Y	5E+2	7E+2	3E-7	1E-9	---	---
30		LLI					
31		(6E+2)	---	---	---	8E-6	8E-5
32	Y, oxides,						
33	hydroxides,						
34	and fluorides	---	7E+2	3E-7	9E-10	---	---
35							
36	Cerium-135						
37							
38	W, see ¹³⁴ Ce	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
39	Y, see ¹³⁴ Ce	---	4E+3	1E-6	5E-9	---	---
40							
41	Cerium-137m						
42							
43	W, see ¹³⁴ Ce	2E+3	4E+3	2E-6	6E-9	---	---
44		LLI					
45		(2E+3)	---	---	---	3E-5	3E-4
46	Y, see ¹³⁴ Ce	---	4E+3	2E-6	5E-9	---	---
47							
48	Cerium-137						
49							
50	W, see ¹³⁴ Ce	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
51	Y, see ¹³⁴ Ce	---	1E+5	5E-5	2E-7	---	---
52							
53	Cerium-139						
54							

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1	W, see ^{134}Ce	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
2	Y, see ^{134}Ce	---	7E+2	3E-7	9E-10	---	---
3							
4	Cerium-141						
5							
6	W, see ^{134}Ce	2E+3	7E+2	3E-7	1E-9	---	---
7	LLI						
8	(2E+3)	---	---	---	---	3E-5	3E-4
9	Y, see ^{134}Ce	---	6E+2	2E-7	8E-10	---	---
10							
11	Cerium-143						
12							
13	W, see ^{134}Ce	1E+3	2E+3	8E-7	3E-9	---	---
14	LLI						
15	(1E+3)	---	---	---	---	2E-5	2E-4
16	Y, see ^{134}Ce	---	2E+3	7E-7	2E-9	---	---
17							
18	Cerium-144						
19							
20	W, see ^{134}Ce	2E+2	3E+1	1E-8	4E-11	---	---
21	LLI						
22	(3E+2)	---	---	---	---	3E-6	3E-5
23	Y, see ^{134}Ce	---	1E+1	6E-9	2E-11	---	---
24							
25	AN 59						
26	Praseodymium-136 ²						
27							
28	W, all compounds						
29	except those						
30	given for Y	5E+4	2E+5	1E-4	3E-7		
31	Stom						
32	(7E+4)	---	---	---	---	1E-3	1E-2
33	Y, oxides,						
34	hydroxides,						
35	carbides, and						
36	fluorides	---	2E+5	9E-5	3E-7	---	---
37							
38	Praseodymium-137 ²						
39							
40	W, see ^{136}Pr	4E+4	2E+5	6E-5	2E-7	5E-4	5E-3
41	Y, see ^{136}Pr	---	1E+5	6E-5	2E-7	---	---
42							
43	Praseodymium-138m						
44							
45	W, see ^{136}Pr	1E+4	5E+4	2E-5	8E-8	1E-4	1E-3
46	Y, see ^{136}Pr	---	4E+4	2E-5	6E-8	---	---
47							
48	Praseodymium-139						
49							
50	W, see ^{136}Pr	4E+4	1E+5	5E-5	2E-7	6E-4	6E-3
51	Y, see ^{136}Pr	---	1E+5	5E-5	2E-7	---	---
52							
53	Praseodymium-142m ²						
54							

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1	W, see ¹³⁶ Pr	8E+4	2E+5	7E-5	2E-7	1E-3	1E-2
2	Y, see ¹³⁶ Pr	---	1E+5	6E-5	2E-7	---	---
3							
4	Praseodymium-142						
5							
6	W, see ¹³⁶ Pr	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
7	Y, see ¹³⁶ Pr	---	2E+3	8E-7	3E-9	---	---
8							
9	Praseodymium-143						
10							
11	W, see ¹³⁶ Pr	9E+2	8E+2	3E-7	1E-9	---	---
12		LLI					
13		(1E+3)	---	---	---	2E-5	2E-4
14	Y, see ¹³⁶ Pr	---	7E+2	3E-7	9E-10	---	---
15							
16	Praseodymium-144 ²						
17							
18	W, see ¹³⁶ Pr	3E+4	1E+5	5E-5	2E-7	---	---
19		Stom					
20		(4E+4)	---	---	---	6E-4	6E-3
21	Y, see ¹³⁶ Pr	---	1E+5	5E-5	2E-7	---	---
22							
23	Praseodymium-145						
24							
25	W, see ¹³⁶ Pr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
26	Y, see ¹³⁶ Pr	---	8E+3	3E-6	1E-8	---	---
27							
28	Praseodymium-147 ²						
29							
30	W, see ¹³⁶ Pr	5E+4	2E+5	8E-5	3E-7	---	---
31		Stom					
32		(8E+4)	---	---	---	1E-3	1E-2
33	Y, see ¹³⁶ Pr	---	2E+5	8E-5	3E-7	---	---
34							
35	AN 60						
36	Neodymium-136 ²						
37							
38	W, all compounds						
39	except those						
40	given for Y	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
41							
42	Y, oxides,						
43	hydroxides,						
44	carbides, and						
45	fluorides	---	5E+4	2E-5	8E-8	---	---
46							
47	Neodymium-138						
48							
49	W, see ¹³⁶ Nd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
50	Y, see ¹³⁶ Nd	---	5E+3	2E-6	7E-9	---	---
51							
52	Neodymium-139m						
53							
54	W, see ¹³⁶ Nd	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4

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1	Y, see ¹³⁶ Nd	---	1E+4	6E-6	2E-8	---	---
2							
3	Neodymium-139 ²						
4							
5	W, see ¹³⁶ Nd	9E+4	3E+5	1E-4	5E-7	1E-3	1E-2
6	Y, see ¹³⁶ Nd	---	3E+5	1E-4	4E-7	---	---
7							
8	Neodymium-141						
9							
10	W, see ¹³⁶ Nd	2E+5	7E+5	3E-4	1E-6	2E-3	2E-2
11	Y, see ¹³⁶ Nd	---	6E+5	3E-4	9E-7	---	---
12							
13	Neodymium-147						
14							
15	W, see ¹³⁶ Nd	1E+3	9E+2	4E-7	1E-9	---	---
16		LLI					
17		(1E+3)	---	---	---	2E-5	2E-4
18	Y, see ¹³⁶ Nd	---	8E+2	4E-7	1E-9	---	---
19							
20	Neodymium-149 ²						
21							
22	W, see ¹³⁶ Nd	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
23	Y, see ¹³⁶ Nd	---	2E+4	1E-5	3E-8	---	---
24							
25	Neodymium-151 ²						
26							
27	W, see ¹³⁶ Nd	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
28	Y, see ¹³⁶ Nd	---	2E+5	8E-5	3E-7	---	---
29							
30	AN 61						
31	Promethium-141 ²						
32							
33	W, all compounds						
34	except those						
35	given for Y	5E+4	2E+5	8E-5	3E-7	---	---
36		Stom					
37		(6E+4)	---	---	---	8E-4	8E-3
38	Y, oxides,						
39	hydroxides,						
40	carbides, and						
41	fluorides	---	2E+5	7E-5	2E-7	---	---
42							
43	Promethium-143						
44							
45	W, see ¹⁴¹ Pm	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
46	Y, see ¹⁴¹ Pm	---	7E+2	3E-7	1E-9	---	---
47							
48	Promethium-144						
49							
50	W, see ¹⁴¹ Pm	1E+3	1E+2	5E-8	2E-10	5E-5	2E-4
51	Y, see ¹⁴¹ Pm	---	1E+2	5E-8	2E-10	---	---
52							
53	Promethium-145						
54							

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1	W, see ^{141}Pm	1E+4	2E+2	7E-8	---	1E-4	1E-3
2			Bone				
3		---	(2E+2)	---	3E-10	---	---
4	Y, see ^{141}Pm	---	2E+2	8E-8	3E-10	---	---
5							
6	Promethium-146						
7							
8	W, see ^{141}Pm	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
9	Y, see ^{141}Pm	---	4E+1	2E-8	6E-11	---	---
10							
11	Promethium-147						
12							
13	W, see ^{141}Pm	4E+3	1E+2	5E-8	---	---	---
14		LLI	Bone				
15		(5E+3)	(2E+2)	---	3E-10	7E-5	7E-4
16	Y, see ^{141}Pm	---	1E+2	6E-8	2E-10	---	---
17							
18	Promethium-148m						
19							
20	W, see ^{141}Pm	7E+2	3E+2	1E-7	4E-10	1E-5	1E-4
21	Y, see ^{141}Pm	---	3E+2	1E-7	5E-10	---	---
22							
23	Promethium-148						
24							
25	W, see ^{141}Pm	4E+2	5E+2	2E-7	8E-10	---	---
26		LLI					
27		(5E+2)	---	---	---	7E-6	7E-5
28	Y, see ^{141}Pm	---	5E+2	2E-7	7E-10	---	---
29							
30	Promethium-149						
31							
32	W, see ^{141}Pm	1E+3	2E+3	8E-7	3E-9	---	---
33		LLI					
34		(1E+3)	---	---	---	2E-5	2E-4
35	Y, see ^{141}Pm	---	2E+3	8E-7	2E-9	---	---
36							
37	Promethium-150						
38							
39	W, see ^{141}Pm	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
40	Y, see ^{141}Pm	---	2E+4	7E-6	2E-8	---	---
41							
42	Promethium-151						
43							
44	W, see ^{141}Pm	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
45	Y, see ^{141}Pm	---	3E+3	1E-6	4E-9	---	---
46							
47	AN 62						
48	Samarium-141m ²						
49							
50	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
51							
52	Samarium-141 ²						
53							
54	W, all compounds	5E+4	2E+5	8E-5	2E-7	---	---

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1		Stom					
2		(6E+4)	---	---	---	8E-4	8E-3
3							
4	Samarium-142 ²						
5							
6	W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
7							
8	Samarium-145						
9							
10	W, all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
11							
12	Samarium-146						
13							
14	W, all compounds	1E+1	4E-2	1E-11	---	---	---
15		Bone	Bone				
16		(3E+1)	(6E-2)	---	9E-14	3E-7	3E-6
17	Samarium-147						
18							
19	W, all compounds	2E+1	4E-2	2E-11	---	---	---
20		Bone	Bone				
21		(3E+1)	(7E-2)	---	1E-13	4E-7	4E-6
22							
23	Samarium-151						
24							
25	W, all compounds	1E+4	1E+2	4E-8	---	---	---
26		LLI	Bone				
27		(1E+4)	(2E+2)	---	2E-10	2E-4	2E-3
28							
29	Samarium-153						
30							
31	W, all compounds	2E+3	3E+3	1E-6	4E-9	---	---
32		LLI					
33		(2E+3)	---	---	---	3E-5	3E-4
34							
35	Samarium-155 ²						
36							
37	W, all compounds	6E+4	2E+5	9E-5	3E-7	---	---
38		Stom					
39		(8E+4)	---	---	---	1E-3	1E-2
40							
41	Samarium-156						
42							
43	W, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
44							
45	AN 63						
46	Europium-145						
47							
48	W, all compounds	2E+3	2E+3	8E-7	3E-9	2E-5	2E-4
49							
50	Europium-146						
51							
52	W, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
53							
54	Europium-147						

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1							
2	W, all compounds	3E+3	2E+3	7E-7	2E-9	4E-5	4E-4
3							
4	Europium-148						
5							
6	W, all compounds	1E+3	4E+2	1E-7	5E-10	1E-5	1E-4
7							
8	Europium-149						
9							
10	W, all compounds	1E+4	3E+3	1E-6	4E-9	2E-4	2E-3
11							
12	Europium-150						
13	(12.62 h)						
14							
15	W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
16							
17	Europium-150						
18	(34.2 y)						
19							
20	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
21							
22	Europium-152m						
23							
24	W, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
25							
26	Europium-152						
27							
28	W, all compounds	8E+2	2E+1	1E-8	3E-11	1E-5	1E-4
29							
30	Europium-154						
31							
32	W, all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5
33							
34	Europium-155						
35							
36	W, all compounds	4E+3	9E+1	4E-8	---	5E-5	5E-4
37			Bone				
38		---	(1E+2)	---	2E-10	---	---
39							
40	Europium-156						
41							
42	W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5
43							
44	Europium-157						
45							
46	W, all compounds	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
47							
48	Europium-158 ²						
49							
50	W, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
51							
52	AN 64						
53	Gadolinium-145 ²						
54							

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1	D, all compounds						
2	except those						
3	given for W	5E+4	2E+5	6E-5	2E-7	---	---
4		Stom					
5		(5E+4)	---	---	---	6E-4	6E-3
6	W, oxides,						
7	hydroxides,						
8	and fluorides	---	2E+5	7E-5	2E-7	---	---
9							
10	Gadolinium-146						
11							
12	D, see ¹⁴⁵ Gd	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
13	W, see ¹⁴⁵ Gd	---	3E+2	1E-7	4E-10	---	---
14							
15	Gadolinium-147						
16							
17	D, see ¹⁴⁵ Gd	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
18	W, see ¹⁴⁵ Gd	---	4E+3	1E-6	5E-9	---	---
19							
20	Gadolinium-148						
21							
22	D, see ¹⁴⁵ Gd	1E+1	8E-3	3E-12	---	---	---
23		Bone	Bone				
24		(2E+1)	(2E-2)	---	2E-14	3E-7	3E-6
25	W, see ¹⁴⁵ Gd	---	3E-2	1E-11	---	---	---
26			Bone				
27		---	(6E-2)	---	8E-14	---	---
28							
29	Gadolinium-149						
30							
31	D, see ¹⁴⁵ Gd	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
32	W, see ¹⁴⁵ Gd	---	2E+3	1E-6	3E-9	---	---
33							
34	Gadolinium-151						
35							
36	D, see ¹⁴⁵ Gd	6E+3	4E+2	2E-7	---	9E-5	9E-4
37			Bone				
38		---	(6E+2)	---	9E-10	---	---
39	W, see ¹⁴⁵ Gd	---	1E+3	5E-7	2E-9	---	---
40							
41	Gadolinium-152						
42							
43	D, see ¹⁴⁵ Gd	2E+1	1E-2	4E-12	---	---	---
44		Bone	Bone				
45		(3E+1)	(2E-2)	---	3E-14	4E-7	4E-6
46	W, see ¹⁴⁵ Gd	---	4E-2	2E-11	---	---	---
47			Bone				
48		---	(8E-2)	---	1E-13	---	---
49	Gadolinium-153						
50							
51	D, see ¹⁴⁵ Gd	5E+3	1E+2	6E-8	---	6E-5	6E-4
52			Bone				
53		---	(2E+2)	---	3E-10	---	---
54	W, see ¹⁴⁵ Gd	---	6E+2	2E-7	8E-10	---	---

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1							
2	Gadolinium-159						
3							
4	D, see ¹⁴⁵ Gd	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
5	W, see ¹⁴⁵ Gd	---	6E+3	2E-6	8E-9	---	---
6							
7	AN 65						
8	Terbium-147 ²						
9							
10	W, all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
11							
12	Terbium-149						
13							
14	W, all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
15							
16	Terbium-150						
17							
18	W, all compounds	5E+3	2E+4	9E-6	3E-8	7E-5	7E-4
19							
20	Terbium-151						
21							
22	W, all compounds	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
23							
24	Terbium-153						
25							
26	W, all compounds	5E+3	7E+3	3E-6	1E-8	7E-5	7E-4
27							
28	Terbium-154						
29							
30	W, all compounds	2E+3	4E+3	2E-6	6E-9	2E-5	2E-4
31							
32	Terbium-155						
33							
34	W, all compounds	6E+3	8E+3	3E-6	1E-8	8E-5	8E-4
35							
36	Terbium-156m						
37	(5.0 h)						
38							
39	W, all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3
40							
41	Terbium-156m						
42	(24.4 h)						
43							
44	W, all compounds	7E+3	8E+3	3E-6	1E-8	1E-4	1E-3
45							
46	Terbium-156						
47							
48	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
49							
50	Terbium-157						
51							
52	W, all compounds	5E+4	3E+2	1E-7	---	---	---
53	LLI		Bone				
54	(5E+4)	(6E+2)	---	8E-10	7E-4	7E-3	

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1							
2	Terbium-158						
3							
4	W, all compounds	1E+3	2E+1	8E-9	3E-11	2E-5	2E-4
5							
6	Terbium-160						
7							
8	W, all compounds	8E+2	2E+2	9E-8	3E-10	1E-5	1E-4
9							
10	Terbium-161						
11							
12	W, all compounds	2E+3	2E+3	7E-7	2E-9	---	---
13		LLI					
14		(2E+3)	---	---	---	3E-5	3E-4
15							
16	AN 66						
17	Dysprosium-155						
18							
19	W, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
20							
21	Dysprosium-157						
22							
23	W, all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
24							
25	Dysprosium-159						
26							
27	W, all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
28							
29	Dysprosium-165						
30							
31	W, all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
32							
33	Dysprosium-166						
34							
35	W, all compounds	6E+2	7E+2	3E-7	1E-9	---	---
36		LLI					
37		(8E+2)	---	---	---	1E-5	1E-4
38							
39	AN 67						
40	Holmium-155 ²						
41							
42	W, all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
43							
44	Holmium-157 ²						
45							
46	W, all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
47							
48	Holmium-159 ²						
49							
50	W, all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
51							
52	Holmium-161						
53							
54	W, all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2

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1							
2	Holmium-162m ²						
3							
4	W, all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
5							
6	Holmium-162 ²						
7							
8	W, all compounds	5E+5	2E+6	1E-3	3E-6	---	---
9		Stom					
10		(8E+5)	---	---	---	1E-2	1E-1
11							
12	Holmium-164m ²						
13							
14	W, all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
15							
16	Holmium-164 ²						
17							
18	W, all compounds	2E+5	6E+5	3E-4	9E-7	---	---
19		Stom					
20		(2E+5)	---	---	---	3E-3	3E-2
21							
22	Holmium-166m						
23							
24	W, all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
25							
26	Holmium-166						
27							
28	W, all compounds	9E+2	2E+3	7E-7	2E-9	---	---
29		LLI					
30		(9E+2)	---	---	---	1E-5	1E-4
31							
32	Holmium-167						
33							
34	W, all compounds	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
35							
36	AN 68						
37	Erbium-161						
38							
39	W, all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3
40							
41	Erbium-165						
42							
43	W, all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3
44							
45	Erbium-169						
46							
47	W, all compounds	3E+3	3E+3	1E-6	4E-9	---	---
48		LLI					
49		(4E+3)	---	---	---	5E-5	5E-4
50							
51	Erbium-171						
52							
53	W, all compounds	4E+3	1E+4	4E-6	1E-8	5E-5	5E-4
54							

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1	Erbium-172						
2							
3	W, all compounds	1E+3	1E+3	6E-7	2E-9	---	---
4		LLI					
5		(E+3)	---	---	---	2E-5	2E-4
6							
7	AN 69						
8	Thulium-162 ²						
9							
10	W, all compounds	7E+4	3E+5	1E-4	4E-7	---	---
11		Stom					
12		(7E+4)	---	---	---	1E-3	1E-2
13							
14	Thulium-166						
15							
16	W, all compounds	4E+3	1E+4	6E-6	2E-8	6E-5	6E-4
17							
18	Thulium-167						
19							
20	W, all compounds	2E+3	2E+3	8E-7	3E-9	---	---
21		LLI					
22		(2E+3)	---	---	---	3E-5	3E-4
23	Thulium-170						
24							
25	W, all compounds	8E+2	2E+2	9E-8	3E-10	---	---
26		LLI					
27		(1E+3)	---	---	---	1E-5	1E-4
28							
29	Thulium-171						
30							
31	W, all compounds	1E+4	3E+2	1E-7	---	---	---
32		LLI	Bone				
33		(1E+4)	(6E+2)	---	8E-10	2E-4	2E-3
34							
35	Thulium-172						
36							
37	W, all compounds	7E+2	1E+3	5E-7	2E-9	---	---
38		LLI					
39		(8E+2)	---	---	---	1E-5	1E-4
40							
41	Thulium-173						
42							
43	W, all compounds	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
44							
45	Thulium-175 ²						
46							
47	W, all compounds	7E+4	3E+5	1E-4	4E-7	---	---
48		Stom					
49		(9E+4)	---	---	---	1E-3	1E-2
50							
51	AN 70						
52	Ytterbium-162 ²						
53							
54	W, all compounds						

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1	except those						
2	given for Y	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
3							
4	Y, oxides,						
5	hydroxides,						
6	and fluorides	---	3E+5	1E-4	4E-7	---	---
7							
8	Ytterbium-166						
9							
10	W, see ¹⁶² Yb	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
11	Y, see ¹⁶² Yb	---	2E+3	8E-7	3E-9	---	---
12							
13	Ytterbium-167 ²						
14							
15	W, see ¹⁶² Yb	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
16	Y, see ¹⁶² Yb	---	7E+5	3E-4	1E-6	---	---
17							
18	Ytterbium-169						
19							
20	W, see ¹⁶² Yb	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
21	Y, see ¹⁶² Yb	---	7E+2	3E-7	1E-9	---	---
22							
23	Ytterbium-175						
24							
25	W, see ¹⁶² Yb	3E+3	4E+3	1E-6	5E-9	---	---
26		LLI					
27		(3E+3)	---	---	---	4E-5	4E-4
28	Y, see ¹⁶² Yb	---	3E+3	1E-6	5E-9	---	---
29							
30	Ytterbium-177 ²						
31							
32	W, see ¹⁶² Yb	2E+4	5E+4	2E-5	7E-8	2E-4	2E-3
33	Y, see ¹⁶² Yb	---	5E+4	2E-5	6E-8	---	---
34							
35	Ytterbium-178 ²						
36							
37	W, see ¹⁶² Yb	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
38	Y, see ¹⁶² Yb	---	4E+4	2E-5	5E-8	---	---
39							
40	AN 71						
41	Lutetium-169						
42							
43	W, all compounds						
44	except those						
45	given for Y	3E+3	4E+3	2E-6	6E-9	3E-5	3E-4
46							
47	Y, oxides,						
48	hydroxides,						
49	and fluorides	---	4E+3	2E-6	6E-9	---	---
50							
51	Lutetium-170						
52							
53	W, see ¹⁶⁹ Lu	1E+3	2E+3	9E-7	3E-9	2E-5	2E-4
54	Y, see ¹⁶⁹ Lu	---	2E+3	8E-7	3E-9	---	---

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1							
2	Lutetium-171						
3							
4	W, see ¹⁶⁹ Lu	2E+3	2E+3	8E-7	3E-9	3E-5	3E-4
5	Y, see ¹⁶⁹ Lu	---	2E+3	8E-7	3E-9	---	---
6							
7	Lutetium-172						
8							
9	W, see ¹⁶⁹ Lu	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
10	Y, see ¹⁶⁹ Lu	---	1E+3	5E-7	2E-9	---	---
11							
12	Lutetium-173						
13							
14	W, see ¹⁶⁹ Lu	5E+3	3E+2	1E-7	---	7E-5	7E-4
15			Bone				
16		---	(5E+2)	---	6E-10	---	---
17	Y, see ¹⁶⁹ Lu	---	3E+2	1E-7	4E-10	---	---
18							
19	Lutetium-174m						
20							
21	W, see ¹⁶⁹ Lu	2E+3	2E+2	1E-7	---	---	---
22		LLI	Bone				
23		(3E+3)	(3E+3)	---	5E-10	4E-5	4E-4
24	Y, see ¹⁶⁹ Lu	---	2E+2	9E-8	3E-10	---	---
25							
26	Lutetium-174						
27							
28	W, see ¹⁶⁹ Lu	5E+3	1E+2	5E-8	---	7E-5	7E-4
29			Bone				
30		---	(2E+2)	---	3E-10	---	---
31	Y, see ¹⁷⁶ Lu	---	2E+2	6E-8	2E-10	---	---
32							
33	Lutetium-176m						
34							
35	W, see ¹⁶⁹ Lu	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
36	Y, see ¹⁶⁹ Lu	---	2E+4	9E-6	3E-8	---	---
37							
38	Lutetium-176						
39							
40	W, see ¹⁶⁹ Lu	7E+2	5E+0	2E-9	---	1E-5	1E-4
41			Bone				
42		---	(1E+1)	---	2E-11	---	---
43	Y, see ¹⁶⁹ Lu	---	8E+0	3E-9	1E-11	---	---
44							
45	Lutetium-177m						
46							
47	W, see ¹⁶⁹ Lu	7E+2	1E+2	5E-8	---	1E-5	1E-4
48			Bone				
49		---	(1E+2)	---	2E-10	---	---
50	Y, see ¹⁶⁹ Lu	---	8E+1	3E-8	1E-10	---	---
51							
52	Lutetium-177						
53							
54	W, see ¹⁶⁹ Lu	2E+3	2E+3	9E-7	3E-9	---	---

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1		LLI					
2		(3E+3)	---	---	---	4E-5	4E-4
3	Y, see ¹⁶⁹ Lu	---	2E+3	9E-7	3E-9	---	---
4							
5	Lutetium-178m ²						
6							
7	W, see ¹⁶⁹ Lu	5E+4	2E+5	8E-5	3E-7	---	---
8		Stom					
9		(6E+4)	---	---	---	8E-4	8E-3
10	Y, see ¹⁶⁹ Lu	---	2E+5	7E-5	2E-7	---	---
11							
12	Lutetium-178 ²						
13							
14	W, see ¹⁶⁹ Lu	4E+4	1E+5	5E-5	2E-7	---	---
15		Stom					
16		(4E+4)	---	---	---	6E-4	6E-3
17	Y, see ¹⁶⁹ Lu	---	1E+5	5E-5	2E-7	---	---
18							
19	Lutetium-179						
20							
21	W, see ¹⁶⁹ Lu	6E+3	2E+4	8E-6	3E-8	9E-5	9E-4
22	Y, see ¹⁶⁹ Lu	---	2E+4	6E-6	3E-8	---	---
23							
24	AN 72						
25	Hafnium-170						
26							
27	D, all compounds						
28	except those						
29	given for W	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4
30							
31	W, oxides,						
32	hydroxides,						
33	carbides,						
34	and nitrates	---	5E+3	2E-6	6E-9	---	---
35							
36	Hafnium-172						
37							
38	D, see ¹⁷⁰ Hf	1E+3	9E+0	4E-9	---	2E-5	2E-4
39			Bone				
40		---	(2E+1)	---	3E-11	---	---
41	W, see ¹⁷⁰ Hf	---	4E+1	2E-8	---	---	---
42			Bone				
43		---	(6E+1)	---	8E-11	---	---
44							
45	Hafnium-173						
46							
47	D, see ¹⁷⁰ Hf	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
48	W, see ¹⁷⁰ Hf	---	1E+4	5E-6	2E-8	---	---
49							
50	Hafnium-175						
51							
52	D, see ¹⁷⁰ Hf	3E+3	9E+2	4E-7	---	4E-5	4E-4
53			Bone				
54		---	(1E+3)	---	1E-9	---	---

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1	W, see ^{170}Hf	---	1E+3	5E-7	2E-9	---	---
2							
3	Hafnium-177m ²						
4							
5	D, see ^{170}Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
6	W, see ^{170}Hf	---	9E+4	4E-5	1E-7	---	---
7							
8	Hafnium-178m						
9							
10	D, see ^{170}Hf	3E+2	1E+0	5E-10	---	3E-6	3E-5
11			Bone				
12		---	(2E+0)	---	3E-12	---	---
13	W, see ^{170}Hf	---	5E+0	2E-9	---	---	---
14			Bone				
15		---	(9E+0)	---	1E-11	---	---
16							
17	Hafnium-179m						
18							
19	D, see ^{170}Hf	1E+3	3E+2	1E-7	---	1E-5	1E-4
20			Bone				
21		---	(6E+2)	---	8E-10	---	---
22	W, see ^{170}Hf	---	6E+2	3E-7	8E-10	---	---
23							
24	Hafnium-180m						
25							
26	D, see ^{170}Hf	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
27	W, see ^{170}Hf	---	3E+4	1E-5	4E-8	---	---
28							
29	Hafnium-181						
30							
31	D, see ^{170}Hf	1E+3	2E+2	7E-8	---	2E-5	2E-4
32			Bone				
33		---	(4E+2)	---	6E-10	---	---
34	W, see ^{170}Hf	---	4E+2	2E-7	6E-10	---	---
35							
36	Hafnium-182m ²						
37							
38	D, see ^{170}Hf	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
39	W, see ^{170}Hf	---	1E+5	6E-5	2E-7	---	---
40							
41	Hafnium-182						
42							
43	D, see ^{170}Hf	2E+2	8E-1	3E-10	---	---	---
44		Bone	Bone				
45		(4E+2)	(2E+0)	---	2E-12	5E-6	5E-5
46	W, see ^{170}Hf	---	3E+0	1E-9	---	---	---
47			Bone				
48		---	(7E+0)	---	1E-11	---	---
49							
50	Hafnium-183 ²						
51							
52	D, see ^{170}Hf	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
53	W, see ^{170}Hf	---	6E+4	2E-5	8E-8	---	---
54							

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1	Hafnium-184						
2							
3	D, see ¹⁷⁰ Hf	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
4	W, see ¹⁷⁰ Hf	---	6E+3	3E-6	9E-9	---	---
5							
6	AN 73						
7	Tantalum-172 ²						
8							
9	W, all compounds						
10	except those						
11	given for Y	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
12							
13	Y, elemental Ta,						
14	oxides, hydroxides,						
15	halides, carbides,						
16	nitrates, and						
17	nitrides	---	1E+5	4E-5	1E-7	---	---
18							
19	Tantalum-173						
20							
21	W, see ¹⁷² Ta	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
22	Y, see ¹⁷² Ta	---	2E+4	7E-6	2E-8	---	---
23							
24	Tantalum-174 ²						
25							
26	W, see ¹⁷² Ta	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
27	Y, see ¹⁷² Ta	---	9E+4	4E-5	1E-7	---	---
28							
29	Tantalum-175						
30							
31	W, see ¹⁷² Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
32	Y, see ¹⁷² Ta	---	1E+4	6E-6	2E-8	---	---
33							
34	Tantalum-176						
35							
36	W, see ¹⁷² Ta	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
37	Y, see ¹⁷² Ta	---	1E+4	5E-6	2E-8	---	---
38							
39	Tantalum-177						
40							
41	W, see ¹⁷² Ta	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
42	Y, see ¹⁷² Ta	---	2E+4	7E-6	2E-8	---	---
43							
44	Tantalum-178						
45							
46	W, see ¹⁷² Ta	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3
47	Y, see ¹⁷² Ta	---	7E+4	3E-5	1E-7	---	---
48							
49	Tantalum-179						
50							
51	W, see ¹⁷² Ta	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3
52	Y, see ¹⁷² Ta	---	9E+2	4E-7	1E-9	---	---
53							
54	Tantalum-180m						

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1							
2	W, see ^{172}Ta	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
3	Y, see ^{172}Ta	---	6E+4	2E-5	8E-8	---	---
4							
5	Tantalum-180						
6							
7	W, see ^{172}Ta	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
8	Y, see ^{172}Ta	---	2E+1	1E-8	3E-11	---	---
9							
10	Tantalum-182m ²						
11							
12	W, see ^{172}Ta	2E+5	5E+5	2E-4	8E-7	---	---
13		Stom					
14		(2E+5)	---	---	---	3E-3	3E-2
15	Y, see ^{172}Ta	---	4E+5	2E-4	6E-7	---	---
16							
17	Tantalum-182						
18							
19	W, see ^{172}Ta	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
20	Y, see ^{172}Ta	---	1E+2	6E-8	2E-10	---	---
21							
22	Tantalum-183						
23							
24	W, see ^{172}Ta	9E+2	1E+3	5E-7	2E-9	---	---
25		LLI					
26		(1E+3)	---	---	---	2E-5	2E-4
27	Y, see ^{172}Ta	---	1E+3	4E-7	1E-9	---	---
28							
29	Tantalum-184						
30							
31	W, see ^{172}Ta	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
32	Y, see ^{172}Ta	---	5E+3	2E-6	7E-9	---	---
33							
34	Tantalum-185 ²						
35							
36	W, see ^{172}Ta	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
37	Y, see ^{172}Ta	---	6E+4	3E-5	9E-8	---	---
38							
39	Tantalum-186 ²						
40							
41	W, see ^{172}Ta	5E+4	2E+5	1E-4	3E-7	---	---
42		Stom					
43		(7E+4)	---	---	---	1E-3	1E-2
44	Y, see ^{172}Ta	---	2E+5	9E-5	3E-7	---	---
45							
46	AN 74						
47	Tungsten-176						
48							
49	D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3
50							
51	Tungsten-177						
52							
53	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3
54							

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1	Tungsten-178						
2							
3	D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
4							
5	Tungsten-179 ²						
6							
7	D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2
8							
9	Tungsten-181						
10							
11	D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3
12							
13	Tungsten-185						
14							
15	D, all compounds	2E+3	7E+3	3E-6	9E-9	---	---
16		LLI					
17		(3E+3)	---	---	---	4E-5	4E-4
18	Tungsten-187						
19							
20	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4
21							
22	Tungsten-188						
23							
24	D, all compounds	4E+2	1E+3	5E-7	2E-9	---	---
25		LLI					
26		(5E+2)	---	---	---	7E-6	7E-5
27							
28	AN 75						
29	Rhenium-177 ²						
30							
31	D, all compounds						
32	except those						
33	given for W	9E+4	3E+5	1E-4	4E-7	---	---
34		Stom					
35		(1E+5)	---	---	---	2E-3	2E-2
36	W, oxides,						
37	hydroxides,						
38	and nitrates	---	4E+5	1E-4	5E-7	---	---
39							
40	Rhenium-178 ²						
41							
42	D, see ¹⁷⁷ Re	7E+4	3E+5	1E-4	4E-7	---	---
43		Stom					
44		(1E+5)	---	---	---	1E-3	1E-2
45	W, see ¹⁷⁷ Re	---	3E+5	1E-4	4E-7	---	---
46							
47	Rhenium-181						
48							
49	D, see ¹⁷⁷ Re	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
50	W, see ¹⁷⁷ Re	---	9E+3	4E-6	1E-8	---	---
51							
52	Rhenium-182						
53	(12.7 h)						
54							

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1	D, see ¹⁷⁷ Re	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4
2	W, see ¹⁷⁷ Re	---	2E+4	6E-6	2E-8	---	---
3							
4	Rhenium-182						
5	(64.0 h)						
6							
7	D, see ¹⁷⁷ Re	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
8	W, see ¹⁷⁷ Re	---	2E+3	9E-7	3E-9	---	---
9							
10	Rhenium-184m						
11							
12	D, see ¹⁷⁷ Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
13	W, see ¹⁷⁷ Re	---	4E+2	2E-7	6E-10	---	---
14							
15	Rhenium-184						
16							
17	D, see ¹⁷⁷ Re	2E+3	4E+3	1E-6	5E-9	3E-5	3E-4
18	W, see ¹⁷⁷ Re	---	1E+3	6E-7	2E-9	---	---
19							
20	Rhenium-186m						
21							
22	D, see ¹⁷⁷ Re	1E+3	2E+3	7E-7	---	---	---
23		Stom	Stom				
24		(2E+3)	(2E+3)	---	3E-9	2E-5	2E-4
25	W, see ¹⁷⁷ Re	---	2E+2	6E-8	2E-10	---	---
26							
27	Rhenium-186						
28							
29	D, see ¹⁷⁷ Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
30	W, see ¹⁷⁷ Re	---	2E+3	7E-7	2E-9	---	---
31							
32	Rhenium-187						
33							
34	D, see ¹⁷⁷ Re	6E+5	8E+5	4E-4	---	8E-3	8E-2
35			Stom				
36		---	(9E+5)	---	1E-6	---	---
37	W, see ¹⁷⁷ Re	---	1E+5	4E-5	1E-7	---	---
38							
39	Rhenium-188m ²						
40							
41	D, see ¹⁷⁷ Re	8E+4	1E+5	6E-5	2E-7	1E-3	1E-2
42	W, see ¹⁷⁷ Re	---	1E+5	6E-5	2E-7	---	---
43							
44	Rhenium-188						
45							
46	D, see ¹⁷⁷ Re	2E+3	3E+3	1E-6	4E-9	2E-5	2E-4
47	W, see ¹⁷⁷ Re	---	3E+3	1E-6	4E-9	---	---
48							
49	Rhenium-189						
50							
51	D, see ¹⁷⁷ Re	3E+3	5E+3	2E-6	7E-9	4E-5	4E-4
52	W, see ¹⁷⁷ Re	---	4E+3	2E-6	6E-9	---	---
53							
54	AN 76						

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1	Osmium-180 ²						
2							
3	D, all compounds						
4	except those						
5	given for W and Y	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
6							
7	W, halides and						
8	nitrates	---	5E+5	2E-4	7E-7	---	---
9							
10	Y, oxides and						
11	hydroxides	---	5E+5	2E-4	6E-7	---	---
12							
13	Osmium-181 ²						
14							
15	D, see 180Os	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
16	W, see 180Os	---	5E+4	2E-5	6E-8	---	---
17	Y, see 180Os	---	4E+4	2E-5	6E-8	---	---
18							
19	Osmium-182						
20							
21	D, see 180Os	2E+3	6E+3	2E-6	8E-9	3E-5	3E-4
22	W, see 180Os	---	4E+3	2E-6	6E-9	---	---
23	Y, see 180Os	---	4E+3	2E-6	6E-9	---	---
24							
25	Osmium-185						
26							
27	D, see 180Os	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
28	W, see 180Os	---	8E+2	3E-7	1E-9	---	---
29	Y, see 180Os	---	8E+2	3E-7	1E-9	---	---
30							
31	Osmium-189m						
32							
33	D, see 180Os	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
34	W, see 180Os	---	2E+5	9E-5	3E-7	---	---
35	Y, see 180Os	---	2E+5	7E-5	2E-7	---	---
36							
37	Osmium-191m						
38							
39	D, see 180Os	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
40	W, see 180Os	---	2E+4	8E-6	3E-8	---	---
41	Y, see 180Os	---	2E+4	7E-6	2E-8	---	---
42							
43	Osmium-191						
44							
45	D, see 180Os	2E+3	2E+3	9E-7	3E-9	---	---
46		LLI					
47		(3E+3)	---	---	---	3E-5	3E-4
48	W, see 180Os	---	2E+3	7E-7	2E-9	---	---
49	Y, see 180Os	---	1E+3	6E-7	2E-9	---	---
50							
51	Osmium-193						
52							
53	D, see 180Os	2E+3	5E+3	2E-6	6E-9	---	---
54		LLI					

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1		(2E+3)	---	---	---	2E-5	2E-4
2	W, see ^{180}Os	---	3E+3	1E-6	4E-9	---	---
3	Y, see ^{180}Os	---	3E+3	1E-6	4E-9	---	---
4							
5	Osmium-194						
6							
7	D, see ^{180}Os	4E+2	4E+1	2E-8	6E-11	---	---
8		LLI					
9		(6E+2)	---	---	---	8E-6	8E-5
10	W, see ^{180}Os	---	6E+1	2E-8	8E-11	---	---
11	Y, see ^{180}Os	---	8E+0	3E-9	1E-11	---	---
12							
13	AN 77						
14	Iridium-182 ²						
15							
16	D, all compounds						
17	except those						
18	given for W and Y	4E+4	1E+5	6E-5	2E-7	---	---
19		Stom					
20		(4E+4)	---	---	---	6E-4	6E-3
21	W, halides,						
22	nitrites, and						
23	metallic iridium	---	2E+5	6E-5	2E-7	---	---
24							
25	Y, oxides and						
26	hydroxides	---	1E+5	5E-5	2E-7	---	---
27							
28	Iridium-184						
29							
30	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
31	W, see ^{182}Ir	---	3E+4	1E-5	5E-8	---	---
32	Y, see ^{182}Ir	---	3E+4	1E-5	4E-8	---	---
33							
34	Iridium-185						
35							
36	D, see ^{182}Ir	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
37	W, see ^{182}Ir	---	1E+4	5E-6	2E-8	---	---
38	Y, see ^{182}Ir	---	1E+4	4E-6	1E-8	---	---
39							
40	Iridium-186						
41							
42	D, see ^{182}Ir	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
43	W, see ^{182}Ir	---	6E+3	3E-6	9E-9	---	---
44	Y, see ^{182}Ir	---	6E+3	2E-6	8E-9	---	---
45							
46	Iridium-187						
47							
48	D, see ^{182}Ir	1E+4	3E+4	1E-5	5E-8	1E-4	1E-3
49	W, see ^{182}Ir	---	3E+4	1E-5	4E-8	---	---
50	Y, see ^{182}Ir	---	3E+4	1E-5	4E-8	---	---
51							
52	Iridium-188						
53							
54	D, see ^{182}Ir	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4

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1	W, see ¹⁸² Ir	---	4E+3	1E-6	5E-9	---	---
2	Y, see ¹⁸² Ir	---	3E+3	1E-6	5E-9	---	---
3							
4	Iridium-189						
5							
6	D, see ¹⁸² Ir	5E+3	5E+3	2E-6	7E-9	---	---
7		LLI					
8		(5E+3)	---	---	---	7E-5	7E-4
9	W, see ¹⁸² Ir	---	4E+3	2E-6	5E-9	---	---
10	Y, see ¹⁸² Ir	---	4E+3	1E-6	5E-9	---	---
11							
12	Iridium-190m ²						
13							
14	D, see ¹⁸² Ir	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2
15	W, see ¹⁸² Ir	---	2E+5	9E-5	3E-7	---	---
16	Y, see ¹⁸² Ir	---	2E+5	8E-5	3E-7	---	---
17							
18	Iridium-190						
19							
20	D, see ¹⁸² Ir	1E+3	9E+2	4E-7	1E-9	1E-5	1E-4
21	W, see ¹⁸² Ir	---	1E+3	4E-7	1E-9	---	---
22	Y, see ¹⁸² Ir	---	9E+2	4E-7	1E-9	---	---
23							
24	Iridium-192m						
25							
26	D, see ¹⁸² Ir	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
27	W, see ¹⁸² Ir	---	2E+2	9E-8	3E-10	---	---
28	Y, see ¹⁸² Ir	---	2E+1	6E-9	2E-11	---	---
29							
30	Iridium-192						
31							
32	D, see ¹⁸² Ir	9E+2	3E+2	1E-7	4E-10	1E-5	1E-4
33	W, see ¹⁸² Ir	---	4E+2	2E-7	6E-10	---	---
34	Y, see ¹⁸² Ir	---	2E+2	9E-8	3E-10	---	---
35							
36	Iridium-194m						
37							
38	D, see ¹⁸² Ir	6E+2	9E+1	4E-8	1E-10	9E-6	9E-5
39	W, see ¹⁸² Ir	---	2E+2	7E-8	2E-10	---	---
40	Y, see ¹⁸² Ir	---	1E+2	4E-8	1E-10	---	---
41							
42	Iridium-194						
43							
44	D, see ¹⁸² Ir	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
45	W, see ¹⁸² Ir	---	2E+3	9E-7	3E-9	---	---
46	Y, see ¹⁸² Ir	---	2E+3	8E-7	3E-9	---	---
47							
48	Iridium-195m						
49							
50	D, see ¹⁸² Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
51	W, see ¹⁸² Ir	---	3E+4	1E-5	4E-8	---	---
52	Y, see ¹⁸² Ir	---	2E+4	9E-6	3E-8	---	---
53							
54	Iridium-195						

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1							
2	D, see 182Ir	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
3	W, see 182Ir	---	5E+4	2E-5	7E-8	---	---
4	Y, see 182Ir	---	4E+4	2E-5	6E-8	---	---
5							
6	AN 78						
7	Platinum-186						
8							
9	D, all compounds	1E+4	4E+4	2E-5	5E-8	2E-4	2E-3
10							
11	Platinum-188						
12							
13	D, all compounds	2E+3	2E+3	7E-7	2E-9	2E-5	2E-4
14							
15	Platinum-189						
16							
17	D, all compounds	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
18							
19	Platinum-191						
20							
21	D, all compounds	4E+3	8E+3	4E-6	1E-8	5E-5	5E-4
22							
23	Platinum-193m						
24							
25	D, all compounds	3E+3	6E+3	3E-6	8E-9	---	---
26		LLI					
27		(3E+4)	---	---	---	4E-5	4E-4
28							
29	Platinum-193						
30							
31	D, all compounds	4E+4	2E+4	1E-5	3E-8	---	---
32		LLI					
33		(5E+4)	---	---	---	6E-4	6E-3
34							
35	Platinum-195m						
36							
37	D, all compounds	2E+3	4E+3	2E-6	6E-9	---	---
38		LLI					
39		(2E+3)	---	---	---	3E-5	3E-4
40							
41	Platinum-197m ²						
42							
43	D, all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
44							
45	Platinum-197						
46							
47	D, all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
48							
49	Platinum-199 ²						
50							
51	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
52							
53	Platinum-200						
54							

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1	D, all compounds	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
2							
3	AN 79						
4	Gold-193						
5							
6	D, all compounds						
7	except those						
8	given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
9							
10	W, halides and						
11	nitrates	---	2E+4	9E-6	3E-8	---	---
12							
13	Y, oxides and						
14	hydroxides	---	2E+4	8E-6	3E-8	---	---
15							
16	Gold-194						
17							
18	D, see ¹⁹³ Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
19	W, see ¹⁹³ Au	---	5E+3	2E-6	8E-9	---	---
20	Y, see ¹⁹³ Au	---	5E+3	2E-6	7E-9	---	---
21							
22	Gold-195						
23							
24	D, see ¹⁹³ Au	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
25	W, see ¹⁹³ Au	---	1E+3	6E-7	2E-9	---	---
26	Y, see ¹⁹³ Au	---	4E+2	2E-7	6E-10	---	---
27							
28	Gold-198m						
29							
30	D, see ¹⁹³ Au	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
31	W, see ¹⁹³ Au	---	1E+3	5E-7	2E-9	---	---
32	Y, see ¹⁹³ Au	---	1E+3	5E-7	2E-9	---	---
33							
34	Gold-198						
35							
36	D, see ¹⁹³ Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
37	W, see ¹⁹³ Au	---	2E+3	8E-7	3E-9	---	---
38	Y, see ¹⁹³ Au	---	2E+3	7E-7	2E-9	---	---
39							
40	Gold-199						
41							
42	D, see ¹⁹³ Au	3E+3	9E+3	4E-6	1E-8	---	---
43	LLI						
44	(3E+3)	---	---	---	---	4E-5	4E-4
45	W, see ¹⁹³ Au	---	4E+3	2E-6	6E-9	---	---
46	Y, see ¹⁹³ Au	---	4E+3	2E-6	5E-9	---	---
47							
48	Gold-200m						
49							
50	D, see ¹⁹³ Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
51	W, see ¹⁹³ Au	---	3E+3	1E-6	4E-9	---	---
52	Y, see ¹⁹³ Au	---	2E+4	1E-6	3E-9	---	---
53							
54	Gold-200 ²						

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1							
2	D, see ^{193}Au	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
3	W, see ^{193}Au	---	8E+4	3E-5	1E-7	---	---
4	Y, see ^{193}Au	---	7E+4	3E-5	1E-7	---	---
5							
6	Gold-201 ²						
7							
8	D, see ^{193}Au	7E+4	2E+5	9E-5	3E-7	---	---
9		Stom					
10		(9E+4)	---	---	---	1E-3	1E-2
11	W, see ^{193}Au	---	2E+5	1E-4	3E-7	---	---
12	Y, see ^{193}Au	---	2E+5	9E-5	3E-7	---	---
13							
14	AN 80						
15	Mercury-193m						
16							
17	Vapor	---	8E+3	4E-6	1E-8	---	---
18							
19	Organic D	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
20							
21	D, sulfates	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
22							
23	W, oxides,						
24	hydroxides,						
25	halides, nitrates,						
26	and sulfides	---	8E+3	3E-6	1E-8	---	---
27							
28	Mercury-193						
29							
30	Vapor	---	3E+4	1E-5	4E-8	---	---
31	Organic ^{193}mHg	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
32	D, see ^{193}mHg	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
33	W, see ^{193}mHg	---	4E+4	2E-5	6E-8	---	---
34							
35	Mercury-194						
36							
37	Vapor	---	3E+1	1E-8	4E-11	---	---
38	Organic ^{193}mHg	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
39	D, see ^{193}mHg	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
40	W, see ^{193}mHg	---	1E+2	5E-8	2E-10	---	---
41							
42	Mercury-195m						
43							
44	Vapor	---	4E+3	2E-6	6E-9	---	---
45	Organic ^{193}mHg	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
46	D, see ^{193}mHg	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
47	W, see ^{193}mHg	---	4E+3	2E-6	5E-9	---	---
48							
49	Mercury-195						
50							
51	Vapor	---	3E+4	1E-5	4E-8	---	---
52	Organic ^{193}mHg	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
53	D, see ^{193}mHg	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
54	W, see ^{193}mHg	---	3E+4	1E-5	5E-8	---	---

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1							
2	Mercury-197m						
3							
4	Vapor	---	5E+3	2E-6	7E-9	---	---
5	Organic ^{193m} D ₃ Hg	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
6	D, see ^{193m} Hg	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
7	W, see ^{193m} Hg	---	5E+3	2E-6	7E-9	---	---
8							
9	Mercury-197						
10							
11	Vapor	---	8E+3	4E-6	1E-8	---	---
12	Organic ^{193m} D ₃ Hg	7E+3	1E+4	6E-6	2E-8	9E-5	9E-4
13	D, see ^{193m} Hg	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
14	W, see ^{193m} Hg	---	9E+3	4E-6	1E-8	---	---
15							
16	Mercury-199m ²						
17							
18	Vapor	---	8E+4	3E-5	1E-7	---	---
19	Organic D	6E+4	2E+5	7E-5	2E-7	---	---
20	Stom						
21	(1E+5)	---	---	---	---	1E-3	1E-2
22	D, see ^{193m} Hg	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
23	W, see ^{193m} Hg	---	2E+5	7E-5	2E-7	---	---
24							
25	Mercury-203						
26							
27	Vapor	---	8E+2	4E-7	1E-9	---	---
28	Organic ^{193m} D ₃ Hg	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
29	D, see ^{193m} Hg	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
30	W, see ^{193m} Hg	---	1E+3	5E-7	2E-9	---	---
31							
32	AN 81						
33	Thallium-194m ²						
34							
35	D, all compounds	5E+4	2E+5	6E-5	2E-7	---	---
36	Stom						
37	(7E+4)	---	---	---	---	1E-3	1E-2
38							
39	Thallium-194 ²						
40							
41	D, all compounds	3E+5	6E+5	2E-4	8E-7	---	---
42	Stom						
43	(3E+5)	---	---	---	---	4E-3	4E-2
44							
45	Thallium-195 ²						
46							
47	D, all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3
48							
49	Thallium-197						
50							
51	D, all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
52							
53	Thallium-198m ²						
54							

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1	D, all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-3
2							
3	Thallium-198						
4							
5	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
6							
7	Thallium-199						
8							
9	D, all compounds	6E+4	8E+4	4E-5	1E-7	9E-4	9E-3
10							
11	Thallium-200						
12							
13	D, all compounds	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
14							
15	Thallium-201						
16							
17	D, all compounds	2E+4	2E+4	9E-6	3E-8	2E-4	2E-3
18							
19	Thallium-202						
20							
21	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
22							
23	Thallium-204						
24							
25	D, all compounds	2E+3	2E+3	9E-7	3E-9	2E-5	2E-4
26							
27	AN 82						
28	Lead-195m ²						
29							
30	D, all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
31							
32	Lead-198						
33							
34	D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
35							
36	Lead-199 ²						
37							
38	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
39							
40	Lead-200						
41							
42	D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
43							
44	Lead-201						
45							
46	D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
47							
48	Lead-202m						
49							
50	D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
51							
52	Lead-202						
53							
54	D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5

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1							
2	Lead-203						
3							
4	D, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
5							
6	Lead-205						
7							
8	D, all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
9							
10	Lead-209						
11							
12	D, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
13							
14	Lead-210						
15							
16	D, all compounds	6E-1	2E-1	1E-10	---	---	---
17		Bone	Bone				
18		(1E+0)	(4E-1)	---	6E-13	1E-8	1E-7
19							
20	Lead-211 ²						
21							
22	D, all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3
23							
24	Lead-212						
25							
26	D, all compounds	8E+1	3E+1	1E-8	5E-11	---	---
27		Bone					
28		(1E+2)	---	---	---	2E-6	2E-5
29							
30	Lead-214 ²						
31							
32	D, all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3
33							
34	AN 83						
35	Bismuth-200 ²						
36							
37	D, nitrates	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
38	W, all other						
39	compounds	---	1E+5	4E-5	1E-7	---	---
40							
41	Bismuth-201 ²						
42							
43	D, see ²⁰⁰ Bi	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
44	W, see ²⁰⁰ Bi	---	4E+4	2E-5	5E-8	---	---
45							
46	Bismuth-202 ²						
47							
48	D, see ²⁰⁰ Bi	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
49	W, see ²⁰⁰ Bi	---	8E+4	3E-5	1E-7	---	---
50							
51	Bismuth-203						
52							
53	D, see ²⁰⁰ Bi	2E+3	7E+3	3E-6	9E-9	3E-5	3E-4
54	W, see ²⁰⁰ Bi	---	6E+3	3E-6	9E-9	---	---

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1							
2	Bismuth-205						
3							
4	D, see ²⁰⁰ Bi	1E+3	3E+3	1E-6	3E-9	2E-5	2E-4
5	W, see ²⁰⁰ Bi	---	1E+3	5E-7	2E-9	---	---
6							
7	Bismuth-206						
8							
9	D, see ²⁰⁰ Bi	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
10	W, see ²⁰⁰ Bi	---	9E+2	4E-7	1E-9	---	---
11							
12	Bismuth-207						
13							
14	D, see ²⁰⁰ Bi	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
15	W, see ²⁰⁰ Bi	---	4E+2	1E-7	5E-10	---	---
16							
17	Bismuth-210m						
18							
19	D, see ²⁰⁰ Bi	4E+1	5E+0	2E-9	---	---	---
20		Kid	Kid				
21		(6E+1)	(6E+0)	---	9E-12	8E-7	8E-6
22	W, see ²⁰⁰ Bi	---	7E-1	3E-10	9E-13	---	---
23							
24	Bismuth-210						
25							
26	D, see ²⁰⁰ Bi	8E+2	2E+2	1E-7	---	1E-5	1E-4
27			Kid				
28		---	(4E+2)	---	5E-10	---	---
29	W, see ²⁰⁰ Bi	---	3E+1	1E-8	4E-11	---	---
30							
31	Bismuth-212 ²						
32							
33	D, see ²⁰⁰ Bi	5E+3	2E+2	1E-7	3E-10	7E-5	7E-4
34	W, see ²⁰⁰ Bi	---	3E+2	1E-7	4E-10	---	---
35							
36	Bismuth-213 ²						
37							
38	D, see ²⁰⁰ Bi	7E+3	3E+2	1E-7	4E-10	1E-4	1E-3
39	W, see ²⁰⁰ Bi	---	4E+2	1E-7	5E-10	---	---
40							
41	Bismuth-214 ²						
42							
43	D, see ²⁰⁰ Bi	2E+4	8E+2	3E-7	1E-9	---	---
44		Stom					
45		(2E+4)	---	---	---	3E-4	3E-3
46	W, see ²⁰⁰ Bi	---	9E-2	4E-7	1E-9	---	---
47							
48	AN 84						
49	Polonium-203 ²						
50							
51	D, all compounds						
52	except those						
53	given for W	3E+4	6E+4	3E-5	9E-8	3E-4	3E-3
54							

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1	W, oxides,						
2	hydroxides,						
3	and nitrates	---	9E+4	4E-5	1E-7	---	---
4							
5	Polonium-205 ²						
6							
7	D, see ²⁰³ Po	2E+4	4E+4	2E-5	5E-8	3E-4	3E-3
8	W, see ²⁰³ Po	---	7E+4	3E-5	1E-7	---	---
9							
10	Polonium-207						
11							
12	D, see ²⁰³ Po	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
13	W, see ²⁰³ Po	---	3E+4	1E-5	4E-8	---	---
14							
15	Polonium-210						
16							
17	D, see ²⁰³ Po	3E+0	6E-1	3E-10	9E-13	4E-8	4E-7
18	W, see ²⁰³ Po	---	6E-1	3E-10	9E-13	---	---
19							
20	AN 85						
21	Astatine-207 ²						
22							
23	D, halides	6E+3	3E+3	1E-6	4E-9	8E-5	8E-4
24	W	---	2E+3	9E-7	3E-9	---	---
25							
26	Astatine-211						
27							
28	D, halides	1E+2	8E+1	3E-8	1E-10	2E-6	2E-5
29	W	---	5E+1	2E-8	8E-11	---	---
30							
31	AN 86						
32	Radon-220						
33							
34	With daughters						
35	removed	---	2E+4	7E-6	2E-8	---	---
36							
37	With daughters						
38	present	---	2E+1	9E-9	3E-11	---	---
39			(or 12	(or			
40			working	1.0			
41			level	working			
42			months)	level)			
43							
44	Radon-222						
45							
46	With daughters						
47	removed	---	1E+4	4E-6	1E-8	---	---
48							
49	With daughters						
50	present	---	1E+2	3E-8	1E-10	---	---
51			(or 4	(or			
52			working	0.33			
53			level	working)			
54			months)	level)			

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1							
2	AN 87						
3	Francium-222 ²						
4							
5	D, all compounds	2E+3	5E+2	2E-7	6E-10	3E-5	3E-4
6							
7	Francium-223 ²						
8							
9	D, all compounds	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
10							
11	AN 88						
12	Radium-223						
13							
14	W, all compounds	5E+0	7E-1	3E-10	9E-13	---	---
15	Bone						
16	(9E+0)	---	---	---	---	1E-7	1E-6
17							
18	Radium-224						
19							
20	W, all compounds	8E+0	2E+0	7E-10	2E-12	---	---
21	Bone						
22	(2E+1)	---	---	---	---	2E-7	2E-6
23							
24	Radium-225						
25							
26	W, all compounds	8E+0	7E-1	3E-10	9E-13	---	---
27	Bone						
28	(2E+1)	---	---	---	---	2E-7	2E-6
29							
30	Radium-226						
31							
32	W, all compounds	2E+0	6E-1	3E-10	9E-13	---	---
33	Bone						
34	(5E+0)	---	---	---	---	6E-8	6E-7
35							
36	Radium-227 ²						
37							
38	W, all compounds	2E+4	1E+4	6E-6	---	---	---
39	Bone		Bone				
40	(2E+4)	(2E+4)	---	---	3E-8	3E-4	3E-3
41							
42	Radium-228						
43							
44	W, all compounds	2E+0	1E+0	5E-10	2E-12	---	---
45	Bone						
46	(4E+0)	---	---	---	---	6E-8	6E-7
47							
48	AN 89						
49	Actinium-224						
50							
51	D, all compounds						
52	except those						
53	given for W and Y	2E+3	3E+1	1E-8	---	---	---
54	LLI	LLI	Bone				

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1		(2E+3)	(4E+1)	---	5E-11	3E-5	3E-4
2	W, halides and						
3	nitrates	---	5E+1	2E-8	7E-11	---	---
4							
5	Y, oxides and						
6	hydroxides	---	5E+1	2E-8	6E-11	---	---
7							
8	Actinium-225						
9							
10	D, see ²²⁴ Ac	5E+1	3E-1	1E-10	---	---	---
11		LLI	Bone				
12		(5E+1)	(5E-1)	---	7E-13	7E-7	7E-6
13	W, see ²²⁴ Ac	---	6E-1	3E-10	9E-13	---	---
14	Y, see ²²⁴ Ac	---	6E-1	3E-10	9E-13	---	---
15							
16	Actinium-226						
17							
18	D, see ²²⁴ Ac	1E+2	3E+0	1E-9	---	---	---
19		LLI	Bone				
20		(1E+2)	(4E+0)	---	5E-12	2E-6	2E-5
21	W, see ²²⁴ Ac	---	5E+0	2E-9	7E-12	---	---
22	Y, see ²²⁴ Ac	---	5E+0	2E-9	6E-12	---	---
23							
24	Actinium-227						
25							
26	D, see ²²⁴ Ac	2E-1	4E-4	2E-13	---	---	---
27		Bone	Bone				
28		(4E-1)	(8E-4)	---	1E-15	5E-9	5E-8
29	W, see ²²⁴ Ac	---	2E-3	7E-13	---	---	---
30			Bone				
31		---	(3E-3)	---	4E-15	---	---
32	Y, see ²²⁴ Ac	---	4E-3	2E-12	6E-15	---	---
33							
34	Actinium-228						
35							
36	D, see ²²⁴ Ac	2E+3	9E+0	4E-9	---	3E-5	3E-4
37			Bone				
38		---	(2E+1)	---	2E-11	---	---
39	W, see ²²⁴ Ac	---	4E+1	2E-8	---	---	---
40			Bone				
41		---	(6E+1)	---	8E-11	---	---
42	Y, see ²²⁴ Ac	---	4E+1	2E-8	6E-11	---	---
43							
44	AN 90						
45	Thorium-226 ²						
46							
47	W, all compounds						
48	except those						
49	given for Y	5E+3	2E+2	6E-8	2E-10	---	---
50		Stom					
51		(5E+3)	---	---	---	7E-5	7E-4
52	Y, oxides and						
53	hydroxides	---	1E+2	6E-8	2E-10	---	---
54							

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1	Thorium-227						
2							
3	W, see ^{226}Th	1E+2	3E-1	1E-10	5E-13	2E-6	2E-5
4	Y, see ^{226}Th	---	3E-1	1E-10	5E-13	---	---
5							
6	Thorium-228						
7							
8	W, see ^{226}Th	6E+0	1E-2	4E-12	---	---	---
9		Bone	Bone				
10		(1E+1)	(2E-2)	---	3E-14	2E-7	2E-6
11	Y, see ^{226}Th	---	2E-2	7E-12	2E-14	---	---
12							
13	Thorium-229						
14							
15	W, see ^{226}Th	6E-1	9E-4	4E-13	---	---	---
16		Bone	Bone				
17		(1E+0)	(2E-3)	---	3E-15	2E-8	2E-7
18	Y, see ^{226}Th	---	2E-3	1E-12	---	---	---
19			Bone				
20		---	(3E-3)	---	4E-15	---	---
21							
22	Thorium-230						
23							
24	W, see ^{226}Th	4E+0	6E-3	3E-12	---	---	---
25		Bone	Bone				
26		(9E+0)	(2E-2)	---	2E-14	1E-7	1E-6
27	Y, see ^{226}Th	---	2E-2	6E-12	---	---	---
28			Bone				
29		---	(2E-2)	---	3E-14	---	---
30							
31	Thorium-231						
32							
33	W, see ^{226}Th	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
34	Y, see ^{226}Th	---	6E+3	3E-6	9E-9	---	---
35							
36	Thorium-232						
37							
38	W, see ^{226}Th	7E-1	1E-3	5E-13	---	---	---
39		Bone	Bone				
40		(2E+0)	(3E-3)	---	4E-15	3E-8	3E-7
41	Y, see ^{226}Th	---	3E-3	1E-12	---	---	---
42			Bone				
43		---	(4E-3)	---	6E-15	---	---
44							
45	Thorium-234						
46							
47	W, see ^{226}Th	3E+2	2E+2	8E-8	3E-10	---	---
48		LLI					
49		(4E+2)	---	---	---	5E-6	5E-5
50	Y, see ^{226}Th	---	2E+2	6E-8	2E-10	---	---
51							
52	AN 91						
53	Protactinium-227 ²						
54							

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1	W, all compounds						
2	except those						
3	given for Y	4E+3	1E+2	5E-8	2E-10	5E-5	5E-4
4							
5	Y, oxides and						
6	hydroxides	---	1E+2	4E-8	1E-10	---	---
7							
8	Protactinium-228						
9							
10	W, see ²²⁷ Pa	1E+3	1E+1	5E-9	---	2E-5	2E-4
11			Bone				
12		---	(2E+1)	---	3E-11	---	---
13	Y, see ²²⁶ Pa	---	1E+1	5E-9	2E-11	---	---
14							
15	Protactinium-230						
16							
17	W, see ²²⁷ Pa	6E+2	5E+0	2E-9	7E-12	---	---
18		Bone					
19		(9E+2)	---	---	---	1E-5	1E-4
20	Y, see ²²⁷ Pa	---	4E+0	1E-9	5E-12	---	---
21							
22	Protactinium-231						
23							
24	W, see ²²⁷ Pa	2E-1	2E-3	6E-13	---	---	---
25		Bone	Bone				
26		(5E-1)	(4E-3)	---	6E-15	6E-9	6E-8
27	Y, see ²²⁷ Pa	---	4E-3	2E-12	---	---	---
28			Bone				
29		---	(6E-3)	---	8E-15	---	---
30							
31	Protactinium-232						
32							
33	W, see ²²⁷ Pa	1E+3	2E+1	9E-9	---	2E-5	2E-4
34			Bone				
35		---	(6E+1)	---	8E-11	---	---
36	Y, see ²²⁷ Pa	---	6E+1	2E-8	---	---	---
37			Bone				
38		---	(7E+1)	---	1E-10	---	---
39							
40	Protactinium-233						
41							
42	W, see ²²⁷ Pa	1E+3	7E+2	3E-7	1E-9	---	---
43		LLI					
44		(2E+3)	---	---	---	2E-5	2E-4
45	Y, see ²²⁷ Pa	---	6E+2	2E-7	8E-10	---	---
46							
47	Protactinium-234						
48							
49	W, see ²²⁷ Pa	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
50	Y, see ²²⁷ Pa	---	7E+3	3E-6	9E-9	---	---
51							
52	AN 92						
53	Uranium-230						
54							

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1	D, UF ₆ , UO ₂ F ₂ ,	4E+0	4E-1	2E-10	---	---	---
2	UO ₂ (NO ₃) ₂	Bone	Bone				
3		(6E+0)	(6E-1)	---	8E-13	8E-8	8E-7
4	W, UO ₃ , UF ₄ ,						
5	UCI ₄	---	4E-1	1E-10	5E-13	---	---
6	Y, UO ₂ , U ₃ O ₈	---	3E-1	1E-10	4E-13	---	---
7							
8							
9	Uranium-231						
10							
11	D, see ²³⁰ U	5E+3	8E+3	3E-6	1E-8	---	---
12		LLI					
13		(4E+3)	---	---	---	6E-5	6E-4
14	W, see ²³⁰ U	---	6E+3	2E-6	8E-9	---	---
15	Y, see ²³⁰ U	---	5E+3	2E-6	6E-9	---	---
16							
17	Uranium-232						
18							
19	D, see ²³⁰ U	2E+0	2E-1	9E-11	---	---	---
20		Bone	Bone				
21		(4E+0)	(4E-1)	---	6E-13	6E-8	6E-7
22	W, see ²³⁰ U	---	4E-1	2E-10	5E-13	---	---
23	Y, see ²³⁰ U	---	8E-3	3E-12	1E-14	---	---
24							
25	Uranium-233						
26							
27	D, see ²³⁰ U	1E+1	1E+0	5E-10	---	---	---
28		Bone	Bone				
29		(2E+1)	(2E+0)	---	3E-12	3E-7	3E-6
30	W, see ²³⁰ U	---	7E-1	3E-10	1E-12	---	---
31	Y, see ²³⁰ U	---	4E-2	2E-11	5E-14	---	---
32							
33	Uranium-234 ³						
34							
35	D, see ²³⁰ U	1E+1	1E+0	5E-10	---	---	---
36		Bone	Bone				
37		(2E+1)	(2E+0)	---	3E-12	3E-7	3E-6
38	W, see ²³⁰ U	---	7E-1	3E-10	1E-12	---	---
39	Y, see ²³⁰ U	---	4E-2	2E-11	5E-14	---	---
40							
41	Uranium-235 ³						
42							
43	D, see ²³⁰ U	1E+1	1E+0	6E-10	---	---	---
44		Bone	Bone				
45		(2E+1)	(2E+0)	---	3E-12	3E-7	3E-6
46	W, see ²³⁰ U	---	8E-1	3E-10	1E-12	---	---
47	Y, see ²³⁰ U	---	4E-2	2E-11	6E-14	---	---
48							
49	Uranium-236						
50							
51	D, see ²³⁰ U	1E+1	1E+0	5E-10	---	---	---
52		Bone	Bone				
53		(2E+1)	(2E+0)	---	3E-12	3E-7	3E-6
54	W, see ²³⁰ U	---	8E-1	3E-10	1E-12	---	---

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1	Y, see ²³⁰ U	---	4E-2	2E-11	6E-14	---	---
2							
3	Uranium-237						
4							
5	D, see ²³⁰ U	2E+3	3E+3	1E-6	4E-9	---	---
6		LLI					
7		(2E+3)	---	---	---	3E-5	3E-4
8	W, see ²³⁰ U	---	2E+3	7E-7	2E-9	---	---
9	Y, see ²³⁰ U	---	2E+3	6E-7	2E-9	---	---
10							
11	Uranium-238 ³						
12							
13	D, see ²³⁰ U	1E+1	1E+0	6E-10	---	---	---
14		Bone	Bone				
15		(2E+1)	(2E+0)	---	3E-12	3E-7	3E-6
16	W, see ²³⁰ U	---	8E-1	3E-10	1E-12	---	---
17	Y, see ²³⁰ U	---	4E-2	2E-11	6E-14	---	---
18							
19	Uranium-239 ²						
20							
21	D, see ²³⁰ U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
22	W, see ²³⁰ U	---	2E+5	7E-5	2E-7	---	---
23	Y, see ²³⁰ U	---	2E+5	6E-5	2E-7	---	---
24							
25	Uranium-240						
26							
27	D, see ²³⁰ U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
28	W, see ²³⁰ U	---	3E+3	1E-6	4E-9	---	---
29	Y, see ²³⁰ U	---	2E+3	1E-6	3E-9	---	---
30							
31	Uranium-natural ³						
32							
33	D, see ²³⁰ U	1E+1	1E+0	5E-10	---	---	---
34		Bone	Bone				
35		(2E+1)	(2E+0)	---	3E-12	3E-7	3E-6
36	W, see ²³⁰ U	---	8E-1	3E-10	9E-13	---	---
37	Y, see ²³⁰ U	---	5E-2	2E-11	9E-14	---	---
38							
39	AN 93						
40	Neptunium-232 ²						
41							
42	W, all compounds	1E+5	2E+3	7E-7	---	2E-3	2E-2
43			Bone				
44		---	(5E+2)	---	6E-9	---	---
45							
46	Neptunium-233 ²						
47							
48	W, all compounds	8E+5	3E+6	1E-3	4E-6	1E-2	1E-1
49							
50	Neptunium-234						
51							
52	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
53							
54	Neptunium-235						

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1							
2	W, all compounds	2E+4	8E+2	3E-7	---	---	---
3		LLI	Bone				
4		(2E+4)	(1E+3)	---	2E-9	3E-4	3E-3
5							
6	Neptunium-236						
7	(1.15E+5 y)						
8							
9	W, all compounds	3E+0	2E-2	9E-12	---	---	---
10		Bone	Bone				
11		(6E+0)	(5E-2)	---	8E-14	9E-8	9E-7
12							
13	Neptunium-236						
14	(22.5 h)						
15							
16	W, all compounds	3E+3	3E+1	1E-8	---	---	---
17		Bone	Bone				
18		(4E+3)	(7E+1)	---	1E-10	5E-5	5E-4
19							
20	Neptunium-237						
21							
22	W, all compounds	5E-1	4E-3	2E-12	---	---	---
23		Bone	Bone				
24		(1E+0)	(1E-2)	---	1E-14	2E-8	2E-7
25							
26	Neptunium-238						
27							
28	W, all compounds	1E+3	6E+1	3E-8	---	2E-5	2E-4
29			Bone				
30		---	(2E+2)	---	2E-10	---	---
31							
32	Neptunium-239						
33							
34	W, all compounds	2E+3	2E+3	9E-7	3E-9	---	---
35		LLI					
36		(2E+3)	---	---	---	2E-5	2E-4
37							
38	Neptunium-240 ²						
39							
40	W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
41							
42	AN 94						
43	Plutonium-234						
44							
45	W, all compounds						
46	except PuO ₂	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3
47							
48	Y, PuO ₂	---	2E+2	8E-8	3E-10	---	---
49							
50	Plutonium-235 ²						
51							
52	W, see ²³⁴ Pu	9E+5	3E+6	1E-3	4E-6	1E-2	1E-1
53	Y, see ²³⁴ Pu	---	3E+6	1E-3	3E-6	---	---
54							

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1	Plutonium-236						
2							
3	W, see ²³⁴ Pu	2E+0	2E-2	8E-12	---	---	---
4		Bone	Bone				
5		(4E+0)	(4E-2)	---	5E-14	6E-8	6E-7
6	Y, see ²³⁴ Pu	---	4E-2	2E-11	6E-14	---	---
7							
8	Plutonium-237						
9							
10	W, see ²³⁴ Pu	1E+4	3E+3	1E-6	5E-9	2E-4	2E-3
11	Y, see ²³⁴ Pu	---	3E+3	1E-6	4E-9	---	---
12							
13	Plutonium-238						
14							
15	W, see ²³⁴ Pu	9E-1	7E-3	3E-12	---	---	---
16		Bone	Bone				
17		(2E+0)	(1E-2)	---	2E-14	2E-8	2E-7
18	Y, see ²³⁴ Pu	---	2E-2	8E-12	2E-14	---	---
19							
20	Plutonium-239						
21							
22	W, see ²³⁴ Pu	8E-1	6E-3	3E-12	---	---	---
23		Bone	Bone				
24		(1E+0)	(1E-2)	---	2E-14	2E-8	2E-7
25	Y, see ²³⁴ Pu	---	2E-2	7E-12	---	---	---
26			Bone				
27		---	(2E-2)	---	2E-14	---	---
28							
29	Plutonium-240						
30							
31	W, see ²³⁴ Pu	8E-1	6E-3	3E-12	---	---	---
32		Bone	Bone				
33		(1E+0)	(1E-2)	---	2E-14	2E-8	2E-7
34	Y, see ²³⁴ Pu	---	2E-2	7E-12	---	---	---
35			Bone				
36		---	(2E-2)	---	2E-14	---	---
37							
38	Plutonium-241						
39							
40	W, see ²³⁴ Pu	4E+1	3E-1	1E-10	---	---	---
41		Bone	Bone				
42		(7E+1)	(6E-1)	---	8E-13	1E-6	1E-5
43	Y, see ²³⁴ Pu	---	8E-1	3E-10	---	---	---
44			Bone				
45		---	(1E+0)	---	1E-12	---	---
46							
47	Plutonium-242						
48							
49	W, see ²³⁴ Pu	8E-1	7E-3	3E-12	---	---	---
50		Bone	Bone				
51		(1E+0)	(1E-2)	---	2E-14	2E-8	2E-7
52	Y, see ²³⁴ Pu	---	2E-2	7E-12	---	---	---
53			Bone				
54		---	(2E-2)	---	2E-14	---	---

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1							
2	Plutonium-243						
3							
4	W, see ^{234}Pu	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
5	Y, see ^{234}Pu	---	4E+4	2E-5	5E-8	---	---
6							
7	Plutonium-244						
8							
9	W, see ^{234}Pu	8E-1	7E-3	3E-12	---	---	---
10		Bone	Bone				
11		(2E+0)	(1E-2)	---	2E-14	2E-8	2E-7
12	Y, see ^{234}Pu	---	2E-2	7E-12	---	---	---
13			Bone				
14		---	(2E-2)	---	2E-14	---	---
15							
16	Plutonium-245						
17							
18	W, see ^{234}Pu	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
19	Y, see ^{234}Pu	---	4E+3	2E-6	6E-9	---	---
20							
21	Plutonium-246						
22							
23	W, see ^{234}Pu	4E+2	3E+2	1E-7	4E-10	---	---
24		LLI					
25		(4E+2)	---	---	---	6E-6	6E-5
26	Y, see ^{234}Pu	---	3E+2	1E-7	4E-10	---	---
27							
28	AN 95						
29	Americium-237 ²						
30							
31	W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
32							
33	Americium-238 ²						
34							
35	W, all compounds	4E+4	3E+3	1E-6	---	5E-4	5E-3
36			Bone				
37		---	(6E+3)	---	9E-9	---	---
38							
39	Americium-239						
40							
41	W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
42							
43	Americium-240						
44							
45	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
46							
47	Americium-241						
48							
49	W, all compounds	8E-1	6E-3	3E-12	---	---	---
50		Bone	Bone				
51		(1E+0)	(1E-2)	---	2E-14	2E-8	2E-7
52							
53	Americium-242m						
54							

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1	W, all compounds	8E-1	6E-3	3E-12	---	---	---
2		Bone	Bone				
3		(1E+0)	(1E-2)	---	2E-14	2E-8	2E-7
4							
5	Americium-242						
6							
7	W, all compounds	4E+3	8E+1	4E-8	---	5E-5	5E-4
8			Bone				
9		---	(9E+1)	---	1E-10	---	---
10							
11	Americium-243						
12							
13	W, all compounds	8E-1	6E-3	3E-12	---	---	---
14		Bone	Bone				
15		(1E+0)	(1E-2)	---	2E-14	2E-8	2E-7
16							
17	Americium-244m ²						
18							
19	W, all compounds	6E+4	4E+3	2E-6	---	---	---
20		Stom	Bone				
21		(8E+4)	(7E+3)	---	1E-8	1E-3	1E-2
22							
23	Americium-244						
24							
25	W, all compounds	3E+3	2E+2	8E-8	---	4E-5	4E-4
26			Bone				
27		---	(3E+2)	---	4E-10	---	---
28							
29	Americium-245						
30							
31	W, all compounds	3E+4	8E+4	3E-5	1E-7	4E-4	4E-3
32							
33	Americium-246m ²						
34							
35	W, all compounds	5E+4	2E+5	8E-5	3E-7	---	---
36		Stom					
37		(6E+4)	---	---	---	8E-4	8E-3
38							
39	Americium-246 ²						
40							
41	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
42							
43	AN 96						
44	Curium-238						
45							
46	W, all compounds	2E+4	1E+3	5E-7	2E-9	2E-4	2E-3
47							
48	Curium-240						
49							
50	W, all compounds	6E+1	6E-1	2E-10	---	---	---
51		Bone	Bone				
52		(8E+1)	(6E-1)	---	9E-13	1E-6	1E-5
53							
54	Curium-241						

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1							
2	W, all compounds	1E+3	3E+1	1E-8	---	2E-5	2E-4
3			Bone				
4		---	(4E+1)	---	5E-11	---	---
5							
6	Curium-242						
7							
8	W, all compounds	3E+1	3E-1	1E-10	---	---	---
9		Bone	Bone				
10		(5E+1)	(3E-1)	---	4E-13	7E-7	7E-6
11							
12	Curium-243						
13							
14	W, all compounds	1E+0	9E-3	4E-12	---	---	---
15		Bone	Bone				
16		(2E+0)	(2E-2)	---	2E-14	3E-8	3E-7
17							
18	Curium-244						
19							
20	W, all compounds	1E+0	1E-2	5E-12	---	---	---
21		Bone	Bone				
22		(3E+0)	(2E-2)	---	3E-14	3E-8	3E-7
23							
24	Curium-245						
25							
26	W, all compounds	7E-1	6E-3	3E-12	---	---	---
27		Bone	Bone				
28		(1E+0)	(1E-2)	---	2E-14	2E-8	2E-7
29							
30	Curium-246						
31							
32	W, all compounds	7E-1	6E-3	3E-12	---	---	---
33		Bone	Bone				
34		(1E+0)	(1E-2)	---	2E-14	2E-8	2E-7
35							
36	Curium-247						
37							
38	W, all compounds	8E-1	6E-3	3E-12	---	---	---
39		Bone	Bone				
40		(1E+0)	(1E-2)	---	2E-14	2E-8	2E-7
41							
42	Curium-248						
43							
44	W, all compounds	2E-1	2E-3	7E-13	---	---	---
45		Bone	Bone				
46		(4E-1)	(3E-3)	---	4E-15	5E-9	5E-8
47							
48	Curium-249 ²						
49							
50	W, all compounds	5E+4	2E+4	7E-6	---	7E-4	7E-3
51			Bone				
52		---	(3E+4)	---	4E-8	---	---
53							
54	Curium-250						

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1							
2	W, all compounds	4E-2	3E-4	1E-13	---	---	---
3		Bone	Bone				
4		(6E-2)	(5E-4)	---	8E-16	9E-10	9E-9
5							
6	AN 97						
7	Berkelium-245						
8							
9	W, all compounds	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
10							
11	Berkelium-246						
12							
13	W, all compounds	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
14							
15	Berkelium-247						
16							
17	W, all compounds	5E-1	4E-3	2E-12	---	---	---
18		Bone	Bone				
19		(1E+0)	(9E-0)	---	1E-14	2E-8	2E-7
20							
21	Berkelium-249						
22							
23	W, all compounds	2E+2	2E+0	7E-10	---	---	---
24		Bone	Bone				
25		(5E+2)	(4E+0)	---	5E-12	6E-6	6E-5
26							
27	Berkelium-250						
28							
29	W, all compounds	9E+3	3E+2	1E-7	---	1E-4	1E-3
30			Bone				
31		---	(7E+2)	---	1E-9	---	---
32							
33	AN 98						
34	Californium-244 ²						
35							
36	W, all compounds						
37	except those						
38	given for Y	3E+4	6E+2	2E-7	8E-10	---	---
39		Stom					
40		(3E+4)	---	---	---	4E-4	4E-3
41	Y, oxides and						
42	hydroxides	---	6E+2	2E-7	8E-10	---	---
43							
44	Californium-246						
45							
46	W, see ²⁴⁴ Cf	4E+2	9E+0	4E-9	1E-11	5E-6	5E-5
47	Y, see ²⁴⁴ Cf	---	9E+0	4E-9	1E-11	---	---
48							
49	Californium-248						
50							
51	W, see ²⁴⁴ Cf	8E+0	6E-2	3E-11	--	---	---
52		Bone	Bone				
53		(2E+1)	(1E-1)	---	2E-13	2E-7	2E-6
54	Y, see ²⁴⁴ Cf	---	1E-1	4E-11	1E-13	---	---

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1							
2	Californium-249						
3							
4	W, see ²⁴⁴ Cf	5E-1	4E-3	24E-12	--	---	---
5		Bone	Bone				
6		(1E+0)	(9E-3)	---	1E-14	2E-8	2E-7
7	Y, see ²⁴⁴ Cf	---	1E-2	4E-12	---	---	---
8			Bone				
9		---	(1E-2)	---	2E-14	---	---
10							
11	Californium-250						
12							
13	W, see ²⁴⁴ Cf	1E+0	9E-3	4E-12	--	---	---
14		Bone	Bone				
15		(2E+0)	(2E-2)	---	3E-14	3E-8	3E-7
16	Y, see ²⁴⁴ Cf	---	3E-2	1E-11	4E-14	---	---
17							
18	Californium-251						
19							
20	W, see ²⁴⁴ Cf	5E-1	4E-3	2E-12	---	---	---
21		Bone	Bone				
22		(1E+0)	(9E-3)	---	1E-14	2E-8	2E-7
23	Y, see ²⁴⁴ Cf	---	1E-2	4E-12	---	---	---
24			Bone				
25		---	(1E-2)	---	2E-14	---	---
26							
27	Californium-252						
28							
29	W, see ²⁴⁴ Cf	2E+0	2E-2	8E-12	--	---	---
30		Bone	Bone				
31		(5E+0)	(4E-2)	---	5E-14	7E-8	7E-7
32	Y, see ²⁴⁴ Cf	---	3E-2	1E-11	5E-14	---	---
33							
34	Californium-253						
35							
36	W, see ²⁴⁴ Cf	2E+2	2E+0	8E-10	3E-12	---	---
37		Bone					
38		(4E+2)	---	---	---	5E-6	5E-5
39	Y, see ²⁴⁴ Cf	---	2E+0	7E-10	2E-12	---	---
40							
41	Californium-254						
42							
43	W, see ²⁴⁴ Cf	2E+0	2E-2	9E-12	3E-14	3E-8	3E-7
44	Y, see ²⁴⁴ Cf	---	2E-2	7E-12	2E-14	---	---
45							
46	AN 99						
47	Einsteinium-250						
48							
49	W, all compounds	4E+4	5E+2	2E-7	---	6E-4	6E-3
50			Bone				
51		---	(1E+3)	---	2E-9	---	---
52							
53	Einsteinium-251						
54							

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1	W, all compounds	7E+3	9E+2	4E-7	---	1E-4	1E-3
2			Bone				
3		---	(1E+3)	---	2E-9	---	---
4							
5	Einsteinium-253						
6							
7	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5
8							
9	Einsteinium-254m						
10							
11	W, all compounds	3E+2	1E+1	4E-9	1E-11	---	---
12		LLI					
13		(3E+2)	---	---	---	4E-6	4E-5
14							
15	Einsteinium-254						
16							
17	W, all compounds	8E+0	7E-2	3E-11	---	---	---
18		Bone	Bone				
19		(2E+1)	(1E-1)	---	2E-13	2E-7	2E-6
20							
21	AN 100						
22	Fermium-252						
23							
24	W, all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
25							
26	Fermium-253						
27							
28	W, all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
29							
30	Fermium-254						
31							
32	W, all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
33							
34	Fermium-255						
35							
36	W, all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
37							
38	Fermium-257						
39							
40	W, all compounds	2E+1	2E-1	7E-11	---	---	---
41		Bone	Bone				
42		(4E+1)	(2E-1)	---	3E-13	5E-7	5E-6
43							
44	AN 101						
45	Mendelevium-257						
46							
47	W, all compounds	7E+3	8E+1	4E-8	---	1E-4	1E-3
48			Bone				
49		---	(9E+1)	---	1E-10	---	---
50							
51	Mendelevium-258						
52							
53	W, all compounds	3E+1	2E-1	1E-10	---	---	---
54		Bone	Bone				

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1		(5E+1)	(3E-1)	---	5E-13	6E-7	6E-6
2							
3	---Any single						
4	radionuclide not						
5	listed above with						
6	decay mode other						
7	than alpha emission						
8	or spontaneous						
9	fission and with						
10	radioactive half-						
11	life less than						
12	2 hours						
13							
14	Submersion ¹	---	2E+2	1E-7	1E-9	---	---
15							
16	---Any single						
17	radionuclide not						
18	listed above with						
19	decay mode other						
20	than alpha emission						
21	or spontaneous						
22	fission and with						
23	radioactive half-						
24	life greater than 2						
25	hours	---	2E-1	1E-10	1E-12	1E-8	1E-7
26							
27	---Any single						
28	radionuclide not						
29	listed above that						
30	decays by alpha						
31	emission or						
32	spontaneous fission						
33	or any mixture						
34	for which either						
35	the identity or the						
36	concentration of						
37	any radionuclide						
38	in the mixture						
39	is not known	---	4E-4	2E-13	1E-15	2E-9	2E-8
40							

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 $1\text{E-}7$ $\mu\text{Ci/ml}$ 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 $8\text{E-}3$ (SA) $\mu\text{Ci-hr/ml}$, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is $6.77\text{E-}7$ curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, is:

SA = $3.6\text{E-}7$ curies/gram U U-depleted

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

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

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

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1 Radionuclide	1	2	3	1	2
2 and Class					
3					
4 If it is known that					
5 Ac-227-D and					
6 Cm-250-W are not					
7 present	---	7E-4	3E-13	---	---
8					
9 If, in addition,					
10 it is known that					
11 Ac-227-W, Y;					
12 Th-229-W, Y;					
13 Th-230-W; Th-232-W,					
14 Y; Pa-231-W, Y;					
15 Np-237-W; Pu-239-W;					
16 Pu-240-W; Pu-242-W;					
17 Am-241-W; Am-242m-W;					
18 Am-243-W; Cm-245-W;					
19 Cm-246-W; Cm-247-W;					
20 Cm-248-W; Bk-247-W;					
21 Cf-249-W; and					
22 Cf-251-W are not					
23 present	---	7E-3	3E-12	---	---
24					
25 If, in addition,					
26 it is known that					
27 Sm-146-W; Sm-147-W;					
28 Gd-148-D, W;					
29 Gd-152-D, W;					
30 Th-228-W, Y;					
31 Th-230-Y; U-232-Y;					
32 U-233-Y; U-234-Y;					
33 U-235-Y; U-236-Y;					
34 U-238-Y; Np-236-W;					
35 Pu-236-W, Y;					
36 Pu-238-W, Y;					
37 Pu-239-Y; Pu-240-Y;					
38 Pu-242-Y; Pu-244-W, Y;					
39 Cm-243-W; Cm-244-W;					
40 Cf-248-W; Cf-249-Y;					
41 Cf-250-W, Y;					
42 Cf-251-Y; Cf-252-W,					
43 Y; and Cf-254-W, Y					
44 are not present	---	7E-2	3E-11	---	---
45					
46 If, in addition,					
47 it is known that					
48 Pb-210-D; Bi-210m-W;					
49 Po-210-D, W;					
50 Ra-223-W; Ra-225-W;					
51 Ra-226-W; Ac-225-D,					
52 W, Y; Th-227-W, Y;					
53 U-230-D, W, Y;					

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1 U-232-D, W; Pu-241-W;
2 Cm-240-W; Cm-242-W;
3 Cf-248-Y; Es-254-W;
4 Fm-257-W; and
5 Md-258-W are not
6 present --- 7E-1 3E-10 --- --- ---
7
8 If, in addition,
9 it is known that
10 Si-32-Y; Ti-44-Y;
11 Fe-60-D; Sr-90-Y;
12 Zr-93-D; Cd-113m-D;
13 Cd-113-D; In-115-D,
14 W; La-138-D;
15 Lu-176-W; Hf-178m-D,
16 W; Hf-182-D, W;
17 Bi-210m-D; Ra-224-W;
18 Ra-228-W; Ac-226-D,
19 W, Y; Pa-230-W,
20 Y; U-233-D, W;
21 U-234-D, W;
22 U-235-D, W;
23 U-236-D, W;
24 U-238-D, W;
25 Pu-241-Y; Bk-249-W;
26 Cf-253-W, Y; and
27 Es-253-W are not
28 present --- 7E-0 3E-9 --- --- ---
29
30 If it is known
31 that Ac-227-D, W,
32 Y; Th-229-W, Y;
33 Th-232-W, Y; Pa-231-W,
34 Y; Cm-248-W; and
35 Cm-250-W are not
36 present --- --- --- 1E-14 --- ---
37
38 If, in addition,
39 it is known that
40 Sm-146-W; Gd-148-D, W;
41 Gd-152-D; Th-228-W,
42 Y; Th-230-W, Y;
43 U-232-Y; U-233-Y;
44 U-234-Y; U-235-Y;
45 U-236-Y; U-238-Y;
46 U-Nat-Y; Np-236-W;
47 Np-237-W; Pu-236-W,
48 Y; Pu-238-W, Y;
49 Pu-239-W, Y;
50 Pu-240-W, Y;
51 Pu-242-W, Y;
52 Pu-244-W, Y;
53 Am-241-W; Am-242m-W;
54 Am-243-W; Cm-243-W;

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1	Cm-244-W; Cm-245-W;						
2	Cm-246-W; Cm-247-W;						
3	Bk-247-W; Cf-249-W,						
4	Y; Cf-250-W, Y;						
5	Cf-251-W, Y;						
6	Cf-252-W, Y; and						
7	Cf-254-W, Y are						
8	not present	---	---	---	1E-13	---	---
9							
10	If, in addition,						
11	it is known that						
12	Sm-147-W; Gd-152-W;						
13	Pb-210-D; Bi-210m-W;						
14	Po-210-D, W;						
15	Ra-223-W; Ra-225-W;						
16	Ra-226-W; Ac-225-D,						
17	W, Y; Th-227-W, Y;						
18	U-230-D, W, Y;						
19	U-232-D, W; U-Nat-W;						
20	Pu-241-W;						
21	Cm-240-W; Cf-242-W;						
22	Cf-248-W, Y;						
23	Es-254-W; Fm-257-W;						
24	and Md-258-W are						
25	not present	---	---	---	1E-12	---	---
26							
27	If, in addition,						
28	it is known that						
29	Fe-60; Sr-90;						
30	Cd-113m; Cd-113;						
31	In-115; I-129;						
32	Cs-134; Sm-145;						
33	Sm-147; Gd-148;						
34	Gd-152;						
35	Hg-194 (organic);						
36	Bi-210m; Ra-223;						
37	Ra-224; Ra-225;						
38	Ac-225; Th-228;						
39	Th-230; U-233;						
40	U-234; U-235;						
41	U-236; U-238;						
42	U-Nat; Cm-242;						
43	Cf-248; Es-254;						
44	Fm-257; and						
45	Md-258 are not						
46	present	---	---	---	---	1E-6	1E-5
47							

48 C. If a mixture of radionuclides consists of uranium
49 and its daughters in ore dust (10 µm AMAD particle distribution
50 assumed) prior to chemical separation of the uranium from the

1 ore, the following values may be used for the DAC of the
 2 mixture: 6E-11 μ Ci of gross alpha activity from uranium-238,
 3 uranium-234, thorium-230, and radium-226 per milliliter of air;
 4 3E-11 μ Ci of natural uranium per milliliter of air; or 45
 5 micrograms of natural uranium per cubic meter of air.

6 D. If the identity and concentration of each
 7 radionuclide in a mixture are known, the limiting values should
 8 be derived as follows: determine, for each radionuclide in the
 9 mixture, the ratio between the concentration present in the
 10 mixture and the concentration otherwise established in this part
 11 for the specific radionuclide when not in a mixture. The sum of
 12 such ratios for all of the ~~radionuclides~~ radionuclides in the
 13 mixture may not exceed one.

14 Example: If radionuclides A, B, and C are present in
 15 concentrations C_A , C_B , C_C , and if the applicable DACs are DAC_A ,
 16 DAC_B , and DAC_C , respectively, then the concentrations shall be
 17 limited so that the following relationship exists:

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC_B} + \frac{C_C}{DAC_C} < 1$$

21 4731.2800 QUANTITIES OF LICENSED MATERIAL REQUIRING LABELING.

22 Subpart 1. Explanation. The quantities listed in subpart
 23 3 were derived by taking one-tenth of the most restrictive ALI
 24 listed in part 4731.2750, subpart 7, Table 1, columns 1 and 2,
 25 rounding to the nearest factor of ten, and arbitrarily
 26 constraining the values listed between 0.001 and 1,000 μ Ci.
 27 Values of 100 μ Ci have been assigned for radionuclides having a
 28 radioactive half-life in excess of 10^9 years (except rhenium,

1 1,000 μCi) to take into account their low specific activity.

2 Subp. 2. Combination of radionuclides. For purposes of
3 parts 4731.2310, subpart 5; 4731.2340, item A; and 4731.2600,
4 subpart 1, where there is involved a combination of
5 radionuclides in known amounts, the limit for the combination
6 should be derived as follows: determine, for each radionuclide
7 in the combination, the ratio between the quantity present in
8 the combination and the limit otherwise established for the
9 specific radionuclide when not in combination. The sum of such
10 ratios for all radionuclides in the combination may not exceed
11 one.

12 Subp. 3. Quantities requiring labeling.

13 A. The following quantities of licensed material
14 require labeling:

15 Radionuclide	16 Abbreviation	17 Quantity (μCi)
18 Hydrogen-3	19 H-3	20 1,000
21 Beryllium-7	22 Be-7	23 1,000
24 Beryllium-10	25 Be-10	26 1
27 Carbon-11	28 C-11	29 1,000
30 Carbon-14	31 C-14	32 100
33 Fluorine-18	34 F-18	35 1,000
36 Sodium-22	37 Na-22	38 10
39 Sodium-24	40 Na-24	100
41 Magnesium-28	Mg-28	100
42 Aluminum-26	Al-26	10
43 Silicon-31	Si-31	1,000
44 Silicon-32	Si-32	1
45 Phosphorus-32	P-32	10
46 Phosphorus-33	P-33	100

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1	Sulfur-35	S-35	100
2			
3	Chlorine-36	Cl-36	10
4	Chlorine-38	Cl-38	1,000
5	Chlorine-39	Cl-39	1,000
6			
7	Argon-39	Ar-39	1,000
8	Argon-41	Ar-41	1,000
9			
10	Potassium-40	K-40	100
11	Potassium-42	K-42	1,000
12	Potassium-43	K-43	1,000
13	Potassium-44	K-44	1,000
14	Potassium-45	K-45	1,000
15			
16	Calcium-41	Ca-41	100
17	Calcium-45	Ca-45	100
18	Calcium-47	Ca-47	100
19			
20	Scandium-43	Sc-43	1,000
21	Scandium-44m	Sc-44m	100
22	Scandium-44	Sc-44	100
23	Scandium-46	Sc-46	10
24	Scandium-47	Sc-47	100
25	Scandium-48	Sc-48	100
26	Scandium-49	Sc-49	1,000
27			
28	Titanium-44	Ti-44	1
29	Titanium-45	Ti-45	1,000
30			
31	Vanadium-47	V-47	1,000
32	Vanadium-48	V-48	100
33	Vanadium-49	V-49	1,000
34			
35	Chromium-48	Cr-48	1,000
36	Chromium-49	Cr-49	1,000
37	Chromium-51	Cr-51	1,000
38			
39	Manganese-51	Mn-51	1,000
40	Manganese-52m	Mn-52m	1,000
41	Manganese-52	Mn-52	100
42	Manganese-53	Mn-53	1,000
43	Manganese-54	Mn-54	100
44	Manganese-56	Mn-56	1,000
45			
46	Iron-52	Fe-52	100
47	Iron-55	Fe-55	100
48	Iron-59	Fe-59	10
49	Iron-60	Fe-60	1
50			
51	Cobalt-55	Co-55	100
52	Cobalt-56	Co-56	10
53	Cobalt-57	Co-57	100
54	Cobalt-58m	Co-58m	1,000

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1	Cobalt-58	Co-58	100
2	Cobalt-60m	Co-60m	1,000
3	Cobalt-60	Co-60	1
4	Cobalt-61	Co-61	1,000
5	Cobalt-62m	Co-62m	1,000
6			
7	Nickel-56	Ni-56	100
8	Nickel-57	Ni-57	100
9	Nickel-59	Ni-59	100
10	Nickel-63	Ni-63	100
11	Nickel-65	Ni-65	1,000
12	Nickel-66	Ni-66	10
13			
14	Copper-60	Cu-60	1,000
15	Copper-61	Cu-61	1,000
16	Copper-64	Cu-64	1,000
17	Copper-67	Cu-67	1,000
18			
19	Zinc-62	Zn-62	100
20	Zinc-63	Zn-63	1,000
21	Zinc-65	Zn-65	10
22	Zinc-69m	Zn-69m	100
23	Zinc-69	Zn-69	1,000
24	Zinc-71m	Zn-71m	1,000
25	Zinc-72	Zn-72	100
26			
27	Gallium-65	Ga-65	1,000
28	Gallium-66	Ga-66	100
29	Gallium-67	Ga-67	1,000
30	Gallium-68	Ga-68	1,000
31	Gallium-70	Ga-70	1,000
32	Gallium-72	Ga-72	100
33	Gallium-73	Ga-73	1,000
34			
35	Germanium-66	Ge-66	1,000
36	Germanium-67	Ge-67	1,000
37	Germanium-68	Ge-68	10
38	Germanium-69	Ge-69	1,000
39	Germanium-71	Ge-71	1,000
40	Germanium-75	Ge-75	1,000
41	Germanium-77	Ge-77	1,000
42	Germanium-78	Ge-78	1,000
43			
44	Arsenic-69	As-69	1,000
45	Arsenic-70	As-70	1,000
46	Arsenic-71	As-71	100
47	Arsenic-72	As-72	100
48	Arsenic-73	As-73	100
49	Arsenic-74	As-74	100
50	Arsenic-76	As-76	100
51	Arsenic-77	As-77	100
52	Arsenic-78	As-78	1,000
53			
54	Selenium-70	Se-70	1,000

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1	Selenium-73m	Se-73m	1,000
2	Selenium-73	Se-73	100
3	Selenium-75	Se-75	100
4	Selenium-79	Se-79	100
5	Selenium-81m	Se-81m	1,000
6	Selenium-81	Se-81	1,000
7	Selenium-83	Se-83	1,000
8			
9	Bromine-74m	Br-74m	1,000
10	Bromine-74	Br-74	1,000
11	Bromine-75	Br-75	1,000
12	Bromine-76	Br-76	100
13	Bromine-77	Br-77	1,000
14	Bromine-80m	Br-80m	1,000
15	Bromine-80	Br-80	1,000
16	Bromine-82	Br-82	100
17	Bromine-83	Br-83	1,000
18	Bromine-84	Br-84	1,000
19			
20	Krypton-74	Kr-74	1,000
21	Krypton-76	Kr-76	1,000
22	Krypton-77	Kr-77	1,000
23	Krypton-79	Kr-79	1,000
24	Krypton-81	Kr-81	1,000
25	Krypton-83m	Kr-83m	1,000
26	Krypton-85m	Kr-85m	1,000
27	Krypton-85	Kr-85	1,000
28	Krypton-87	Kr-87	1,000
29	Krypton-88	Kr-88	1,000
30			
31	Rubidium-79	Rb-79	1,000
32	Rubidium-81m	Rb-81m	1,000
33	Rubidium-81	Rb-81	1,000
34	Rubidium-82m	Rb-82m	1,000
35	Rubidium-83	Rb-83	100
36	Rubidium-84	Rb-84	100
37	Rubidium-86	Rb-86	100
38	Rubidium-87	Rb-87	100
39	Rubidium-88	Rb-88	1,000
40	Rubidium-89	Rb-89	1,000
41			
42	Strontium-80	Sr-80	100
43	Strontium-81	Sr-81	1,000
44	Strontium-83	Sr-83	100
45	Strontium-85m	Sr-85m	1,000
46	Strontium-85	Sr-85	100
47	Strontium-87m	Sr-87m	1,000
48	Strontium-89	Sr-89	10
49	Strontium-90	Sr-90	0.1
50	Strontium-91	Sr-91	100
51	Strontium-92	Sr-92	100
52			
53	Yttrium-86m	Y-86m	1,000
54	Yttrium-86	Y-86	100

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1	Yttrium-87	Y-87	100
2	Yttrium-88	Y-88	10
3	Yttrium-90m	Y-90m	1,000
4	Yttrium-90	Y-90	10
5	Yttrium-91m	Y-91m	1,000
6	Yttrium-91	Y-91	10
7	Yttrium-92	Y-92	100
8	Yttrium-93	Y-93	100
9	Yttrium-94	Y-94	1,000
10	Yttrium-95	Y-95	1,000
11			
12	Zirconium-86	Zr-86	100
13	Zirconium-88	Zr-88	10
14	Zirconium-89	Zr-89	100
15	Zirconium-93	Zr-93	1
16	Zirconium-95	Zr-95	10
17	Zirconium-97	Zr-97	100
18			
19	Niobium-88	Nb-88	1,000
20	Niobium-89m (66 min)	Nb-89m	1,000
21	Niobium-89 (122 min)	Nb-89	1,000
22	Niobium-89	Nb-89	1,000
23	Niobium-90	Nb-90	100
24	Niobium-93m	Nb-93m	10
25	Niobium-94	Nb-94	1
26	Niobium-95m	Nb-95m	100
27	Niobium-95	Nb-95	100
28	Niobium-96	Nb-96	100
29	Niobium-97	Nb-97	1,000
30	Niobium-98	Nb-98	1,000
31			
32	Molybdenum-90	Mo-90	100
33	Molybdenum-93m	Mo-93m	100
34	Molybdenum-93	Mo-93	10
35	Molybdenum-99	Mo-99	100
36	Molybdenum-101	Mo-101	1,000
37			
38	Technetium-93m	Tc-93m	1,000
39	Technetium-93	Tc-93	1,000
40	Technetium-94m	Tc-94m	1,000
41	Technetium-94	Tc-94	1,000
42	Technetium-96m	Tc-96m	1,000
43	Technetium-96	Tc-96	100
44	Technetium-97m	Tc-97m	100
45	Technetium-97	Tc-97	1,000
46	Technetium-98	Tc-98	10
47	Technetium-99m	Tc-99m	1,000
48	Technetium-99	Tc-99	100
49	Technetium-101	Tc-101	1,000
50	Technetium-104	Tc-104	1,000
51			
52	Ruthenium-94	Ru-94	1,000
53	Ruthenium-97	Ru-97	1,000
54	Ruthenium-103	Ru-103	100

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1	Ruthenium-105	Ru-105	1,000
2	Ruthenium-106	Ru-106	1
3			
4	Rhodium-99m	Rh-99m	1,000
5	Rhodium-99	Rh-99	100
6	Rhodium-100	Rh-100	100
7	Rhodium-101m	Rh-101m	1,000
8	Rhodium-101	Rh-101	10
9	Rhodium-102m	Rh-102m	10
10	Rhodium-102	Rh-102	10
11	Rhodium-103m	Rh-103m	1,000
12	Rhodium-105	Rh-105	100
13	Rhodium-106m	Rh-106m	1,000
14	Rhodium-107	Rh-107	1,000
15			
16	Palladium-100	Pd-100	100
17	Palladium-101	Pd-101	1,000
18	Palladium-103	Pd-103	100
19	Palladium-107	Pd-107	10
20	Palladium-109	Pd-109	100
21			
22	Silver-102	Ag-102	1,000
23	Silver-103	Ag-103	1,000
24	Silver-104m	Ag-104m	1,000
25	Silver-104	Ag-104	1,000
26	Silver-105	Ag-105	100
27	Silver-106m	Ag-106m	100
28	Silver-106	Ag-106	1,000
29	Silver-108m	Ag-108m	1
30	Silver-110m	Ag-110m	10
31	Silver-111	Ag-111	100
32	Silver-112	Ag-112	100
33	Silver-115	Ag-115	1,000
34			
35	Cadmium-104	Cd-104	1,000
36	Cadmium-107	Cd-107	1,000
37	Cadmium-109	Cd-109	1
38	Cadmium-113m	Cd-113m	0.1
39	Cadmium-113	Cd-113	100
40	Cadmium-115m	Cd-115m	10
41	Cadmium-115	Cd-115	100
42	Cadmium-117m	Cd-117m	1,000
43	Cadmium-117	Cd-117	1,000
44			
45	Indium-109	In-109	1,000
46	Indium-110 (69.1 min)	In-110	1,000
47	Indium-110 (4.9h)	In-110	1,000
48	Indium-111	In-111	100
49	Indium-112	In-112	1,000
50	Indium-113m	In-113m	1,000
51	Indium-114m	In-114m	10
52	Indium-115m	In-115m	1,000
53	Indium-115	In-115	100
54	Indium-116m	In-116m	1,000

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1	Indium-117m	In-117m	1,000
2	Indium-117	In-117	1,000
3	Indium-119m	In-119m	1,000
4			
5	Tin-110	Sn-110	100
6	Tin-111	Sn-111	1,000
7	Tin-113	Sn-113	100
8	Tin-117m	Sn-117m	100
9	Tin-119m	Sn-119m	100
10	Tin-121m	Sn-121m	100
11	Tin-121	Sn-121	1,000
12	Tin-123m	Sn-123m	1,000
13	Tin-123	Sn-123	10
14	Tin-125	Sn-125	10
15	Tin-126	Sn-126	10
16	Tin-127	Sn-127	1,000
17	Tin-128	Sn-128	1,000
18			
19	Antimony-115	Sb-115	1,000
20	Antimony-116m	Sb-116m	1,000
21	Antimony-116	Sb-116	1,000
22	Antimony-117	Sb-117	1,000
23	Antimony-118m	Sb-118m	1,000
24	Antimony-119	Sb-119	1,000
25	Antimony-120 (16 min)	Sb-120	1,000
26	Antimony-120 (5.76d)	Sb-120	100
27	Antimony-122	Sb-122	100
28	Antimony-124m	Sb-124m	1,000
29	Antimony-124	Sb-124	10
30	Antimony-125	Sb-125	100
31	Antimony-126m	Sb-126m	1,000
32	Antimony-126	Sb-126	100
33	Antimony-127	Sb-127	100
34	Antimony-128 (10.4 min)	Sb-128	1,000
35	Antimony-128 (9.01h)	Sb-128	100
36	Antimony-129	Sb-129	100
37	Antimony-130	Sb-130	1,000
38	Antimony-131	Sb-131	1,000
39			
40	Tellurium-116	Te-116	1,000
41	Tellurium-121m	Te-121m	10
42	Tellurium-121	Te-121	100
43	Tellurium-123m	Te-123m	10
44	Tellurium-123	Te-123	100
45	Tellurium-125m	Te-125m	10
46	Tellurium-127m	Te-127m	10
47	Tellurium-127	Te-127	1,000
48	Tellurium-129m	Te-129m	10
49	Tellurium-129	Te-129	1,000
50	Tellurium-131m	Te-131m	10
51	Tellurium-131	Te-131	100
52	Tellurium-132	Te-132	10
53	Tellurium-133m	Te-133m	100
54	Tellurium-133	Te-133	1,000

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1	Tellurium-134	Te-134	1,000
2			
3	Iodine-120m	I-120m	1,000
4	Iodine-120	I-120	100
5	Iodine-121	I-121	1,000
6	Iodine-123	I-123	100
7	Iodine-124	I-124	10
8	Iodine-125	I-125	1
9	Iodine-126	I-126	1
10	Iodine-128	I-128	1,000
11	Iodine-129	I-129	1
12	Iodine-130	I-130	10
13	Iodine-131	I-131	1
14	Iodine-132m	I-132m	100
15	Iodine-132	I-132	100
16	Iodine-133	I-133	10
17	Iodine-134	I-134	1,000
18	Iodine-135	I-135	100
19			
20	Xenon-120	Xe-120	1,000
21	Xenon-121	Xe-121	1,000
22	Xenon-122	Xe-122	1,000
23	Xenon-123	Xe-123	1,000
24	Xenon-125	Xe-125	1,000
25	Xenon-127	Xe-127	1,000
26	Xenon-129m	Xe-129m	1,000
27	Xenon-131m	Xe-131m	1,000
28	Xenon-133m	Xe-133m	1,000
29	Xenon-133	Xe-133	1,000
30	Xenon-135m	Xe-135m	1,000
31	Xenon-135	Xe-135	1,000
32	Xenon-138	Xe-138	1,000
33			
34	Cesium-125	Cs-125	1,000
35	Cesium-127	Cs-127	1,000
36	Cesium-129	Cs-129	1,000
37	Cesium-130	Cs-130	1,000
38	Cesium-131	Cs-131	1,000
39	Cesium-132	Cs-132	100
40	Cesium-134m	Cs-134m	1,000
41	Cesium-134	Cs-134	10
42	Cesium-135m	Cs-135m	1,000
43	Cesium-135	Cs-135	100
44	Cesium-136	Cs-136	10
45	Cesium-137	Cs-137	10
46	Cesium-138	Cs-138	1,000
47			
48	Barium-126	Ba-126	1,000
49	Barium-128	Ba-128	100
50	Barium-131m	Ba-131m	1,000
51	Barium-131	Ba-131	100
52	Barium-133m	Ba-133m	100
53	Barium-133	Ba-133	100
54	Barium-135m	Ba-135m	100

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1	Barium-139	Ba-139	1,000
2	Barium-140	Ba-140	100
3	Barium-141	Ba-141	1,000
4	Barium-142	Ba-142	1,000
5			
6	Lanthanum-131	La-131	1,000
7	Lanthanum-132	La-132	100
8	Lanthanum-135	La-135	1,000
9	Lanthanum-137	La-137	10
10	Lanthanum-138	La-138	100
11	Lanthanum-140	La-140	100
12	Lanthanum-141	La-141	100
13	Lanthanum-142	La-142	1,000
14	Lanthanum-143	La-143	1,000
15			
16	Cerium-134	Ce-134	100
17	Cerium-135	Ce-135	100
18	Cerium-137m	Ce-137m	100
19	Cerium-137	Ce-137	1,000
20	Cerium-139	Ce-139	100
21	Cerium-141	Ce-141	100
22	Cerium-143	Ce-143	100
23	Cerium-144	Ce-144	1
24			
25	Praseodymium-136	Pr-136	1,000
26	Praseodymium-137	Pr-137	1,000
27	Praseodymium-138m	Pr-138m	1,000
28	Praseodymium-139	Pr-139	1,000
29	Praseodymium-142m	Pr-142m	1,000
30	Praseodymium-142	Pr-142	100
31	Praseodymium-143	Pr-143	100
32	Praseodymium-144	Pr-144	1,000
33	Praseodymium-145	Pr-145	100
34	Praseodymium-147	Pr-147	1,000
35			
36	Neodymium-136	Nd-136	1,000
37	Neodymium-138	Nd-138	100
38	Neodymium-139m	Nd-139m	1,000
39	Neodymium-139	Nd-139	1,000
40	Neodymium-141	Nd-141	1,000
41	Neodymium-147	Nd-147	100
42	Neodymium-149	Nd-149	1,000
43	Neodymium-151	Nd-151	1,000
44			
45	Promethium-141	Pm-141	1,000
46	Promethium-143	Pm-143	100
47	Promethium-144	Pm-144	10
48	Promethium-145	Pm-145	10
49	Promethium-146	Pm-146	1
50	Promethium-147	Pm-147	10
51	Promethium-148m	Pm-148m	10
52	Promethium-148	Pm-148	10
53	Promethium-149	Pm-149	100
54	Promethium-150	Pm-150	1,000

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1	Promethium-151	Pm-151	100
2			
3	Samarium-141m	Sm-141m	1,000
4	Samarium-141	Sm-141	1,000
5	Samarium-142	Sm-142	1,000
6	Samarium-145	Sm-145	100
7	Samarium-146	Sm-146	1
8	Samarium-147	Sm-147	100
9	Samarium-151	Sm-151	10
10	Samarium-153	Sm-153	100
11	Samarium-155	Sm-155	1,000
12	Samarium-156	Sm-156	1,000
13			
14	Europium-145	Eu-145	100
15	Europium-146	Eu-146	100
16	Europium-147	Eu-147	100
17	Europium-148	Eu-148	10
18	Europium-149	Eu-149	100
19	Europium-150 (12.62h)	Eu-150	100
20	Europium-150 (34.2y)	Eu-150	1
21	Europium-152m	Eu-152m	100
22	Europium-152	Eu-152	1
23	Europium-154	Eu-154	1
24	Europium-155	Eu-155	10
25	Europium-156	Eu-156	100
26	Europium-157	Eu-157	100
27	Europium-158	Eu-158	1,000
28			
29	Gadolinium-145	Gd-145	1,000
30	Gadolinium-146	Gd-146	10
31	Gadolinium-147	Gd-147	100
32	Gadolinium-148	Gd-148	0.001
33	Gadolinium-149	Gd-149	100
34	Gadolinium-151	Gd-151	10
35	Gadolinium-152	Gd-152	100
36	Gadolinium-153	Gd-153	10
37	Gadolinium-159	Gd-159	100
38			
39	Terbium-147	Tb-147	1,000
40	Terbium-149	Tb-149	100
41	Terbium-150	Tb-150	1,000
42	Terbium-151	Tb-151	100
43	Terbium-153	Tb-153	1,000
44	Terbium-154	Tb-154	100
45	Terbium-155	Tb-155	1,000
46	Terbium-156m (5.0h)	Tb-156m	1,000
47	Terbium-156m (24.4h)	Tb-156m	1,000
48	Terbium-156	Tb-156	100
49	Terbium-157	Tb-157	10
50	Terbium-158	Tb-158	1
51	Terbium-160	Tb-160	10
52	Terbium-161	Tb-161	100
53			
54	Dysprosium-155	Dy-155	1,000

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1	Dysprosium-157	Dy-157	1,000
2	Dysprosium-159	Dy-159	100
3	Dysprosium-165	Dy-165	1,000
4	Dysprosium-166	Dy-166	100
5			
6	Holmium-155	Ho-155	1,000
7	Holmium-157	Ho-157	1,000
8	Holmium-159	Ho-159	1,000
9	Holmium-161	Ho-161	1,000
10	Holmium-162m	Ho-162m	1,000
11	Holmium-162	Ho-162	1,000
12	Holmium-164m	Ho-164m	1,000
13	Holmium-164	Ho-164	1,000
14	Holmium-166m	Ho-166m	1
15	Holmium-166	Ho-166	100
16	Holmium-167	Ho-167	1,000
17			
18	Erbium-161	Er-161	1,000
19	Erbium-165	Er-165	1,000
20	Erbium-169	Er-169	100
21	Erbium-171	Er-171	100
22	Erbium-172	Er-172	100
23			
24	Thulium-162	Tm-162	1,000
25	Thulium-166	Tm-166	100
26	Thulium-167	Tm-167	100
27	Thulium-170	Tm-170	10
28	Thulium-171	Tm-171	10
29	Thulium-172	Tm-172	100
30	Thulium-173	Tm-173	100
31	Thulium-175	Tm-175	1,000
32			
33	Ytterbium-162	Yb-162	1,000
34	Ytterbium-166	Yb-166	100
35	Ytterbium-167	Yb-167	1,000
36	Ytterbium-169	Yb-169	100
37	Ytterbium-175	Yb-175	100
38	Ytterbium-177	Yb-177	1,000
39	Ytterbium-178	Yb-178	1,000
40			
41	Lutetium-169	Lu-169	100
42	Lutetium-170	Lu-170	100
43	Lutetium-171	Lu-171	100
44	Lutetium-172	Lu-172	100
45	Lutetium-173	Lu-173	10
46	Lutetium-174m	Lu-174m	10
47	Lutetium-174	Lu-174	10
48	Lutetium-176m	Lu-176m	1,000
49	Lutetium-176	Lu-176	100
50	Lutetium-177m	Lu-177m	10
51	Lutetium-177	Lu-177	100
52	Lutetium-178m	Lu-178m	1,000
53	Lutetium-178	Lu-178	1,000
54	Lutetium-179	Lu-179	1,000

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1			
2	Hafnium-170	Hf-170	100
3	Hafnium-172	Hf-172	1
4	Hafnium-173	Hf-173	1,000
5	Hafnium-175	Hf-175	100
6	Hafnium-177m	Hf-177m	1,000
7	Hafnium-178m	Hf-178m	0.1
8	Hafnium-179m	Hf-179m	10
9	Hafnium-180m	Hf-180m	1,000
10	Hafnium-181	Hf-181	10
11	Hafnium-182m	Hf-182m	1,000
12	Hafnium-182	Hf-182	0.1
13	Hafnium-183	Hf-183	1,000
14	Hafnium-184	Hf-184	100
15			
16	Tantalum-172	Ta-172	1,000
17	Tantalum-173	Ta-173	1,000
18	Tantalum-174	Ta-174	1,000
19	Tantalum-175	Ta-175	1,000
20	Tantalum-176	Ta-176	100
21	Tantalum-177	Ta-177	1,000
22	Tantalum-178	Ta-178	1,000
23	Tantalum-179	Ta-179	100
24	Tantalum-180m	Ta-180m	1,000
25	Tantalum-180	Ta-180	100
26	Tantalum-182m	Ta-182m	1,000
27	Tantalum-182	Ta-182	10
28	Tantalum-183	Ta-183	100
29	Tantalum-184	Ta-184	100
30	Tantalum-185	Ta-185	1,000
31	Tantalum-186	Ta-186	1,000
32			
33	Tungsten-176	W-176	1,000
34	Tungsten-177	W-177	1,000
35	Tungsten-178	W-178	1,000
36	Tungsten-179	W-179	1,000
37	Tungsten-181	W-181	1,000
38	Tungsten-185	W-185	100
39	Tungsten-187	W-187	100
40	Tungsten-188	W-188	10
41			
42	Rhenium-177	Re-177	1,000
43	Rhenium-178	Re-178	1,000
44	Rhenium-181	Re-181	1,000
45	Rhenium-182 (12.7h)	Re-182	1,000
46	Rhenium-182 (64.0h)	Re-182	100
47	Rhenium-184m	Re-184m	10
48	Rhenium-184	Re-184	100
49	Rhenium-186m	Re-186m	10
50	Rhenium-186	Re-186	100
51	Rhenium-187	Re-187	1,000
52	Rhenium-188m	Re-188m	1,000
53	Rhenium-188	Re-188	100
54	Rhenium-189	Re-189	100

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1			
2	Osmium-180	Os-180	1,000
3	Osmium-181	Os-181	1,000
4	Osmium-182	Os-182	100
5	Osmium-185	Os-185	100
6	Osmium-189m	Os-189m	1,000
7	Osmium-191m	Os-191m	1,000
8	Osmium-191	Os-191	100
9	Osmium-193	Os-193	100
10	Osmium-194	Os-194	1
11			
12	Iridium-182	Ir-182	1,000
13	Iridium-184	Ir-184	1,000
14	Iridium-185	Ir-185	1,000
15	Iridium-186	Ir-186	100
16	Iridium-187	Ir-187	1,000
17	Iridium-188	Ir-188	100
18	Iridium-189	Ir-189	100
19	Iridium-190m	Ir-190m	1,000
20	Iridium-190	Ir-190	100
21	Iridium-192 (73.8d)	Ir-192	1
22	Iridium-192m (1.4 min)	Ir-192m	10
23	Iridium-194m	Ir-194m	10
24	Iridium-194	Ir-194	100
25	Iridium-195m	Ir-195m	1,000
26	Iridium-195	Ir-195	1,000
27			
28	Platinum-186	Pt-186	1,000
29	Platinum-188	Pt-188	100
30	Platinum-189	Pt-189	1,000
31	Platinum-191	Pt-191	100
32	Platinum-193m	Pt-193m	100
33	Platinum-193	Pt-193	1,000
34	Platinum-195m	Pt-195m	100
35	Platinum-197m	Pt-197m	1,000
36	Platinum-197	Pt-197	100
37	Platinum-199	Pt-199	1,000
38	Platinum-200	Pt-200	100
39			
40	Gold-193	Au-193	1,000
41	Gold-194	Au-194	100
42	Gold-195	Au-195	10
43	Gold-198m	Au-198m	100
44	Gold-198	Au-198	100
45	Gold-199	Au-199	100
46	Gold-200m	Au-200m	100
47	Gold-200	Au-200	1,000
48	Gold-201	Au-201	1,000
49			
50	Mercury-193m	Hg-193m	100
51	Mercury-193	Hg-193	1,000
52	Mercury-194	Hg-194	1
53	Mercury-195m	Hg-195m	100
54	Mercury-195	Hg-195	1,000

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1	Mercury-197m	Hg-197m	100
2	Mercury-197	Hg-197	1,000
3	Mercury-199m	Hg-199m	1,000
4	Mercury-203	Hg-203	100
5			
6	Thallium-194m	Tl-194m	1,000
7	Thallium-194	Tl-194	1,000
8	Thallium-195	Tl-195	1,000
9	Thallium-197	Tl-197	1,000
10	Thallium-198m	Tl-198m	1,000
11	Thallium-198	Tl-198	1,000
12	Thallium-199	Tl-199	1,000
13	Thallium-200	Tl-200	1,000
14	Thallium-201	Tl-201	1,000
15	Thallium-202	Tl-202	100
16	Thallium-204	Tl-204	100
17			
18	Lead-195m	Pb-195m	1,000
19	Lead-198	Pb-198	1,000
20	Lead-199	Pb-199	1,000
21	Lead-200	Pb-200	100
22	Lead-201	Pb-201	1,000
23	Lead-202m	Pb-202m	1,000
24	Lead-202	Pb-202	10
25	Lead-203	Pb-203	1,000
26	Lead-205	Pb-205	100
27	Lead-209	Pb-209	1,000
28	Lead-210	Pb-210	0.01
29	Lead-211	Pb-211	100
30	Lead-212	Pb-212	1
31	Lead-214	Pb-214	100
32			
33	Bismuth-200	Bi-200	1,000
34	Bismuth-201	Bi-201	1,000
35	Bismuth-202	Bi-202	1,000
36	Bismuth-203	Bi-203	100
37	Bismuth-205	Bi-205	100
38	Bismuth-206	Bi-206	100
39	Bismuth-207	Bi-207	10
40	Bismuth-210m	Bi-210m	0.1
41	Bismuth-210	Bi-210	1
42	Bismuth-212	Bi-212	10
43	Bismuth-213	Bi-213	10
44	Bismuth-214	Bi-214	100
45			
46	Polonium-203	Po-203	1,000
47	Polonium-205	Po-205	1,000
48	Polonium-207	Po-207	1,000
49	Polonium-210	Po-210	0.1
50			
51	Astatine-207	At-207	100
52	Astatine-211	At-211	10
53			
54	Radon-220	Rn-220	1

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1	Radon-222	Rn-222	1
2			
3	Francium-222	Fr-222	100
4	Francium-223	Fr-223	100
5			
6	Radium-223	Ra-223	0.1
7	Radium-224	Ra-224	0.1
8	Radium-225	Ra-225	0.1
9	Radium-226	Ra-226	0.1
10	Radium-227	Ra-227	1,000
11	Radium-228	Ra-228	0.1
12			
13	Actinium-224	Ac-224	1
14	Actinium-225	Ac-225	0.01
15	Actinium-226	Ac-226	0.1
16	Actinium-227	Ac-227	0.001
17	Actinium-228	Ac-228	1
18			
19	Thorium-226	Th-226	10
20	Thorium-227	Th-227	0.01
21	Thorium-228	Th-228	0.001
22	Thorium-229	Th-229	0.001
23	Thorium-230	Th-230	0.001
24	Thorium-231	Th-231	100
25	Thorium-232	Th-232	100
26	Thorium-234	Th-234	10
27	Thorium-natural		100
28			
29	Protactinium-227	Pa-227	10
30	Protactinium-228	Pa-228	1
31	Protactinium-230	Pa-230	0.01
32	Protactinium-231	Pa-231	0.001
33	Protactinium-232	Pa-232	1
34	Protactinium-233	Pa-233	100
35	Protactinium-234	Pa-234	100
36			
37	Uranium-230	U-230	0.01
38	Uranium-231	U-231	100
39	Uranium-232	U-232	0.001
40	Uranium-233	U-233	0.001
41	Uranium-234	U-234	0.001
42	Uranium-235	U-235	0.001
43	Uranium-236	U-236	0.001
44	Uranium-237	U-237	100
45	Uranium-238	U-238	100
46	Uranium-239	U-239	1,000
47	Uranium-240	U-240	100
48	Uranium-natural		100
49			
50	Neptunium-232	Np-232	100
51	Neptunium-233	Np-233	1,000
52	Neptunium-234	Np-234	100
53	Neptunium-235	Np-235	100
54	Neptunium-236 (1.15x10 ⁵ y)	Np-236	0.001

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1	Neptunium-236 (22.5h)	Np-236	1
2	Neptunium-237	Np-237	0.001
3	Neptunium-238	Np-238	10
4	Neptunium-239	Np-239	100
5	Neptunium-240	Np-240	1,000
6			
7	Plutonium-234	Pu-234	10
8	Plutonium-235	Pu-235	1,000
9	Plutonium-236	Pu-236	0.001
10	Plutonium-237	Pu-237	100
11	Plutonium-238	Pu-238	0.001
12	Plutonium-239	Pu-239	0.001
13	Plutonium-240	Pu-240	0.001
14	Plutonium-241	Pu-241	0.01
15	Plutonium-242	Pu-242	0.001
16	Plutonium-243	Pu-243	1,000
17	Plutonium-244	Pu-244	0.001
18	Plutonium-245	Pu-245	100
19			
20	Americium-237	Am-237	1,000
21	Americium-238	Am-238	100
22	Americium-239	Am-239	1,000
23	Americium-240	Am-240	100
24	Americium-241	Am-241	0.001
25	Americium-242m	Am-242m	0.001
26	Americium-242	Am-242	10
27	Americium-243	Am-243	0.001
28	Americium-244m	Am-244m	100
29	Americium-244	Am-244	10
30	Americium-245	Am-245	1,000
31	Americium-246m	Am-246m	1,000
32	Americium-246	Am-246	1,000
33			
34	Curium-238	Cm-238	100
35	Curium-240	Cm-240	0.1
36	Curium-241	Cm-241	1
37	Curium-242	Cm-242	0.01
38	Curium-243	Cm-243	0.001
39	Curium-244	Cm-244	0.001
40	Curium-245	Cm-245	0.001
41	Curium-246	Cm-246	0.001
42	Curium-247	Cm-247	0.001
43	Curium-248	Cm-248	0.001
44	Curium-249	Cm-249	1,000
45			
46	Berkelium-245	Bk-245	100
47	Berkelium-246	Bk-246	100
48	Berkelium-247	Bk-247	0.001
49	Berkelium-249	Bk-249	0.1
50	Berkelium-250	Bk-250	10
51			
52	Californium-244	Cf-244	100
53	Californium-246	Cf-246	1
54	Californium-248	Cf-248	0.01

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1	Californium-249	Cf-249	0.001
2	Californium-250	Cf-250	0.001
3	Californium-251	Cf-251	0.001
4	Californium-252	Cf-252	0.001
5	Californium-253	Cf-253	0.1
6	Californium-254	Cf-254	0.001

7
8 Any alpha emitting radionuclide
9 not listed above or mixtures
10 or alpha emitters of
11 unknown composition 0.001

12			
13	Einsteinium-250	Es-250	100
14	Einsteinium-251	Es-251	100
15	Einsteinium-253	Es-253	0.1
16	Einsteinium-254m	Es-254m	1
17	Einsteinium-254	Es-254	0.01

18			
19	Fermium-252	Fm-252	1
20	Fermium-253	Fm-253	1
21	Fermium-254	Fm-254	10
22	Fermium-255	Fm-255	1
23	Fermium-257	Fm-257	0.01

24			
25	Mendelevium-257	Md-257	10
26	Mendelevium-258	Md-258	0.01

27
28 Any radionuclide other than
29 alpha emitter radionuclides
30 not listed above or mixtures
31 of beta emitters of
32 unknown composition 0.01

33 B. The quantities listed in item A were derived by
34 taking one-tenth of the most restrictive ALI listed under part
35 4731.2750, subpart 7, Table 1, columns 1 and 2, rounding to the
36 nearest factor of ten, and arbitrarily constraining the values
37 listed between 0.001 and 1,000 μCi . Values of 100 μCi have been
38 assigned for radionuclides having a radioactive half-life in
39 excess of 10^9 years (except rhenium, 1000 μCi) to take into
40 account their low specific activity.

41 C. For purposes of parts 4731.2310, subpart 5;
42 4731.2340, item A; and 4731.2600, subpart 1, where there is
43 involved a combination of radionuclides in known amounts, the

1 limit for the combination should be derived as follows:
2 determine, for each radionuclide in the combination, the ratio
3 between the quantity present in the combination and the limit
4 otherwise established for the specific radionuclide when not in
5 combination. The sum of the ratios for all radionuclides in the
6 combination may not exceed one.

7 4731.2950 LOW-LEVEL RADIOACTIVE WASTE; TRANSFER AND DISPOSAL.

8 Subpart 1. Definitions.

9 A. The terms used in this part have the meanings
10 given in this subpart and part 4731.0100.

11 B. "Chemical description" means a description of the
12 principal chemical characteristics of a low-level radioactive
13 waste.

14 C. "Computer-readable medium" means that the
15 regulatory agency's computer can transfer the information from
16 the medium into its memory.

17 D. "Consignee" means the designated receiver of the
18 shipment of low-level radioactive waste.

19 E. "Decontamination facility" means a facility,
20 operating under a license issued by the commissioner, the NRC,
21 or an agreement state, whose principal purpose is
22 decontamination of equipment or materials to accomplish recycle,
23 reuse, or other waste management objectives, and which, for
24 purposes of this part, is not considered to be a consignee for
25 low-level radioactive waste shipments.

26 F. "Disposal container" means a container principally
27 used to confine low-level radioactive waste during disposal

1 operations at a land disposal facility. For some shipments, the
2 disposal container may be the transport package.

3 G. "EPA identification number" means the number
4 received by a transporter following application to the
5 administrator of the Environmental Protection Agency as required
6 under Code of Federal Regulations, title 40, part 263.

7 H. "Generator" means a licensee, operating under a
8 license issued by the commissioner, the NRC, or an agreement
9 state, that:

10 (1) is a waste generator; or

11 (2) is the licensee to whom waste, such as waste
12 generated as a result of decontamination or recycle activities,
13 can be attributed within the context of the Low-Level
14 Radioactive Waste Policy Amendments Act of 1985, Public Law
15 99-240.

16 I. "NRC Form 540," "NRC Form 540A," "NRC Form 541,"
17 "NRC Form 541A," "NRC Form 542," and "NRC Form 542A" are
18 official NRC forms referenced in this part. Licensees need not
19 use originals of the NRC forms as long as any substitute forms
20 are equivalent to the original documentation in respect to
21 content, clarity, size, and location of information. Upon
22 agreement between the shipper and consignee, NRC Forms 541,
23 541A, 542, and 542A may be completed, transmitted, and stored in
24 electronic media. The electronic media must have the capability
25 for producing legible, accurate, and complete records in the
26 format of the uniform manifest.

27 J. "Package" means the assembly of components

1 necessary to ensure compliance with the packaging requirements
2 of DOT regulations, together with its radioactive contents, as
3 presented for transport.

4 K. "Physical description" means the items called for
5 on NRC Form 541 to describe a low-level radioactive waste.

6 L. "Residual waste" means low-level radioactive waste
7 resulting from processing or decontamination activities that
8 cannot be easily separated into distinct batches attributable to
9 specific waste generators. Residual waste is attributable to
10 the waste processor or decontamination facility, as applicable.

11 M. "Shipper" means the licensed waste generator,
12 waste collector, or waste processor that offers low-level
13 radioactive waste for transportation, typically consigning this
14 type of waste to a licensed waste collector, waste processor, or
15 land disposal facility operator.

16 N. "Shipping paper" means NRC Form 540 and, if
17 required, NRC Form 540A, which includes the information required
18 under Code of Federal Regulations, title 49, part 172.

19 O. "Uniform low-level radioactive waste manifest" or
20 "uniform manifest" means the combination of NRC Forms 540, 541,
21 and, if necessary, 542, and their respective continuation sheets
22 as needed, or equivalent.

23 P. "Waste collector" means an entity, operating under
24 a license issued by the commissioner, the NRC, or an agreement
25 state, whose principal purpose is to collect and consolidate
26 waste generated by others and to transfer the waste, without
27 processing or repackaging the collected waste, to another

1 licensed waste collector, licensed waste processor, or licensed
2 land disposal facility.

3 Q. "Waste description" means the physical, chemical,
4 and radiological description of a low-level radioactive waste as
5 called for on NRC Form 541.

6 R. "Waste generator" means an entity, operating under
7 a license issued by the commissioner, the NRC, or an agreement
8 state, that:

9 (1) possesses any material or component that
10 contains radioactivity or is radioactively contaminated for
11 which the licensee foresees no further use; and

12 (2) transfers the material or component to a
13 licensed land disposal facility or to a licensed waste collector
14 or waste processor for handling or treatment prior to disposal.

15 A licensee performing processing or decontamination
16 services may be a waste generator if the transfer of low-level
17 radioactive waste from its facility is defined as residual waste.

18 S. "Waste processor" means an entity, operating under
19 a license issued by the commissioner, the NRC, or an agreement
20 state, whose principal purpose is to process, repackage, or
21 otherwise treat low-level radioactive material or waste
22 generated by others before eventual transfer of the waste to a
23 licensed low-level radioactive waste land disposal facility.

24 T. "Waste type" means a waste within a disposal
25 container having a unique physical description, such as a
26 specific waste descriptor code or description or a waste sorbed
27 on or solidified in a specifically defined media.

1 Subp. 2. Manifest.

2 A. A waste generator, waste collector, or waste
3 processor that transports, or offers for transportation,
4 low-level radioactive waste intended for ultimate disposal at a
5 licensed low-level radioactive waste land disposal facility must
6 prepare a manifest reflecting information requested on
7 applicable NRC Forms 540 (Uniform Low-Level Radioactive Waste
8 Manifest (Shipping Paper)) and 541 (Uniform Low-Level
9 Radioactive Waste Manifest (Container and Waste Description))
10 and, if necessary, on an applicable NRC Form 542 (Uniform
11 Low-Level Radioactive Waste Manifest (Manifest Index and
12 Regional Compact Tabulation)).

13 B. NRC Forms 540 and 540A must be completed and must
14 physically accompany the pertinent low-level waste shipment.

15 C. Upon agreement between shipper and consignee, NRC
16 Forms 541, 541A, 542, and 542A may be completed, transmitted,
17 and stored in electronic media with the capability for producing
18 legible, accurate, and complete records on the respective forms.

19 D. Licensees are not required by the commissioner,
20 the NRC, or an agreement state to comply with the manifesting
21 requirements of this subpart when they ship:

22 (1) low-level radioactive waste for processing
23 and expect its return, such as for storage under their license,
24 prior to disposal at a licensed land disposal facility;

25 (2) low-level radioactive waste that is being
26 returned to the licensee that is the waste generator or
27 generator; or

1 (3) radioactively contaminated material to a
2 waste processor that becomes the processor's residual waste.

3 E. For guidance in completing the forms required
4 under item A, refer to the instructions that accompany the
5 forms. Copies of manifests required by this subpart may be
6 legible carbon copies, photocopies, or computer printouts that
7 reproduce the data in the format of the uniform manifest.

8 F. NRC Forms 540, 540A, 541, 541A, 542, and 542A, and
9 the accompanying instructions, in hard copy, may be obtained
10 from the Information and Records Management Branch, Office of
11 Information Resources Management, U.S. Nuclear Regulatory
12 Commission, Washington, DC 20555, telephone (301) 415-7232. The
13 forms are available on-line at
14 <http://www.nrc.gov/reading-rm/doc-collections/forms>.

15 Subp. 3. Other federal law. This part includes
16 information requirements of the DOT, as codified in Code of
17 Federal Regulations, title 49, part 172. Information on
18 hazardous, medical, or other waste, required to meet
19 Environmental Protection Agency (EPA) regulations, as codified
20 in Code of Federal Regulations, title 40, part 261 or elsewhere,
21 is not addressed in this part and must be provided on the
22 required EPA forms. However, the required EPA forms must
23 accompany the uniform low-level radioactive waste manifest
24 required by this part.

25 Subp. 4. General information. The shipper of the
26 radioactive waste must provide the following information on the
27 uniform manifest:

1 A. the name, facility address, and telephone number
2 of the licensee shipping the waste;

3 B. an explicit declaration indicating whether the
4 shipper is acting as a waste generator, waste collector, waste
5 processor, or a combination of these identifiers for purposes of
6 the manifested shipment; and

7 C. the name, address, and telephone number, or the
8 name and EPA identification number for the carrier transporting
9 the waste.

10 Subp. 5. Shipment information. The shipper of the
11 radioactive waste must provide the following information
12 regarding the waste shipment on the uniform manifest:

13 A. the date of the waste shipment;

14 B. the total number of packages or disposal
15 containers;

16 C. the total disposal volume and disposal weight in
17 the shipment;

18 D. the total radionuclide activity in the shipment;

19 E. the activity of each of the radionuclides H-3,
20 C-14, Tc-99, and I-129 contained in the shipment; and

21 F. the total masses of U-233, U-235, and plutonium in
22 special nuclear material and the total mass of uranium and
23 thorium in source material.

24 Subp. 6. Disposal container and waste information. The
25 shipper of the radioactive waste must provide the following
26 information on the uniform manifest regarding the waste and each
27 disposal container of waste in the shipment:

- 1 A. an alphabetic or numeric identification that
2 uniquely identifies each disposal container in the shipment;
- 3 B. a physical description of the disposal container,
4 including the manufacturer and model of any high integrity
5 container;
- 6 C. the volume displaced by the disposal container;
- 7 D. the gross weight of the disposal container,
8 including the waste;
- 9 E. for waste consigned to a disposal facility, the
10 maximum radiation level at the surface of each disposal
11 container;
- 12 F. a physical and chemical description of the waste;
- 13 G. the total weight percentage of chelating agent for
14 any waste containing more than 0.1 percent chelating agent by
15 weight, plus the identity of the principal chelating agent;
- 16 H. the approximate volume of waste within a
17 container;
- 18 I. the sorbing or solidification media, if any, and
19 the identity of the solidification media vendor and brand name;
- 20 J. the identities and activities of individual
21 radionuclides contained in each container, the masses of U-233,
22 U-235, and plutonium in special nuclear material, and the masses
23 of uranium and thorium in source material. For discrete waste
24 types, such as activated materials, contaminated equipment,
25 mechanical filters, sealed source or devices, and wastes in
26 solidification or stabilization media, the identities and
27 activities of individual radionuclides associated with or

1 contained on these waste types within a disposal container must
2 be reported; and

3 K. the total radioactivity within each container.

4 Subp. 7. Uncontainerized waste information. The shipper
5 of the radioactive waste must provide the following information
6 on the uniform manifest regarding a waste shipment delivered
7 without a disposal container:

8 A. the approximate volume and weight of the waste;

9 B. a physical and chemical description of the waste;

10 C. the total weight percentage of chelating agent if
11 the chelating agent exceeds 0.1 percent by weight, plus the
12 identity of the principal chelating agent;

13 D. for waste consigned to a disposal facility, the
14 classification of the waste according to Code of Federal
15 Regulations, title 10, section 61.55. Waste not meeting the
16 structural stability requirements of Code of Federal
17 Regulations, title 10, section 61.56, paragraph (b), must be
18 identified;

19 E. the identities and activities of individual
20 radionuclides contained in the waste, the masses of U-233,
21 U-235, and plutonium in special nuclear material, and the masses
22 of uranium and thorium in source material; and

23 F. for wastes consigned to a disposal facility, the
24 maximum radiation levels at the surface of the waste.

25 Subp. 8. Multigenerator disposal container information.

26 A. This subpart applies to disposal containers
27 enclosing mixtures of waste originating from different

1 generators. The origin of the low-level radioactive waste
2 resulting from a waste processor's activities may be
3 attributable to one or more generators, including waste
4 generators. This subpart also applies to mixtures of wastes
5 shipped in an uncontainerized form, for which portions of the
6 mixture within the shipment originate from different generators.

7 B. For homogeneous mixtures of waste, such as
8 incinerator ash, the shipper must provide the waste description
9 applicable to the mixture and the volume of the waste attributed
10 to each generator.

11 C. For heterogeneous mixtures of waste, such as the
12 combined products from a large compactor, the shipper must
13 identify each generator contributing waste to the disposal
14 container and for discrete waste types, such as activated
15 materials, contaminated equipment, mechanical filters, sealed
16 source or devices, and wastes in solidification or stabilization
17 media, the identities and activities of individual radionuclides
18 contained on these waste types within the disposal container.
19 For each generator, the shipper must provide the following:

20 (1) the volume of waste within the disposal
21 container;

22 (2) a physical and chemical description of the
23 waste, including the solidification agent, if any;

24 (3) the total weight percentage of chelating
25 agents for any disposal container containing more than 0.1
26 percent chelating agent by weight, plus the identity of the
27 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

1 61.55, and meets the waste characteristics requirements under
2 Code of Federal Regulations, title 10, section 61.56;

3 B. label each disposal container of waste, or
4 transport package if potential radiation hazards preclude
5 labeling of the individual disposal container, to identify
6 whether it is Class A waste, Class B waste, Class C waste, or
7 greater than Class C waste, according to Code of Federal
8 Regulations, title 10, section 61.55;

9 C. conduct a quality assurance program to ensure
10 compliance with Code of Federal Regulations, title 10, sections
11 61.55 and 61.56. The program must include management evaluation
12 of audits;

13 D. prepare the uniform low-level radioactive waste
14 manifest as required by this part;

15 E. forward a copy or electronically transfer the
16 uniform low-level radioactive waste manifest to the intended
17 consignee so that receipt of the manifest precedes the low-level
18 radioactive waste shipment or the manifest is delivered to the
19 consignee with the waste at the time the waste is transferred to
20 the consignee, or both;

21 F. include NRC Form 540, and Form 540A if required,
22 with the shipment regardless of the option chosen in item E;

23 G. receive acknowledgment of the receipt of the
24 shipment in the form of a signed copy of NRC Form 540;

25 H. retain a copy of or electronically store the
26 uniform low-level radioactive waste manifest and documentation
27 of acknowledgment of receipt as the record of transfer of

1 licensed material as required under parts 4731.0525 to 4731.0840
2 and 4731.3000 to 4731.3175; and

3 I. for any shipment or any part of a shipment for
4 which acknowledgment of receipt has not been received within the
5 times set forth in this part, conduct an investigation according
6 to subpart 14.

7 Subp. 11. Control and tracking; prepackaged waste. A
8 waste collector licensee that handles only prepackaged waste
9 must:

10 A. acknowledge receipt of the waste from the shipper
11 within one week of receipt by returning a signed copy of NRC
12 Form 540;

13 B. prepare a new manifest to reflect consolidated
14 shipments that meet the requirements of this part. The waste
15 collector must ensure that, for each container of waste in the
16 shipment, the manifest identifies the generator of that
17 container of waste;

18 C. forward a copy or electronically transfer the
19 uniform low-level radioactive waste manifest to the intended
20 consignee so that receipt of the manifest precedes the low-level
21 radioactive waste shipment or the manifest is delivered to the
22 consignee with the waste at the time the waste is transferred to
23 the consignee, or both;

24 D. include NRC Form 540, and 540A if required, with
25 the shipment regardless of the option chosen in item C;

26 E. receive acknowledgment of the receipt of the
27 shipment in the form of a signed copy of NRC Form 540;

1 F. retain a copy of or electronically store the
2 uniform low-level radioactive waste manifest and documentation
3 of acknowledgment of receipt as the record of transfer of
4 licensed material as required under parts 4731.0525 to 4731.0840
5 and 4731.3000 to 4731.3120;

6 G. for any shipment or any part of a shipment for
7 which acknowledgment of receipt has not been received within the
8 times set forth in this part, conduct an investigation according
9 to subpart 14; and

10 H. notify the shipper and the commissioner, the
11 administrator of the nearest NRC regional office, or an
12 agreement state licensing agency when any shipment, or part of a
13 shipment, has not arrived within 60 days after receipt of an
14 advance manifest, unless notified by the shipper that the
15 shipment has been canceled.

16 Subp. 12. Control and tracking; treatment or repackaging.
17 A licensed waste processor that treats or repackages waste must:

18 A. acknowledge receipt of the waste from the shipper
19 within one week of receipt by returning a signed copy of NRC
20 Form 540;

21 B. prepare a new manifest that meets the requirements
22 of this part. Preparation of the new manifest reflects that the
23 waste processor is responsible for meeting these requirements.
24 For each container of waste in the shipment, the manifest must
25 identify the waste generators, the preprocessed waste volume,
26 and the other information as required under subpart 8;

27 C. prepare all wastes so that the waste is classified

1 according to Code of Federal Regulations, title 10, section
2 61.55, and meets the waste characteristics requirements under
3 Code of Federal Regulations, title 10, section 61.56;

4 D. label each package of waste to identify whether it
5 is Class A waste, Class B waste, or Class C waste, according to
6 Code of Federal Regulations, title 10, sections 61.55 and 61.57;

7 E. conduct a quality assurance program to ensure
8 compliance with Code of Federal Regulations, title 10, sections
9 61.55 and 61.56. The program must include management evaluation
10 of audits;

11 F. forward a copy or electronically transfer the
12 uniform low-level radioactive waste manifest to the intended
13 consignee so that receipt of the manifest precedes the low-level
14 radioactive waste shipment or the manifest is delivered to the
15 consignee with the waste at the time the waste is transferred to
16 the consignee, or both;

17 G. include NRC Form 540, and Form 540A if required,
18 with the shipment regardless of the option chosen in item F;

19 H. receive acknowledgment of the receipt of the
20 shipment in the form of a signed copy of NRC Form 540;

21 I. retain a copy of or electronically store the
22 uniform low-level radioactive waste manifest and documentation
23 of acknowledgment of receipt as the record of transfer of
24 licensed material as required under parts 4731.0525 to 4731.0840
25 and 4731.3000 to 4731.3120;

26 J. for any shipment or any part of a shipment for
27 which acknowledgment of receipt has not been received within the

1 times set forth in this part, conduct an investigation according
2 to subpart 14; and

3 K. notify the shipper and the commissioner, the
4 administrator of the nearest NRC regional office, or an
5 agreement state licensing agency when any shipment, or part of a
6 shipment, has not arrived within 60 days after receipt of an
7 advance manifest, unless notified by the shipper that the
8 shipment has been canceled.

9 Subp. 13. Control and tracking; land disposal facility. A
10 land disposal facility operator must:

11 A. acknowledge receipt of the waste within one week
12 of receipt by returning, as a minimum, a signed copy of NRC Form
13 540 to the shipper. The shipper to be notified is the licensee
14 that last possessed the waste and transferred the waste to the
15 operator. If any discrepancy exists between materials listed on
16 the uniform low-level radioactive waste manifest and materials
17 received, copies or electronic transfer of the affected forms
18 must be returned indicating the discrepancy;

19 B. maintain copies of all completed manifests and
20 electronically store the information required under Code of
21 Federal Regulations, title 10, section 61.80, paragraph (1),
22 until the commissioner or the NRC terminates the license; and

23 C. notify the shipper and the commissioner, the
24 administrator of the nearest NRC regional office, or an
25 agreement state licensing agency when any shipment, or part of a
26 shipment, has not arrived within 60 days after receipt of an
27 advance manifest, unless notified by the shipper that the

1 shipment has been canceled.

2 Subp. 14. Investigation. A shipment or part of a shipment
3 for which acknowledgment is not received within the times set
4 forth in this part must:

5 A. be investigated by the shipper if the shipper has
6 not received notification or receipt within 20 days after
7 transfer; and

8 B. be traced and reported. The investigation must
9 include tracing the shipment and filing a report with the
10 commissioner, the administrator of the nearest NRC regional
11 office, or an agreement state licensing agency. A licensee that
12 conducts a trace investigation must file a written report with
13 the commissioner within two weeks of completing the
14 investigation.

15 DOMESTIC LICENSING OF RADIOACTIVE MATERIALS

16 4731.3000 APPLICABILITY; DOMESTIC LICENSING OF RADIOACTIVE
17 MATERIAL.

18 Parts 4731.3000 to 4731.3245 apply to all persons and
19 govern domestic licensing of radioactive material. Parts
20 4731.3000 to 4731.3245 also give notice to all persons who
21 knowingly provide to any licensee, applicant, certificate of
22 registration holder, contractor, or subcontractor, components,
23 equipment, materials, or other goods or services, that relate to
24 a licensee's, applicant's, or certificate of registration
25 holder's activities subject to parts 4731.3000 to 4731.3245,
26 that they may be individually subject to the commissioner's
27 enforcement action for violation of part 4731.0260.

1 4731.3005 ACTIVITIES REQUIRING LICENSE.

2 Except for persons exempt under parts 4731.0300 to
3 4731.0370 and 4731.3010 to 4731.3245, no person shall
4 manufacture, produce, transfer, receive, acquire, own, possess,
5 or use radioactive material except as authorized in a specific
6 or general license issued under this chapter.

7 4731.3010 SPECIFIC EXEMPTIONS.

8 A. The commissioner may, upon application of any
9 interested person or upon the commissioner's own initiative,
10 grant exemptions from parts 4731.3200 to 4731.7280 as the
11 commissioner determines are authorized by law and will not
12 endanger life or property or the common defense and security and
13 are otherwise in the public interest.

14 B. A licensee's activities are exempt from parts
15 4731.3000 to 4731.3245 to the extent that the licensee's
16 activities are licensed under Code of Federal Regulations, title
17 10, part 72.

18 C. The United States Department of Energy is exempt
19 from parts 4731.3000 to 4731.3245 to the extent that the
20 licensee's activities are subject to the requirements of Code of
21 Federal Regulations, title 10, parts 60 and 63.

22 4731.3015 EXEMPTION; USE OF RADIOACTIVE MATERIAL UNDER CERTAIN
23 FEDERAL CONTRACTS.

24 A. Except to the extent that United States Department
25 of Energy facilities or activities of the types subject to
26 licensing under United States Code, title 42, section 5842, the

1 Energy Reorganization Act of 1974 are involved, a prime
2 contractor of the United States Department of Energy is exempt
3 from parts 4731.3000 to 4731.3245 to the extent that the
4 contractor, under the prime contract with the United States
5 Department of Energy, manufactures, produces, transfers,
6 receives, acquires, owns, possesses, or uses radioactive
7 material for:

8 (1) the performance of work for the United States
9 Department of Energy at a United States government-owned or
10 -controlled site, including the transportation of radioactive
11 material to or from such site and the performance of contract
12 services during temporary interruptions of such transportation;

13 (2) research in or development, manufacture,
14 storage, testing, or transportation of atomic weapons or
15 components thereof; or

16 (3) the use or operation of nuclear reactors or
17 other nuclear devices in United States government-owned vehicles
18 or vessels.

19 B. In addition to the exemptions under item A, and
20 subject to the requirement for licensing of Department of Energy
21 facilities and activities under the Energy Reorganization Act of
22 1974, a prime contractor or subcontractor of the Department of
23 Energy or the NRC is exempt from parts 4731.3000 to 4731.3245 to
24 the extent that:

25 (1) the prime contractor or subcontractor
26 manufactures, produces, transfers, receives, acquires, owns,
27 possesses, or uses radioactive material under the prime contract

1 or subcontract; and

2 (2) the NRC determines and the commissioner
3 determine that:

4 (a) the exemption is authorized by law; and

5 (b) under the terms of the contract or
6 subcontract, there is adequate assurance that the work
7 thereunder can be accomplished without undue risk to the public
8 health and safety.

9 4731.3020 EXEMPTION; CARRIERS.

10 Common and contract carriers, freight forwarders,
11 warehousers, and the United States Postal Service are exempt
12 from parts 4731.3000 to 4731.7280 to the extent that they
13 transport or store radioactive material in the regular course of
14 the carriage for another or storage incident thereto.

15 4731.3025 EXEMPTION; CERTAIN CONCENTRATIONS.

16 Subpart 1. Exemption. Except as provided in subparts 3
17 and 4, a person is exempt from parts 4731.3000 to 4731.7280 to
18 the extent that the person receives, possesses, uses, transfers,
19 owns, or acquires products or materials containing radioactive
20 material in concentrations not in excess of those listed in part
21 4731.3140.

22 Subp. 2. Import not authorized. Parts 4731.3000 to
23 4731.3245 do not authorize the import of radioactive material or
24 products containing radioactive materials.

25 Subp. 3. Introduction by specific licensee. A
26 manufacturer, processor, or producer of a product or material in

1 an agreement state is exempt from parts 4731.3000 to 4731.7280
2 to the extent that:

3 A. the manufacturer, processor, or producer transfers
4 radioactive material contained in a product or material in
5 concentrations not in excess of those specified in part
6 4731.3140; and

7 B. the radioactive material is introduced into the
8 product or material by a licensee holding a specific license
9 issued by the commissioner, the NRC, or an agreement state
10 expressly authorizing such introduction.

11 The exemption in this subpart does not apply to the transfer of
12 radioactive material in any food, beverage, cosmetic, drug, or
13 other commodity or product designed for ingestion or inhalation
14 by, or application to, a human being.

15 Subp. 4. Transfer limitations. No person may introduce
16 radioactive material into a product or material knowing or
17 having reason to believe that it will be transferred to persons
18 exempt under this part or equivalent regulations of the NRC or
19 an agreement state, except according to a license issued under
20 part 4731.3305 or the general license issued under part
21 4731.0355.

22 4731.3030 EXEMPTION; CERTAIN ITEMS CONTAINING RADIOACTIVE
23 MATERIAL.

24 Subpart 1. Exempt products. Except for persons who apply
25 radioactive material to or incorporate radioactive material into
26 the following products or persons who initially transfer for
27 sale or distribution the following products containing

1 radioactive material, a person is exempt from parts 4731.3000 to
2 4731.7280 to the extent that the person receives, possesses,
3 uses, transfers, owns, or acquires the following products:

4 A. timepieces or hands or dials of timepieces that:

5 (1) contain not more than the following specified
6 quantities of radioactive material:

7 (a) 25 millicuries of tritium per timepiece;

8 (b) five millicuries of tritium per hand;

9 (c) 15 millicuries of tritium per dial

10 (bezels, when used, are considered part of the dial);

11 (d) 100 microcuries of promethium-147 per

12 watch or 200 microcuries of promethium-147 per any other

13 timepiece;

14 (e) 20 microcuries of promethium-147 per

15 watch hand or 40 microcuries of promethium-147 per other

16 timepiece hand; and

17 (f) 60 microcuries of promethium-147 per

18 watch dial or 120 microcuries of promethium-147 per any other

19 timepiece dial (bezels, when used, are considered as part of the
20 dial); and

21 (2) do not exceed the following levels of

22 radiation. The levels of radiation from hands and dials

23 containing promethium-147 must not exceed, when measured through
24 50 milligrams per square centimeter of absorber:

25 (a) for wrist watches, 0.1 millirad per hour
26 at ten centimeters from any surface;

27 (b) for pocket watches, 0.1 millirad per

1 hour at one centimeter from any surface; or

2 (c) for any other timepiece, 0.2 millirad
3 per hour at ten centimeters from any surface;

4 B. lock illuminators containing not more than 15
5 millicuries of tritium or not more than two millicuries of
6 promethium-147 installed on automobile locks. The levels of
7 radiation from each lock illuminator containing promethium-147
8 must not exceed one millirad per hour at one centimeter from any
9 surface when measured through 50 milligrams per square
10 centimeter absorber;

11 C. balances of precision containing not more than one
12 millicurie of tritium per balance or not more than 0.5
13 millicurie of tritium per balance part;

14 D. automobile shift quadrants containing not more
15 than 25 millicuries of tritium;

16 E. marine compasses containing not more than 750
17 millicuries of tritium gas and other marine navigational
18 instruments containing not more than 250 millicuries of tritium
19 gas;

20 F. thermostat dials and pointers containing not more
21 than 25 millicuries of tritium per thermostat;

22 G. electron tubes. For purposes of this item,
23 "electron tubes" include spark gap tubes, power tubes, gas tubes
24 including glow lamps, receiving tubes, microwave tubes,
25 indicator tubes, pickup tubes, radiation detection tubes, and
26 any other completely sealed tube that is designed to conduct or
27 control electrical currents. The exemption under this item

1 applies only if the levels of radiation from each electron tube
2 containing radioactive material do not exceed one millirad per
3 hour at one centimeter from any surface when measured through
4 seven milligrams per square centimeter of absorber and if each
5 tube does not contain more than one of the following specified
6 quantities of radioactive materials:

7 (1) 150 millicuries of tritium per microwave
8 receiver protector tube or ten millicuries of tritium per any
9 other electron tube;

10 (2) one microcurie of cobalt-60;

11 (3) five microcuries of nickel-63;

12 (4) 30 microcuries of krypton-85;

13 (5) five microcuries of cesium-137; or

14 (6) 30 microcuries of promethium-147;

15 H. ionizing radiation measuring instruments

16 containing, for purposes of internal calibration or
17 standardization, one or more sources of radioactive material.
18 For purposes of this item, an instrument's source may contain
19 either one type or different types of radionuclides and an
20 individual exempt quantity may be composed of fractional parts
21 of one or more of the exempt quantities in part 4731.3145,
22 provided that the sum of the fractions does not exceed unity.
23 For purposes of this item, 0.05 microcurie of americium-241 is
24 an exempt quantity under part 4731.3145. The exemption under
25 this item applies only if:

26 (1) each source contains no more than one exempt
27 quantity under part 4731.3145; and

1 (2) each instrument contains no more than ten
2 exempt quantities; or

3 I. spark gap irradiators containing not more than one
4 microcurie of cobalt-60 per spark gap irradiator for use in
5 electrically ignited fuel oil burners having a firing rate of at
6 least three gallons (11.4 liters) per hour.

7 Subp. 2. Specific license required. A person who desires
8 to apply radioactive material to or incorporate radioactive
9 material into the products exempted under subpart 1 or who
10 desires to initially transfer for sale or distribution such
11 products containing radioactive material must apply for a
12 specific license under Code of Federal Regulations, title 10,
13 section 32.14, which license states that the product may be
14 distributed by the licensee to persons exempt under subpart 1.

15 4731.3035 EXEMPTION; RESINS CONTAINING SCANDIUM-46;
16 SAND-CONSOLIDATION IN OIL WELLS.

17 A person is exempt from parts 4731.2000 to 4731.2090 and
18 4731.3000 to 4731.7280 to the extent that the person receives,
19 possesses, uses, transfers, owns, or acquires synthetic plastic
20 resins containing scandium-46 that are designed for
21 sand-consolidation in oil wells and that have been manufactured
22 or initially transferred for sale or distribution according to a
23 specific license issued under part 4731.3320 or equivalent
24 regulations of the NRC or an agreement state. This part does
25 not authorize the manufacture or initial transfer for sale or
26 distribution of any resins containing scandium-46.

1 4731.3040 EXEMPT QUANTITIES.

2 Subpart 1. Exempt quantities. Except as provided in
3 subparts 3 and 4, a person is exempt from parts 4731.3000 to
4 4731.7280 to the extent that the person receives, possesses,
5 uses, transfers, owns, or acquires radioactive material in
6 individual quantities, each of which does not exceed the
7 applicable quantity in part 4731.3145.

8 Subp. 2. Receipt under prior license. A person who
9 possesses radioactive material received or acquired before
10 September 25, 1971, under the general license then provided
11 under Code of Federal Regulations, title 10, section ~~32.4~~ 31.4,
12 is exempt from parts 4731.3000 to 4731.4360 to the extent that
13 the person possesses, uses, transfers, or owns such radioactive
14 material.

15 Subp. 3. Limitation. This part does not authorize, for
16 purposes of commercial distribution, the production, packaging,
17 repackaging, or transfer of radioactive material or the
18 incorporation of radioactive material into products intended for
19 commercial distribution.

20 Subp. 4. Specific license required. No person may, for
21 purposes of commercial distribution, transfer radioactive
22 material in the individual quantities under part 4731.3145,
23 knowing or having reason to believe that such quantities of
24 radioactive material will be transferred to persons exempt under
25 this part or equivalent regulations of the NRC or an agreement
26 state, except according to a license issued under Code of
27 Federal Regulations, title 10, section 32.18, that states that

1 the radioactive material may be transferred by the licensee to
2 persons exempt under this part or equivalent regulations of the
3 NRC or an agreement state.

4 4731.3045 EXEMPTION; SELF-LUMINOUS PRODUCTS CONTAINING TRITIUM,
5 KRYPTON-85, OR PROMETHIUM-147.

6 Subpart 1. Specific license exemption. Except for persons
7 who manufacture, process, produce, or initially transfer for
8 sale or distribution self-luminous products containing tritium,
9 krypton-85, or promethium-147, and except as provided in subpart
10 3, a person is exempt from parts 4731.2000 to 4731.2090 and
11 4731.3000 to 4731.7280 to the extent that the person receives,
12 possesses, uses, transfers, owns, or acquires tritium,
13 krypton-85, or promethium-147 in self-luminous products
14 manufactured, processed, produced, or initially transferred
15 according to a specific license issued under Code of Federal
16 Regulations, title 10, section 32.22, that authorizes the
17 initial transfer of the product for use under this part.

18 Subp. 2. Specific license required. A person who desires
19 to manufacture, process, or produce self-luminous products
20 containing tritium, krypton-85, or promethium-147 or to transfer
21 such products for use under subpart 1 must apply for a license
22 according to Code of Federal Regulations, title 10, section
23 32.22, that states that the product may be transferred by the
24 licensee to persons exempt under subpart 1 or equivalent
25 regulations of the NRC or an agreement state.

26 Subp. 3. Limitation. The exemption in subpart 1 does not
27 apply to tritium, krypton-85, or promethium-147 used in products

1 primarily for frivolous purposes or in toys or adornments.

2 4731.3050 EXEMPTION; GAS AND AEROSOL DETECTORS CONTAINING
3 RADIOACTIVE MATERIAL.

4 Subpart 1. Specific license exemption. Except for persons
5 who manufacture, process, produce, or initially transfer for
6 sale or distribution gas and aerosol detectors containing
7 radioactive material, a person is exempt from parts 4731.2000 to
8 4731.2090 and 4731.3000 to 4731.7280 to the extent that the
9 person receives, possesses, uses, transfers, owns, or acquires
10 radioactive material in gas or aerosol detectors designed to
11 protect life or property from fires and airborne hazards and
12 manufactured, processed, produced, or initially transferred
13 according to a specific license issued under Code of Federal
14 Regulations, title 10, section 32.26, that authorizes the
15 initial transfer of the product for use under this part.

16 Subp. 2. Specific license required. A person who desires
17 to manufacture, process, or produce gas and aerosol detectors
18 containing radioactive material or to initially transfer such
19 products for use under subpart 1 must apply for a license under
20 Code of Federal Regulations, title 10, section 32.26, that
21 states that the product may be initially transferred by the
22 licensee to persons exempt under subpart 1 or equivalent
23 regulations of the NRC or an agreement state.

24 4731.3055 EXEMPTION; RADIOACTIVE DRUGS.

25 Subpart 1. Exemption. Except as provided in subparts 2
26 and 3, a person is exempt from parts 4731.3000 to 4731.3245 and

1 4731.4400 to 4731.4527, if the person receives, possesses, uses,
2 transfers, owns, or acquires capsules containing one μCi (37
3 kBq) carbon-14 urea (allowing for nominal variation that may
4 occur during the manufacturing process) each, for in vivo
5 diagnostic use for humans.

6 Subp. 2. Research; license required. A person who desires
7 to use the capsules under subpart 1 for research involving human
8 subjects must apply for and receive a specific license according
9 to parts 4731.4400 to 4731.4527.

10 Subp. 3. Specific license required. A person who desires
11 to manufacture, prepare, process, produce, package, repackage,
12 or transfer for commercial distribution the capsules under
13 subpart 1 must apply for and receive a specific license under
14 Code of Federal Regulations, title 10, section 32.21.

15 Subp. 4. Other law. Nothing in this part relieves a
16 person from complying with applicable United States Food and
17 Drug Administration or other federal and state requirements
18 governing receipt, administration, and use of drugs.

19 4731.3060 TYPES OF LICENSES.

20 A. Licenses for radioactive material are of two
21 types: general and specific.

22 B. The commissioner issues a specific license to a
23 named person who has filed an application for the license under
24 parts 4731.3300 to 4731.7280.

25 C. A general license is provided by rule, grants
26 authority to a person for certain activities involving
27 radioactive material, and is effective without the filing of an

1 application with the commissioner or the issuance of a licensing
2 document to a particular person. However, registration with the
3 commissioner may be required by the particular general license.

4 4731.3065 SPECIFIC LICENSES; APPLICATION.

5 Subpart 1. General requirements.

6 A. Applications for specific licenses must be filed
7 in duplicate on an application for radioactive material license
8 form prescribed by the commissioner.

9 B. The applicant may incorporate by reference
10 information contained in previous applications, statements, or
11 reports filed with the commissioner, provided the references are
12 clear and specific.

13 C. An application must be signed by the applicant or
14 licensee or a person duly authorized to act for and on behalf of
15 the applicant or licensee.

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

21 E. An application for a license under this part shall
22 be considered also as an application for licenses authorizing
23 other activities for which licenses are required by the
24 commissioner, provided that the application specifies the
25 additional activities for which licenses are requested and
26 complies with requirements for applications for such licenses.

27 F. An application must be accompanied by the fee

1 prescribed under Minnesota Statutes, section 144.1205.

2 G. An application for a license to receive and
3 possess radioactive material that the commissioner has
4 determined will significantly affect the quality of the
5 environment must be filed at least nine months prior to
6 commencement of construction of the plant or facility in which
7 the activity will be conducted and must be accompanied by any
8 environmental report as required under Code of Federal
9 Regulations, title 10, part 51, subpart A.

10 Subp. 2. Sealed source requirements. An application for a
11 specific license to use radioactive material in the form of a
12 sealed source or in a device that contains the sealed source
13 must identify the source or device by manufacturer and model
14 number as registered with the NRC under Code of Federal
15 Regulations, title 10, section 32.210, or with an agreement
16 state.

17 Subp. 3. Decommissioning requirements. As provided under
18 parts 4731.3080, 4731.3300 to 4731.3420, and 4731.4000 to
19 4731.4527, certain applications for specific licenses filed
20 under part 4731.3065 must contain a proposed decommissioning
21 funding plan or a certification of financial assurance for
22 decommissioning.

23 Subp. 4. Additional requirements.

24 A. An application to possess radioactive materials in
25 unsealed form, on foils or plated sources, or sealed in glass in
26 excess of the quantities in part 4731.3150 must contain:

27 (1) an evaluation showing that the maximum dose

1 to a person off-site due to a release of radioactive material
2 would not exceed one rem effective dose equivalent or five rems
3 to the thyroid; or

4 (2) an emergency plan for responding to a release
5 of radioactive material.

6 B. One or more of the following factors may be used
7 to support an evaluation submitted under item A, subitem (1):

8 (1) the radioactive material is physically
9 separated so that only a portion could be involved in an
10 accident;

11 (2) all or part of the radioactive material is
12 not subject to release during an accident because of the way it
13 is stored or packaged;

14 (3) the release fraction in the respirable size
15 range would be lower than the release fraction shown in part
16 4731.3150 due to the chemical or physical form of the material;

17 (4) the solubility of the radioactive material
18 would reduce the dose received;

19 (5) facility design or engineered safety features
20 in the facility would cause the release fraction to be lower
21 than shown in part 4731.3150;

22 (6) operating restrictions or procedures would
23 prevent a release fraction as large as that shown in part
24 4731.3150; or

25 (7) other factors appropriate for the specific
26 facility.

27 Subp. 5. Emergency plan. An emergency plan submitted

1 under subpart 4, item A, subitem (2), must include:

2 A. a brief description of the licensee's facility and
3 area near the site;

4 B. identification of each type of radioactive
5 materials accident for which protective actions may be needed;

6 C. a classification system for classifying accidents
7 as alert or site area emergencies;

8 D. identification of the means of detecting each type
9 of accident in a timely manner;

10 E. a brief description of the means and equipment for
11 mitigating the consequences of each type of accident, including
12 those provided to protect workers on-site, and a description of
13 the program for maintaining the equipment;

14 F. a brief description of the methods and equipment
15 to assess releases of radioactive materials;

16 G. a brief description of the responsibilities of
17 licensee personnel should an accident occur, including
18 identification of personnel responsible for promptly notifying
19 off-site response organizations and the commissioner, and the
20 responsibilities for developing, maintaining, and updating the
21 plan;

22 H. a commitment to and a brief description of the
23 means to promptly notify off-site response organizations and
24 request off-site assistance, including medical assistance for
25 the treatment of contaminated injured on-site workers when
26 appropriate. A control point must be established. The
27 notification and coordination must be planned so that

1 unavailability of some personnel, parts of the facility, and
2 some equipment does not prevent notification and coordination.
3 The licensee must also commit to notifying the commissioner
4 immediately after the licensee has notified the appropriate
5 off-site response organizations and not later than one hour
6 after the licensee declares an emergency. These reporting
7 requirements do not supersede or release a licensee's
8 responsibility to comply with the Emergency Planning and
9 Community Right-to-Know Act of 1986, title III, Public Law
10 99-499, or other state or federal reporting requirements;

11 I. a brief description of the types of information on
12 facility status, radioactive releases, and recommended
13 protective actions, if necessary, to be given to off-site
14 response organizations and to the commissioner;

15 J. a brief description of the frequency, performance
16 objectives, and plans for the training that the licensee will
17 provide workers on how to respond to an emergency, including any
18 special instructions and orientation tours the licensee would
19 offer to fire, police, medical, and other emergency personnel.
20 The training must:

21 (1) familiarize personnel with site-specific
22 emergency procedures;

23 (2) thoroughly prepare site personnel for their
24 responsibilities in the event of an accident, using accident
25 scenarios postulated as the most probable for the specific site;
26 and

27 (3) use team training for accident scenarios

1 postulated as the most probable for the specific site;

2 K. a brief description of the means of restoring the
3 facility to a safe condition after an accident;

4 L. provisions for conducting quarterly communications
5 checks with off-site response organizations and biennial on site
6 exercises to test response to simulated emergencies. Quarterly
7 communications ~~check~~ checks with off-site response organizations
8 must include checking and updating all necessary telephone
9 numbers. The licensee must invite off-site response

10 organizations to participate in the biennial exercises.

11 Participation of off-site response organizations in biennial
12 exercises, although recommended, is not required. Exercises
13 must use accident scenarios postulated as most probable for the
14 specific site and the scenarios must not be known to most
15 exercise participants. The licensee must critique the exercises
16 using individuals not having direct implementation
17 responsibility for the plan. Critiques of exercises must
18 evaluate the appropriateness of the plan, emergency procedures,
19 facilities, equipment, training of personnel, and overall
20 effectiveness of the response. Deficiencies found by the
21 critiques must be corrected; and

22 M. a certification that the applicant has met its
23 responsibilities under the Emergency Planning and Community
24 Right-to-Know Act of 1986, title III, Public Law 99-499, if
25 applicable to the applicant's activities at the proposed place
26 of use of the radioactive material.

27 Subp. 6. Comments. A licensee must:

1 A. allow the off-site response organizations expected
2 to respond in case of an accident 60 days to comment on the
3 licensee's emergency plan before submitting it to the
4 commissioner; and

5 B. provide any comments received within the 60 days
6 to the commissioner along with the emergency plan.

7 4731.3070 SPECIFIC LICENSES; APPROVAL.

8 The commissioner shall approve an application for a
9 specific license if:

10 A. the application is for a purpose authorized under
11 this chapter;

12 B. the applicant is qualified by training and
13 experience to use the material for the purpose requested in such
14 manner as to protect health and minimize danger to life and
15 property;

16 C. the applicant's proposed equipment and facilities
17 are adequate to protect health and minimize danger to life and
18 property;

19 D. the applicant satisfies any applicable special
20 requirements under this chapter; and

21 E. in the case of an application for a license to
22 receive and possess radioactive material for the conduct of any
23 activity that the commissioner determines will significantly
24 affect the quality of the environment, before commencement of
25 construction of the plant or facility in which the activity will
26 be conducted, the commissioner, on the basis of information
27 filed and evaluations made according to Code of Federal

1 Regulations, title 10, part 51, subpart A, has concluded, after
2 weighing the environmental, economic, technical, and other
3 benefits against environmental costs and considering available
4 alternatives, that the action called for is the issuance of the
5 proposed license, with any appropriate conditions to protect
6 environmental values. Commencement of construction prior to
7 such conclusion is grounds for denial of a license to receive
8 and possess radioactive material in such plant or facility.
9 Commencement of construction does not mean site exploration,
10 necessary roads for site exploration, borings to determine
11 foundation conditions, or other preconstruction monitoring or
12 testing to establish background information related to the
13 suitability of the site or the protection of environmental
14 values.

15 4731.3075 TERMS AND CONDITIONS OF LICENSES.

16 Subpart 1. Applicable regulation. A license issued under
17 this chapter is subject to all rules and orders of the
18 commissioner.

19 Subp. 2. Transfer prohibited. No license issued or
20 granted under this chapter nor any right under a license must be
21 transferred, assigned, or in any manner disposed of, either
22 voluntarily or involuntarily, directly or indirectly, through
23 transfer of control of a license to any person, unless the
24 commissioner, after securing full information, finds that the
25 transfer is in accordance with this chapter and gives consent in
26 writing.

27 Subp. 3. Scope of license. A person licensed by the

1 commissioner under this chapter must confine the licensee's
2 possession and use of radioactive material to the locations and
3 purposes authorized in the license. Except as otherwise
4 provided in the license, a license issued under parts 4731.3000
5 to 4731.7280 carries with it the right to receive, acquire, own,
6 and possess radioactive material. Preparation for shipment and
7 transport of radioactive material must be according to parts
8 4731.0400 to 4731.0424.

9 Subp. 4. Bankruptcy.

10 A. A general licensee required to register under part
11 4731.3215, subpart 3, item Q, and a specific licensee issued a
12 license under this chapter must notify the commissioner, in
13 writing, immediately following the filing of a voluntary or
14 involuntary petition for bankruptcy under any chapter of United
15 States Code, title 11, by or against:

16 (1) the licensee;

17 (2) an entity, which includes a person, estate,
18 trust, governmental unit, or United States trustee, that
19 controls the licensee or lists the license or licensee as
20 property; or

21 (3) an affiliate of the licensee, as defined
22 under United States Code, chapter 11, section 101, clause (2).

23 B. The bankruptcy notification must indicate the
24 bankruptcy court in which the petition for bankruptcy was filed
25 and the date of the filing of the petition.

26 Subp. 5. Additional conditions.

27 A. The commissioner may incorporate in any license,

1 at the time of issuance or thereafter by appropriate rule or
2 order, such additional conditions and requirements with respect
3 to the licensee's receipt, possession, use, and transfer of
4 radioactive material as the commissioner deems appropriate or
5 necessary to protect health or to minimize danger to life or
6 property.

7 B. The commissioner may require reports, record
8 keeping, and inspections of activities under the license as may
9 be necessary or appropriate to effectuate the purposes of this
10 chapter.

11 Subp. 6. **Emergency plan.** A licensee that is required to
12 submit an emergency plan under part 4731.3065, subpart 4, item
13 A, must follow the emergency plan approved by the commissioner.
14 The licensee:

15 A. may change the plan without commissioner approval
16 only if the changes do not decrease the effectiveness of the
17 plan;

18 B. must furnish the change to the commissioner and to
19 affected off-site response organizations within six months after
20 the change is made; and

21 C. may not implement proposed changes that decrease,
22 or potentially decrease, the effectiveness of the approved
23 emergency plan without prior application to and prior approval
24 by the commissioner.

25 Subp. 7. **Molybdenum-99 requirement.** A licensee preparing
26 technetium-99m radiopharmaceuticals from molybdenum-99 or
27 technetium-99m generators must test the generator eluates for

1 molybdenum-99 breakthrough according to part 4731.4435. The
2 licensee must record the results of each test and retain each
3 record for three years after the record is made.

4 4731.3080 FINANCIAL ASSURANCE AND RECORD KEEPING FOR
5 DECOMMISSIONING.

6 Subpart 1. Decommissioning funding plan required. An
7 applicant for a specific license authorizing the possession and
8 use of unsealed radioactive material of half-life greater than
9 120 days and in quantities exceeding 10^5 times the applicable
10 quantities under part 4731.3160 must submit a decommissioning
11 funding plan according to subpart 5. A decommissioning funding
12 plan must also be submitted when a combination of isotopes is
13 involved, if R divided by 10^5 is greater than one (unity rule),
14 where R is the sum of the ratios of the quantity of each isotope
15 to the applicable value under part 4731.3160.

16 Subp. 2. Plan or financial assurance required.

17 A. A holder of or an applicant for a specific license
18 authorizing possession and use of sealed sources or plated foils
19 of half-life greater than 120 days and in quantities exceeding
20 10^{12} times the applicable quantities set forth in part 4731.3160
21 or, when a combination of isotopes is involved, if R , as defined
22 in subpart 1, divided by 10^{12} is greater than 1, must:

23 (1) submit a decommissioning funding plan as
24 described in subpart 5; or

25 (2) submit a certification that financial
26 assurance for decommissioning has been provided in the amount
27 prescribed by subpart 4, using one of the methods described in

1 subpart 6. The certification may state that the appropriate
2 assurance will be obtained after the application has been
3 approved and the license issued but before the receipt of
4 licensed material.

5 B. If the applicant defers execution of the financial
6 instrument until after the license has been issued, a signed
7 original of the financial instrument obtained to satisfy the
8 requirements of subpart 6 must be submitted to the commissioner
9 before receipt of licensed material.

10 C. If the applicant does not defer execution of the
11 financial instrument, the applicant must submit to the
12 commissioner, as part of the certification, a signed original of
13 the financial instrument obtained to satisfy the requirements of
14 subpart 6.

15 Subp. 3. Date-specific requirements.

16 A. A holder of a specific license issued on or after
17 July 27, 1990, which is of a type described in subpart 1 or 2,
18 must provide financial assurance for decommissioning according
19 to this subpart.

20 B. A holder of a specific license issued before July
21 27, 1990, and of a type described in subpart 1, must submit, on
22 or before July 27, 1990, a decommissioning funding plan
23 according to subpart 5 or a certification of financial assurance
24 for decommissioning in an amount at least equal to \$1,125,000
25 according to this part. If the licensee submits the
26 certification of financial assurance rather than a
27 decommissioning funding plan, the licensee must include a

1 decommissioning funding plan in any application for license
2 renewal.

3 C. A holder of a specific license issued before July
4 27, 1990, and of a type described in subpart 2, must submit, on
5 or before July 27, 1990, a decommissioning funding plan as
6 described in subpart 5 or a certification of financial assurance
7 for decommissioning according to this part.

8 D. A licensee who has submitted an application before
9 July 27, 1990, for renewal of a license according to part
10 4731.3090, must provide financial assurance for decommissioning
11 according to subparts 1 and 2.

12 E. Waste collectors and waste processors, as defined
13 under part 4731.2950, must provide financial assurance in an
14 amount based on a decommissioning funding plan as described in
15 subpart 5. The decommissioning funding plan must include the
16 cost of disposal of the maximum amount (curies) of radioactive
17 material permitted by license and the cost of disposal of the
18 maximum quantity, by volume, of radioactive material that could
19 be present at the licensee's facility at any time, in addition
20 to the cost to remediate the licensee's site to meet the license
21 termination criteria of parts 4731.2000 to 4731.2950. The
22 decommissioning funding plan must be submitted by December 2,
23 2005.

24 Subp. 4. Financial assurance; amounts. The following
25 amounts of financial assurance are required for decommissioning
26 by quantity of material. Licensees required to submit the
27 \$113,000 or \$225,000 amount must do so by June 2, 2005.

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1 Licensees having possession limits exceeding the upper bounds of
2 this subpart must base financial assurance on a decommissioning
3 funding plan:

4 Greater than 10^4 but less than
5 or equal to 10^5 times the
6 applicable quantities of part
7 4731.3160 in unsealed form.

8 For a combination of
9 isotopes, if R, as defined
10 in subpart 1, divided by
11 10^4 is greater than 1 but
12 R divided by 10^5 is less
13 than or equal to 1.

\$1,125,000

14
15 Greater than 10^3 but less than
16 or equal to 10^4 times the
17 applicable quantities of part
18 4731.3160 in unsealed form.

19 For a combination of
20 isotopes, if R, as defined
21 in subpart 1, divided by
22 10^3 is greater than 1 but
23 R divided by 10^4 is less
24 than or equal to 1.

\$225,000

25
26 Greater than 10^{10} times but
27 less than or equal to 10^{12} times

1 the applicable quantities of part
2 4731.3160 in sealed sources or
3 plated foils. For a
4 combination of isotopes, if R,
5 as defined in subpart 1,
6 divided by 10^{10} is greater
7 than 1, but R divided by 10^{12}
8 is less than or equal to 1. \$113,000
9

10 Subp. 5. Funding plan requirements. A decommissioning
11 funding plan must contain:

12 A. a cost estimate for decommissioning and a
13 description of the method of assuring funds for decommissioning
14 from subpart 6, including means of adjusting cost estimates and
15 associated funding levels periodically over the life of the
16 facility. Cost estimates must be adjusted at intervals not to
17 exceed three years; and

18 B. a certification by the licensee that financial
19 assurance for decommissioning has been provided in the amount of
20 the cost estimate for decommissioning. A signed original of the
21 financial instrument obtained to satisfy the requirements of
22 subpart 6 must accompany the certification.

23 Subp. 6. Financial assurance requirements.

24 A. Financial assurance for decommissioning must be
25 provided by one or more of the methods described in items B to F.

26 B. Prepayment is the deposit prior to the start of
27 operation into an account segregated from licensee assets and

1 outside the licensee's administrative control of cash or liquid
2 assets such that the amount of funds would be sufficient to pay
3 decommissioning costs. Prepayment may be in the form of a
4 trust, escrow account, government fund, certificate of deposit,
5 or deposit of government securities.

6 C. A surety method, insurance, or other guarantee
7 method guarantees that decommissioning costs will be paid. A
8 surety method may be in the form of a surety bond, letter of
9 credit, or line of credit. A parent company guarantee of funds
10 for decommissioning costs based on a financial test may be used
11 if the guarantee and test comply with part 4731.3155, but may
12 not be used in combination with other financial methods to
13 satisfy the requirements of this part. For commercial
14 corporations that issue bonds, a guarantee of funds by the
15 applicant or licensee for decommissioning costs based on a
16 financial test may be used if the guarantee and test comply with
17 part 4731.3165. For commercial corporations that do not issue
18 bonds, a guarantee of funds by the applicant or licensee for
19 decommissioning costs may be used if the guarantee and test
20 comply with part 4731.3170. For nonprofit entities, such as
21 colleges, universities, and nonprofit hospitals, a guarantee of
22 funds by the applicant or licensee may be used if the guarantee
23 and test comply with part 4731.3175. A guarantee by the
24 applicant or licensee may not be used in combination with other
25 financial methods used to satisfy this part or in any situation
26 where the applicant or licensee has a parent company holding
27 majority control of the voting stock of the company. Any surety

1 method or insurance used to provide financial assurance for
2 decommissioning must:

3 (1) be open-ended or, if written for a specified
4 term, such as five years, must be renewed automatically unless
5 90 days or more before the renewal date, the issuer notifies the
6 commissioner, the beneficiary, and the licensee of its intention
7 not to renew;

8 (2) provide that the full face amount be paid to
9 the beneficiary automatically before the expiration without
10 proof of forfeiture if the licensee fails to provide a
11 replacement acceptable to the commissioner within 30 days after
12 receipt of notification of cancellation;

13 (3) be payable to a trust established for
14 decommissioning costs. The trustee and trust must be acceptable
15 to the commissioner. An acceptable trustee includes an
16 appropriate state or federal government agency or an entity that
17 has authority to act as a trustee and whose trust operations are
18 regulated and examined by a federal or state agency; and

19 (4) remain in effect until the commissioner
20 terminates the license.

21 D. An external sinking fund in which deposits are
22 made at least annually, coupled with a surety method or
23 insurance, the value of which may decrease by the amount being
24 accumulated in the sinking fund, may be used as a method of
25 financial assurance. The surety or insurance provisions must be
26 as stated in item C. An external sinking fund:

27 (1) is a fund established and maintained by

1 setting aside funds periodically in an account segregated from
2 licensee assets and outside the licensee's administrative
3 control in which the total amount of funds would be sufficient
4 to pay decommissioning costs at the time termination of
5 operation is expected; and

6 (2) may be in the form of a trust, escrow
7 account, government fund, certificate of deposit, or deposit of
8 government securities.

9 E. In the case of federal, state, or local government
10 licensees, a statement of intent containing a cost estimate for
11 decommissioning or an amount according to subpart 4 and
12 indicating that funds for decommissioning will be obtained when
13 necessary may be used as a method of financial assurance.

14 F. When a governmental entity assumes custody and
15 ownership of a site, an arrangement that is deemed acceptable by
16 the governmental entity may be used as a method of financial
17 assurance.

18 Subp. 7. Record keeping.

19 A. A person issued a license under parts 4731.3000 to
20 4731.7280 must keep records of information important to the
21 decommissioning of the facility in an identified location until
22 the site is released for unrestricted use.

23 B. Before licensed activities are transferred or
24 assigned according to part 4731.3075, subpart 2, a licensee must
25 transfer all records described in this subpart to the new
26 licensee. The new licensee is responsible for maintaining the
27 records until the license is terminated.

1 C. If records important to the decommissioning of a
2 facility are kept for other purposes, reference to the records
3 and their location may be used.

4 D. Information the commissioner considers important
5 to decommissioning are:

6 (1) records of spills or other unusual
7 occurrences involving the spread of contamination in and around
8 the facility, equipment, or site, which:

9 (a) must include any known information on
10 identification of involved nuclides, quantities, forms, and
11 concentrations; and

12 (b) may be limited to instances when
13 contamination remains after cleanup procedures or when there is
14 reasonable likelihood that contaminants may have spread to
15 inaccessible areas, as in the case of possible seepage into
16 porous materials such as concrete;

17 (2) as-built drawings and modifications of
18 structures and equipment in restricted areas where radioactive
19 materials are used or stored and of locations of possible
20 inaccessible contamination, such as buried pipes, that may be
21 subject to contamination. If required drawings are referenced,
22 each relevant document need not be indexed individually. If
23 drawings are not available, the licensee must substitute
24 appropriate records of available information concerning these
25 areas and locations;

26 (3) except for areas containing only sealed
27 sources, if the sources have not leaked or if no contamination

1 remains after a leak, or radioactive materials having only
2 half-lives of less than 65 days, a list of the following,
3 contained in a single document and updated every two years:

4 (a) all areas designated and formerly
5 designated as restricted areas;

6 (b) all areas outside of restricted areas
7 that require documentation under subitem (1);

8 (c) all areas outside of restricted areas
9 where current and previous wastes have been buried as documented
10 under part 4731.2560; and

11 (d) all areas outside of restricted areas
12 that contain material such that, if the license expired, the
13 licensee would be required to either decontaminate the area to
14 meet the criteria for decommissioning under part 4731.2100 or
15 apply for approval for disposal under part 4731.2410; and

16 (4) records of:

17 (a) the cost estimate performed for the
18 decommissioning funding plan or of the amount certified for
19 decommissioning; and

20 (b) the funding method used for assuring
21 funds if either a funding plan or certification is used.

22 4731.3085 LICENSE EXPIRATION AND TERMINATION; DECOMMISSIONING.

23 Subpart 1. Expiration.

24 A. Except as provided under item C, a specific
25 license expires at the end of the day on the expiration date
26 stated in the license, unless the licensee has filed an
27 application for renewal under part 4731.3090 not less than 30

1 days before the expiration date stated in the existing license
2 or, for licenses under item C, 30 days before the deemed
3 expiration date according to item C.

4 B. If an application for renewal has been filed at
5 least 30 days before the expiration date stated in the existing
6 license, or 30 days before the deemed expiration date under item
7 C, the existing license expires at the end of the day on which
8 the commissioner makes a final determination to deny the renewal
9 application or, if the determination states an expiration date,
10 the expiration date stated in the determination.

11 C. A specific license that has an expiration date
12 after July 1, 1995, and is not one of the licenses described in
13 item D, is deemed to have an expiration date that is five years
14 after the expiration date stated in the current license.

15 D. The following specific licenses are not subject
16 to, or otherwise affected by, item C:

17 (1) a specific license for which, on February 15,
18 1996, an evaluation or an emergency plan is required according
19 to part 4731.3065, subpart 4, item A;

20 (2) a specific license whose holder is subject to
21 the financial assurance requirements under part 4731.3080, and
22 on February 15, 1996, the holder:

23 (a) has not submitted a decommissioning
24 funding plan or certification of financial assurance for
25 decommissioning; or

26 (b) has not received written notice that the
27 decommissioning funding plan or certification of financial

1 assurance for decommissioning is acceptable; and

2 (3) a specific license whose holder is on the
3 list of contaminated sites maintained for the NRC's site
4 decommissioning management plan (SDMP) and published in Site
5 Decommissioning Management Plan, NUREG-1444, Supplement 1
6 (November 1995).

7 Subp. 2. Revocation. A specific license revoked by the
8 commissioner expires at the end of the day on the date of the
9 commissioner's final determination to revoke the license, on the
10 expiration date stated in the determination, or as otherwise
11 provided by a commissioner's order.

12 Subp. 3. Termination notice. A specific license continues
13 in effect, beyond the expiration date if necessary, with respect
14 to possession of radioactive material, until the commissioner
15 notifies the licensee in writing that the license is
16 terminated. During this time, the licensee must:

17 A. limit actions involving radioactive material to
18 those related to decommissioning; and

19 B. continue to control entry to restricted areas
20 until they are suitable for release according to this chapter.

21 Subp. 4. Decommissioning.

22 A. Within 60 days of any of the occurrences under
23 item B, and consistent with the administrative directions under
24 part 4731.0200, subpart 4 3, a licensee must provide
25 notification to the commissioner in writing of such occurrence
26 and:

27 (1) begin decommissioning the licensee's site or

1 any separate building or outdoor area that contains residual
2 radioactivity so that the building or outdoor area is suitable
3 for release according to this chapter; or

4 (2) submit within 12 months of notification a
5 decommissioning plan, if required under item E, and begin
6 decommissioning upon approval of that plan.

7 B. Notice under item A is required when:

8 (1) the license has expired under subpart 1 or 2;

9 (2) the licensee has decided to permanently cease
10 principal activities at the entire site or in any separate
11 building or outdoor area that contains residual radioactivity
12 such that the building or outdoor area is unsuitable for release
13 according to this chapter;

14 (3) no principal activities have been conducted
15 under the license for a period of 24 months; or

16 (4) no principal activities have been conducted
17 for a period of 24 months in any separate building or outdoor
18 area that contains residual radioactivity such that the building
19 or outdoor area is unsuitable for release according to this
20 chapter.

21 C. Coincident with the notification required under
22 item A, the licensee must maintain in effect all decommissioning
23 financial assurances established by the licensee under part
24 4731.3080 in conjunction with license issuance or renewal or as
25 required under this part. The amount of the financial assurance
26 must be increased, or may be decreased, as appropriate, to cover
27 the detailed cost estimate for decommissioning established under

1 item H, subitem (5). Following approval of the decommissioning
2 plan, a licensee may reduce the amount of the financial
3 assurance as decommissioning proceeds and radiological
4 contamination is reduced at the site with the approval of the
5 commissioner.

6 D. The commissioner may grant a request to extend the
7 time periods established under item A if the commissioner
8 determines that this relief is not detrimental to the public
9 health and safety and is otherwise in the public interest. The
10 request must be submitted no later than 30 days before
11 notification under item A. The schedule for decommissioning in
12 this subpart may not commence until the commissioner has made a
13 determination on the request.

14 E. A decommissioning plan must be submitted if:
15 (1) required by a license condition; or
16 (2) the procedures and activities necessary to
17 carry out decommissioning of the site or separate building or
18 outdoor area have not been previously approved by the
19 commissioner and the procedures could increase potential health
20 and safety impacts to workers or the public, as in any of the
21 following cases:

22 (a) procedures would involve techniques not
23 applied routinely during cleanup and maintenance operations;

24 (b) workers would be entering areas not
25 normally occupied where surface contamination and radiation
26 levels are significantly higher than routinely encountered
27 during operation;

1 (c) procedures could result in significantly
2 greater airborne concentrations of radioactive materials than
3 are present during operation; or

4 (d) procedures could result in significantly
5 greater releases of radioactive material to the environment than
6 those associated with operation.

7 F. The commissioner may approve an alternate schedule
8 for submittal of a decommissioning plan required under this
9 subpart if the commissioner determines that the alternative
10 schedule is necessary to the effective conduct of
11 decommissioning operations and presents no undue risk from the
12 radiation to the public health and safety and is otherwise in
13 the public interest.

14 G. Procedures such as those under item E, subitem
15 (2), with potential health and safety impacts, may not be
16 performed before approval of the decommissioning plan.

17 H. The proposed decommissioning plan for the site or
18 separate building or outdoor area must include:

19 (1) a description of the conditions of the site
20 or separate building or outdoor area sufficient to evaluate the
21 acceptability of the plan;

22 (2) a description of planned decommissioning
23 activities;

24 (3) a description of the methods used to ensure
25 protection of workers and the environment against radiation
26 hazards during decommissioning;

27 (4) a description of the planned final radiation

1 survey;

2 (5) an updated detailed cost estimate for
3 decommissioning, comparison of that estimate with present funds
4 set aside for decommissioning, and a plan for ensuring the
5 availability of adequate funds for completion of
6 decommissioning; and

7 (6) for decommissioning plans calling for
8 completion of decommissioning later than 24 months after plan
9 approval, a justification for the delay based on the criteria in
10 item K.

11 I. The commissioner shall approve a proposed
12 decommissioning plan if the information in the plan demonstrates
13 that the decommissioning will be completed as soon as
14 practicable and that the health and safety of the workers and
15 the public will be adequately protected.

16 J. Except as provided in item K, a licensee must:

17 (1) complete decommissioning of the site or
18 separate building or outdoor area as soon as practicable but no
19 later than 24 months following the initiation of
20 decommissioning; and

21 (2) request license termination as soon as
22 practicable but no later than 24 months following the initiation
23 of decommissioning, when decommissioning involves the entire
24 site.

25 K. The commissioner may approve a request for an
26 alternative schedule for completion of decommissioning of the
27 site or separate building or outdoor area, and license

1 termination if appropriate, if the commissioner determines that
2 the alternative is warranted by consideration of the following:

3 (1) whether it is technically feasible to
4 complete decommissioning within the allotted 24-month period;

5 (2) whether sufficient waste disposal capacity is
6 available to allow completion of decommissioning within the
7 allotted 24-month period;

8 (3) whether a significant volume reduction in
9 wastes requiring disposal will be achieved by allowing
10 short-lived radionuclides to decay;

11 (4) whether a significant reduction in radiation
12 exposure to workers can be achieved by allowing short-lived
13 radionuclides to decay; and

14 (5) other site-specific factors that the
15 commissioner may consider appropriate on a case-by-case basis,
16 such as the regulatory requirements of other governmental
17 agencies, lawsuits, groundwater treatment activities, monitored
18 natural groundwater restoration, actions that could result in
19 more environmental harm than deferring clean up, and other
20 factors beyond the control of the licensee.

21 L. As the final step in decommissioning, the licensee
22 must:

23 (1) certify the disposition of all licensed
24 material, including accumulated wastes, by submitting a
25 completed NRC Form 314 or equivalent information; and

26 (2) conduct a radiation survey of the premises
27 where the licensed activities were carried out and submit a

1 report of the results of the survey, unless the licensee
2 demonstrates in some other manner that the premises are suitable
3 for release according to part 4731.2100. The licensee must, as
4 appropriate:

5 (a) for gamma radiation, report levels of
6 radiation in units of microroentgens (millisieverts) per hour at
7 one meter from surfaces;

8 (b) for radioactivity, including alpha and
9 beta radiation, report levels of radiation in units of
10 disintegrations per minute or microcuries (megabecquerels) per
11 100 square centimeters removable and fixed for surfaces,
12 microcuries (megabecquerels) per milliliter for water, and
13 picocuries (becquerels) per gram for solids such as soils or
14 concrete; and

15 (c) specify the survey instruments used and
16 certify that each instrument is properly calibrated and tested.

17 M. Specific licenses, including expired licenses,
18 shall be terminated by written notice to the licensee when the
19 commissioner determines that:

20 (1) radioactive material has been properly
21 disposed of;

22 (2) reasonable effort has been made to eliminate
23 residual radioactive contamination, if present;

24 (3) a radiation survey has been performed that
25 demonstrates, or other information submitted by the licensee is
26 sufficient to demonstrate, that the premises are suitable for
27 release according to part 4731.2100; and

1 (4) records required under part 4731.3115,
2 subparts 3 and 5, have been received.

3 4731.3090 RENEWAL AND AMENDMENT OF LICENSES.

4 Subpart 1. Renewal application. Applications for renewal
5 of a specific license must be filed on an application for
6 radioactive material license form, as prescribed by the
7 commissioner, according to part 4731.3065.

8 Subp. 2. Extension; renewal pending. If a licensee
9 granted the extension described under part 4731.3085, subpart 1,
10 item C, has a currently pending renewal application for the
11 extended license, the application shall be considered withdrawn
12 by the licensee and any renewal fees paid by the licensee for
13 the application shall be refunded.

14 Subp. 3. Amendment applications. Applications for
15 amendment of a license must be filed on an application for
16 radioactive material license form, as prescribed by the
17 commissioner, according to part 4731.3065 and must specify the
18 respects in which the licensee desires the license to be amended
19 and the grounds for the amendment.

20 Subp. 4. Consideration criteria. In considering an
21 application by a licensee to renew or amend a license, the
22 commissioner shall apply the applicable criteria under parts
23 4731.3070 and 4731.3300 to 4731.7280.

24 4731.3105 TRANSFER OF RADIOACTIVE MATERIAL.

25 Subpart 1. Authorization required. No licensee shall
26 transfer radioactive material except as authorized under this

1 chapter.

2 Subp. 2. Approved transfer. Except as otherwise provided
3 in a license and subject to subpart 3, a licensee may transfer
4 radioactive material:

5 A. to the commissioner;

6 B. to the DOE or an agency in an agreement state that
7 regulates radioactive material;

8 C. to any person exempt from the licensing
9 requirements of parts 4731.3000 to 4731.3245, to the extent
10 permitted under the exemption;

11 D. to a person in an agreement state subject to the
12 jurisdiction of that state or the NRC who has been exempted from
13 the licensing requirements of that state or the NRC, to the
14 extent permitted under the exemption;

15 E. to a person authorized to receive radioactive
16 material under terms of a specific license or a general license
17 or their equivalents issued by the Atomic Energy Commission, the
18 NRC, or an agreement state; or

19 F. as otherwise authorized by the commissioner in
20 writing.

21 Subp. 3. Verification for transfer.

22 A. Before transferring radioactive material to a
23 specific licensee of the NRC or an agreement state, or to a
24 general licensee who is required to register with the NRC or an
25 agreement state before receipt of the radioactive material, the
26 licensee transferring the material must verify that the
27 transferee's license authorizes the receipt of the type, form,

1 and quantity of radioactive material to be transferred.

2 B. Any of the following methods of verification are
3 acceptable:

4 (1) the transferor may possess and read a current
5 copy of the transferee's specific license or general license
6 registration certificate;

7 (2) the transferor may possess a written
8 certification by the transferee that the transferee is
9 authorized by license or registration certificate to receive the
10 type, form, and quantity of radioactive material to be
11 transferred, specifying:

12 (a) the license or registration certificate
13 number;

14 (b) the issuing agency; and

15 (c) the expiration date;

16 (3) for emergency shipments, the transferor may
17 accept oral certification by the transferee that the transferee
18 is authorized by license or registration certificate to receive
19 the type, form, and quantity of radioactive material to be
20 transferred, specifying:

21 (a) the license or registration certificate
22 number;

23 (b) the issuing agency; and

24 (c) the expiration date.

25 The oral certification must be confirmed in writing within ten
26 days; or

27 (4) the transferor may obtain other information

1 compiled by a reporting service from official records of the NRC
2 or the licensing agency of an agreement state regarding the
3 identity of licensees or registrants and the scope and
4 expiration dates of the licenses or registrations.

5 Subp. 4. Confirmation. The transferor may obtain and
6 record confirmation from the NRC or the licensing agency of an
7 agreement state that the transferee is licensed to receive the
8 radioactive material:

9 A. when none of the methods of verification described
10 in subpart 3 are readily available; or

11 B. when a transferor desires to verify that
12 information received by one of the verification methods is
13 correct or up-to-date.

14 4731.3110 REPORTING REQUIREMENTS.

15 Subpart 1. Immediate notification required. A licensee
16 must notify the commissioner as soon as possible but not later
17 than four hours after the discovery of an event that prevents
18 immediate protective actions necessary to avoid exposures to
19 radiation or radioactive materials that could exceed regulatory
20 limits or releases of licensed material that could exceed
21 regulatory limits. Reportable events under this subpart include
22 fires, explosions, toxic gas release, or similar hazards.

23 Subp. 2. 24-hour notification required. A licensee must
24 notify the commissioner within 24 hours after discovery of any
25 of the following events involving licensed material:

26 A. an unplanned contamination event that:

27 (1) requires access to the contaminated area, by

1 workers or the public, to be restricted for more than 24 hours
2 by imposing additional radiological controls or by prohibiting
3 entry into the areas;

4 (2) involves a quantity of material greater than
5 five times the lowest annual limit on intake specified in part
6 4731.2750 for the material; and

7 (3) restricts access to the area for a reason
8 other than to allow isotopes with a half-life of less than 24
9 hours to decay prior to decontamination;

10 B. an event in which equipment is disabled or fails
11 to function as designed when:

12 (1) the equipment is required by rule or license
13 condition to prevent releases exceeding regulatory limits, to
14 prevent exposure to radiation and radioactive materials
15 exceeding regulatory limits, or to mitigate the consequences of
16 an accident;

17 (2) the equipment is required to be available and
18 operable when it is disabled or fails to function; and

19 (3) no redundant equipment is available and
20 operable to perform the required safety function;

21 C. an event that requires unplanned medical treatment
22 at a medical facility of an individual with spreadable
23 radioactive contamination on the individual's clothing or body;
24 or

25 D. an unplanned fire or explosion that damages any
26 licensed material or any device, container, or equipment
27 containing licensed materials when:

1 (1) the quantity of material involved is five
2 times the lowest annual limit on intake specified in part
3 4731.2750 for the material; and

4 (2) the damage affects the integrity of the
5 licensed material or its container.

6 Subp. 3. Preparation and submission of reports.

7 A. A licensee must make reports required under
8 subparts 1 and 2 by telephone to the commissioner. To the
9 extent that the information is available at the time of
10 notification, the information provided in the report must
11 include:

12 (1) the caller's name and call-back telephone
13 number;

14 (2) a description of the event, including date
15 and time;

16 (3) the exact location of the event;

17 (4) the isotopes, quantities, and chemical and
18 physical form of the licensed material involved; and

19 (5) any personnel radiation exposure data
20 available.

21 B. A licensee who makes a report required under
22 subpart 1 or 2 must submit a written follow-up report within 30
23 days of the initial report. Written reports prepared as
24 required by other rules may be submitted to fulfill this
25 requirement if the reports contain all of the necessary
26 information and the appropriate distribution is made. The
27 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.

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.

1 D. A licensee who disposed of the material must
2 retain each record of disposal of radioactive material until the
3 commissioner terminates each license that authorizes the
4 disposal of the material.

5 Subp. 2. Retention.

6 A. A licensee must retain each record that is
7 required by this part or parts 4731.3200 to 4731.7280 or by
8 license condition for the period specified by the appropriate
9 rule or license condition.

10 B. If a retention period is not otherwise specified
11 by rule or license condition, the record must be retained until
12 the commissioner terminates the license that authorizes the
13 activity that is subject to the record-keeping requirement.

14 C. If there is a conflict between this chapter, a
15 license condition, or other written commissioner approval or
16 authorization pertaining to the retention period for the same
17 type of record, the retention period specified in this chapter
18 applies unless the commissioner, under part 4731.3010, grants a
19 specific exemption from the record retention requirements
20 specified in this chapter.

21 D. Required records must be maintained according to
22 part 4731.0210.

23 Subp. 3. Transfer to commissioner. Prior to license
24 termination, a licensee authorized to possess radioactive
25 material with a half-life greater than 120 days, in an unsealed
26 form, must forward the following records to the commissioner:

27 A. records of disposal of licensed material made

1 under parts 4731.2410 to 4731.2440, including burials authorized
2 before January 28, 1981; and

3 B. records required under part 4731.2510, subpart 2,
4 item D.

5 Subp. 4. Transfer to new licensee. If licensed activities
6 are transferred or assigned under part 4731.3075, subpart 2, a
7 licensee authorized to possess radioactive material, with a
8 half-life greater than 120 days, in an unsealed form, must
9 transfer the following records to the new licensee and the new
10 licensee is responsible for maintaining the records until the
11 license is terminated:

12 A. records of disposal of licensed material made
13 under parts 4731.2410 to 4731.2440, including burials authorized
14 before January 28, 1981; and

15 B. records required under part 4731.2510, subpart 2,
16 item D.

17 Subp. 5. Decommissioning records. Prior to license
18 termination, a licensee must forward the records required under
19 part 4731.3080, subpart 7, to the commissioner.

20 4731.3120 INSPECTIONS AND TESTS.

21 Subpart 1. Material and premises inspection. A licensee
22 must afford to the commissioner at all reasonable times
23 opportunity to inspect radioactive material and the premises and
24 facilities wherein radioactive material is used or stored.

25 Subp. 2. Record inspection. A licensee must make
26 available to the commissioner for inspection, upon reasonable
27 notice, records kept by the licensee as required under this

1 chapter.

2 Subp. 3. Testing.

3 A. A licensee must perform, or permit the
4 commissioner to perform, such tests as the commissioner deems
5 appropriate or necessary for the administration of this chapter,
6 including tests of:

7 (1) radioactive material;

8 (2) facilities wherein radioactive material is
9 utilized or stored;

10 (3) radiation detection and monitoring
11 instruments; and

12 (4) other equipment and devices used in
13 connection with the utilization or storage of radioactive
14 material.

15 4731.3130 MODIFICATION AND REVOCATION OF LICENSES.

16 A. The terms and conditions of a license issued under
17 parts 4731.3000 to 4731.3245 are subject to amendment, revision,
18 or modification by reason of rules and orders issued according
19 to this chapter.

20 B. A license may be revoked, suspended, or modified,
21 in whole or in part, for any material false statement in the
22 application or any statement of fact required under Section 182
23 of the Act, or because of conditions revealed by such
24 application or statement of fact or any report, record, or
25 inspection or other means, which would warrant the commissioner
26 to refuse to grant a license on an original application or for
27 violation of or failure to observe any of the terms and

1 provisions of any rule or order of the commissioner.

2 C. Except in cases of willfulness or those in which
3 the public health, interest, or safety requires otherwise, no
4 license must be modified, suspended, or revoked unless, prior to
5 the institution of proceedings therefore, facts or conduct that
6 may warrant such action are called to the attention of the
7 licensee in writing and the licensee is accorded an opportunity
8 to demonstrate or achieve compliance with all lawful
9 requirements.

10 4731.3135 WITHHOLDING OR RECALL OF RADIOACTIVE MATERIAL.

11 The commissioner may cause the withholding or recall of
12 radioactive material from a licensee who is not equipped to
13 observe or fails to observe safety standards to protect health
14 as may be established by the commissioner or who uses
15 radioactive materials in violation of law or rule of the
16 commissioner or in a manner other than as disclosed in the
17 license application therefore or approved by the commissioner.

18 4731.3140 EXEMPT CONCENTRATIONS.

19 Subpart 1. Parent isotope. Many radioisotopes
20 disintegrate into isotopes that are also radioactive. In
21 expressing the concentrations in subpart 3, the activity stated
22 is that of the parent isotope and takes into account the
23 daughters.

24 Subp. 2. Combination of isotopes. For purposes of part
25 4731.3025, where a combination of isotopes is involved, the
26 limit for the combination should be derived as follows:

1 determine for each isotope in the product the ratio between the
 2 concentration present in the product and the exempt
 3 concentration established in subpart 3 for the specific isotope
 4 when not in combination. The sum of the ratios may not exceed
 5 one.

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

10 Exempt concentration of
 11 isotope A
 12
 13 Subp. 3. Exempt concentrations.

		Column I	Column II
		Gas concen-	Liquid and
		tration	solid concen-
Element	Isotope	$\mu\text{Ci/ml}^1$	tration $\mu\text{Ci/ml}^2$
(atomic number)			
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}

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1	Chlorine (17)	Cl 38	9×10^{-7}	4×10^{-3}
2	Chromium (24)	Cr 51		2×10^{-2}
3	Cobalt (27)	Co 57		5×10^{-3}
4		Co 58		1×10^{-3}
5		Co 60		5×10^{-4}
6	Copper (29)	Cu 64		3×10^{-3}
7				
8	Dysprosium (66)	Dy 165		4×10^{-3}
9		Dy 166		4×10^{-4}
10				
11	Erbium (68)	Er 169		9×10^{-4}
12		Er 171		1×10^{-3}
13	Europium (63)	Eu 152 (T/2=9.2 hrs)		6×10^{-4}
14		Eu 155		2×10^{-3}
15				
16	Fluorine (9)	F 18	2×10^{-6}	8×10^{-3}
17				
18	Gadolinium (64)	Gd 153		2×10^{-3}
19		Gd 159		8×10^{-4}
20	Gallium (31)	Ga 72		4×10^{-4}
21	Germanium (32)	Ge 71		2×10^{-2}
22	Gold (79)	Au 196		2×10^{-3}
23		Au 198		5×10^{-4}
24		Au 199		2×10^{-3}
25				
26	Hafnium (72)	Hf 181		7×10^{-4}
27	Hydrogen (1)	H 3	5×10^{-6}	3×10^{-2}
28				
29	Indium (49)	In 113m		1×10^{-2}
30		In 114m		2×10^{-4}
31	Iodine (53)	I 126	3×10^{-9}	2×10^{-5}
32		I 131	3×10^{-9}	2×10^{-5}
33		I 132	8×10^{-8}	6×10^{-4}
34		I 133	1×10^{-8}	7×10^{-5}
35		I 134	2×10^{-7}	1×10^{-3}
36	Iridium (77)	Ir 190		2×10^{-3}
37		Ir 192		4×10^{-4}
38		Ir 194		3×10^{-4}
39	Iron (26)	Fe 55		8×10^{-3}
40		Fe 59		6×10^{-4}
41				
42	Krypton (36)	Kr 85m	1×10^{-6}	
43		Kr 85	3×10^{-6}	
44				
45	Lanthanum (57)	La 140		2×10^{-4}
46	Lead (82)	Pb 203		4×10^{-3}
47	Lutetium (71)	Lu 177		1×10^{-3}
48				
49	Manganese (25)	Mn 52		3×10^{-4}
50		Mn 54		1×10^{-3}
51		Mn 56		1×10^{-3}
52	Mercury (80)	Hg 197m		2×10^{-3}
53		Hg 197		3×10^{-3}
54		Hg 203		2×10^{-4}

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1	Molybdenum (42)	Mo 99	2 x 10 ⁻³
2			
3	Neodymium (60)	Nd 147	6 x 10 ⁻⁴
4		Nd 149	3 x 10 ⁻³
5	Nickel (28)	Ni 65	1 x 10 ⁻³
6	Niobium (Columbium) (41)	Nb 95	1 x 10 ⁻³
7		Nb 97	9 x 10 ⁻³
8			
9	Osmium (76)	Os 185	7 x 10 ⁻⁴
10		Os 191m	3 x 10 ⁻²
11		Os 191	2 x 10 ⁻³
12		Os 193	6 x 10 ⁻⁴
13			
14	Palladium (46)	Pd 103	3 x 10 ⁻³
15		Pd 109	9 x 10 ⁻⁴
16	Phosphorus (15)	P 32	2 x 10 ⁻³
17	Platinum (78)	Pt 191	1 x 10 ⁻²
18		Pt 193m	1 x 10 ⁻²
19		Pt 197m	1 x 10 ⁻³
20		Pt 197	1 x 10 ⁻³
21	Potassium (19)	K 42	3 x 10 ⁻⁴
22	Praseodymium (59)	Pr 142	3 x 10 ⁻⁴
23		Pr 143	5 x 10 ⁻³
24	Promethium (61)	Pm 147	2 x 10 ⁻⁴
25		Pm 149	4 x 10 ⁻⁴
26			
27	Rhenium (75)	Re 183	6 x 10 ⁻³
28		Re 186	9 x 10 ⁻⁴
29		Re 188	6 x 10 ⁻¹
30	Rhodium (45)	Rh 103m	1 x 10 ⁻³
31		Rh 105	1 x 10 ⁻⁴
32	Rubidium (37)	Rb 86	7 x 10 ⁻⁴
33	Ruthenium (44)	Ru 97	4 x 10 ⁻⁴
34		Ru 103	8 x 10 ⁻³
35		Ru 105	1 x 10 ⁻⁴
36		Ru 106	1 x 10 ⁻⁴
37			
38	Samarium (62)	Sm 153	8 x 10 ⁻⁴
39	Scandium (21)	Sc 46	4 x 10 ⁻⁴
40		Sc 47	9 x 10 ⁻⁴
41		Sc 48	3 x 10 ⁻³
42	Selenium (34)	Se 75	3 x 10 ⁻³
43	Silicon (14)	Si 31	9 x 10 ⁻³
44	Silver (47)	Ag 105	1 x 10 ⁻⁴
45		Ag 110m	3 x 10 ⁻⁴
46		Ag 111	4 x 10 ⁻³
47	Sodium (11)	Na 24	2 x 10 ⁻³
48	Strontium (38)	Sr 85	1 x 10 ⁻³
49		Sr 89	1 x 10 ⁻⁴
50		Sr 91	7 x 10 ⁻⁴
51		Sr 92	7 x 10 ⁻⁴
52	Sulfur (16)	S 35	9 x 10 ⁻⁸
53			
54	Tantalum (73)	Ta 182	4 x 10 ⁻⁴

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1	Technetium (43)	Tc 96m		1 x 10 ⁻¹
2		Tc 96		1 x 10 ⁻³
3	Tellurium (52)	Te 125m		2 x 10 ⁻⁴
4		Te 125m		6 x 10 ⁻³
5		Te 127		3 x 10 ⁻⁴
6		Te 129m		3 x 10 ⁻⁴
7		Te 131m		6 x 10 ⁻⁴
8		Te 132		3 x 10 ⁻⁴
9	Terbium (65)	Tb 160		4 x 10 ⁻³
10	Thallium (81)	Tl 200		4 x 10 ⁻³
11		Tl 201		3 x 10 ⁻³
12		Tl 202		1 x 10 ⁻³
13		Tl 204		1 x 10 ⁻⁴
14	Thulium (69)	Tm 170		5 x 10 ⁻³
15		Tm 171		5 x 10 ⁻⁴
16	Tin (50)	Sn 113		9 x 10 ⁻⁴
17		Sn 125		2 x 10 ⁻³
18	Tungsten (Wolfram) (74)	W 181		4 x 10 ⁻⁴
19		W 187		7 x 10 ⁻⁴
20				
21	Vanadium (23)	V 48		3 x 10 ⁻⁴
22				
23	Xenon (54)	Xe 131m	4 x 10 ⁻⁶	
24		Xe 133	3 x 10 ⁻⁶	
25		Xe 135	1 x 10 ⁻⁶	
26				
27	Ytterbium (70)	Yb 175		1 x 10 ⁻³
28	Yttrium (39)	Y 90		2 x 10 ⁻⁴
29		Y 91m		3 x 10 ⁻⁴
30		Y 91		3 x 10 ⁻⁴
31		Y 92		6 x 10 ⁻⁴
32		Y 93		3 x 10 ⁻⁴
33				
34	Zinc (30)	Zn 65		1 x 10 ⁻³
35		Zn 69m		7 x 10 ⁻⁴
36		Zn 69		2 x 10 ⁻²
37	Zirconium (40)	Zr 95		6 x 10 ⁻⁴
38		Zr 97		2 x 10 ⁻⁴
39				
40	Beta- or gamma-		1 x 10 ⁻¹⁰	1 x 10 ⁻⁶
41	emitting radioactive			
42	material not listed			
43	above with half-life			
44	less than three years			
45				

46 ¹Values are given only for those materials normally used as
 47 gases.

48 ²μCi/gm for solids.

49 4731.3145 EXEMPT QUANTITIES.

	Radioactive Material	Microcuries
1		
2		
3	Antimony 122 (Sb 122)	100
4	Antimony 124 (Sb 124)	10
5	Antimony 125 (Sb 125)	10
6	Arsenic 73 (As 73)	100
7	Arsenic 74 (As 74)	10
8	Arsenic 76 (As 76)	10
9	Arsenic 77 (As 77)	100
10		
11	Barium 131 (Ba 131)	10
12	Barium 133 (Ba 133)	10
13	Barium 140 (Ba 140)	10
14	Bismuth 210 (Bi 210)	1
15	Bromine 82 (Br 82)	10
16		
17	Cadmium 109 (Cd 109)	10
18	Cadmium 115m (Cd 115m)	10
19	Cadmium 115 (Cd 115)	100
20	Calcium 45 (Ca 45)	10
21	Calcium 47 (Ca 47)	10
22	Carbon 11 (C 11)	1,000
23	Carbon 14 (C 14)	100
24	Cerium 141 (Ce 141)	100
25	Cerium 143 (Ce 143)	100
26	Cerium 144 (Ce 144)	1
27	Cesium 131 (Cs 131)	1,000
28	Cesium 134m (Cs 134m)	100
29	Cesium 134 (Cs 134)	1
30	Cesium 135 (Cs 135)	10
31	Cesium 136 (Cs 136)	10
32	Cesium 137 (Cs 137)	10
33	Chlorine 36 (Cl 36)	10
34	Chlorine 38 (Cl 38)	10
35	Chromium 51 (Cr 51)	1,000
36	Cobalt 57 (Co 57)	100
37	Cobalt 58m (Co 58m)	10
38	Cobalt 58 (Co 58)	10
39	Cobalt 60 (Co 60)	1
40	Copper 64 (Cu 64)	100
41		
42	Dysprosium 165 (Dy 165)	10
43	Dysprosium 166 (Dy 166)	100
44		
45	Erbium 169 (Er 169)	100
46	Erbium 171 (Er 171)	100
47	Europium 152 9.2 h (Eu 152 9.2 h)	100
48	Europium 152 13 yr (Eu 152 13 yr)	1
49	Europium 154 (Eu 154)	1
50	Europium 155 (Eu 155)	10
51		
52	Fluorine 18 (F 18)	1,000
53		
54	Gadolinium 153 (Gd 153)	10

1	Gadolinium 159 (Gd 159)	100
2	Gallium 67 (Ga 67)	100
3	Gallium 72 (Ga 72)	10
4	Germanium 68 (Ge 68)	10
5	Germanium 71 (Ge 71)	100
6	Gold 195 (Au 195)	10
7	Gold 198 (Au 198)	100
8	Gold 199 (Au 199)	100
9		
10	Hafnium 181 (Hf 181)	10
11	Holmium 166 (Ho 166)	100
12	Hydrogen 3 (H 3)	1,000
13		
14	Indium 111 (In 111)	100
15	Indium 113m (In 113m)	100
16	Indium 114m (In 114m)	10
17	Indium 115m (In 115m)	100
18	Indium 115 (In 115)	10
19	Iodine 123 (I 123)	100
20	Iodine 125 (I 125)	1
21	Iodine 126 (I 126)	1
22	Iodine 129 (I 129)	0.1
23	Iodine 131 (I 131)	1
24	Iodine 132 (I 132)	10
25	Iodine 133 (I 133)	1
26	Iodine 134 (I 134)	10
27	Iodine 135 (I 135)	10
28	Iridium 192 (Ir 192)	10
29	Iridium 194 (Ir 194)	100
30	Iron 52 (Fe 52)	10
31	Iron 55 (Fe 55)	100
32	Iron 59 (Fe 59)	10
33		
34	Krypton 85 (Kr 85)	100
35	Krypton 87 (Kr 87)	10
36		
37	Lanthanum 140 (La 140)	10
38	Lutetium 177 (Lu 177)	100
39		
40	Manganese 52 (Mn 52)	10
41	Manganese 54 (Mn 54)	10
42	Manganese 56 (Mn 56)	10
43	Mercury 197m (Hg 197m)	100
44	Mercury 197 (Hg 197)	100
45	Mercury 203 (Hg 203)	10
46	Molybdenum 99 (Mo 99)	100
47		
48	Neodymium 147 (Nd 147)	100
49	Neodymium 149 (Nd 149)	100
50	Nickel 59 (Ni 59)	100
51	Nickel 63 (Ni 63)	10
52	Nickel 65 (Ni 65)	100
53	Niobium 93m (Nb 93m)	10
54	Niobium 95 (Nb 95)	10

1	Niobium 97 (Nb 97)	10
2	Nitrogen 13 (N 13)	1,000
3		
4	Osmium 185 (Os 185)	10
5	Osmium 191m (Os 191m)	100
6	Osmium 191 (Os 191)	100
7	Osmium 193 (Os 193)	100
8	Oxygen 15 (O 15)	1,000
9		
10	Palladium 103 (Pd 103)	100
11	Palladium 109 (Pd 109)	100
12	Phosphorus 32 (P 32)	10
13	Platinum 191 (Pt 191)	100
14	Platinum 193m (Pt 193m)	100
15	Platinum 193 (Pt 193)	100
16	Platinum 197m (Pt 197m)	100
17	Platinum 197 (Pt 197)	100
18	Polonium 210 (Po 210)	0.1
19	Potassium 42 (K 42)	10
20	Praseodymium 142 (Pr 142)	100
21	Praseodymium 143 (Pr 143)	100
22	Promethium 147 (Pm 147)	10
23	Promethium 149 (Pm 149)	10
24		
25	Radium 226 (Ra 226)	1
26	Rhenium 186 (Re 186)	100
27	Rhenium 188 (Re 188)	100
28	Rhodium 103m (Rh 103m)	100
29	Rhodium 105 (Rh 105)	100
30	Rubidium 81 (Rb 81)	10
31	Rubidium 86 (Rb 86)	10
32	Rubidium 87 (Rb 87)	10
33	Ruthenium 97 (Ru 97)	100
34	Ruthenium 103 (Ru 103)	10
35	Ruthenium 105 (Ru 105)	10
36	Ruthenium 106 (Ru 106)	1
37		
38	Samarium 151 (Sm 151)	10
39	Samarium 153 (Sm 153)	100
40	Scandium 46 (Sc 46)	10
41	Scandium 47 (Sc 47)	100
42	Scandium 48 (Sc 48)	10
43	Selenium 75 (Se 75)	10
44	Silicon 31 (Si 31)	100
45	Silver 105 (Ag 105)	10
46	Silver 110m (Ag 110m)	1
47	Silver 111 (Ag 111)	100
48	Sodium 22 (Na 22)	10
49	Sodium 24 (Na 24)	10
50	Strontium 85 (Sr 85)	10
51	Strontium 89 (Sr 89)	1
52	Strontium 90 (Sr 90)	0.1
53	Strontium 91 (Sr 91)	10
54	Strontium 92 (Sr 92)	10

1	Sulfur 35 (S 35)	100
2		
3	Tantalum 182 (Ta 182)	10
4	Technetium 96 (Tc 96)	10
5	Technetium 97m (Tc 97m)	100
6	Technetium 97 (Tc 97)	100
7	Technetium 99m (Tc 99m)	100
8	Technetium 99 (Tc 99)	10
9	Tellurium 125m (Te 125m)	10
10	Tellurium 127m (Te 127m)	10
11	Tellurium 127 (Te 127)	100
12	Tellurium 129m (Te 129m)	10
13	Tellurium 129 (Te 129)	100
14	Tellurium 131m (Te 131m)	10
15	Tellurium 132 (Te 132)	10
16	Terbium 160 (Tb 160)	10
17	Thallium 200 (Tl 200)	100
18	Thallium 201 (Tl 201)	100
19	Thallium 202 (Tl 202)	100
20	Thallium 204 (Tl 204)	10
21	Thulium 170 (Tm 170)	10
22	Thulium 171 (Tm 171)	10
23	Tin 113 (Sn 113)	10
24	Tin 125 (Sn 125)	10
25	Tungsten 181 (W 181)	10
26	Tungsten 185 (W 185)	10
27	Tungsten 187 (W 187)	100
28		
29	Vanadium 48 (V 48))	10
30		
31	Xenon 131m (Xe 131m)	1,000
32	Xenon 133 (Xe 133)	100
33	Xenon 135 (Xe 135)	100
34		
35	Ytterbium 175 (Yb 175)	100
36	Yttrium 88 (Y 88)	10
37	Yttrium 90 (Y 90)	10
38	Yttrium 91 (Y 91)	10
39	Yttrium 92 (Y 92)	100
40	Yttrium 93 (Y 93)	100
41		
42	Zinc 65 (Zn 65)	10
43	Zinc 69m (Zn 69m)	100
44	Zinc 69 (Zn 69)	1,000
45	Zirconium 93 (Zr 93)	10
46	Zirconium 95 (Zr 95)	10
47	Zirconium 97 (Zr 97)	10
48		
49	Any radioactive material not	
50	listed above other than alpha-	
51	emitting radioactive materials	0.1
52		

1 4731.3150 RADIOACTIVE MATERIALS; EMERGENCY PLAN QUANTITIES.

2 This part specifies quantities of radioactive materials
 3 requiring consideration of the need for an emergency plan for
 4 responding to a release.

5		Release	Quantity
6	Radioactive material ¹	fraction	(curies)
7			
8	Actinium-228	0.001	4,000
9	Americium-241	0.001	2
10	Americium-242	0.001	2
11	Americium-243	0.001	2
12	Antimony-124	0.01	4,000
13	Antimony-126	0.01	6,000
14			
15	Barium-133	0.01	10,000
16	Barium-140	0.01	30,000
17	Bismuth-207	0.01	5,000
18	Bismuth-210	0.01	600
19			
20	Cadmium-109	0.01	1,000
21	Cadmium-113	0.01	80
22	Calcium-45	0.01	20,000
23	Californium-252	0.001	9 (20 mg)
24	Carbon-14 (noncarbon dioxide)	0.01	50,000
25	Cerium-141	0.01	10,000
26	Cerium-144	0.01	300
27	Cesium-134	0.01	2,000
28	Cesium-137	0.01	3,000
29	Chlorine-36	0.5	100
30	Chromium-51	0.01	300,000
31	Cobalt-60	0.001	5,000
32	Copper-64	0.01	200,000
33	Curium-242	0.001	60
34	Curium-243	0.001	3
35	Curium-244	0.001	4
36	Curium-245	0.001	2
37			
38	Europium-152	0.01	500
39	Europium-154	0.01	400
40	Europium-155	0.01	3,000
41			
42	Germanium-68	0.01	2,000
43	Gadolinium-153	0.01	5,000
44	Gold-198	0.01	30,000
45			
46	Hafnium-172	0.01	400
47	Hafnium-181	0.01	7,000
48	Holmium-166m	0.01	100
49	Hydrogen-3	0.5	20,000
50			

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1	Iodine-125	0.5	1
2	Iodine-131	0.5	10
3	Indium-114m	0.01	1,000
4	Iridium-192	0.001	40,000
5	Iron-55	0.01	40,000
6	Iron-59	0.01	7,000
7			
8	Krypton-85	1.0	6,000,000
9			
10	Lead-210	0.01	8
11			
12	Manganese-56	0.01	60,000
13	Mercury-203	0.01	10,000
14	Molybdenum-99	0.01	30,000
15			
16	Neptunium-237	0.001	2
17	Nickel-63	0.01	20,000
18	Niobium-94	0.01	300
19			
20	Phosphorus-32	0.5	100
21	Phosphorus-33	0.5	1,000
22	Polonium-210	0.01	10
23	Potassium-42	0.01	9,000
24	Promethium-145	0.01	4,000
25	Promethium-147	0.01	4,000
26			
27	Ruthenium-106	0.01	200
28			
29	Samarium-151	0.01	4,000
30	Scandium-46	0.01	3,000
31	Selenium-75	0.01	10,000
32	Silver-110m	0.01	1,000
33	Sodium-22	0.01	9,000
34	Sodium-24	0.01	10,000
35	Strontium-89	0.01	3,000
36	Strontium-90	0.01	90
37	Sulfur-35	0.5	900
38			
39	Technetium-99	0.01	10,000
40	Technetium-99m	0.01	400,000
41	Tellurium-127m	0.01	5,000
42	Tellurium-129m	0.01	5,000
43	Terbium-160	0.01	4,000
44	Thulium-170	0.01	4,000
45	Tin-113	0.01	10,000
46	Tin-123	0.01	3,000
47	Tin-126	0.01	1,000
48	Titanium-44	0.01	100
49			
50	Vanadium-48	0.01	7,000
51			
52	Xenon-133	1.0	900,000
53			
54	Yttrium-91	0.01	2,000

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1			
2	Zinc-65	0.01	5,000
3	Zirconium-93	0.01	400
4	Zirconium-95	0.01	5,000
5			
6	Any other beta-gamma emitter	0.01	10,000
7			
8	Mixed fission products	0.01	1,000
9			
10	Mixed corrosion products	0.01	10,000
11			
12	Contaminated equipment, beta-gamma	0.001	10,000
13			
14	Irradiated material, any form other		
15	than solid noncombustible	0.01	1,000
16			
17	Irradiated material, solid		
18	noncombustible	0.001	10,000
19			
20	Mixed radioactive waste, beta-gamma	0.01	1,000
21			
22	Packaged mixed waste, beta-gamma ²	0.001	10,000
23			
24	Any other alpha emitter	0.001	2
25			
26	Contaminated equipment, alpha	0.0001	20
27			
28	Packaged waste, alpha ²	0.0001	20
29			
30	Combinations of radioactive		
31	materials listed above ¹		
32			

33 ¹For combinations of radioactive materials, consideration
 34 of the need for an emergency plan is required if the sum of the
 35 ratios of the quantity of each radioactive material authorized
 36 to the quantity listed for that material in this part exceeds
 37 one.

38 ²Waste packaged in Type B containers does not require an
 39 emergency plan.

40 4731.3155 ASSURING DECOMMISSIONING FUNDS; PARENT COMPANY
 41 GUARANTEES.

42 Subpart 1. General requirement. An applicant or licensee

1 may provide reasonable assurance of the availability of funds
2 for decommissioning based on obtaining a parent company
3 guarantee that funds will be available for decommissioning costs
4 and on a demonstration that the parent company passes the
5 financial test under subpart 2. This part establishes criteria
6 for passing the financial test and for obtaining the parent
7 company guarantee.

8 Subp. 2. Financial test requirements.

9 A. To pass the financial test, a parent company must
10 meet the criteria of item B or C.

11 B. The parent company must have:

12 (1) two of the following three ratios:

13 (a) a ratio of total liabilities to net
14 worth less than 2.0;

15 (b) a ratio of the sum of net income plus
16 depreciation, depletion, and amortization to total liabilities
17 greater than 0.1; and

18 (c) a ratio of current assets to current
19 liabilities greater than 1.5;

20 (2) net working capital and tangible net worth
21 each at least six times the current decommissioning cost
22 estimates for the total of all facilities or parts thereof, or
23 prescribed amount if a certification is used, or, for a power
24 reactor licensee, at least six times the amount of
25 decommissioning funds being assured by a parent company
26 guarantee for the total of all reactor units or parts thereof.
27 Tangible net worth must be calculated to exclude the net book

1 value of the nuclear units;

2 (3) tangible net worth of at least \$10,000,000;

3 and

4 (4) assets located in the United States amounting
5 to at least 90 percent of the total assets or at least six times
6 the current decommissioning cost estimates for the total of all
7 facilities or parts thereof, or prescribed amount if a
8 certification is used, or, for a power reactor licensee, at
9 least six times the amount of decommissioning funds being
10 assured by a parent company guarantee for the total of all
11 reactor units or parts thereof.

12 C. The parent company must have:

13 (1) a current rating for its most recent bond
14 issuance of AAA, AA, A, or BBB as issued by Standard and Poor's
15 or Aaa, Aa, A, or Baa as issued by Moody's;

16 (2) tangible net worth at least six times the
17 current decommissioning cost estimates for the total of all
18 facilities or parts thereof, or prescribed amount if a
19 certification is used, or, for a power reactor licensee, at
20 least six times the amount of decommissioning funds being
21 assured by a parent company guarantee for the total of all
22 reactor units or parts thereof. Tangible net worth must be
23 calculated to exclude the net book value of the nuclear units;

24 (3) tangible net worth of at least \$10,000,000;

25 and

26 (4) assets located in the United States amounting
27 to at least 90 percent of the total assets or at least six times

1 the current decommissioning cost estimates for the total of all
2 facilities or parts thereof, or prescribed amount if a
3 certification is used, or, for a power reactor licensee, at
4 least six times the amount of decommissioning funds being
5 assured by a parent company guarantee for the total of all
6 reactor units or parts thereof.

7 Subp. 3. Audit. A parent company's independent certified
8 public accountant must compare the data used by the parent
9 company in the financial test, which must be derived from the
10 independently audited, year-end financial statements for the
11 latest fiscal year, with the amounts in such financial
12 statements. In connection with that procedure, the licensee
13 must inform the NRC within 90 days of any matters coming to the
14 auditor's attention that cause the auditor to believe that the
15 data in the financial test should be adjusted and that the
16 company no longer passes the test.

17 Subp. 4. Continued compliance.

18 A. After the initial financial test, a parent company
19 must repeat the passage of the test within 90 days after the
20 close of each succeeding fiscal year.

21 B. If a parent company no longer meets the
22 requirements of subpart 2, the licensee must send notice to the
23 commissioner of intent to establish alternate financial
24 assurance according to this chapter. The notice must be sent by
25 certified mail within 90 days after the end of the fiscal year
26 for which the year-end financial data show that the parent
27 company no longer meets the financial test requirements. The

1 licensee must provide alternate financial assurance within 120
2 days after the end of such fiscal year.

3 Subp. 5. Terms of guarantee. The terms of a parent
4 company guarantee that an applicant or licensee obtains must
5 provide that:

6 A. the parent company guarantee remains in force
7 unless the guarantor sends notice of cancellation by certified
8 mail to the licensee and the commissioner. Cancellation may not
9 occur, however, during the 120 days beginning on the date of
10 receipt of the notice of cancellation by both the licensee and
11 the commissioner, as evidenced by the return receipts;

12 B. if the licensee fails to provide alternate
13 financial assurance according to this chapter within 90 days
14 after receipt by the licensee and commissioner of a notice of
15 cancellation of the parent company guarantee from the guarantor,
16 the guarantor must provide alternative financial assurance in
17 the name of the licensee;

18 C. the parent company guarantee and financial test
19 provisions remain in effect until the commissioner terminates
20 the license; and

21 D. if a trust is established for decommissioning
22 costs, the trustee and trust must be acceptable to the
23 commissioner. An acceptable trustee includes an appropriate
24 state or federal government agency or an entity that has the
25 authority to act as a trustee and whose trust operations are
26 regulated and examined by a federal or state agency.

27 4731.3160 QUANTITIES OF LICENSED MATERIAL REQUIRING LABELING FOR

1 DECOMMISSIONING.

2 Subpart 1. Table. The following quantities of licensed
3 material require labeling for decommissioning:

4	Materials	Microcuries
5		
6	Americium-241	0.01
7	Antimony-122	100
8	Antimony-124	10
9	Antimony-125	10
10	Arsenic-73	100
11	Arsenic-74	10
12	Arsenic-76	10
13	Arsenic-77	100
14		
15	Barium-131	10
16	Barium-133	10
17	Barium-140	10
18	Bismuth-210	1
19	Bromine-82	10
20		
21	Cadmium-109	10
22	Cadmium-115m	10
23	Cadmium-115	100
24	Calcium-45	10
25	Calcium-47	10
26	Carbon-14	100
27	Cerium-141	100
28	Cerium-143	100
29	Cerium-144	1
30	Cesium-131	1,000
31	Cesium-134m	100
32	Cesium-134	1
33	Cesium-135	10
34	Cesium-136	10
35	Cesium-137	10
36	Chlorine-36	10
37	Chlorine-38	10
38	Chromium-51	1,000
39	Cobalt-58m	10
40	Cobalt-58	10
41	Cobalt-60	1
42	Copper-64	100
43		
44	Dysprosium-165	10
45	Dysprosium-166	100
46		
47	Erbium-169	100
48	Erbium-171	100
49	Europium-152 9.2h	100
50	Europium-152 13 yr	1
51	Europium-154	1

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1	Europium-155	10
2		
3	Fluorine-18	1,000
4		
5	Gadolinium-153	10
6	Gadolinium-159	100
7	Gallium-72	10
8	Germanium-71	100
9	Gold-198	100
10	Gold-199	100
11		
12	Hafnium-181	10
13	Holmium-166	100
14	Hydrogen-3	1,000
15		
16	Indium-113m	100
17	Indium-114m	10
18	Indium-115m	100
19	Indium-115	10
20	Iodine-125	1
21	Iodine-126	1
22	Iodine-129	0.1
23	Iodine-131	1
24	Iodine-132	10
25	Iodine-133	1
26	Iodine-134	10
27	Iodine-135	10
28	Iridium-192	10
29	Iridium-194	100
30	Iron-55	100
31	Iron-59	10
32		
33	Krypton-85	100
34	Krypton-87	10
35		
36	Lanthanum-140	10
37	Lutetium-177	100
38		
39	Manganese-52	10
40	Manganese-54	10
41	Manganese-56	10
42	Mercury-197m	100
43	Mercury-197	100
44	Mercury-203	10
45	Molybdenum-99	100
46		
47	Neodymium-147	100
48	Neodymium-149	100
49	Nickel-59	100
50	Nickel-63	10
51	Nickel-65	100
52	Niobium-93m	10
53	Niobium-95	10
54	Niobium-97	10

1		
2	Osmium-185	10
3	Osmium-191m	100
4	Osmium-191	100
5	Osmium-193	100
6		
7	Palladium-103	100
8	Palladium-109	100
9	Phosphorus-32	10
10	Platinum-191	100
11	Platinum-193m	100
12	Platinum-193	100
13	Platinum-197m	100
14	Platinum-197	100
15	Plutonium-239	0.01
16	Polonium-210	0.1
17	Potassium-42	10
18	Praseodymium-142	100
19	Praseodymium-143	100
20	Promethium-147	10
21	Promethium-149	10
22		
23	Radium-226	0.01
24	Rhenium-186	100
25	Rhenium-188	100
26	Rhodium-103m	100
27	Rhodium-105	100
28	Rubidium-86	10
29	Rubidium-87	10
30	Ruthenium-97	100
31	Ruthenium-103	10
32	Ruthenium-105	10
33	Ruthenium-106	1
34		
35	Samarium-151	10
36	Samarium-153	100
37	Scandium-46	10
38	Scandium-47	100
39	Scandium-48	10
40	Selenium-75	10
41	Silicon-31	100
42	Silver-105	10
43	Silver-110m	1
44	Silver-111	100
45	Sodium-24	10
46	Strontium-85	10
47	Strontium-89	1
48	Strontium-90	0.1
49	Strontium-91	10
50	Strontium-92	10
51	Sulfur-35	100
52		
53	Tantalum-182	10
54	Technetium-96	10

1	Technetium-97m	100
2	Technetium-97	100
3	Technetium-99m	100
4	Technetium-99	10
5	Tellurium-125m	10
6	Tellurium-127m	10
7	Tellurium-127	100
8	Tellurium-129m	10
9	Tellurium-129	100
10	Tellurium-131m	10
11	Tellurium-132	10
12	Terbium-160	10
13	Thallium-200	100
14	Thallium-201	100
15	Thallium-202	100
16	Thallium-204	10
17	Thorium (natural) ¹	100
18	Thulium-170	10
19	Thulium-171	10
20	Tin-113	10
21	Tin-125	10
22	Tungsten-181	10
23	Tungsten-185	10
24	Tungsten-187	100
25		
26	Uranium (natural) ²	100
27	Uranium-233	0.01
28	Uranium-234 -- Uranium-235	0.01
29		
30	Vanadium-48	10
31		
32	Xenon-131m	1,000
33	Xenon-133	100
34	Xenon-135	100
35		
36	Ytterbium-175	100
37	Yttrium-90	10
38	Yttrium-91	10
39	Yttrium-92	100
40	Yttrium-93	100
41		
42	Zinc-65	10
43	Zinc-69m	100
44	Zinc-69	1,000
45	Zirconium-93	10
46	Zirconium-95	10
47	Zirconium-97	10
48		
49	Any alpha-emitting radionuclide not	0.01
50	listed above or mixtures of alpha	
51	emitters of unknown composition	
52		
53	Any radionuclide other than alpha-	0.1
54	emitting radionuclides not	

1 listed above or mixtures of beta
2 emitters of unknown composition

3
4 ¹Based on alpha disintegration rate of Th-232, Th-230, and
5 their daughter products.

6 ²Based on alpha disintegration rate of U-238, U-234, and
7 U-235.

8 Subp. 2. Combination of isotopes. For purposes of parts
9 4731.3000 to 4731.3245, where a combination of isotopes in known
10 amounts is involved, the limit for the combination should be
11 derived as follows: determine, for each isotope in the
12 combination, the ratio between the quantity present in the
13 combination and the limit otherwise established for the specific
14 isotope when not in combination. The sum of such ratios for all
15 the isotopes in the combination must not exceed one.

16 4731.3165 ASSURING DECOMMISSIONING FUNDS; SELF-GUARANTEES; BOND
17 RATING.

18 Subpart 1. General requirement. This part applies to an
19 applicant or licensee that has a rated bond issuance and wishes
20 to self-guarantee. An applicant or licensee may provide
21 reasonable assurance of the availability of funds for
22 decommissioning based on furnishing its own guarantee that funds
23 will be available for decommissioning costs and on a
24 demonstration that the company passes the financial test under
25 subpart 2. This part establishes criteria for passing the
26 financial test for the self-guarantee and establishes the terms
27 for a self-guarantee.

28 Subp. 2. Financial test requirements. To pass the

1 financial test, a company must have:

2 A. tangible net worth at least ten times the total
3 current decommissioning cost estimate for the total of all
4 facilities or parts thereof, or the current amount required if
5 certification is used, or, for a power reactor licensee, at
6 least ten times the amount of decommissioning funds being
7 assured by a self-guarantee, for all decommissioning activities
8 for which the company is responsible as a self-guaranteeing
9 licensee and as a parent-guarantor for the total of all reactor
10 units or parts thereof. Tangible net worth must be calculated
11 to exclude the net book value of the nuclear units;

12 B. assets located in the United States amounting to
13 at least 90 percent of total assets or at least ten times the
14 total current decommissioning cost estimate for the total of all
15 facilities or parts thereof, or the current amount required if
16 certification is used, or, for a power reactor licensee, at
17 least ten times the amount of decommissioning funds being
18 assured by a self-guarantee, for all decommissioning activities
19 for which the company is responsible as a self-guaranteeing
20 licensee and as a parent-guarantor for the total of all reactor
21 units or parts thereof;

22 C. a current rating for its most recent bond issuance
23 of AAA, AA, or A as issued by Standard and Poor's or Aaa, Aa, or
24 A as issued by Moody's; and

25 D. at least one class of equity securities registered
26 under the Securities Exchange Act of 1934, United States Code,
27 title 15, sections 78a to 78mm.

1 Subp. 3. Audit. A company's independent certified public
2 accountant must compare the data used by the company in the
3 financial test, which must be derived from the independently
4 audited, year-end financial statements for the latest fiscal
5 year, with the amounts in such financial statements. In
6 connection with that procedure, the licensee must inform the
7 commissioner within 90 days of any matters coming to the
8 attention of the auditor that cause the auditor to believe that
9 the data in the financial test should be adjusted and that the
10 company no longer passes the test.

11 Subp. 4. Continued compliance.

12 A. After the initial financial test, a company must
13 repeat passage of the test within 90 days after the close of
14 each succeeding fiscal year.

15 B. If a licensee no longer meets the requirements of
16 subpart 2, the licensee must send immediate notice to the
17 commissioner of its intent to establish alternate financial
18 assurance according to this chapter within 120 days of the
19 notice.

20 Subp. 5. Terms of guarantee. The terms of a
21 self-guarantee that an applicant or licensee furnishes must
22 provide that:

23 A. the guarantee remains in force unless the licensee
24 sends notice of cancellation by certified mail to the
25 commissioner. Cancellation may not occur, however, during the
26 120 days beginning on the date of receipt of the notice of
27 cancellation by the commissioner, as evidenced by the return

1 receipt;

2 B. the licensee must provide alternative financial
3 assurance according to this chapter within 90 days following
4 receipt by the commissioner of a notice of cancellation of the
5 guarantee;

6 C. the guarantee and financial test provisions remain
7 in effect until the commissioner terminates the license or until
8 another financial assurance method acceptable to the
9 commissioner is put in effect by the licensee;

10 D. the licensee must promptly forward to the
11 commissioner and the licensee's independent auditor all reports
12 covering the latest fiscal year filed by the licensee with the
13 Securities and Exchange Commission according to section 13 of
14 the Securities Exchange Act of 1934, United States Code, title
15 15, section 78m;

16 E. if, at any time, the licensee's most recent bond
17 issuance ceases to be rated in any category of A or above by
18 either Standard and Poor's or Moody's, the licensee must provide
19 notice in writing of such fact to the commissioner within 20
20 days after publication of the change by the rating service. If
21 the licensee's most recent bond issuance ceases to be rated in
22 any category of A or above by both Standard and Poor's and
23 Moody's, the licensee no longer meets the requirements of
24 subpart 2; and

25 F. the applicant or licensee must provide to the
26 commissioner a written guarantee (a written commitment by a
27 corporate officer) that states that the licensee shall fund and

1 carry out the required decommissioning activities or, upon
2 issuance of an order by the commissioner, the licensee shall set
3 up and fund a trust in the amount of the current cost estimates
4 for decommissioning.

5 4731.3170 ASSURING DECOMMISSIONING FUNDS; SELF-GUARANTEE; NO
6 OUTSTANDING RATED BONDS.

7 Subpart 1. General requirement. This part applies to an
8 applicant or licensee that has no outstanding rated bonds and
9 wishes to self-guarantee. An applicant or licensee may provide
10 reasonable assurance of the availability of funds for
11 decommissioning based on furnishing its own guarantee that funds
12 will be available for decommissioning costs and on a
13 demonstration that the company passes the financial test under
14 subpart 2. This part establishes criteria for passing the
15 financial test for the self-guarantee and establishes the terms
16 for a self-guarantee.

17 Subp. 2. Financial test requirement. To pass the
18 financial test, a company must have:

19 A. tangible net worth greater than \$10,000,000, or
20 least ten times the total current decommissioning cost estimate,
21 or the current amount required if certification is used,
22 whichever is greater, for all decommissioning activities
23 which the company is responsible as a self-guaranteee
24 and as a parent-guarantor;

25 B. assets located in the United States ;
26 at least 90 percent of total assets or at least
27 total current decommissioning cost estimate, or

1 amount required if certification is used, for all
2 decommissioning activities for which the company is responsible
3 as a self-guaranteeing licensee and as a parent-guarantor; and

4 C. a ratio of cash flow divided by total liabilities
5 greater than 0.15 and a ratio of total liabilities divided by
6 net worth less than 1.5.

7 Subp. 3. Audit. A company's independent certified public
8 accountant must compare the data used by the company in the
9 financial test, which must be derived from the independently
10 audited year-end financial statements, based on United States
11 generally accepted accounting practices, for the latest fiscal
12 year, with the amounts in such financial statements. In
13 connection with that procedure, the licensee must inform the
14 commissioner within 90 days of any matters that may cause the
15 auditor to believe that the data in the financial test should be
16 adjusted and that the company no longer passes the test.

17 Subp. 4. Continued compliance.

18 A. After the initial financial test, a company must
19 repeat passage of the test within 90 days after the close of
20 each succeeding fiscal year.

21 B. If a licensee no longer meets the requirements of
22 subpart 2, the licensee must send notice to the commissioner of
23 intent to establish alternative financial assurance according to
24 this chapter. The notice must be sent by certified mail, return
25 receipt requested, within 90 days after the end of the fiscal
26 year for which the year-end financial data show that the
27 licensee no longer meets the financial test requirements. The

1 licensee must provide alternative financial assurance within 120
2 days after the end of the fiscal year.

3 Subp. 5. Terms of guarantee. The terms of a
4 self-guarantee that an applicant or licensee furnishes must
5 provide that:

6 A. the guarantee remains in force unless the licensee
7 sends notice of cancellation by certified mail, return receipt
8 requested, to the commissioner. Cancellation may not occur
9 until an alternative financial assurance mechanism is in place;

10 B. the licensee must provide alternative financial
11 assurance according to this chapter within 90 days following
12 receipt by the commissioner of a notice of cancellation of the
13 guarantee;

14 C. the guarantee and financial test provisions remain
15 in effect until the commissioner terminates the license or until
16 another financial assurance method acceptable to the
17 commissioner is put in effect by the licensee; and

18 D. the applicant or licensee must provide to the
19 commissioner a written guarantee (a written commitment by a
20 corporate officer) that states that the licensee shall fund and
21 carry out the required decommissioning activities or, upon
22 issuance of an order by the commissioner, the licensee shall set
23 up and fund a trust in the amount of the current cost estimates
24 for decommissioning.

25 4731.3175 ASSURING DECOMMISSIONING FUNDS; NONPROFIT ENTITIES.

26 Subpart 1. General requirement. This part applies to an
27 applicant or licensee that is a nonprofit entity, such as a

1 college, university, or nonprofit hospital, and wishes to
2 self-guarantee. An applicant or licensee may provide reasonable
3 assurance of the availability of funds for decommissioning based
4 on furnishing its own guarantee that funds will be available for
5 decommissioning costs and on a demonstration that the applicant
6 or licensee passes the financial test under subpart 2. This
7 part establishes criteria for passing the financial test for the
8 self-guarantee and establishes the terms for a self-guarantee.

9 Subp. 2. Financial test requirements.

10 A. To pass the financial test, a college or
11 university must:

12 (1) for applicants or licensees that issue bonds,
13 have a current rating for its most recent uninsured,
14 uncollateralized, and unencumbered bond issuance of AAA, AA, or
15 A as issued by Standard and Poor's or Aaa, Aa, or A as issued by
16 Moody's; or

17 (2) for applicants or licensees that do not issue
18 bonds, have an unrestricted endowment consisting of assets
19 located in the United States of at least \$50,000,000, or at
20 least 30 times the total current decommissioning cost estimate,
21 or the current amount required if certification is used,
22 whichever is greater, for all decommissioning activities for
23 which the college or university is responsible as a
24 self-guaranteeing licensee.

25 B. To pass the financial test, a hospital must:

26 (1) for applicants or licensees that issue bonds,
27 have a current rating for its most recent uninsured,

1 uncollateralized, and unencumbered bond issuance of AAA, AA, or
2 A as issued by Standard and Poor's or Aaa, Aa, or A as issued by
3 Moody's; or

4 (2) for applicants or licensees that do not issue
5 bonds, meet all the following tests:

6 (a) total revenues less total expenditures,
7 divided by total revenues, must be equal to or greater than
8 0.04;

9 (b) long-term debt divided by net fixed
10 assets must be less than or equal to 0.67;

11 (c) current assets and depreciation fund,
12 divided by current liabilities, must be greater than or equal to
13 2.55; and

14 (d) operating revenues must be at least 100
15 times the total current decommissioning cost estimate, or the
16 current amount required if certification is used, for all
17 decommissioning activities for which the hospital is responsible
18 as a self-guaranteeing licensee.

19 Subp. 3. Audit. A licensee's independent certified public
20 accountant must compare the data used by the licensee in the
21 financial test, which must be derived from the independently
22 audited, year-end financial statements, based on United States
23 generally accepted accounting practices, for the latest fiscal
24 year, with the amounts in such financial statements. In
25 connection with that procedure, the licensee must inform the
26 commissioner within 90 days of any matters coming to the
27 attention of the auditor that cause the auditor to believe that

1 the data in the financial test should be adjusted and that the
2 licensee no longer passes the test.

3 Subp. 4. Continued compliance.

4 A. After the initial financial test, a licensee must
5 repeat passage of the test within 90 days after the close of
6 each succeeding fiscal year.

7 B. If a licensee no longer meets the requirements of
8 subpart 2, the licensee must send notice to the commissioner of
9 its intent to establish alternative financial assurance
10 according to this chapter. The notice must be sent by certified
11 mail, return receipt requested, within 90 days after the end of
12 the fiscal year for which the year-end financial data show that
13 the licensee no longer meets the financial test requirements.
14 The licensee must provide alternate financial assurance within
15 120 days after the end of the fiscal year.

16 Subp. 5. Terms of guarantee. The terms of a
17 self-guarantee that an applicant or licensee furnishes must
18 provide that:

19 A. the guarantee remains in force unless the licensee
20 sends notice of cancellation by certified mail or return receipt
21 requested to the commissioner. Cancellation may not occur
22 unless an alternative financial assurance mechanism is in place;

23 B. the licensee must provide alternative financial
24 assurance according to this chapter within 90 days following
25 receipt by the commissioner of a notice of cancellation of the
26 guarantee;

27 C. the guarantee and financial test provisions remain

1 in effect until the commissioner terminates the license or until
2 another financial assurance method acceptable to the
3 commissioner is put in effect by the licensee;

4 D. the applicant or licensee must provide to the
5 commissioner a written guarantee (a written commitment by a
6 corporate officer or officer of the institution) that states
7 that the licensee shall fund and carry out the required
8 decommissioning activities or, upon issuance of an order by the
9 commissioner, the licensee shall set up and fund a trust in the
10 amount of the current cost estimates for decommissioning; and

11 E. if, at any time, the licensee's most recent bond
12 issuance ceases to be rated in any category of A or above by
13 either Standard and Poor's or Moody's, the licensee must provide
14 notice in writing of the fact to the commissioner within 20 days
15 after publication of the change by the rating service.

16 4731.3200 GENERAL DOMESTIC LICENSES FOR RADIOACTIVE MATERIAL.

17 A. Parts 4731.3200 to 4731.3245 establish general
18 licenses for the possession and use of radioactive material and
19 a general license for ownership of radioactive material.
20 Specific provisions of this chapter are applicable to general
21 licenses established under parts 4731.3200 to 4731.3245, as
22 provided under item B and as provided in the particular general
23 license.

24 B. A general license issued under parts 4731.3200 to
25 4731.3245 is subject to parts 4731.1000 to 4731.1090, 4731.2000
26 to 4731.2950, and 4731.3000 to 4731.3175 and Code of Federal
27 Regulations, title 10, part 21, unless indicated otherwise in

1 the specific provision of the general license. Attention is
2 directed particularly to the provisions of parts 4731.2000 to
3 4731.2950 concerning labeling of containers.

4 4731.3210 GENERAL LICENSE; STATIC ELIMINATION AND ION-GENERATING
5 DEVICES.

6 Persons are issued a general license to transfer, receive,
7 acquire, own, possess, and use radioactive material incorporated
8 in the devices or equipment in items A and B that have been
9 manufactured, tested, and labeled by the manufacturer according
10 to a specific license issued to the manufacturer by the
11 commissioner, the NRC, or an agreement state. The devices are
12 those:

13 A. designed for use as static eliminators that
14 contain, as a sealed source or sources, radioactive material
15 consisting of a total of not more than 500 microcuries (18.5
16 MBq) of polonium-210 per device; and

17 B. designed for ionization of air that contain, as a
18 sealed source or sources, radioactive material consisting of a
19 total of not more than 500 microcuries (18.5 MBq) of
20 polonium-210 per device or a total of not more than 50
21 millicuries (1.85 GBq) of hydrogen-3(tritium) per device.

22 4731.3215 GENERAL LICENSE; DETECTING, MEASURING, GAUGING,
23 CONTROLLING, AND OTHER DEVICES.

24 Subpart 1. License issued. Commercial and industrial
25 firms; research, educational, and medical institutions;
26 individuals in the conduct of their business; and state or local

1 government agencies are issued a general license to acquire,
2 receive, possess, use, or transfer, according to this part,
3 radioactive material contained in devices designed and
4 manufactured for:

5 A. detecting, measuring, gauging, or controlling
6 thickness, density, level, interface location, radiation,
7 leakage, or qualitative or quantitative chemical composition; or

8 B. producing light or an ionized atmosphere.

9 Subp. 2. Applicability.

10 A. The general license under subpart 1 applies only
11 to radioactive material contained in devices that have been
12 manufactured or initially transferred and labeled according to:

13 (1) a specific license issued under part
14 4731.3330; or

15 (2) an equivalent specific license issued by the
16 NRC or an agreement state.

17 B. The devices must have been received from one of
18 the specific licensees described in item A or through a transfer
19 made under subpart 3, item M.

20 Subp. 3. Requirements. A person who acquires, receives,
21 possesses, uses, or transfers radioactive material in a device
22 according to the general license issued under subpart 1 must:

23 A. ensure that all labels that are affixed to the
24 device at the time of receipt and that bear a statement that
25 removal of the label is prohibited are maintained on the device
26 and must comply with all instructions and precautions provided
27 by the labels;

1 B. ensure that the device is tested for leakage of
2 radioactive material and proper operation of the on-off
3 mechanism and indicator, if any, at no longer than six-month
4 intervals or at such other intervals as are specified in the
5 label, except:

6 (1) devices containing only krypton need not be
7 tested for leakage of radioactive material;

8 (2) devices containing only tritium or not more
9 than 100 microcuries of other beta- or gamma-emitting material
10 or ten microcuries of alpha-emitting material need not be tested
11 for any purpose; and

12 (3) devices held in storage in the original
13 shipping container prior to initial installation need not be
14 tested for any purpose;

15 C. ensure that the tests under item B and other
16 testing, installation, servicing, and removal from installation
17 involving the radioactive material, its shielding, or its
18 containment are performed:

19 (1) according to the instructions provided by the
20 labels; or

21 (2) by a person holding a specific license issued
22 under parts 4731.3000 to 4731.3175 or 4731.3300 to 4731.3420 or
23 issued by the NRC or an agreement state to perform such
24 activities;

25 D. maintain records showing compliance with items B
26 and C. The records must include:

27 (1) the results of the tests;

1 (2) the dates the tests were performed; and
2 (3) the names of persons performing the tests,
3 installation, servicing, and removal from installation of
4 radioactive material and its shielding or containment;

5 E. retain the records under item D as follows:

6 (1) each record of a test for leakage or
7 radioactive material required by item B must be retained for
8 three years after the next required leak test is performed or
9 until the sealed source is transferred or disposed of;
10 (2) each record of a test of the on-off mechanism
11 and indicator required by item B must be retained for three
12 years after the next required test of the on-off mechanism and
13 indicator is performed or until the sealed source is transferred
14 or disposed of; and

15 (3) each record showing compliance with item C
16 must be retained for three years from the date of the recorded
17 event or until the device is transferred or disposed of;

18 F. immediately suspend operation of the device if
19 there is a failure of or damage to or any indication of a
20 possible failure of or damage to the shielding of the
21 radioactive material or the on-off mechanism or indicator or
22 upon the detection of 0.005 microcurie (185 Bq) or more
23 removable radioactive material until the device has been
24 repaired by the manufacturer or other person holding a specific
25 license issued under parts 4731.3000 to 4731.3175 or 4731.3300
26 to 4731.3420 or issued by the NRC or an agreement state to
27 repair the device. The device and any radioactive material from

1 the device may only be disposed of by transfer to a person
2 authorized by a specific license to receive the radioactive
3 material contained in the device or as otherwise approved by the
4 commissioner;

5 G. within 30 days, furnish to the commissioner a
6 report containing a brief description of any event under item F
7 and the remedial actions taken and, in the case of detection of
8 0.005 microcurie or more of removable radioactive material or
9 failure of or damage to a source likely to result in
10 contamination of the premises or environs, a plan for ensuring
11 that the premises and environs are acceptable for unrestricted
12 use. Under these circumstances, the criteria under part
13 4731.2105, subpart 2, may be applicable, as determined by the
14 commissioner on a case-by-case basis;

15 H. not abandon the device containing radioactive
16 material;

17 I. not export the device containing radioactive
18 material, except according to Code of Federal Regulations, title
19 10, part 110;

20 J. transfer or dispose of the device containing
21 radioactive material only:

22 (1) by export as provided in item I;

23 (2) by transfer to another general licensee as
24 authorized under item M;

25 (3) to a person authorized to receive the device
26 by a specific license issued under parts 4731.3000 to 4731.3175
27 or 4731.3300 to 4731.3420 or under equivalent regulations of the

1 NRC or an agreement state that authorizes waste collection; or

2 (4) as otherwise approved under item L;

3 K. within 30 days of a transfer under item J, report
4 to the commissioner:

5 (1) the identification of the device by
6 manufacturer's or initial transferor's name, model number, and
7 serial number;

8 (2) the name, address, and license number of the
9 person receiving the device. No license number is required if
10 the device is exported; and

11 (3) the date of the transfer;

12 L. obtain written approval from the commissioner
13 before transferring the device to another specific licensee not
14 specifically identified in item J;

15 M. transfer the device to another general licensee
16 only if:

17 (1) the device remains in use at a particular
18 location, in which case the transferor must give the transferee
19 a copy of this part and parts 4731.2600, 4731.2610, 4731.3115,
20 and 4731.3200 and any safety documents identified in the label
21 of the device. Within 30 days of the transfer, the transferor
22 must report to the commissioner:

23 (a) the manufacturer's or initial
24 transferor's name;

25 (b) the model number and the serial number
26 of the device transferred;

27 (c) the transferee's name and mailing

1 address for the location of use; and

2 (d) the name, title, and telephone number of
3 the responsible individual identified by the transferee under
4 item P to have knowledge of and authority to take actions to
5 ensure compliance with the appropriate rules and requirements;
6 or

7 (2) the device is held in storage by an
8 intermediate person in the original shipping container at its
9 intended location of use prior to initial use by a general
10 licensee;

11 N. comply with parts 4731.2600 and 4731.2610 for
12 reporting radiation incidents, theft, and loss of licensed
13 material, but is exempt from the remainder of parts 4731.1000 to
14 4731.1090 and 4731.2000 to 4731.2950 and Code of Federal
15 Regulations, title 10, part 21;

16 O. respond to written requests from the commissioner
17 to provide information relating to the general license within 30
18 calendar days of the date of the request, or other time
19 specified in the request. If the general licensee cannot
20 provide the requested information within the allotted time, the
21 general licensee must, within the same time period, request a
22 longer period to supply the information by submitting a letter
23 to the commissioner and provide written justification as to why
24 it cannot comply;

25 P. appoint an individual responsible for having
26 knowledge of the appropriate rules and requirements and the
27 authority for taking required actions to comply with appropriate

1 rules and requirements. The general licensee, through the
2 appointed individual, must ensure the day-to-day compliance with
3 appropriate rules and requirements. The appointment does not
4 relieve the general licensee of any of the general licensee's
5 responsibility in this regard;

6 Q. register, according to items R and S, devices
7 containing:

8 (1) at least ten millicuries (370 MBq) of
9 cesium-137;

10 (2) at least 0.1 millicurie (3.7 MBq) of
11 strontium-90;

12 (3) at least one millicurie (37 MBq) of
13 cobalt-60;

14 (4) at least one millicurie (37 MBq) of
15 americium-241; or

16 (5) any other transuranic (any other element with
17 an atomic number greater than uranium-92) based on the activity
18 indicated on the label;

19 R. if in possession of a device meeting the criteria
20 of item Q, register the device annually with the commissioner
21 and pay the fee required under Minnesota Statutes, section
22 144.1205. Registration must be done by verifying, correcting,
23 or adding to the information provided in a request for
24 registration received from the commissioner. Registration
25 information must be submitted to the commissioner within 30 days
26 of the date of the request for registration or as otherwise
27 indicated in the request. A general licensee holding devices

1 meeting the criteria of item Q is subject to the bankruptcy
2 notification requirement under part 4731.3075, subpart 4. Each
3 address for a location of use under item S, subitem (4),
4 represents a separate general licensee and requires a separate
5 registration and fee. Persons generally licensed by an
6 agreement state with respect to devices meeting the criteria in
7 item Q are not subject to registration under this item if the
8 devices are used in areas subject to the commissioner's
9 jurisdiction for a period of less than 180 days in any calendar
10 year. The commissioner shall not request registration
11 information from such licensees;

12 S. in registering devices under item R, furnish the
13 following information and any other information specifically
14 requested by the commissioner:

15 (1) name and mailing address of the general
16 licensee;

17 (2) the following information about each device:

18 (a) the manufacturer or initial transferor;

19 (b) the model number;

20 (c) the serial number; and

21 (d) the radioisotope and activity, as

22 indicated on the label;

23 (3) name, title, and telephone number of the
24 responsible person designated as a representative of the general
25 licensee under item P;

26 (4) address or location at which each device is
27 used or stored. For portable devices, the address of the

1 primary place of storage must be furnished;

2 (5) certification by the responsible
3 representative of the general licensee that the information
4 concerning the device has been verified through a physical
5 inventory and checking of label information; and

6 (6) certification by the responsible
7 representative of the general licensee that the responsible
8 representative is aware of the requirements of the general
9 license;

10 T. report changes to the mailing address for the
11 location of use, including change in name of the general
12 licensee, to the commissioner within 30 days of the effective
13 date of the change. For a portable device, a report of address
14 change is required only for a change in the device's primary
15 place of storage; and

16 U. not hold devices that are not in use for more than
17 two years. If a device with shutters is not being used, the
18 shutters must be locked in the closed position. The testing
19 required under item B need not be performed during the period of
20 storage only. When a device is put back into service or
21 transferred to another person, and has not been tested within
22 the required test interval, the device must be tested for
23 leakage before use or transfer and the shutters must be tested
24 before use. Devices kept in standby for future use are excluded
25 from the two-year time limit if the general licensee performs
26 quarterly physical inventories of these devices while they are
27 in standby.

1 Subp. 4. Limitation. The general license issued under
2 subpart 1 does not authorize the manufacture or import of
3 devices containing radioactive material.

4 4731.3220 GENERAL LICENSE; INSTALLATION OF GENERALLY LICENSED
5 DEVICES.

6 A person who holds a specific license issued by the
7 commissioner, the NRC, or an agreement state authorizing the
8 holder to manufacture, install, or service a device described
9 under part 4731.3215 within-an-agreement-state is issued a
10 general license to install and service such device in a-state
11 that-is-not-an-agreement-state-and-a-general-license-to-install
12 and-service-such-device-in-offshore-waters areas subject to the
13 commissioner's authority, if:

14 A. the device has been manufactured, labeled,
15 installed, and serviced according to applicable provisions of
16 the specific license issued to the person by the commissioner,
17 the NRC, or an agreement state; and

18 B. the specific license holder ensures that any
19 labels required to be affixed to the device under rules of the
20 commissioner, the NRC, or the agreement state that licensed
21 manufacture of the device bear a statement that removal of the
22 label is prohibited.

23 4731.3225 GENERAL LICENSE; LUMINOUS SAFETY DEVICES FOR AIRCRAFT.

24 Subpart 1. License issued. A general license is issued to
25 own, receive, acquire, possess, and use tritium or
26 promethium-147 contained in luminous safety devices for use in

1 aircraft, provided that:

2 A. each device contains not more than ten curies (370
3 GBq) of tritium or 300 millicuries (11.1 GBq) of promethium-147;
4 and

5 B. each device:

6 (1) has been manufactured, assembled, or
7 initially transferred according to a license issued by the
8 commissioner under part 4731.3345; or

9 (2) has been manufactured or assembled according
10 to a specific license issued by the commissioner, the NRC, or an
11 agreement state that authorizes the manufacture or assembly of
12 the device for distribution to persons generally licensed by the
13 commissioner, the NRC, or an agreement state.

14 Subp. 2. Exemption. Persons who own, receive, acquire,
15 possess, or use luminous safety devices under the general
16 license issued in subpart 1 are exempt from parts 4731.1000 to
17 4731.1090 and 4731.2000 to 4731.2950 and Code of Federal
18 Regulations, title 10, part 21, except that they must comply
19 with parts 4731.2600 and 4731.2610.

20 Subp. 3. Limitation. The general license under this part
21 does not authorize:

22 A. the manufacture, assembly, repair, export, or
23 import of luminous safety devices containing tritium or
24 promethium-147; or

25 B. the ownership, receipt, acquisition, possession,
26 or use of promethium-147 contained in instrument dials.

27 4731.3230 GENERAL LICENSE; CALIBRATION OR REFERENCE SOURCES.

Subpart 1. License issued; americium-241. Persons listed in items A and B are issued a general license to own, receive, acquire, possess, use, and transfer, according to this part, americium-241 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. License issued; plutonium. A general license is issued to own, receive, possess, use, and transfer plutonium in the form of calibration or reference sources according to this part to persons who hold a specific license issued by the commissioner that authorizes the person to receive, possess, use, and transfer radioactive material.

Subp. 3. License issued; radium-226. A general license is issued to own, receive, possess, use, and transfer radium-226 in the form of calibration or reference sources according to this part to persons who hold a specific license issued by the commissioner that authorizes the person to receive, possess, use, and transfer radioactive material.

Subp. 4. Calibration or reference source requirements. The general licenses under this part 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

1 state that authorizes manufacture of the sources for
2 distribution to persons generally licensed by an agreement state.

3 Subp. 5. Additional requirements.

4 A. The general licenses issued under this part are
5 subject to parts 4731.0260; 4731.1000 to 4731.2950; 4731.3025,
6 subpart 4; 4731.3075, subparts 1, 2, 3, 5, and 6; and 4731.3110
7 to 4731.3135 and Code of Federal Regulations, title 10, part 21.

8 B. Persons who own, receive, acquire, possess, use,
9 or transfer one or more calibration or reference sources under
10 the general licenses:

11 (1) must not possess at any one time, at any one
12 location of storage or use, more than five microcuries (185 kBq)
13 of americium-241, five microcuries (185 kBq) of plutonium, or
14 five microcuries (185 kBq) of radium-226 in the sources;

15 (2) must not receive, possess, use, or transfer
16 the source unless the source or storage container bears a label
17 that includes one of the following statements or a substantially
18 similar statement that contains the information called for:

19 (a) "The receipt, possession, use, and
20 transfer of this source, Model, Serial No., are
21 subject to a general license and the regulations of the Nuclear
22 Regulatory Commission or of a state with which the Nuclear
23 Regulatory Commission has entered into an agreement for the
24 exercise of regulatory authority. Do not remove this label.

25 CAUTION - RADIOACTIVE MATERIAL - THIS SOURCE CONTAINS
26 [AMERICIUM-241 or PLUTONIUM, as appropriate]. DO NOT
27 TOUCH RADIOACTIVE PORTION OF THIS SOURCE.

1 (Name of manufacturer or initial transferor)"; or

2 (b) "The receipt, possession, use, and
3 transfer of this source, Model, Serial No., are
4 subject to a general license and the regulations of a licensing
5 state. Do not remove this label.

6 CAUTION - RADIOACTIVE MATERIAL - THIS SOURCE CONTAINS
7 RADIUM-226. DO NOT TOUCH RADIOACTIVE PORTION OF THIS
8 SOURCE.

9 (Name of manufacturer or initial transferor)";

10 (3) must not transfer, abandon, or dispose of the
11 source except by transfer to a person authorized by a license
12 from the commissioner, the NRC, or an agreement state to receive
13 the source;

14 (4) must store the source, except when the source
15 is being used, in a closed container adequately designed and
16 constructed to contain americium-241, plutonium, or radium-226
17 that might otherwise escape during storage; and

18 (5) must not use the source for any purpose other
19 than the calibration of radiation detectors or the
20 standardization of other sources.

21 Subp. 6. Limitation. The general licenses under this part
22 do not authorize the manufacture, export, or import of
23 calibration or reference sources containing americium-241,
24 plutonium, or radium-226.

25 4731.3235 GENERAL LICENSE; OWNING RADIOACTIVE MATERIAL.

26 A general license is issued to own radioactive material
27 without regard to quantity. Notwithstanding any other provision

1 of this chapter, a general licensee under this part is not
2 authorized to manufacture, produce, transfer, receive, possess,
3 use, import, or export radioactive material, except as
4 authorized in a specific license.

5 4731.3240 GENERAL LICENSE; STRONTIUM-90 ICE DETECTION DEVICES.

6 Subpart 1. License issued. A general license is issued to
7 own, receive, acquire, possess, use, and transfer strontium-90
8 contained in ice detection devices, provided that:

9 A. each device contains not more than 50 microcuries
10 (1.85 MBq) of strontium-90; and

11 B. each device has been manufactured or initially
12 transferred according to a license issued under part 4731.3380
13 or according to a specific license issued to the manufacturer by
14 the commissioner, the NRC, or an agreement state that authorizes
15 manufacture of the ice detection devices for distribution to
16 persons generally licensed by the commissioner, the NRC, or an
17 agreement state.

18 Subp. 2. Requirements. Persons who own, receive, acquire,
19 possess, use, or transfer strontium-90 contained in ice
20 detection devices under the general license issued under subpart
21 1:

22 A. must, upon occurrence of visually observable
23 damage to the device, such as a bend, crack, or discoloration
24 from overheating:

25 (1) discontinue use of the device until it has
26 been inspected, tested for leakage, and repaired by a person
27 holding a specific license issued under parts 4731.3000 to

1 4731.3175 or 4731.3300 to 4731.3420 or by the NRC or an
2 agreement state to manufacture or service the device; or
3 (2) dispose of the device according to part
4 4731.2400;

5 B. must ensure that all labels affixed to the device
6 at the time of receipt, and which bear a statement that
7 prohibits removal of the labels, are maintained thereon; and

8 C. are exempt from parts 4731.1000 to 4731.2950 and
9 Code of Federal Regulations, title 10, part 21, except that the
10 persons must comply with parts 4731.2400, 4731.2600, and
11 4731.2610.

12 Subp. 3. Limitation. The general license issued under
13 subpart 1 does not authorize the manufacture, assembly,
14 disassembly, repair, or import of strontium-90 in ice detection
15 devices.

16 4731.3245 GENERAL LICENSE; IN VITRO CLINICAL OR LABORATORY
17 TESTING USE.

18 Subpart 1. License issued. A physician, veterinarian in
19 the practice of veterinary medicine, clinical laboratory, or
20 hospital is issued a general license to receive, acquire,
21 possess, transfer, or use, according to this part, the following
22 radioactive materials in prepackaged units for use in in vitro
23 clinical or laboratory tests not involving internal or external
24 administration of radioactive material, or the radiation
25 therefrom, to human beings or animals:

26 A. iodine-125, in units not exceeding ten microcuries
27 each;

1 B. iodine-131, in units not exceeding ten microcuries
2 each;

3 C. carbon-14, in units not exceeding ten microcuries
4 each;

5 D. hydrogen-3 (tritium), in units not exceeding 50
6 microcuries each;

7 E. iron-59, in units not exceeding 20 microcuries
8 each;

9 F. selenium-75, in units not exceeding ten
10 microcuries each; and

11 G. mock iodine-125 reference or calibration sources,
12 in units not exceeding 0.05 microcurie of iodine-129 and 0.005
13 microcurie of americium-241 each; and

14 H. cobalt-57, in units not exceeding ten microcuries
15 each.

16 Subp. 2. License requirements. A person must not receive,
17 acquire, possess, use, or transfer radioactive material under
18 the general license issued under subpart 1 unless the person:

19 A. has filed a registration certificate in vitro
20 testing with radioactive material under general license form, as
21 prescribed by the commissioner, with the commissioner and
22 received from the commissioner a validated copy of the form with
23 a registration number assigned; or

24 B. has a license that authorizes the medical use of
25 radioactive material issued under parts 4731.4400 to 4731.4527.

26 Subp. 3. Additional requirements. A person who receives,
27 acquires, possesses, or uses radioactive material under the

1 general license issued under subpart 1 must:

2 A. not possess at any one time, at any one location
3 of storage or use, a total amount of iodine-125, iodine-131,
4 selenium-75, or iron-59, or cobalt-57 in excess of 200
5 microcuries (7.4 MBq);

6 B. store the radioactive material, until used, in the
7 original shipping container or in a container providing
8 equivalent radiation protection;

9 C. use the radioactive material only for the uses
10 authorized under subpart 1;

11 D. not transfer the radioactive material, except by
12 transfer to a person who is authorized to receive it under a
13 license issued by the commissioner, the NRC, or an agreement
14 state, nor transfer the radioactive material in any manner other
15 than in the unopened, labeled shipping container as received
16 from the supplier; and

17 E. dispose of the mock iodine-125 reference or
18 calibration sources described in subpart 1, item G, as required
19 under part 4731.2400.

20 Subp. 4. Limitation. A general licensee under this part
21 must not receive, acquire, possess, or use radioactive material:

22 A. except as prepackaged units that are labeled
23 according to:

24 (1) a specific license issued under part
25 4731.3390; or

26 (2) a specific license issued by the NRC or an
27 agreement state that authorizes the manufacture and distribution

1 of iodine-125, iodine-131, carbon-14, hydrogen-3 (tritium),
2 selenium-75, iron-59, or mock iodine-125, or cobalt-57 to
3 persons generally licensed by the commissioner NRC or an
4 agreement state; and

5 B. unless the following statement, or a substantially
6 similar statement that contains the information called for,
7 appears on a label affixed to each prepackaged unit or appears
8 in a leaflet or brochure that accompanies the package:

9 "This radioactive material may be received, acquired,
10 possessed, and used only by physicians, veterinarians
11 in the practice of veterinary medicine, clinical
12 laboratories, or hospitals and only for in vitro
13 clinical or laboratory tests not involving internal or
14 external administration of the material, or the
15 radiation therefrom, to human beings or animals. Its
16 receipt, acquisition, possession, use, and transfer
17 are subject to the rules of and a general license
18 issued by the Nuclear Regulatory Commission or a state
19 with which the Nuclear Regulatory Commission has
20 entered into an agreement for the exercise of
21 regulatory authority.

22 (Name of manufacturer)"

23 Subp. 5. Changes in registration. A registrant possessing
24 or using radioactive material under the general license issued
25 under subpart 1 must report in writing to the commissioner any
26 changes in the information provided in the form under subpart 2,
27 item A. The report must be furnished within 30 days after the

1 effective date of the change.

2 Subp. 6. Exemptions. A person using radioactive material
3 under the general license issued under subpart 1 is exempt from
4 parts 4731.1000 to 4731.2950 and Code of Federal Regulations,
5 title 10, part 21, with respect to radioactive material covered
6 by the general license, except that persons using mock
7 iodine-125 under subpart 1, item G, must comply with parts
8 4731.2400, 4731.2600, and 4731.2610.

9 SPECIFIC DOMESTIC LICENSING OF RADIOACTIVE MATERIAL

10 4731.3300 SPECIFIC DOMESTIC LICENSES TO MANUFACTURE OR TRANSFER
11 CERTAIN ITEMS CONTAINING RADIOACTIVE MATERIAL.

12 Subpart 1. Scope. Parts 4731.3300 to 4731.3420 provide
13 for:

14 A. issuance of specific licenses to persons who
15 manufacture or initially transfer items containing radioactive
16 material for sale or distribution to persons exempted from the
17 licensing requirements of parts 4731.3000 to 4731.3175 or
18 persons generally licensed under parts 4731.3200 to 4731.3245 or
19 4731.4400 to 4731.4527 and rules governing holders of such
20 licenses;

21 B. issuance of specific licenses to persons who
22 introduce radioactive material into a product or material owned
23 by or in the possession of the licensee or another and rules
24 governing holders of such licenses; and

25 C. issuance of certificates of registration
26 (governing radiation safety information about a product) to
27 manufacturers or initial transferors of sealed source or devices

1 containing sealed sources that are to be used by persons
2 specifically licensed under parts 4731.3000 to 4731.3175 or
3 equivalent regulations of the NRC or an agreement state.

4 Subp. 2. **Applicability.** Parts 4731.3300 to 4731.3420 are
5 in addition to, and not in substitution for, other requirements
6 of this chapter. In particular, the provisions of parts
7 4731.3000 to 4731.3175 apply to applications, licenses, and
8 certificates of registration subject to parts 4731.3300 to
9 4731.3420.

10 4731.3305 SPECIFIC LICENSE; INTRODUCTION OF RADIOACTIVE MATERIAL
11 IN EXEMPT CONCENTRATIONS; TRANSFER OF OWNERSHIP OR POSSESSION.

12 Subpart 1. **Approval criteria.** An application for a
13 specific license authorizing the introduction of radioactive
14 material into a product or material owned by or in the
15 possession of the licensee or another and the transfer of
16 ownership or possession of the product or material containing
17 the radioactive material shall be approved if the applicant:

18 A. satisfies the general requirements under part
19 4731.3070;

20 B. provides a description of the:

21 (1) product or material into which the
22 radioactive material will be introduced;

23 (2) intended use of the radioactive material and
24 the product or material into which the radioactive material is
25 introduced;

26 (3) method of manufacture;

27 (4) initial concentration of the radioactive

1 material in the product or materials;

2 (5) control methods to ensure that no more than
3 the specified concentration is introduced into the product or
4 material;

5 (6) estimated time interval between introduction
6 and transfer of the product or material; and

7 (7) estimated concentration of the radioisotopes
8 in the product or material at the time of transfer; and

9 C. provides reasonable assurance that the:

10 (1) concentrations of radioactive material at the
11 time of transfer will not exceed the concentration
12 concentrations under part 4731.3140;

13 (2) reconcentration of the radioactive material
14 in concentrations exceeding those under part 4731.3140 is not
15 likely;

16 (3) use of lower concentrations is not feasible;
17 and

18 (4) product or material is not likely to be
19 incorporated in any food, beverage, cosmetic, drug, or other
20 commodity or product designed for ingestion or inhalation by, or
21 application to, a human being.

22 Subp. 2. Records and reports.

23 A. A person licensed under this part must maintain
24 records of transfer of material and file a report with the
25 commissioner. The report must identify:

26 (1) the type and quantity of each product or
27 material into which radioactive material has been introduced

1 during the reporting period;

2 (2) the name and address of the person who owned
3 or possessed the product or material into which radioactive
4 material has been introduced, at the time of introduction;

5 (3) the type and quantity of radionuclide
6 introduced in each product or material; and

7 (4) the initial concentrations of the
8 radionuclide in the product or material at the time of transfer
9 of the radioactive material by the licensee.

10 B. A licensee must file the report required under
11 item A within 30 days following:

12 (1) five years after filing the preceding report;

13 (2) filing an application for renewal of the
14 license under part 4731.3090; or

15 (3) notifying the commissioner under part
16 4731.3075, subpart 6, of the licensee's decision to permanently
17 discontinue activities authorized under the license issued under
18 this part.

19 C. The report under item A must cover the period
20 between the filing of the preceding report and the occurrence
21 specified in item B, subitem (2) or (3). If no transfers of
22 radioactive material have been made under this part during the
23 reporting period, the report must so indicate.

24 D. A licensee must maintain the record of a transfer
25 for one year after the event is included in a report to the
26 commissioner.

27 4731.3315 PROHIBITION OF INTRODUCTION.

1 No person may introduce radioactive material in a product
2 or material knowing or having reason to believe that it will be
3 transferred to a person that is exempt under part 4731.3025 or
4 equivalent regulations of the NRC or an agreement state, except
5 according to a license issued under part 4731.3305 or the
6 general license issued under part 4731.0355.

7 4731.3320 SPECIFIC LICENSE; RESINS CONTAINING SCANDIUM-46;
8 MANUFACTURE OR INITIAL TRANSFER.

9 An application for a specific license to manufacture, or
10 initially transfer for sale or distribution, synthetic plastic
11 resins containing scandium-46 for use according to part
12 4731.3035 shall be approved if:

13 A. the applicant satisfies the general requirements
14 under part 4731.3070;

15 B. the product is designed to be used only for
16 sand-consolidation in oil wells;

17 C. the applicant submits the following information:

18 (1) a general description of the product to be
19 manufactured or initially transferred; and

20 (2) a description of control procedures to be
21 used to ensure that the concentration of scandium-46 in the
22 final product at the time of distribution does not exceed $1.4 \times$
23 $\pm 10^{-3}$ microcurie/milliliter; and

24 D. each container of the product will bear a durable,
25 legible label approved by the commissioner that contains the
26 following information:

27 (1) the product name;

1 (2) a statement that the product contains
 2 radioactive scandium and is designed and manufactured only for
 3 sand-consolidation in oil wells;

4 (3) instructions necessary for proper use; and

5 (4) the manufacturer's name.

6 4731.3325 ORGAN DOSES.

7 This part specifies dose limits for exposure to radioactive
 8 materials in self-luminous products containing tritium or
 9 promethium-147 and certain other devices containing radioactive
 10 material according to part 4731.3225.

11 Part of Body	Column I	Column II	Column III	Column IV
12	(rem)	(rem)	(rem)	(rem)
13				
14 Whole body; head				
15 and trunk; active				
16 blood-forming				
17 organs; gonads;				
18 or lens of eyes	0.001	0.01	0.5	15
19				
20 Hands and forearms;				
21 feet and ankles;				
22 localized areas of				
23 skin averaged over				
24 areas no larger				
25 than one square				
26 centimeter	0.015	0.15	7.5	200
27				
28 Other organs	0.003	0.03	1.5	50
29				

30 4731.3330 SPECIFIC LICENSE; CERTAIN DEVICES CONTAINING
 31 RADIOACTIVE MATERIALS; MANUFACTURE OR INITIAL TRANSFER.

32 Subpart 1. Approval criteria. An application for a
 33 specific license to manufacture or initially transfer devices
 34 containing radioactive material to a person generally licensed
 35 under part 4731.3215 or equivalent regulations of the NRC or an.

1 agreement state shall be approved if:

2 A. the applicant satisfies the general requirements
3 of part 4731.3070;

4 B. the applicant submits sufficient information
5 relating to the design, manufacture, prototype testing, quality
6 control, labels, proposed uses, installation, servicing, leak
7 testing, operating and safety instructions, and potential
8 hazards of the device to provide reasonable assurance that:

9 (1) the device can be safely operated by persons
10 not having training in radiological protection;

11 (2) under ordinary conditions of handling,
12 storage, and use of the device, the radioactive material
13 contained in the device will not be released or inadvertently
14 removed from the device and it is unlikely that any person will
15 receive in one year a dose in excess of ten percent of the
16 annual limits under part 4731.2020, subpart 1; and

17 (3) under accident conditions, such as fire and
18 explosion, associated with handling, storage, and use of the
19 device, it is unlikely that any person would receive an external
20 radiation dose or dose commitment in excess of the dose to the
21 appropriate organ as specified in part 4731.3325, Column IV;

22 C. each device bears a durable, legible, clearly
23 visible label or labels approved by the commissioner, which
24 contain in a clearly identified and separate statement:

25 (1) instructions and precautions necessary to
26 ensure safe installation, operation, and servicing of the
27 device. Documents such as operating and service manuals may be

1 identified in the label and used to provide this information;

2 (2) the requirement, or lack of requirement, for
3 leak testing or for testing any on-off mechanism and indicator,
4 including the maximum time interval for the testing, and the
5 identification of radioactive material by isotope, quantity of
6 radioactivity, and date of determination of the quantity; and

7 (3) the information called for in the following
8 statement, in the same or substantially similar form:

9 "The receipt, possession, use, and transfer of this
10 device, Model, Serial No., are subject to
11 a general license or the equivalent and the
12 regulations of the Minnesota commissioner of health,
13 the Nuclear Regulatory Commission, or a state that has
14 entered into an agreement with the Nuclear Regulatory
15 Commission for the exercise of regulatory authority.

16 This label must be maintained on the device in a
17 legible condition. Removal of this label is
18 prohibited.

19 CAUTION - RADIOACTIVE MATERIAL

20 (Name of manufacturer or initial transferor)"

21 The model, serial number, and name of the manufacturer or
22 initial transferor may be omitted from the label if the
23 information is elsewhere specified in labeling affixed to the
24 device;

25 D. each device having a separable source housing that
26 provides the primary shielding for the source also bears, on the
27 source housing, a durable label containing the device model

1 number and serial number, the isotope and quantity, the words
2 "Caution-Radioactive Material," the radiation symbol described
3 in part 4731.2300, and the name of the manufacturer or initial
4 distributor; and

5 E. each device meeting the criteria of part
6 4731.3215, subpart 3, item R, bears a permanent embossed,
7 etched, stamped, or engraved label affixed to the source housing
8 if separable, or the device if the source housing is not
9 separable, that includes the words "Caution-Radioactive
10 Material" and, if practicable, the radiation symbol described in
11 part 4731.2300.

12 Subp. 2. Additional requirements; alternate testing
13 intervals. In the event the applicant desires that the device
14 be required to be tested at intervals longer than six months,
15 for proper operation of the on-off mechanism and indicator, if
16 any, or for leakage of radioactive material, or for both:

17 A. the applicant must include in the application
18 sufficient information to demonstrate that the longer interval
19 is justified:

20 (1) by performance characteristics of the device
21 or similar devices; and

22 (2) by design features that have a significant
23 bearing on the probability or consequences of leakage of
24 radioactive material from the device or failure of the on-off
25 mechanism and indicator; and

26 B. the commissioner, in determining the acceptable
27 interval for the test for leakage of radioactive material, shall

1 consider information that includes, but is not limited to:

- 2 (1) primary containment (source capsule);
- 3 (2) protection of primary containment;
- 4 (3) method of sealing containment;
- 5 (4) containment construction materials;
- 6 (5) form of contained radioactive material;
- 7 (6) maximum temperature withstood during
- 8 prototype tests;
- 9 (7) maximum pressure withstood during prototype
- 10 tests;
- 11 (8) maximum quantity of contained radioactive
- 12 material;
- 13 (9) radiotoxicity of contained radioactive
- 14 material; and
- 15 (10) operating experience with identical devices
- 16 or similarly designed and constructed devices.

17 Subp. 3. Additional requirements; general licensee
18 authority. If the applicant desires that a general licensee
19 under part 4731.3215 or under equivalent regulations of the NRC
20 or an agreement state be authorized to install the device,
21 collect the sample to be analyzed by a specific licensee for
22 leakage of radioactive material, service the device, test the
23 on-off mechanism and indicator, or remove the device from
24 installation, the applicant must:

- 25 A. include in the application written instructions to
- 26 be followed by the general licensee, the estimated calendar
- 27 quarter doses associated with such activity, and the bases for

1 these estimates; and

2 B. submit information to demonstrate that performance
3 of the activity by an individual untrained in radiological
4 protection, in addition to other handling, storage, and use of
5 devices under the general license, is unlikely to cause the
6 individual to receive a dose in excess of ten percent of the
7 annual limits under part 4731.2020, subpart 1.

8 Subp. 4. Transfer for use under general license;
9 requirements. If a device containing radioactive material is to
10 be transferred for use under a general license issued under part
11 4731.3215, a person that is licensed under this part must
12 provide the information specified in this subpart to each person
13 to whom a device is to be transferred. The information must be
14 provided before the device may be transferred. In case of a
15 transfer through an intermediate person, the information must
16 also be provided to the intended user before the initial
17 transfer to the intermediate person. The required information
18 includes:

19 A. a copy of the general license issued under part
20 4731.3215. If part 4731.3215, subpart 3, items B to D or item Q
21 do not apply to the particular device, those items may be
22 omitted;

23 B. a copy of parts 4731.2600, 4731.2610, 4731.3115,
24 and 4731.3205;

25 C. a list of the services that can only be performed
26 by a specific licensee;

27 D. information on acceptable disposal options,

1 including estimated costs of disposal; and

2 E. an indication that the commissioner's policy is to
3 issue high civil penalties for improper disposal.

4 Subp. 5. Transfer for use under equivalent regulations;
5 requirements. If radioactive material is to be transferred in a
6 device for use under an equivalent general license of the NRC or
7 an agreement state, a person that is licensed under this part
8 must provide the information specified in this subpart to each
9 person to whom a device is to be transferred. The information
10 must be provided before the device may be transferred. In the
11 case of a transfer through an intermediate person, the
12 information must also be provided to the intended user before
13 initial transfer to the intermediate person. The required
14 information includes:

15 A. a copy of the NRC or agreement state regulations
16 equivalent to parts 4731.2600; 4731.2610; 4731.3115; 4731.3205;
17 and 4731.3215, or a copy of parts 4731.2600; 4731.2610;
18 4731.3115; 4731.3205; and 4731.3215. If a copy of the
19 commissioner's rules is provided to a prospective general
20 licensee in lieu of the NRC or agreement state regulations, the
21 copy must be accompanied by a note explaining that use of the
22 device is regulated by the NRC or agreement state. If certain
23 subparts, items, or subitems do not apply to the particular
24 device, those subparts, items, and subitems may be omitted;

25 B. a list of the services that can only be performed
26 by a specific licensee;

27 C. information on acceptable disposal options,

1 including estimated costs of disposal; and

2 D. the name or title, address, and telephone number
3 of the contact at the NRC or agreement state regulatory agency
4 from which additional information may be obtained.

5 Subp. 6. Alternative methods. A licensee may propose an
6 alternative method of informing customers, other than that
7 specified under subparts 4 and 5, for approval by the
8 commissioner.

9 Subp. 7. Labeling requirements. A device that is
10 transferred after February 19, 2002, must meet the labeling
11 requirements in subpart 1, items D and E.

12 Subp. 8. Records upon bankruptcy. If a notification of
13 bankruptcy is made under part 4731.3075, subpart 4, or the
14 license is to be terminated, a person licensed under this part
15 must provide, upon request, to the commissioner, the NRC, and
16 any appropriate agreement state, records of final disposition
17 required under subpart 11.

18 Subp. 9. Report; transfer for use under general license.
19 A person licensed under this part to initially transfer devices
20 to generally licensed persons must report all transfers of
21 devices to persons for use under the general license in part
22 4731.3215 and all receipts of devices from persons licensed
23 under part 4731.3215 to the commissioner. The report must be
24 submitted on a quarterly basis on a transfers of industrial
25 devices report form prescribed by the commissioner or in a clear
26 and legible report containing all the data required by the
27 form. The report must:

1 A. include:

2 (1) the identity of each general licensee by name
3 and mailing address for the location of use. If there is no
4 mailing address for the location of use, an alternate address
5 for the general licensee must be submitted along with
6 information on the actual location of use;

7 (2) the name, title, and telephone number of the
8 person identified by the general licensee as having knowledge of
9 and authority to take required actions to ensure compliance with
10 the appropriate rules and requirements;

11 (3) the date of transfer;

12 (4) the type, model number, and serial number of
13 the device transferred; and

14 (5) the quantity and type of radioactive material
15 in the device;

16 B. if one or more intermediate persons will
17 temporarily possess the device at the intended place of use
18 before its possession by the user, include the same information
19 for both the intended user and the intermediate person and
20 clearly designate the intermediate person;

21 C. for devices received from a person generally
22 licensed under part 4731.3215, include the identity of the
23 general licensee by name and address, the type, model number,
24 and serial number of the device received, the date of receipt,
25 and, in the case of devices not initially transferred by the
26 reporting licensee, the name of the manufacturer or initial
27 transferor;

1 D. if the licensee makes changes to a device
2 possessed by a person generally licensed under part 4731.3215,
3 such that the label must be changed to update the required
4 information, identify the general licensee, the device, and the
5 changes to information on the device label;

6 E. cover each calendar quarter, be filed within 30
7 days of the end of the calendar quarter, and clearly indicate
8 the period covered by the report;

9 F. clearly identify the specific licensee submitting
10 the report and include the license number of the specific
11 licensee; and

12 G. if no transfers have been made to or from persons
13 generally licensed under part 4731.3215 during the reporting
14 period, so indicate.

15 Subp. 10. Report; transfer for use under equivalent
16 regulations. A person licensed under this part to initially
17 transfer devices to generally licensed persons must report all
18 transfers of devices to persons for use under a general license
19 issued by the NRC or an agreement state under regulations that
20 are equivalent to part 4731.3215, and all receipts of devices
21 from general licensees in the NRC's or agreement state's
22 jurisdiction to the NRC or the responsible agreement state
23 agency. The report must be submitted on a transfers of
24 industrial devices report form prescribed by the NRC or in a
25 clear and legible report containing all of the data required by
26 the form. The report must:

27 A. include:

1 (1) the identity of each general licensee by name
2 and mailing address for the location of use. If there is no
3 mailing address for the location of use, an alternate address
4 for the general licensee must be submitted along with
5 information on the actual location of use;

6 (2) the name, title, and telephone number of the
7 person identified by the general licensee as having knowledge of
8 and authority to take required actions to ensure compliance with
9 the appropriate rules and requirements;

10 (3) the date of transfer;

11 (4) the type, model number, and serial number of
12 the device transferred; and

13 (5) the quantity and type of radioactive material
14 contained in the device;

15 B. if one or more intermediate persons will
16 temporarily possess the device at the intended place of use
17 before its possession by the user, include the same information
18 for both the intended user and each intermediate person and
19 clearly designate the intermediate person;

20 C. for devices received from a general licensee,
21 include the identity of the general licensee by name and
22 address; the type, model number, and serial number of the device
23 received; the date of receipt; and in the case of devices not
24 initially transferred by the reporting licensee, the name of the
25 manufacturer or initial transferor;

26 D. if the licensee makes changes to a device
27 possessed by a general licensee, such that the label must be

1 changed to update required information, identify the general
2 licensee, the device, and the changes to information on the
3 device label;

4 E. cover each calendar quarter, be filed within 30
5 days of the end of the calendar quarter, and clearly indicate
6 the period covered by the report;

7 F. clearly identify the specific licensee submitting
8 the report and include the license number of the specific
9 licensee; and

10 G. upon request of the NRC or responsible agreement
11 state agency, include a statement that no transfers have been
12 made to or from a general licensee during the reporting period,
13 if applicable.

14 Subp. 11. Record retention. A person licensed under this
15 part to initially transfer devices to generally licensed persons
16 must maintain all information concerning transfers and receipts
17 of devices that supports the reports required under subparts 9
18 and 10. The records must be maintained for three years
19 following the date of the recorded event.

20 4731.3345 SPECIFIC LICENSE; LUMINOUS SAFETY DEVICES;
21 MANUFACTURE, ASSEMBLE, REPAIR, OR INITIALLY TRANSFER.

22 Subpart 1. Approval criteria. An application for a
23 specific license to manufacture, assemble, repair, or initially
24 transfer luminous safety devices containing tritium or
25 promethium-147 for use in aircraft, for distribution to persons
26 generally licensed under part 4731.3225, shall be approved if:

27 A. the applicant satisfies the general requirements

1 of part 4731.3070;

2 B. the applicant submits sufficient information
3 regarding each device pertinent to evaluation of the potential
4 radiation exposure, including:

5 (1) chemical and physical form and maximum
6 quantity of tritium or promethium-147 in each device;

7 (2) details of construction and design;

8 (3) details of the method of binding or
9 containing the tritium or promethium-147;

10 (4) procedures for and results of prototype
11 testing to demonstrate that the tritium or promethium-147 will
12 not be released to the environment under the most severe
13 conditions likely to be encountered in normal use;

14 (5) any quality control procedures proposed as
15 alternatives to those prescribed in subpart 4; and

16 (6) any additional information, including
17 experimental studies and tests, required by the commissioner to
18 facilitate a determination of the safety of the device;

19 C. each device will contain no more than ten curies
20 of tritium or 300 millicuries of promethium-147. The levels of
21 radiation from each device containing promethium-147 will not
22 exceed 0.5 millirad per hour at ten centimeters from any surface
23 when measured through 50 milligrams per square centimeter of
24 absorber; and

25 D. the commissioner determines that:

26 (1) the method of incorporation and binding of
27 the tritium or promethium-147 in the device is such that the

1 tritium or promethium-147 will not be released under the most
2 severe conditions that are likely to be encountered in normal
3 use and handling of the device;

4 (2) the tritium or promethium-147 is incorporated
5 or enclosed so as to preclude direct physical contact by any
6 person with it;

7 (3) the device is so designed that it cannot
8 easily be disassembled; and

9 (4) the device has been subjected to and has
10 satisfactorily passed the prototype tests under part 4731.3405.

11 Subp. 2. Labeling requirements. A person licensed under
12 this part to manufacture, assemble, or initially transfer
13 devices containing tritium or promethium-147 for distribution to
14 persons generally licensed under part 4731.3225 must, except as
15 provided in subpart 3, affix to each device a label containing:

16 A. the radiation symbol prescribed by part 4731.2300;

17 B. such other information as may be required by the
18 commissioner, including disposal instructions when appropriate;
19 and

20 C. the following or a substantially similar statement
21 that contains all of the information called for:

22 "The receipt, possession, use, and transfer of this
23 device, Model ..., Serial No. ..., containing ...

24 (identity and quantity of radioactive material) are
25 subject to a general license or the equivalent and the
26 regulations of the Minnesota commissioner of health,
27 the Nuclear Regulatory Commission, or a state with

1 which the Nuclear Regulatory Commission has entered
2 into an agreement for the exercise of regulatory
3 authority. Do not remove this label.

4 CAUTION -- RADIOACTIVE MATERIAL

5 (Name of manufacturer, assembler, or initial transferor)"

6 The model, serial number, and name of manufacturer, assembler,
7 or initial transferor may be omitted from the label if they are
8 elsewhere specified in the labeling affixed to the device.

9 Subp. 3. Alternative labeling. If the commissioner
10 determines that it is not feasible to affix a label to the
11 device containing all the information required under subpart 2,
12 the commissioner may waive those requirements and require in
13 lieu thereof that:

14 A. a label be affixed to the device identifying:

15 (1) the manufacturer, assembler, or initial
16 transferor; and

17 (2) the type of radioactive material; and

18 B. a leaflet bearing the following information be
19 enclosed in or accompany the container in which the device is
20 shipped:

21 (1) the name of the manufacturer, assembler, or
22 initial transferor;

23 (2) the type and quantity of radioactive
24 material;

25 (3) the model number;

26 (4) a statement that the receipt, possession,
27 use, and transfer of the device are subject to a general license

1 or the equivalent and the rules of the commissioner, the NRC, or
2 an agreement state; and

3 (5) such other information as may be required by
4 the commissioner, including disposal instructions when
5 appropriate.

6 Subp. 4. Quality assurance; transfer prohibition.

7 A. A person licensed under this part must visually
8 inspect each device and must reject any that has an observable
9 physical defect that could affect containment of the tritium or
10 promethium-147.

11 B. A person licensed under this part must take a
12 random sample of the size required under part 4731.3420 for lot
13 tolerance percent defective of five percent from each inspection
14 lot and must subject each unit in the sample to the tests under
15 items C to E.

16 C. Each device must be immersed in 30 inches of water
17 for 24 hours and must show no visible evidence of water entry.
18 Absolute pressure of the air above the water must then be
19 reduced to one inch of mercury. Lowered pressure must be
20 maintained for one minute or until air bubbles cease to be given
21 off by the water, whichever is longer. Pressure must then be
22 increased to normal atmospheric pressure. Any device that leaks
23 as evidenced by bubbles emanating from within the device or
24 water entering the device must be considered a defective unit.

25 D. The immersion test water from the test in item C
26 must be measured for tritium or promethium-147 content by an
27 apparatus that has been calibrated to measure tritium or

1 promethium-147, as appropriate. If more than 0.1 percent of the
2 original amount of tritium or promethium-147 in any device is
3 found to have leaked into the immersion test water, the leaking
4 device must be considered a defective unit.

5 E. The levels of radiation from each device
6 containing promethium-147 must be measured. Any device that has
7 a radiation level in excess of 0.5 millirad per hour at ten
8 centimeters from any surface when measured through 50 milligrams
9 per square centimeter of absorber must be considered a defective
10 unit.

11 F. An application for a license or for amendment of a
12 license may include a description of procedures proposed as
13 alternatives to those under items B to E and proposed criteria
14 for acceptance under those procedures. The commissioner shall
15 approve the proposed alternative procedures if the applicant
16 demonstrates that:

17 (1) the procedures will consider defective any
18 sampled device that has a leakage rate exceeding 0.1 percent of
19 the original quantity of tritium or promethium-147 in any
20 24-hour period; and

21 (2) the operating characteristic curve or
22 confidence interval estimate for the alternative procedures
23 provides a lot tolerance percent defective of five percent at
24 the consumer's risk of 0.10.

25 G. No person licensed under this part shall transfer
26 to persons generally licensed under part 4731.3225:

27 (1) any luminous safety device that has been

1 tested and found defective under the criteria and procedures in
2 this subpart unless the defective units have been repaired or
3 reworked and have then met the tests in items B to E; or

4 (2) any inspection lot that has been rejected as
5 a result of the procedures under part 4731.3420, or alternative
6 procedures under item F, unless the defective units have been
7 sorted and removed or have been repaired or reworked and have
8 then met the tests under items B to E.

9 Subp. 5. Transfer reports. A person licensed under this
10 part must file an annual report with the commissioner that:

11 A. states the total quantity of tritium or
12 promethium-147 transferred to persons generally licensed under
13 part 4731.3225;

14 B. identifies each general licensee by name;

15 C. states the kinds and numbers of luminous devices
16 transferred;

17 D. specifies the quantity of tritium or
18 promethium-147 in each kind of device; and

19 E. covers the year ending June 30 and is filed within
20 30 days thereafter.

21 4731.3365 SPECIFIC LICENSE; CALIBRATION OR REFERENCE SOURCES;
22 MANUFACTURE OR INITIAL TRANSFER.

23 Subpart 1. Approval criteria. An application for a
24 specific license to manufacture or initially transfer
25 calibration and reference sources containing americium-241,
26 plutonium, or radium-226 for distribution to persons generally
27 licensed under part 4731.3230 shall be approved if:

1 A. the applicant satisfies the general requirements
2 of part 4731.3070;

3 B. the applicant submits sufficient information
4 regarding each type of calibration or reference source pertinent
5 to evaluation of the potential radiation exposure, including:

6 (1) chemical and physical form and maximum
7 quantity of americium-241, plutonium, or radium-226 in the
8 source;

9 (2) details of construction and design;

10 (3) details of the method of incorporation and
11 binding of the americium-241, plutonium, or radium-226 in the
12 source;

13 (4) procedures for and results of prototype
14 testing of sources that are designed to contain more than 0.005
15 microcurie (185 Bq) of americium-241, 0.005 microcurie (185 Bq)
16 of plutonium, or 0.005 microcurie (185 Bq) of radium-226, to
17 demonstrate that the americium-241, plutonium, or radium-226,
18 respectively, contained in each source will not be released or
19 be removed from the source under normal conditions of use;

20 (5) details of quality control procedures to be
21 followed in manufacture of the source;

22 (6) a description of labeling to be affixed to
23 the source or the storage container for the source; and

24 (7) any additional information, including
25 experimental studies and tests, required by the commissioner to
26 facilitate a determination of the safety of the source;

27 C. each source will contain no more than five

1 microcuries (185 kBq) of americium-241, five microcuries (185
2 kBq) of plutonium, or five microcuries (185 kBq) of radium-226;
3 and

4 D. the commissioner determines, with respect to any
5 type of source containing more than 0.005 microcurie (185 Bq) of
6 americium-241, 0.005 microcurie (185 Bq) of plutonium, or 0.005
7 microcurie (185 Bq) of radium-226, that:

8 (1) the method of incorporation and binding of
9 the americium-241, plutonium, or radium-226 in the source is
10 such that the americium-241, plutonium, or radium-226 will not
11 be released or be removed from the source under normal
12 conditions of use and handling of the source; and

13 (2) the source has been subjected to and has
14 satisfactorily passed the prototype tests under part 4731.3410.

15 Subp. 2. Labeling requirements. A person licensed under
16 this part must affix to each source or storage container for the
17 source a label that:

18 A. contains sufficient information relative to safe
19 use and storage of the source; and

20 B. includes the following statement or a
21 substantially similar statement that contains the information
22 called for:

23 "The receipt, possession, use, and transfer of this
24 source, Model ..., Serial No. ..., are subject to a
25 general license and the regulations of the Minnesota
26 commissioner of health, the Nuclear Regulatory
27 Commission, or a state with which the Nuclear

1 Regulatory Commission has entered into an agreement
2 for the exercise of regulatory authority. Do not
3 remove this label.

4 CAUTION -- RADIOACTIVE MATERIAL -- THIS SOURCE CONTAINS
5 AMERICIUM-241 OR PLUTONIUM OR RADIUM-226. DO NOT TOUCH
6 RADIOACTIVE PORTION OF THIS SOURCE.

7 (Name of manufacturer or initial transferor)"

8 Subp. 3. Leak testing.

9 A. A person licensed under this part must perform a
10 dry wipe test upon each source containing more than 0.1
11 microcurie (3.7 kBq) of americium-241, 0.1 microcurie (3.7 kBq)
12 of plutonium, or 0.1 microcurie (3.7 kBq) of radium-226 before
13 transferring the source to a general licensee under part
14 4731.3230.

15 B. The test must be performed by wiping the entire
16 radioactive surface of the source with a filter paper with the
17 application of moderate finger pressure.

18 C. The radioactivity on the paper must be measured by
19 using radiation detection instrumentation capable of detecting
20 0.005 microcurie (185 Bq) of americium-241, plutonium, or
21 radium-226.

22 D. If the test discloses more than 0.005 microcurie
23 (185 Bq) of radioactive material, the source must be deemed to
24 be leaking or losing americium-241, plutonium, or radium-226 and
25 must not be transferred to a general licensee under part
26 4731.3230.

27 4731.3380 SPECIFIC LICENSE; ICE DETECTION DEVICES; MANUFACTURE

1 OR INITIAL TRANSFER.

2 Subpart 1. Approval criteria. An application for a
3 specific license to manufacture or initially transfer ice
4 detection devices containing strontium-90 for distribution to
5 persons generally licensed under part 4731.3240 shall be
6 approved if:

7 A. the applicant satisfies the general requirements
8 of part 4731.3070;

9 B. the applicant submits sufficient information
10 regarding each type of device pertinent to evaluation of the
11 potential radiation exposure, including:

12 (1) chemical and physical form and maximum
13 quantity of strontium-90 in the device;

14 (2) details of construction and design of the
15 source of radiation and its shielding;

16 (3) radiation profile of a prototype device;

17 (4) procedures for and results of prototype
18 testing of devices to demonstrate that the strontium-90
19 contained in each device will not be released or be removed from
20 the device under the most severe conditions likely to be
21 encountered in normal handling and use;

22 (5) details of quality control procedures to be
23 followed in manufacture of the device;

24 (6) description of labeling to be affixed to the
25 device;

26 (7) instructions for handling and installation of
27 the device; and

1 (8) any additional information, including
2 experimental studies and tests, required by the commissioner to
3 facilitate a determination of the safety of the device;

4 C. each device will contain no more than 50
5 microcuries of strontium-90 in an insoluble form;

6 D. each device will bear durable, legible labeling
7 that includes:

8 (1) the radiation caution symbol prescribed by
9 part 4731.2300;

10 (2) a statement that the device contains
11 strontium-90 and the quantity thereof;

12 (3) instructions for disposal;

13 (4) a statement that the device may be possessed
14 pursuant to a general license;

15 (5) a statement that the manufacturer or civil
16 authorities should be notified if the device is found;

17 (6) a statement that removal of the labeling is
18 prohibited; and

19 (7) a statement that disassembly and repair of
20 the device may be performed only by a person holding a specific
21 license to manufacture or service such devices; and

22 E. the commissioner determines that:

23 (1) the method of incorporation and binding of
24 the strontium-90 in the device is such that the strontium-90
25 will not be released from the device under the most severe
26 conditions that are likely to be encountered in normal use and
27 handling of the device;

1 (2) the strontium-90 is incorporated or enclosed
2 so as to preclude direct physical contact by any individual with
3 it and is shielded so that no individual will receive a
4 radiation exposure to a major portion of the individual's body
5 in excess of 0.5 rem in a year under ordinary circumstances of
6 use;

7 (3) the device is so designed that it cannot be
8 easily disassembled;

9 (4) the device has been subjected to and has
10 satisfactorily passed the prototype tests under part 4731.3415;
11 and

12 (5) quality control procedures have been
13 established to satisfy the requirements of subpart 2.

14 Subp. 2. Quality assurance; transfer prohibition.

15 A. A person licensed under this part must visually
16 inspect each device and must reject any that has an observable
17 physical defect that could affect containment of the
18 strontium-90.

19 B. A person licensed under this part must test each
20 device for possible loss of strontium-90 or for contamination by
21 wiping with filter paper an area of at least 100 square
22 centimeters on the outside surface of the device or wiping the
23 entire surface area if it is less than 100 square centimeters.
24 Detection on the filter paper of more than 2,200 disintegrations
25 per minute of radioactive material per 100 square centimeters of
26 surface wiped must be cause for rejection of the tested device.

27 C. A person licensed under this part must take a

1 random sample of the size required by part 4731.3420 for lot
2 tolerance percent defective of five percent from each inspection
3 lot and must subject each unit in the sample to the tests in
4 items D and E.

5 D. Each device must be immersed in 30 inches of water
6 for 24 hours and must show no visible evidence of physical
7 contact between the water and the strontium-90. Absolute
8 pressure of the air above the water must then be reduced to one
9 inch of mercury. Lowered pressure must be maintained for one
10 minute or until air bubbles cease to be given off by the water,
11 whichever is longer. Pressure must then be increased to normal
12 atmospheric pressure. Any device that leaks, as evidenced by
13 physical contact between the water and the strontium-90, must be
14 considered a defective unit.

15 E. The immersion test water from the test under item
16 D must be measured for radioactive material. If the amount of
17 radioactive material in the immersion test water is greater than
18 0.1 percent of the original amount of strontium-90 in any
19 device, the device must be considered a defective unit.

20 F. An application for a license or for amendment to a
21 license may include a description of procedures proposed as
22 alternatives to those prescribed under items C to E and proposed
23 criteria for acceptance under those procedures. The
24 commissioner shall approve the proposed alternative procedures
25 if the applicant demonstrates that:

26 (1) the procedures will consider defective any
27 sampled device that has a leakage rate exceeding 0.1 percent of

1 the original quantity of strontium-90 in any 24-hour period; and
2 (2) the operating characteristic curve or
3 confidence interval estimate for the alternative procedures
4 provides a lot tolerance percent defective of five percent at
5 the consumer's risk of 0.10.

6 G. No person licensed under this part shall transfer
7 to persons generally licensed under part 4731.3240:

8 (1) any device that has been tested and found
9 defective under the criteria and procedures specified in this
10 subpart, unless the defective units have been repaired or
11 reworked and then met the tests required under items C to E; or

12 (2) any inspection lot that has been rejected as
13 a result of the procedures under part 4731.3420, or alternative
14 procedures under item F, unless the defective units have been
15 sorted and removed or have been repaired or reworked and have
16 then met the tests required under items C to E.

17 4731.3390 SPECIFIC LICENSE; MATERIAL FOR IN VITRO CLINICAL OR
18 LABORATORY TESTING; MANUFACTURE AND DISTRIBUTION.

19 An application for a specific license to manufacture or
20 distribute radioactive material for use under the general
21 license under part 4731.3245 shall be approved if:

22 A. the applicant satisfies the general requirements
23 of part 4731.3070;

24 B. the radioactive material is prepared for
25 distribution in prepackaged units of:

26 (1) iodine-125 in units not exceeding ten
27 microcuries (370 kBq) each;

- 1 (2) iodine-131 in units not exceeding ten
2 microcuries (370 kBq) each;
- 3 (3) carbon-14 in units not exceeding ten
4 microcuries (370 kBq) each;
- 5 (4) hydrogen-3 (tritium) in units not exceeding
6 50 microcuries (1.85 MBq) each;
- 7 (5) iron-59 in units not exceeding 20 microcuries
8 (740 kBq) each;
- 9 (6) selenium-75 in units not exceeding ten
10 microcuries (370 kBq) each; and
- 11 (7) mock iodine-125 in units not exceeding 0.05
12 microcurie (1.85 kBq) of iodine-129 and 0.005 microcurie (185
13 Bq) of americium-241 each;
- 14 C. each prepackaged unit bears a durable, clearly
15 visible label that:
- 16 (1) identifies the radioactive contents as to
17 chemical form and radionuclide; and
- 18 (2) indicates that the amount of radioactivity
19 does not exceed:
- 20 (a) ten microcuries (370 kBq) of iodine-125,
21 iodine-131, carbon-14, or selenium-75;
- 22 (b) 50 microcuries (1.85 MBq) of hydrogen-3
23 (tritium);
- 24 (c) 20 microcuries (740 kBq) of iron-59; or
25 (d) mock iodine-125 in units not exceeding
26 0.05 microcuries (1.85 kBq) of iodine-129 and 0.005 microcurie
27 (185 Bq) of americium-241 each; and

1 (3) displays the radiation caution symbol
2 described in part 4731.2300, and the words "Caution, Radioactive
3 Material" and "Not for Internal or External Use in Humans or
4 Animals";

5 D. the following statement, or a substantially
6 similar statement that contains all the information called for,
7 appears on a label affixed to each prepackaged unit or appears
8 in a leaflet or brochure that accompanies the package:

9 "The radioactive material may be received, acquired,
10 possessed, and used only by physicians, veterinarians
11 in the practice of veterinary medicine, clinical
12 laboratories, or hospitals and only for in vitro
13 clinical or laboratory tests not involving internal or
14 external administration of the material, or the
15 radiation therefrom, to human beings or animals. Its
16 receipt, acquisition, possession, use, and transfer
17 are subject to the regulations and a general license
18 of the Minnesota commissioner of health, the Nuclear
19 Regulatory Commission, or a state with which the
20 Nuclear Regulatory Commission has entered into an
21 agreement for the exercise of regulatory authority.

22 (Name of manufacturer)"; and

23 E. the label affixed to the unit, or the leaflet or
24 brochure that accompanies the package, contains adequate
25 information as to the precautions to be observed in handling and
26 storing the radioactive material. In the case of a mock
27 iodine-125 reference or calibration source, the information

1 accompanying the source must also contain directions to the
2 licensee regarding the waste disposal requirements under part
3 4731.2400.

4 4731.3395 SPECIFIC LICENSE; RADIOACTIVE DRUGS FOR MEDICAL USE;
5 MANUFACTURE, PREPARATION, OR TRANSFER.

6 Subpart 1. Approval criteria. An application for a
7 specific license to manufacture, prepare, or transfer for
8 commercial distribution radioactive drugs containing radioactive
9 material for use by persons authorized according to parts
10 4731.4400 to 4731.4527 shall be approved if the applicant:

11 A. satisfies the general requirements specified in
12 part 4731.3070;

13 B. submits evidence that the applicant is at least
14 one of the following:

15 (1) registered or licensed with the United States
16 Food and Drug Administration as a drug manufacturer;

17 (2) registered or licensed with a state agency as
18 a drug manufacturer;

19 (3) licensed as a pharmacy by a state board of
20 pharmacy; or

21 (4) operating as a nuclear pharmacy within a
22 federal medical institution;

23 C. submits the following information regarding the
24 radionuclide:

25 (1) the chemical and physical form;

26 (2) the maximum activity per vial, syringe,
27 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. satisfies 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

1 item C, or an individual under the supervision of an authorized
2 nuclear pharmacist, as specified in part 4731.4407; and

3 (2) allow a pharmacist to work as an authorized
4 nuclear pharmacist if:

5 (a) the individual qualifies as an
6 authorized nuclear pharmacist;

7 (b) the individual meets the requirements
8 under part 4731.4413 and the licensee has received an approved
9 license amendment identifying the individual as an authorized
10 nuclear pharmacist; or

11 (c) the individual is designated as an
12 authorized nuclear pharmacist according to item C.

13 B. The actions authorized in item A are permitted
14 notwithstanding more restrictive language in license conditions.

15 C. A licensee described in subpart 1, item B, subitem
16 (3) or (4), may designate a pharmacist as an authorized nuclear
17 pharmacist if the individual is identified as of December 2,
18 1994, as an authorized user on a nuclear pharmacy license issued
19 by the NRC or an agreement state.

20 D. No later than 30 days after the date that a
21 licensee described in subpart 1, item B, subitem (3) or (4),
22 allows an individual to work as an authorized nuclear pharmacist
23 under item A, subitem (2), unit (a) or (c), the licensee must
24 provide to the commissioner a copy of:

25 (1) the individual's certification by the Board
26 of Pharmaceutical Specialties, the NRC or agreement state
27 license, or the permit issued by a licensee of broad scope; and

1 (2) the individual's state pharmacy licensure or
2 registration.

3 Subp. 3. Measuring radioactivity. A licensee under this
4 part must:

5 A. possess and use instrumentation to measure the
6 radioactivity of radioactive drugs;

7 B. have procedures for use of the instrumentation;

8 C. measure, by direct measurement or a combination of
9 measurements and calculations, the amount of radioactivity in
10 dosages of alpha-, beta-, or photon-emitting radioactive drugs
11 prior to transfer for commercial distribution;

12 D. perform tests before initial use, periodically,
13 and following repair on each instrument for accuracy, linearity,
14 and geometry dependence, as appropriate for the use of the
15 instrument, and make adjustments when necessary; and

16 E. check each instrument for constancy and proper
17 operation at the beginning of each day of use.

18 Subp. 4. Other law. Nothing in this part relieves a
19 licensee from complying with applicable United States Food and
20 Drug Administration, other federal, or state requirements
21 governing radioactive drugs.

22 4731.3400 SPECIFIC LICENSE; SOURCES OR DEVICES FOR MEDICAL USE;
23 MANUFACTURE AND DISTRIBUTION.

24 Subpart 1. Approval criteria. An application for a
25 specific license to manufacture and distribute sources and
26 devices containing radioactive material to persons licensed
27 according to parts 4731.4400 to 4731.4527 for use as a

1 calibration or reference source or for the uses listed under
2 parts 4731.4450, 4731.4460, and 4731.4463 shall be approved if:

3 A. the applicant satisfies the general requirements
4 of part 4731.3070;

5 B. the applicant submits sufficient information
6 regarding each type of source or device pertinent to an
7 evaluation of its radiation safety, including:

8 (1) the radioactive material contained, its
9 chemical and physical form, and amount;

10 (2) details of design and construction of the
11 source or device;

12 (3) procedures for, and results of, prototype
13 tests to demonstrate that the source or device will maintain its
14 integrity under stresses likely to be encountered in normal use
15 and accidents;

16 (4) for devices containing radioactive material,
17 the radiation profile of a prototype device;

18 (5) details of quality control procedures to
19 ensure that production sources and devices meet the standards of
20 the design and prototype tests;

21 (6) procedures and standards for calibrating
22 sources and devices;

23 (7) legend and methods for labeling sources and
24 devices as to their radioactive content; and

25 (8) instructions for handling and storing the
26 source or device from the radiation safety standpoint. These
27 instructions must be:

1 (a) included on a durable label attached to
2 the source or device;

3 (b) attached to a permanent storage
4 container for the source of device; or

5 (c) summarized on the label, for
6 instructions that are too lengthy for the label, and printed in
7 detail on a brochure that is referenced on the label; and

8 C. the label affixed to the source of or device, or
9 to the permanent storage container for the source of or device,
10 contains:

11 (1) information on the radionuclide;

12 (2) the quantity;

13 (3) the date of assay; and

14 (4) a statement that the commissioner has
15 approved distribution of the (name of source or device) to
16 persons licensed to use radioactive material identified under
17 parts 4731.4423, 4731.4450, 4731.4460, and 4731.4463, as
18 appropriate, and to persons who hold equivalent licenses issued
19 by the NRC or an agreement state.

20 Subp. 2. Alternative testing intervals.

21 A. In the event the applicant desires that the source
22 or device be required to be tested for leakage of radioactive
23 material at intervals longer than six months, the applicant must
24 include in the application sufficient information to demonstrate
25 that the longer interval is justified by:

26 (1) performance characteristics of the source or
27 device or similar sources or devices; and

1 (2) design features that have a significant
2 bearing on the probability or consequences of leakage of
3 radioactive material from the source.

4 B. In determining the acceptable interval for testing
5 leakage of radioactive material, the commissioner shall consider
6 information that includes, but is not limited to:

- 7 (1) primary containment (source capsule);
- 8 (2) protection of primary containment;
- 9 (3) method of sealing containment;
- 10 (4) containment construction materials;
- 11 (5) form of contained radioactive materials;
- 12 (6) maximum temperature withstood during
13 prototype tests;
- 14 (7) maximum pressure withstood during prototype
15 tests;
- 16 (8) maximum quantity of contained radioactive
17 material;
- 18 (9) radiotoxicity of contained radioactive
19 material; and
- 20 (10) operating experience with identical sources
21 or devices or similarly designed and constructed sources or
22 devices.

23 Subp. 3. Application pending. If an application was filed
24 according to subpart 1 on or before October 15, 1974, for a
25 license to manufacture and distribute a source or device that
26 was distributed commercially on or before August 16, 1974, the
27 applicant may continue the distribution until the commissioner

1 issues the license or notifies the applicant otherwise.

2 4731.3405 PROTOTYPE TESTS; LUMINOUS SAFETY DEVICES FOR AIRCRAFT.

3 Subpart 1. Applicability. An applicant for a license
4 under part 4731.3345 must conduct prototype tests on each of
5 five prototype luminous safety devices for use in aircraft
6 according to this part.

7 Subp. 2. Temperature-altitude test. The device must be
8 placed in a test chamber as it would be used in service. A
9 temperature-altitude condition schedule must be followed as
10 outlined in the following steps:

11 A. Step 1. The internal temperature of the test
12 chamber must be reduced to -62° Celsius (-80° Fahrenheit) and
13 the device must be maintained for at least one hour at this
14 temperature at atmospheric pressure.

15 B. Step 2. The internal temperature of the test
16 chamber must be raised to -54° Celsius (-65° Fahrenheit) and
17 maintained until the temperature of the device has stabilized at
18 -54° Celsius at atmospheric temperature.

19 C. Step 3. The atmospheric pressure of the chamber
20 must be reduced to 83 millimeters of mercury absolute pressure
21 while the chamber temperature is maintained at -54° Celsius.

22 D. Step 4. The internal temperature of the chamber
23 must be raised to -10° Celsius (+14° Fahrenheit) and maintained
24 until the temperature of the device has stabilized at -10°
25 Celsius and the internal pressure of the chamber must then be
26 adjusted to atmospheric pressure. The test chamber door must
27 then be opened to allow frost to form on the device, and must

1 remain open until the frost has melted but not long enough to
2 allow the moisture to evaporate. The door must then be closed.

3 E. Step 5. The internal temperature of the chamber
4 must be raised to +85° Celsius (+185° Fahrenheit) at atmospheric
5 pressure. The temperature of the device must be stabilized at
6 +85° Celsius and maintained for two hours. The device must then
7 be visually inspected to determine the extent of any
8 deterioration.

9 F. Step 6. The chamber temperature must be reduced
10 to +71° Celsius (+160° Fahrenheit) at atmospheric pressure. The
11 temperature of the device must be stabilized at +71° Celsius for
12 30 minutes.

13 G. Step 7. The chamber temperature must be reduced
14 to +55° Celsius (+130° Fahrenheit) at atmospheric pressure. The
15 temperature of the device must be stabilized at this temperature
16 for four hours.

17 H. Step 8. The internal temperature of the chamber
18 must be reduced to +30° Celsius (+86° Fahrenheit) and the
19 pressure to 138 millimeters of mercury absolute pressure and
20 stabilized. The device must be maintained under these
21 conditions for four hours.

22 I. Step 9. The temperature of the test chamber must
23 be raised to +35° Celsius (+95° Fahrenheit) and the pressure
24 reduced to 83 millimeters of mercury absolute pressure and
25 stabilized. The device must be maintained under these
26 conditions for 30 minutes.

27 J. Step 10. The internal pressure of the chamber

1 must be maintained at 83 millimeters of mercury absolute
2 pressure and the temperature reduced to +20° Celsius (+68°
3 Fahrenheit) and stabilized. The device must be maintained under
4 these conditions for four hours.

5 Subp. 3. Vibration tests.

6 A. This procedure applies to items of equipment,
7 including vibration isolating assemblies, intended to be mounted
8 directly on the structure of aircraft powered by reciprocating,
9 turbojet, or turbo-propeller engines or to be mounted directly
10 on gas-turbine engines. The device must be mounted on an
11 apparatus dynamically similar to the most severe conditions
12 likely to be encountered in normal use. At the end of the test
13 period, the device must be inspected thoroughly for possible
14 damage. Vibration tests must be conducted under both resonant
15 and cycling conditions.

16 B. Vibration test schedule.

17 Times shown refer to one axis of vibration:

	Vibration at room temperature (minutes)	Vibration at 160° F. (71° C.) (minutes)	Vibration at -65° F. (-54° C.) (minutes)
18 Type			
19 Resonance	60	15	15
20 Cycling	60	15	15
21			
22			
23			
24			

25 C. Individual resonance frequency surveys must be
26 conducted by applying vibration to each device along each of any
27 set of three mutually perpendicular axes and varying the
28 frequency of applied vibration slowly through a range of
29 frequencies from five cycles per second to 500 cycles per second
30 with the double amplitude of the vibration not exceeding that

1 shown in Figure 1 for the related frequency.

2 D. The device must be vibrated at the determined
3 resonance frequency for each axis of vibration for the periods
4 and temperature conditions shown in item B and with the applied
5 double amplitude specified in Figure 1 for that resonance
6 frequency. When more than one resonant frequency is encountered
7 with vibration applied along any one axis, the test period may
8 be accomplished at the most severe resonance or the period may
9 be divided among the resonant frequencies, whichever is
10 considered most likely to produce failure. When resonant
11 frequencies are not apparent within the specified frequency
12 range, the specimen must be vibrated for periods twice as long
13 as those shown for resonance in item B at a frequency of 55
14 cycles per second and an applied double amplitude of 0.060 inch.

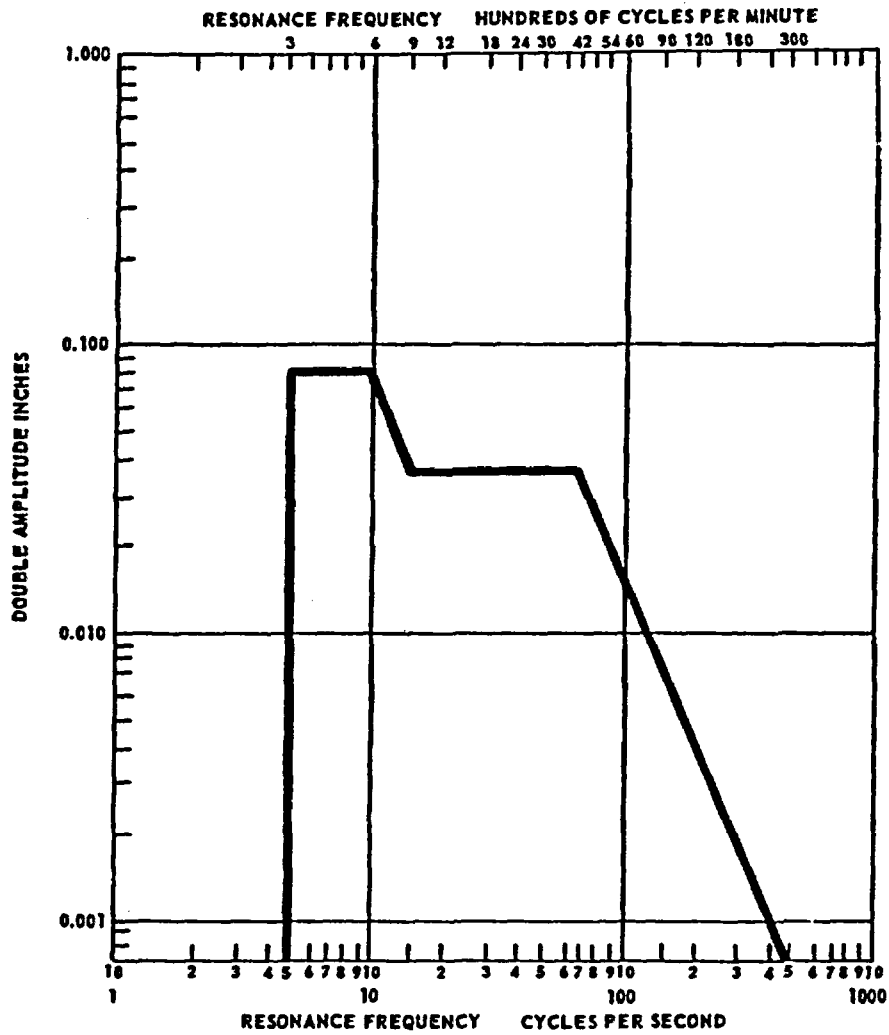


FIGURE 1: AMPLITUDE OF VIBRATION AT RESONANCE FREQUENCY

1 E. Devices to be mounted only on vibration isolators
2 must be tested by applying vibration along each of three
3 mutually perpendicular axes of the device with an applied double
4 amplitude of 0.060 inch and the frequency cycling between ten
5 and 55 cycles per second in one-minute cycles for the periods
6 and temperature conditions shown in item B. Devices to be
7 installed in aircraft without vibration isolators must be tested
8 by applying vibration along each of three mutually perpendicular
9 axes of the device with an applied double amplitude of 0.036
10 inch or an applied acceleration of 10G, whichever is the
11 limiting value, and the frequency cycling between ten and 500
12 cycles per second on 15-minute cycles for the periods and
13 temperature conditions shown in item B.

14 Subp. 4. Accelerated weathering tests. The device must be
15 subject to 100 hours of accelerated weathering in a suitable
16 weathering machine. Panels of Corex D glass must surround the
17 arc to cut off the ultraviolet radiation below a wavelength of
18 2,700 angstroms. The light of the carbon arcs must fall
19 directly on the face of the device. The temperature at the
20 sample must be maintained at 50° Celsius, plus or minus 3°
21 Celsius. Temperature measurements must be made with a black
22 panel thermometer.

23 Subp. 5. Shock test. The device must be dropped upon a
24 concrete or iron surface in a three-foot free gravitational
25 fall, or must be subjected to equivalent treatment in a test
26 device simulating such a free fall. The drop test must be
27 repeated 100 times from random orientations.

1 Subp. 6. Hermetic seal and waterproof test. On completion
2 of all other tests required by this part, the device must be
3 immersed in 30 inches of water for 24 hours and must show no
4 visible evidence of water entry. Absolute pressure of the air
5 above the water must then be reduced to one inch of mercury.
6 Lowered pressure must be maintained for one minute or until air
7 bubbles cease to be given off by the water, whichever is the
8 longer. Pressure must then be increased to normal atmospheric
9 pressure. Any evidence of bubbles emanating from within the
10 device, or water entering the device, must be considered leakage.

11 Subp. 7. Observations. After each of the tests required
12 by this part, each device must be examined for evidence of
13 physical damage and for loss of tritium or promethium-147. Any
14 evidence of damage to or failure of any device that could affect
15 containment of the tritium or promethium-147 must be cause for
16 rejection of the design if the damage or failure is attributable
17 to a design defect. Loss of tritium or promethium-147 from each
18 tested device must be measured by wiping with filter paper an
19 area of at least 100 square centimeters on the outside surface
20 of the device, or by wiping the entire surface area if it is
21 less than 100 square centimeters. The amount of tritium or
22 promethium-147 in the water used in the hermetic seal and
23 waterproof test under subpart 6 must also be measured.
24 Measurements must be made in an apparatus calibrated to measure
25 tritium or promethium-147, as appropriate. The detection on the
26 filter paper of more than 2,200 disintegrations per minute of
27 tritium or promethium-147 per 100 square centimeters of surface

1 wiped or in the water of more than 0.1 percent of the original
2 amount of tritium or promethium-147 in any device must be cause
3 for rejection of the tested device.

4 4731.3410 PROTOTYPE TESTS; CALIBRATION OR REFERENCE SOURCES
5 CONTAINING AMERICIUM-241, PLUTONIUM, OR RADIUM-226.

6 An applicant for a license under part 4731.3365 must, for
7 any type of source that is designed to contain more than 0.005
8 microcurie (185 Bq) of americium-241, 0.005 microcurie (185 Bq)
9 of plutonium, or 0.005 microcurie (185 Bq) of radium-226,
10 conduct prototype tests, in the order listed, on each of five
11 prototypes of such source that contains more than 0.005
12 microcurie (185 Bq) of americium-241, 0.005 microcurie (185 Bq)
13 of plutonium, or 0.005 microcurie (185 Bq) of radium-226 as
14 follows:

15 A. an initial measurement. The quantity of
16 radioactive material deposited on the source must be measured by
17 direct counting of the source;

18 B. a dry wipe test. The entire radioactive surface
19 of the source must be wiped with filter paper with the
20 application of moderate finger pressure. Removal of radioactive
21 material from the source must be determined by measuring the
22 radioactivity on the filter paper or by direct measurement of
23 the radioactivity on the source following the dry wipe;

24 C. a wet wipe test. The entire radioactive surface
25 of the source must be wiped with filter paper moistened with
26 water, with the application of moderate finger pressure.
27 Removal of radioactive material from the source must be

1 determined by measuring the radioactivity on the filter paper
2 after it has dried or by direct measurement of the radioactivity
3 on the source following the wet wipe;

4 D. a water soak test. The source must be immersed in
5 water at room temperature for 24 consecutive hours. The source
6 must then be removed from the water. Removal of radioactive
7 material from the source must be determined by direct
8 measurement of the radioactivity on the source after it has
9 dried or by measuring the radioactivity in the residue obtained
10 by evaporation of the water in which the source was immersed;

11 E. a dry wipe test. On completion of the preceding
12 tests under items A to D, the dry wipe test described in item B
13 must be repeated; and

14 F. observations. Removal of more than 0.005
15 microcurie of radioactivity in any test prescribed by this part
16 must be cause for rejection of the source design. Results of
17 prototype tests submitted to the commissioner must be given in
18 terms of radioactivity in microcuries and percent of removal
19 from the total amount of radioactive material deposited on the
20 source.

21 4731.3415 PROTOTYPE TESTS; ICE DETECTION DEVICES CONTAINING
22 STRONTIUM-90.

23 An applicant for a license under part 4731.3380 must
24 conduct prototype tests on each of five prototype ice detection
25 devices as follows:

26 A. a temperature-altitude test. The device must be
27 placed in a test chamber as it would be used in service. A

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1 temperature-altitude condition schedule must be followed
2 according to part 4731.3405, subpart 2;

3 B. vibration tests according to part 4731.3405,
4 subpart 3;

5 C. a shock test according to part 4731.3405, subpart
6 5;

7 D. a hermetic seal and waterproof test. On
8 completion of all other tests required under items A to C, the
9 device must be immersed in 30 inches of water for 24 hours and
10 must show no visible evidence of physical contact between the
11 water and the strontium-90. Absolute pressure of the air above
12 the water must then be reduced to one inch of mercury. Lowered
13 pressure must be maintained for one minute or until air bubbles
14 cease to be given off by the water, whichever is the longer.
15 Pressure must then be increased to normal atmospheric pressure.
16 Any visible evidence of physical contact between the water and
17 the strontium-90 must be considered leakage; and

18 E. observations. After each of the tests required in
19 items A to D, each device must be examined for evidence of
20 physical damage and for loss of strontium-90. Any evidence of
21 leakage or damage to or failure of any device that could affect
22 containment of the strontium-90 must be cause for rejection of
23 the design if the damage or failure is attributable to a design
24 defect. Loss of strontium-90 from each tested device must be
25 measured by wiping with filter paper an area of at least 100
26 square centimeters on the outside surface of the device, or by
27 wiping the entire surface area if it is less than 100 square

1 centimeters. The amount of strontium-90 in the water used in
2 the hermetic seal and waterproof test under item D must also be
3 measured. The detection on the filter paper of more than 2,200
4 disintegrations per minute of strontium-90 per 100 square
5 centimeters of surface wiped or in the water of more than 0.1
6 percent of the original amount of strontium-90 in any device
7 must be cause for rejection of the tested device.

8 4731.3420 ACCEPTANCE SAMPLING PROCEDURES.

9 A random sample must be taken from each inspection lot of
10 devices licensed under part 4731.3345 or 4731.3380 or Code of
11 Federal Regulations, title 10, section 32.14, for which testing
12 is required under part 4731.3345, subpart 4, or 4731.3380,
13 subpart 2, or Code of Federal Regulations, title 10, section
14 32.15, according to the appropriate sampling table under this
15 part, determined by the designated lot tolerance percent
16 defective. If the number of defectives in the sample does not
17 exceed the acceptance number in the appropriate sampling table
18 under this part, the lot must be accepted. If the number of
19 defectives in the sample exceeds the acceptance number in the
20 appropriate sampling table under this part, the entire
21 inspection lot must be rejected.

22 TABLE 1

23 LOT TOLERANCE PERCENT DEFECTIVE 0.5 PERCENT:

24	Lot size	Sample size	Acceptance No.
25	1 to 180	All	0
26	181 to 210	180	0
27	211 to 250	210	0
28	251 to 300	240	0
29	301 to 400	275	0
30	401 to 500	300	0

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1	501 to 600	320	0
2	601 to 800	350	0
3	801 to 1,000	365	0
4	1,001 to 2,000	410	0
5	2,001 to 3,000	430	0
6	3,001 to 4,000	440	0
7	4,001 to 5,000	445	0
8	5,001 to 7,000	450	0
9	7,001 to 10,000	455	0
10	10,001 to 20,000	460	0
11	20,001 to 50,000	775	1
12	50,001 to 100,000	780	1
13			

14 TABLE 2

15 LOT TOLERANCE PERCENT DEFECTIVE 1.0 PERCENT:

16	Lot size	Sample size	Acceptance No.
17	1 to 120	All	0
18	121 to 150	120	0
19	151 to 200	140	0
20	201 to 300	165	0
21	301 to 400	175	0
22	401 to 500	180	0
23	501 to 600	190	0
24	601 to 800	200	0
25	801 to 1,000	205	0
26	1,001 to 3,000	220	0
27	3,001 to 5,000	225	0
28	5,001 to 10,000	230	0
29	10,001 to 100,000	390	1
30			

31 TABLE 3

32 LOT TOLERANCE PERCENT DEFECTIVE 2.0 PERCENT:

33	Lot size	Sample size	Acceptance No.
34	1 to 75	All	0
35	76 to 100	70	0
36	101 to 200	85	0
37	201 to 300	95	0
38	301 to 400	100	0
39	401 to 600	105	0
40	601 to 800	110	0
41	801 to 4,000	115	0
42	4,001 to 10,000	195	1
43	10,001 to 100,000	200	1
44			

45 TABLE 4

46 LOT TOLERANCE PERCENT DEFECTIVE 3.0 PERCENT:

Lot size	Sample size	Acceptance No.
1 to 40	All	0
41 to 55	40	0
56 to 100	55	0
101 to 200	65	0
201 to 500	70	0
501 to 3,000	75	0
3,001 to 100,000	130	1

TABLE 5

LOT TOLERANCE PERCENT DEFECTIVE 4.0 PERCENT:

Lot size	Sample size	Acceptance No.
1 to 35	All	0
36 to 50	34	0
51 to 100	44	0
101 to 200	50	0
201 to 2,000	55	0
2,001 to 100,000	95	1

TABLE 6

LOT TOLERANCE PERCENT DEFECTIVE 5.0 PERCENT:

Lot size	Sample size	Acceptance No.
1 to 30	All	0
31 to 50	30	0
51 to 100	37	0
101 to 200	40	0
201 to 300	43	0
301 to 400	44	0
401 to 2,000	45	0
2,001 to 100,000	75	1

TABLE 7

LOT TOLERANCE PERCENT DEFECTIVE 7.0 PERCENT:

Lot size	Sample size	Acceptance No.
1 to 25	All	0
26 to 50	24	0
51 to 100	28	0
101 to 200	30	0
201 to 300	31	0
301 to 800	32	0
801 to 1,000	33	0
1,001 to 100,000	55	1

TABLE 8

1 LOT TOLERANCE PERCENT DEFECTIVE 10.0 PERCENT:

2	Lot size	Sample size	Acceptance No.
3	1 to 20	All	0
4	21 to 50	17	0
5	51 to 100	20	0
6	101 to 200	22	0
7	201 to 800	23	0
8	801 to 100,000	39	1

9 4731.3500 SPECIFIC DOMESTIC LICENSES OF BROAD SCOPE FOR
10 RADIOACTIVE MATERIAL.

11 Subpart 1. Applicability. Parts 4731.3500 to 4731.3580
12 contain requirements for the issuance of specific licenses of
13 broad scope for radioactive material and for holders of such
14 licenses. Parts 4731.3500 to 4731.3580 are in addition to and
15 not in substitution for other requirements of this chapter. In
16 particular, parts 4731.3000 to 4731.3175 apply to applications
17 and licenses subject to parts 4731.3500 to 4731.3580.

18 Subp. 2. Types of broad scope licenses. The different
19 types of broad scope licenses are as follows:

20 A. "Type A specific license of broad scope" is a
21 specific license authorizing receipt, acquisition, ownership,
22 possession, use, and transfer of any chemical or physical form
23 of the radioactive material specified in the license, but not
24 exceeding quantities specified in the license, for purposes
25 authorized by the commissioner. The quantities specified are
26 usually in the multicurie range;

27 B. "Type B specific license of broad scope" is a
28 specific license authorizing receipt, acquisition, ownership,
29 possession, use, and transfer of any chemical or physical form
30 of radioactive material specified in part 4731.3580 for purposes

1 authorized by the commissioner. The possession limit for a Type
2 B specific license of broad scope:

3 (1) if only one radionuclide is possessed
4 thereunder, is the quantity specified for that radionuclide in
5 part 4731.3580, Column I; and

6 (2) if two or more radionuclides are possessed
7 thereunder, is determined as follows:

8 (a) for each radionuclide, determine the
9 ratio of the quantity possessed to the applicable quantity
10 specified in part 4731.3580, Column I, for that radionuclide;
11 and

12 (b) the sum of the ratios for all
13 radionuclides possessed under the license must not exceed unity;
14 and

15 C. "Type C specific license of broad scope" is a
16 specific license authorizing receipt, acquisition, ownership,
17 possession, use, and transfer of any chemical or physical form
18 of radioactive material specified in part 4731.3580 for purposes
19 authorized by the commissioner. The possession limit for a Type
20 C specific license of broad scope:

21 (1) if only one radionuclide is possessed
22 thereunder, is the quantity specified for that radionuclide in
23 part 4731.3580, Column II; and

24 (2) if two or more radionuclides are possessed
25 thereunder, is determined for each as follows:

26 (a) for each radionuclide, determine the
27 ratio of the quantity possessed to the applicable quantity

1 specified in part 4731.3580, Column II, for that radionuclide;
2 and

3 (b) the sum of ratios for all radionuclides
4 possessed under the license must not exceed unity.

5 4731.3520 SPECIFIC LICENSE OF BROAD SCOPE; APPLICATION.

6 A person must file an application for a specific license of
7 broad scope in duplicate on an application for radioactive
8 material license form according to part 4731.3065.

9 4731.3530 TYPE A SPECIFIC LICENSE OF BROAD SCOPE.

10 An application for a Type A specific license of broad scope
11 shall be approved if the applicant:

12 A. satisfies the general requirements under part
13 4731.3070;

14 B. has engaged in an appropriate number of activities
15 involving the use of radioactive material; and

16 C. has established administrative controls and
17 provisions relating to organization and management, procedures,
18 record keeping, material control and accounting, and management
19 review that are necessary to ensure safe operations, including:

20 (1) the establishment of a radiation safety
21 committee composed of such persons as a radiation safety
22 officer, a representative of management, and other persons
23 trained and experienced in the safe use of radioactive
24 materials;

25 (2) the appointment of a radiation safety officer
26 who is qualified by training and experience in radiation

1 protection and who is available for advice and assistance on
2 radiological safety matters; and

3 (3) the establishment of appropriate
4 administrative procedures to ensure:

5 (a) control of procurement and use of
6 radioactive material;

7 (b) completion of safety evaluations of
8 proposed uses of radioactive material that take into
9 consideration such matters as the adequacy of facilities and
10 equipment, the training and experience of the user, and the
11 operating or handling procedures; and

12 (c) review, approval, and recording by the
13 radiation safety committee of safety evaluations of proposed
14 uses prepared according to unit (b) before use of the
15 radioactive material.

16 4731.3540 TYPE B SPECIFIC LICENSE OF BROAD SCOPE.

17 An application for a Type B specific license of broad scope
18 shall be approved if the applicant:

19 A. satisfies the general requirements under part
20 4731.3070; and

21 B. has established administrative controls and
22 provisions relating to organization and management, procedures,
23 record keeping, material control and accounting, and management
24 review that are necessary to ensure safe operations, including:

25 (1) the appointment of a radiation safety officer
26 who is qualified by training and experience in radiation
27 protection and who is available for advice and assistance on

1 radiological safety matters; and

2 (2) the establishment of appropriate
3 administrative procedures to ensure:

4 (a) control of procurement and use of
5 radioactive material;

6 (b) completion of safety evaluations of
7 proposed uses of radioactive material that take into
8 consideration such matters as the adequacy of facilities and
9 equipment, the training and experience of the user, and the
10 operating or handling procedures; and

11 (c) review, approval, and recording by the
12 radiation safety officer of safety evaluations of proposed uses
13 prepared according to unit (b) before use of the radioactive
14 material.

15 4731.3550 TYPE C SPECIFIC LICENSE OF BROAD SCOPE.

16 An application for a Type C specific license of broad scope
17 shall be approved if the applicant:

18 A. satisfies the general requirements under part
19 4731.3070;

20 B. submits a statement that radioactive material will
21 be used only by, or under the direct supervision of, individuals
22 who have received:

23 (1) a college degree at the bachelor level, or
24 equivalent training and experience, in the physical or
25 biological sciences or in engineering; and

26 (2) at least 40 hours of training and experience
27 in the safe handling of radioactive material and in the

1 characteristics of ionizing radiation, units of radiation dose
2 and quantities, radiation detection instrumentation, and
3 biological hazards of exposure to radiation appropriate to the
4 type and forms of radioactive material to be used; and

5 C. has established administrative controls and
6 provisions relating to procurement of radioactive material,
7 procedures, record keeping, material control and accounting, and
8 management review necessary to ensure safe operation.

9 4731.3560 APPLICATION FOR OTHER SPECIFIC LICENSES.

10 An application filed under parts 4731.3000 to 4731.3175 for
11 a specific license other than one of broad scope shall be
12 considered by the commissioner as an application for a specific
13 license of broad scope under parts 4731.3500 to 4731.3580 if the
14 applicable requirements of parts 4731.3500 to 4731.3580 are
15 satisfied.

16 4731.3570 SPECIFIC LICENSES OF BROAD SCOPE; CONDITIONS.

17 A. Unless specifically authorized in this chapter,
18 persons licensed under parts 4731.3500 to 4731.3580 must not:

19 (1) conduct tracer studies in the environment
20 involving direct release of radioactive material;

21 (2) receive, acquire, own, possess, use,
22 transfer, or import devices containing 100,000 curies or more of
23 radioactive material in sealed sources used for irradiation of
24 materials;

25 (3) conduct activities for which a specific
26 license issued by the commissioner under parts 4731.3300 to

1 4731.4527, is required; or

2 (4) add or cause the addition of radioactive
3 material to any food, beverage, cosmetic, drug, or other product
4 designed for ingestion or inhalation by, or application to, a
5 human being.

6 B. Each Type A specific license of broad scope issued
7 under parts 4731.3500 to 4731.3580 is subject to the condition
8 that radioactive material possessed under the license may only
9 be used by, or under the direct supervision of, individuals
10 approved by the licensee's radiation safety committee.

11 C. Each Type B specific license of broad scope issued
12 under parts 4731.3500 to 4731.3580 is subject to the condition
13 that radioactive material possessed under the license may only
14 be used by, or under the direct supervision of, individuals
15 approved by the licensee's radiation safety officer.

16 D. Each Type C specific license of broad scope issued
17 under parts 4371.3500 to 4731.3580 is subject to the condition
18 that radioactive material possessed under the license may only
19 be used by, or under the direct supervision of, individuals who
20 satisfy the requirements of part 4731.3550.

21 4731.3580 LIMITS FOR BROAD SCOPE LICENSES.

22 The following limits apply to specific licenses of broad
23 scope issued under parts 4731.3500 to 4731.3580:

24		Column I	Column II
25	Radioactive Material	curies	curies
26			
27	Antimony-122	1	0.01
28	Antimony-124	1	0.01
29	Antimony-125	1	0.01
30	Arsenic-73	10	0.1

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1	Arsenic-74	1	0.01
2	Arsenic-76	1	0.01
3	Arsenic-77	10	0.1
4			
5	Barium-131	10	0.1
6	Barium-140	1	0.01
7	Bismuth-210	0.1	0.001
8	Bromine-82	10	0.1
9			
10	Cadmium-109	1	0.01
11	Cadmium-115m	1	0.01
12	Cadmium-115	10	0.1
13	Calcium-45	1	0.01
14	Calcium-47	10	0.1
15	Carbon-14	100	1
16	Cerium-141	10	0.1
17	Cerium-143	10	0.1
18	Cerium-144	0.1	0.001
19	Cesium-131	100	1
20	Cesium-134m	100	1
21	Cesium-134	0.1	0.001
22	Cesium-135	1	0.01
23	Cesium-136	10	0.1
24	Cesium-137	0.1	0.001
25	Chlorine-36	1	0.01
26	Chlorine-38	100	1
27	Chromium-51	100	1
28	Cobalt-58m	100	1
29	Cobalt-58	1	0.01
30	Cobalt-60	0.1	0.001
31	Copper-64	10	0.1
32			
33	Dysprosium-165	100	1
34	Dysprosium-166	10	0.1
35			
36	Erbium-169	10	0.1
37	Erbium-171	10	0.1
38	Europium-152 9.2 h	10	0.1
39	Europium-152 13 y	0.1	0.001
40	Europium-154	0.1	0.001
41	Europium-155	1	0.01
42			
43	Fluorine-18	100	1
44			
45	Gadolinium-153	1	0.01
46	Gadolinium-159	10	0.1
47	Gallium-72	10	0.1
48	Germanium-71	100	1
49	Gold-198	10	0.1
50	Gold-199	10	0.1
51			
52	Hafnium-181	1	0.01
53	Holmium-166	10	0.1
54	Hydrogen-3	100	1

1			
2	Indium-113m	100	1
3	Indium-114m	1	0.01
4	Indium-115m	100	1
5	Indium-115	1	0.01
6	Iodine-125	0.1	0.001
7	Iodine-126	0.1	0.001
8	Iodine-129	0.1	0.01
9	Iodine-131	0.1	0.001
10	Iodine-132	10	0.1
11	Iodine-133	1	0.01
12	Iodine-134	10	0.1
13	Iodine-135	1	0.01
14	Iridium-192	1	0.01
15	Iridium-194	10	0.1
16	Iron-55	10	0.1
17	Iron-59	1	0.01
18			
19	Krypton-85	100	1
20	Krypton-87	10	0.1
21			
22	Lanthanum-140	1	0.01
23	Lutetium-177	10	0.1
24			
25	Manganese-52	1	0.01
26	Manganese-54	1	0.01
27	Manganese-56	10	0.1
28	Mercury-197m	10	0.1
29	Mercury-197	10	0.1
30	Mercury-203	1	0.01
31	Molybdenum-99	10	0.1
32			
33	Neodymium-147	10	0.1
34	Neodymium-149	10	0.1
35	Nickel-59	10	0.1
36	Nickel-63	1	0.01
37	Nickel-65	10	0.1
38	Niobium-93m	1	0.01
39	Niobium-95	1	0.01
40	Niobium-97	100	1
41			
42	Osmium-185	1	0.01
43	Osmium-191m	100	1
44	Osmium-191	10	0.1
45	Osmium-193	10	0.1
46			
47	Palladium-103	10	0.1
48	Palladium-109	10	0.1
49	Phosphorus-32	1	0.01
50	Platinum-191	10	0.1
51	Platinum-193m	100	1
52	Platinum-193	10	0.1
53	Platinum-197m	100	1
54	Platinum-197	10	0.1

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1	Polonium-210	0.01	0.0001
2	Potassium-42	1	0.01
3	Praseodymium-142	10	0.1
4	Praseodymium-143	10	0.1
5	Promethium-147	1	0.01
6	Promethium-149	10	0.1
7			
8	Rhenium-186	10	0.1
9	Rhenium-188	10	0.1
10	Rhodium-103m	1,000	10
11	Rhodium-105	10	0.1
12	Rubidium-86	1	0.01
13	Rubidium-87	1	0.01
14	Ruthenium-97	100	1
15	Ruthenium-103	1	0.01
16	Ruthenium-105	10	0.1
17	Ruthenium-106	0.1	0.001
18			
19	Samarium-151	1	0.01
20	Samarium-153	10	0.1
21	Scandium-46	1	0.01
22	Scandium-47	10	0.1
23	Scandium-48	1	0.01
24	Selenium-75	1	0.01
25	Silicon-31	10	0.1
26	Silver-105	1	0.01
27	Silver-110m	0.1	0.001
28	Silver-111	10	0.1
29	Sodium-24	1	0.01
30	Strontium-85m	1,000	10
31	Strontium-85	1	0.01
32	Strontium-89	1	0.01
33	Strontium-90	0.01	0.0001
34	Strontium-91	10	0.1
35	Strontium-92	10	0.1
36	Sulfur-35	10	0.1
37			
38	Tantalum-182	1	0.01
39	Technetium-96	10	0.1
40	Technetium-97m	10	0.1
41	Technetium-97	10	0.1
42	Technetium-99m	100	1
43	Technetium-99	1	0.01
44	Tellurium-125m	1	0.01
45	Tellurium-127m	1	0.01
46	Tellurium-127	10	0.1
47	Tellurium-129m	1	0.01
48	Tellurium-129	100	1
49	Tellurium-131m	10	0.1
50	Tellurium-132	1	0.01
51	Terbium-160	1	0.01
52	Thallium-200	10	0.1
53	Thallium-201	10	0.1
54	Thallium-202	10	0.1

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1	Thallium-204	1	0.01
2	Thulium-170	1	0.01
3	Thulium-171	1	0.01
4	Tin-113	1	0.01
5	Tin-125	1	0.01
6	Tungsten-181	1	0.01
7	Tungsten-185	1	0.01
8	Tungsten-187	10	0.1
9			
10	Vanadium-48	1	0.01
11			
12	Xenon-131m	1,000	10
13	Xenon-133	100	1
14	Xenon-135	100	1
15			
16	Ytterbium-175	10	0.1
17	Yttrium-90	1	0.01
18	Yttrium-91	1	0.01
19	Yttrium-92	10	0.1
20	Yttrium-93	1	0.01
21			
22	Zinc-65	1	0.01
23	Zinc-69m	10	0.1
24	Zinc-69	100	1
25	Zirconium-93	1	0.01
26	Zirconium-95	1	0.01
27	Zirconium-97	1	0.01
28			
29	Any radioactive material		
30	other than alpha-emitting		
31	by-product material not		
32	listed above	0.1	0.001
33			

INDUSTRIAL RADIOGRAPHY

34 4731.4000 LICENSES FOR INDUSTRIAL RADIOGRAPHY AND RADIATION
 35 SAFETY REQUIREMENTS FOR INDUSTRIAL RADIOGRAPHIC OPERATIONS.

36 Parts 4731.4000 to 4731.4360 prescribe licensing
 37 requirements for the use of sealed sources containing
 38 radioactive material and radiation safety requirements for
 39 persons using these sealed sources in industrial radiography.
 40 The requirements of parts 4731.4000 to 4731.4360 are in addition
 41 to, and not in substitution for, other requirements of this
 42 chapter. In particular, parts 4731.0300 to 4731.0424 and
 43 4731.1000 to 4731.3175 apply to applications and licenses

1 subject to parts 4731.4000 to 4731.4360. Parts 4731.4000 to
2 4731.4360 do not apply to medical uses of radioactive material.

3 4731.4010 SPECIFIC LICENSE; APPLICATION.

4 A person must file an application for a specific license
5 for use of sealed sources in industrial radiography in duplicate
6 on the application for radioactive material license form
7 according to part 4731.3070.

8 4731.4020 SPECIFIC LICENSE; INDUSTRIAL RADIOGRAPHY.

9 An application for a specific license for the use of
10 licensed material in industrial radiography shall be approved if
11 the applicant:

12 A. satisfies the general requirements under part
13 4731.3070, as appropriate, and any special requirements
14 contained in parts 4731.4000 to 4731.4360;

15 B. submits a program for training radiographers and
16 radiographers' assistants that meets the requirements of part
17 4731.4140;

18 C. submits procedures for verifying and documenting
19 the certification status of radiographers and for ensuring that
20 the certification of individuals acting as radiographers remains
21 valid;

22 D. submits written operating and emergency procedures
23 according to part 4731.4150;

24 E. submits a description of a program for inspections
25 of the job performance of each radiographer and radiographer's
26 assistant at intervals not to exceed six months according to

1 part 4731.4140, subpart 4;

2 F. submits a description of the applicant's overall
3 organizational structure as it applies to the radiation safety
4 responsibilities in industrial radiography, including specified
5 delegation of authority and responsibility;

6 G. identifies and lists the qualifications of the
7 individual designated as the radiation safety officer under part
8 4731.4130 and potential designees responsible for ensuring that
9 the licensee's radiation safety program is implemented according
10 to approved procedures;

11 H. if the applicant intends to perform leak testing
12 of sealed sources or exposure devices containing depleted
13 uranium shielding, describes the procedures for performing leak
14 testing and the qualifications of the person authorized to do
15 the leak testing. If the applicant intends to analyze its own
16 wipe samples, the application must include a description of the
17 procedures to be followed. The description must include:

18 (1) the instruments to be used;
19 (2) the methods of performing the analysis; and
20 (3) the pertinent experience of the person who
21 will analyze the wipe samples;

22 I. if the applicant intends to perform in-house
23 calibrations of survey instruments, describes methods to be used
24 and the relevant experience of the person who will perform the
25 calibrations. All calibrations must be performed according to
26 part 4731.4060; and

27 J. identifies and describes the location of all field

1 stations and permanent radiographic installations and the
2 locations where all records required by this chapter will be
3 maintained.

4 4731.4030 PERFORMANCE REQUIREMENTS; INDUSTRIAL RADIOGRAPHY
5 EQUIPMENT.

6 Subpart 1. ANSI standard.

7 A. This subpart applies to equipment used in
8 industrial radiographic operations.

9 B. A radiographic exposure device, source assembly,
10 or sealed source and all associated equipment must meet the
11 requirements specified in American National Standard N432,
12 "Radiological Safety for the Design and Construction of
13 Apparatus for Gamma Radiography," American National Standards
14 Institute (ANSI) (1981). The ANSI standard is incorporated by
15 reference, is not subject to frequent change, and is available
16 through the Minitex interlibrary loan system.

17 C. Engineering analysis may be submitted by an
18 applicant or licensee to demonstrate the applicability of
19 previously performed testing on similar individual radiography
20 equipment components. Upon review, the commissioner may find
21 the engineering analysis an acceptable alternative to actual
22 testing of the component according to the ANSI standard.

23 Subp. 2. Additional requirements.

24 A. In addition to the requirements under subpart 1,
25 the requirements in this subpart apply to radiographic exposure
26 devices, source changers, source assemblies, and sealed sources.

27 B. A licensee must ensure that a radiographic

1 exposure device has attached to it a durable, legible, clearly
2 visible label bearing:

3 (1) the chemical symbol and mass number of the
4 radionuclide in the device;

5 (2) the activity and the date on which the
6 activity was last measured;

7 (3) the model or product code and serial number
8 of the sealed source;

9 (4) the manufacturer of the sealed source; and

10 (5) the licensee's name, address, and telephone
11 number.

12 C. Radiographic exposure devices intended for use as
13 Type B transport containers must meet the applicable
14 requirements under parts 4731.0400 to 4731.0424.

15 D. Modification of radiographic exposure devices,
16 source changers, source assemblies, and associated equipment is
17 prohibited, unless the design of a replacement component,
18 including source holder, source assembly, controls, or guide
19 tubes, would not compromise the design safety features of the
20 system.

21 Subp. 3. Removable sources and source changers;
22 requirements.

23 A. In addition to the requirements in subparts 1 and
24 2, the requirements in this subpart apply to radiographic
25 exposure devices, source assemblies, and associated equipment
26 that allow the source to be moved out of the device for
27 radiographic operations or to source changers.

1 B. The coupling between the source assembly and the
2 control cable must be designed so that the source assembly will
3 not become disconnected if cranked outside the guide tube. The
4 coupling must be such that it cannot be unintentionally
5 disconnected under normal and reasonably foreseeable abnormal
6 conditions.

7 C. The device must automatically secure the source
8 assembly when it is cranked back into the fully shielded
9 position within the device. This securing system may only be
10 released by means of a deliberate operation on the exposure
11 device.

12 D. The outlet fittings, lock box, and drive cable
13 fittings on each radiographic exposure device must be equipped
14 with safety plugs or covers that must be installed during
15 storage and transportation to protect the source assembly from
16 water, mud, sand, or other foreign matter.

17 E. A sealed source or source assembly must have
18 attached to it or engraved on it a durable, legible, visible
19 label with the words: "DANGEROUS--RADIOACTIVE" and the label
20 may not interfere with the safe operation of the exposure device
21 or associated equipment.

22 F. The guide tube must be:

23 (1) able to withstand a crushing test that
24 closely approximates the crushing forces that are likely to be
25 encountered during use; and

26 (2) able to withstand a kinking resistance test
27 that closely approximates the kinking forces that are likely to

1 be encountered during use.

2 G. Guide tubes must be used when moving the source
3 out of the device.

4 H. An exposure head or similar device that is
5 designed to prevent the source assembly from passing out of the
6 end of the guide tube must be attached to the outermost end of
7 the guide tube during industrial radiography operations.

8 I. The guide tube exposure head connection must be
9 able to withstand the tensile test for control units specified
10 in ANSI N432, incorporated by reference under subpart 1, item B.

11 J. Source changers must provide a system that ensures
12 the source will not be accidentally withdrawn from the changer
13 when connecting or disconnecting the drive cable to or from a
14 source assembly.

15 Subp. 4. Exception. Notwithstanding subpart 1, item B,
16 equipment used in industrial radiographic operations need not
17 comply with section 8.9.2(c) of the endurance test in ANSI N432
18 if the prototype equipment has been tested using a torque value
19 representative of the torque that an individual using the
20 radiography equipment can realistically exert on the lever or
21 crankshaft of the drive mechanism.

22 4731.4040 LIMITS ON EXTERNAL RADIATION LEVELS.

23 The maximum exposure rate limits for storage containers and
24 source changers are 200 millirems (2 mSv) per hour at any
25 exterior surface, and ten millirems (0.1 mSv) per hour at one
26 meter from any exterior surface with the sealed source in the
27 shielded position.

1 4731.4050 LOCKING OF RADIOGRAPHIC EXPOSURE DEVICES, STORAGE
2 CONTAINERS, AND SOURCE CHANGERS.

3 Subpart 1. Radiographic exposure devices.

4 A. A radiographic exposure device must have a lock or
5 outer locked container designed to prevent unauthorized or
6 accidental removal of the sealed source from its shielded
7 position.

8 B. The exposure device and its container must be kept
9 locked, and if a keyed lock, with the key removed at all times,
10 when not under the direct surveillance of a radiographer or a
11 radiographer's assistant, except at permanent radiographic
12 installations according to part 4731.4190.

13 C. During radiographic operations, the sealed source
14 assembly must be secured in the shielded position each time the
15 source is returned to that position.

16 Subp. 2. Storage containers and source changers. A sealed
17 source storage container and source changer must:

18 A. have a lock or outer locked container designed to
19 prevent unauthorized or accidental removal of the sealed source
20 from its shielded position; and

21 B. be kept locked, and if a keyed lock, with the key
22 removed at all times, when containing sealed sources, except
23 when under the direct surveillance of a radiographer or a
24 radiographer's assistant.

25 4731.4060 RADIATION SURVEY INSTRUMENTS.

26 Subpart 1. Required instruments. A licensee must keep

1 sufficient calibrated and operable radiation survey instruments
2 at each location where radioactive material is present to make
3 the radiation surveys required under parts 4731.2000 to
4 4731.2950 and 4731.4000 to 4731.4360. Instrumentation required
5 under this part must be capable of measuring a range from two
6 millirems (0.02 mSv) per hour through one rem (0.01 Sv) per hour.

7 Subp. 2. Calibration. A licensee must have each radiation
8 survey instrument required under subpart 1 calibrated:

9 A. at intervals not to exceed six months and after
10 instrument servicing, except for battery changes;

11 B. for linear scale instruments, at two points
12 located approximately one-third and two-thirds of full-scale on
13 each scale; for logarithmic scale instruments, at midrange of
14 each decade and at two points of at least one decade; and for
15 digital instruments, at three points between two and 1,000
16 millirems (0.02 and 10 mSv) per hour; and

17 C. so that an accuracy within plus or minus 20
18 percent of the calibration source can be demonstrated at each
19 point checked.

20 Subp. 3. Record keeping. A licensee must maintain records
21 of the instrument calibrations that are required under this part
22 and must retain each record for three years after it is made.

23 4731.4070 LEAK TESTING, REPLACEMENT, AND OTHER MODIFICATIONS OF
24 SEALED SOURCES.

25 Subpart 1. Authorized personnel.

26 A. The replacement of any sealed source fastened to
27 or contained in a radiographic exposure device and leak testing

1 of any sealed source must be performed by persons authorized to
2 do so by the NRC or an agreement state.

3 B. The opening, repair, or modification of any sealed
4 source must be performed by persons specifically authorized to
5 do so by the NRC or an agreement state.

6 Subp. 2. Leak testing requirements.

7 A. A licensee who uses a sealed source must have the
8 source tested for leakage at intervals not to exceed six months.

9 B. Leak testing of a sealed source must be performed
10 using a method approved by the NRC or an agreement state.

11 C. A wipe sample must be taken from the nearest
12 accessible point to the sealed source where contamination might
13 accumulate. The wipe sample must be analyzed for radioactive
14 contamination. The analysis must be capable of detecting the
15 presence of 0.005 microcurie (185 Bq) of radioactive material on
16 the test sample. The analysis must be performed by a person
17 specifically authorized by the NRC or an agreement state to
18 perform the analysis.

19 D. A licensee must maintain records of the leak tests
20 according to part 4731.4240.

21 E. Unless a sealed source is accompanied by a
22 certificate from the transferor that shows that it has been leak
23 tested within six months before the transfer, the sealed source
24 may not be used by the licensee until tested for leakage.
25 Sealed sources that are in storage and not in use do not require
26 leak testing, but must be tested before use or transfer to
27 another person if the interval of storage exceeds six months.

1 Subp. 3. Leaking source.

2 A. A test conducted under subpart 2 that reveals the
3 presence of 0.005 microcurie (185 Bq) or more of removable
4 radioactive material must be considered evidence that the sealed
5 source is leaking.

6 B. The licensee must immediately withdraw the
7 equipment involved from use and must have it decontaminated and
8 repaired or disposed of according to this chapter.

9 C. A report must be filed with the commissioner,
10 within five days, of any test with results that exceed the
11 threshold in item A, describing the equipment involved, the test
12 results, and corrective action taken.

13 Subp. 4. Depleted uranium testing.

14 A. An exposure device using depleted uranium
15 shielding and an S-tube configuration must be tested for
16 depleted uranium contamination at intervals not to exceed 12
17 months. The analysis must be capable of detecting the presence
18 of 0.005 microcuries (185 Bq) of radioactive material on the
19 test sample and must be performed by a person specifically
20 authorized by the NRC or an agreement state to perform the
21 analysis.

22 B. If testing under item A reveals the presence of
23 0.005 microcuries (185 Bq) or more of removable depleted uranium
24 contamination, the exposure device must be removed from use
25 until an evaluation of the wear on the S-tube has been made.

26 C. If the evaluation under item B reveals that the
27 S-tube is worn through, the device may not be used again.

1 D. Depleted uranium shielded devices do not have to
2 be tested for depleted uranium contamination while in storage
3 and not in use.

4 E. Before using or transferring a depleted uranium
5 shielded device, the device must be tested for depleted uranium
6 contamination if the interval of storage exceeded 12 months.

7 F. A record of the depleted uranium leak test must be
8 made according to part 4731.4240.

9 4731.4080 QUARTERLY INVENTORY.

10 Subpart 1. Inventory required. A licensee must conduct a
11 quarterly physical inventory to account for all sealed sources
12 and for devices containing depleted uranium received and
13 possessed under a license issued under parts 4731.4000 to
14 4731.4360.

15 Subp. 2. Record keeping. A licensee must maintain records
16 of the quarterly inventory according to part 4731.4250.

17 4731.4090 EQUIPMENT INSPECTION AND MAINTENANCE.

18 Subpart 1. Daily checks required. A licensee must perform
19 visual and operability checks on survey meters, radiographic
20 exposure devices and associated equipment, transport and storage
21 containers, and source changers before use on each day the
22 equipment is to be used to ensure that the equipment is in good
23 working condition, that the sources are adequately shielded, and
24 that required labeling is present. Survey instrument
25 operability must be performed using check sources or other
26 appropriate means. If equipment problems are found, the

1 equipment must be removed from service until repaired.

2 Subp. 2. Written procedures. A licensee must have written
3 procedures for:

4 A. inspection and routine maintenance, at intervals
5 not to exceed three months or before the first use thereafter to
6 ensure the proper functioning of components important to safety,
7 of the following. If equipment problems are found, the
8 equipment must be removed from service until repaired:

- 9 (1) radiographic exposure devices;
10 (2) source changers;
11 (3) associated equipment;
12 (4) transport and storage containers; and
13 (5) survey instruments;

14 B. ensuring that replacement components meet design
15 specifications;

16 C. inspection and maintenance necessary to maintain
17 the Type B packaging used to transport radioactive materials.
18 The inspection and maintenance program must include procedures
19 to ensure that Type B packages are shipped and maintained
20 according to the certificate of compliance or other approval;
21 and

22 D. maintaining records of equipment problems and of
23 any maintenance performed under subpart 1 according to part
24 4731.4270.

25 4731.4100 PERMANENT RADIOGRAPHIC INSTALLATIONS; ENTRANCE
26 CONTROLS.

27 Subpart 1. Required entrance controls. An entrance that

1 is used for personnel access to the high radiation area in a
2 permanent radiographic installation must have:

3 A. an entrance control of the type described in part
4 4731.2220, subpart 1, item A, subitem (1), that reduces the
5 radiation level upon entry into the area; or

6 B. conspicuous visible and audible warning signals to
7 warn of the presence of radiation. The visible signal must be
8 actuated by radiation whenever the source is exposed. The
9 audible signal must be actuated when an attempt is made to enter
10 the installation while the source is exposed.

11 Subp. 2. Testing.

12 A. The alarm system under subpart 1 must be tested
13 for proper operation with a radiation source each day before the
14 installation is used for radiographic operations. The test must
15 include a check of both the visible and audible signals.

16 Entrance control devices that reduce the radiation level upon
17 entry as provided under subpart 1, item A, must be tested
18 monthly.

19 B. If an entrance control device or an alarm is
20 operating improperly, it must be immediately labeled as
21 defective and repaired within seven calendar days. The facility
22 may continue to be used during the seven-day period if the
23 licensee implements the continuous surveillance requirements
24 under part 4731.4190 and uses an alarming ratemeter.

25 C. A licensee must maintain records of alarm system
26 and entrance control device tests required under this part and
27 retain each record for three years after it is made.

1 4731.4110 LABELING; PACKAGING; SECURITY.

2 Subpart 1. Required label. A licensee may not use a
3 source changer or a container to store licensed material unless
4 the source changer or the storage container has securely
5 attached to it a durable, legible, and clearly visible label
6 bearing the standard radiation symbol under part 4731.2300,
7 having a minimum diameter of 25 millimeters, and the wording:
8 "CAUTION (or DANGER) - RADIOACTIVE MATERIAL. NOTIFY CIVIL
9 AUTHORITIES (or name of company)."

10 Subp. 2. Required packaging. A licensee may not transport
11 licensed material unless the material is packaged, and the
12 package is labeled, marked, and accompanied with appropriate
13 shipping papers, according to parts 4731.0400 to 4731.0424.

14 Subp. 3. Required security. Locked radiographic exposure
15 devices and storage containers must be physically secured to
16 prevent tampering or removal by unauthorized personnel. A
17 licensee must store licensed material in a manner that minimizes
18 danger from explosion or fire.

19 Subp. 4. Required transport security. A licensee must
20 lock and physically secure the transport package containing
21 licensed material in the transporting vehicle to prevent
22 accidental loss, tampering, or unauthorized removal of the
23 licensed material from the vehicle.

24 4731.4120 INDUSTRIAL RADIOGRAPHIC OPERATIONS.

25 Subpart 1. Qualified personnel present. When radiography
26 is performed at a location other than a permanent radiographic

1 installation, the radiographer must be accompanied by at least
2 one other qualified radiographer or an individual who has at a
3 minimum met the requirements of part 4731.4140, subpart 2. The
4 additional qualified individual must observe the operations and
5 be capable of providing immediate assistance to prevent
6 unauthorized entry. Radiography may not be performed if only
7 one qualified individual is present.

8 Subp. 2. Permanent installation; requirement. All
9 radiographic operations conducted at locations of use authorized
10 on the license must be conducted in a permanent radiographic
11 installation, unless specifically authorized by the commissioner.

12 Subp. 3. Offshore water operations. A licensee may
13 conduct lay-barge, offshore platform, or underwater radiography
14 only if procedures have been approved by the commissioner, the
15 NRC, or an agreement state.

16 4731.4130 RADIATION SAFETY OFFICER.

17 Subpart 1. Generally. A licensee's radiation safety
18 officer must ensure that radiation safety activities are
19 performed according to approved procedures and regulatory
20 requirements in the daily operation of the licensee's program.

21 Subp. 2. Minimum qualifications. At a minimum, a
22 radiation safety officer for industrial radiography must
23 complete:

24 A. training and testing according to part 4731.4140,
25 subpart 1;

26 B. 2,000 hours of hands-on experience as a qualified
27 radiographer in industrial radiographic operations; and

1 C. formal training in the establishment and
2 maintenance of a radiation protection program.

3 Subp. 3. Alternate qualifications. The commissioner shall
4 consider alternatives to subpart 2 when the radiation safety
5 officer has appropriate training or experience in the field of
6 ionizing radiation and has adequate formal training with respect
7 to the establishment and maintenance of a radiation safety
8 protection program.

9 Subp. 4. Duties. Duties of the radiation safety officer
10 include, but are not limited to:

11 A. establishing and overseeing all operating,
12 emergency, and ALARA procedures as required under parts
13 4731.2000 to 4731.2950, and reviewing them regularly to ensure
14 that the procedures in use conform to parts 4731.2000 to
15 4731.2950, to other rules, and to the license conditions;

16 B. overseeing and approving all phases of the
17 training program for radiographic personnel, ensuring that
18 appropriate and effective radiation protection practices are
19 taught;

20 C. ensuring that required radiation surveys and leak
21 tests are performed and documented according to this chapter,
22 including any corrective measures when levels of radiation
23 exceed established limits;

24 D. ensuring that personnel monitoring devices are
25 calibrated and used properly by occupationally exposed
26 personnel, that records are kept of the monitoring results, and
27 that timely notifications are made as required under part

1 4731.2620; and

2 E. ensuring that operations are conducted safely and
3 assuming control for instituting corrective actions, including
4 stopping operations when necessary.

5 4731.4140 RADIOGRAPHER TRAINING.

6 Subpart 1. Requirements; radiographer. A licensee may not
7 permit an individual to act as a radiographer until the
8 individual:

9 A. receives training according to subpart 6;

10 B. completes a minimum of two months of on-the-job
11 training;

12 C. is certified through a radiographer certification
13 program by a certifying entity according to part 4731.4360;

14 D. receives copies of and instruction in parts
15 4731.0200, 4731.0280, and 4731.0290; the applicable DOT
16 regulations under parts 4731.0400 to 4731.0424; the applicable
17 portions of parts 4731.1000 to 4731.2950; parts 4731.4000 to
18 4731.4360; the license under which the radiographer will perform
19 industrial radiography; and the licensee's operating and
20 emergency procedures;

21 E. demonstrates understanding of the licensee's
22 license and operating and emergency procedures by successfully
23 completing a written or oral examination covering the material;

24 F. receives training in the use of the licensee's
25 radiographic exposure devices and sealed sources, in the daily
26 inspection of devices and associated equipment, and in the use
27 of radiation survey instruments; and

1 G. demonstrates understanding of the use of the
2 radiographic exposure devices, sources, survey instruments, and
3 associated equipment under item F by successfully completing a
4 practical examination covering the material.

5 Subp. 2. Requirements; radiographer's assistant. A
6 licensee may not permit an individual to act as a radiographer's
7 assistant until the individual:

8 A. receives copies of and instruction in parts
9 4731.0200, 4731.0280, and 4731.0290; the applicable DOT
10 regulations under parts 4731.0400 to 4731.0424; the applicable
11 portions of parts 4731.1000 to 4731.2950; parts 4731.4000 to
12 4731.4360; the license under which the radiographer's assistant
13 will perform industrial radiography; and the licensee's
14 operating and emergency procedures;

15 B. develops competence to use, under the personal
16 supervision of a radiographer, the radiographic exposure
17 devices, sealed sources, associated equipment, and radiation
18 survey instruments that the assistant will use; and

19 C. demonstrates understanding of the instructions
20 provided under item A by successfully completing a written test
21 on the subjects covered and demonstrates competence in the use
22 of hardware described under item B by successfully completing a
23 practical examination on the use of the hardware.

24 Subp. 3. Refresher training. A licensee must provide
25 annual refresher safety training for each radiographer and
26 radiographer's assistant at intervals not to exceed 12 months.

27 Subp. 4. Job performance review.

1 A. Except as provided in item C, the radiation safety
2 officer or designee must conduct an inspection program of the
3 job performance of each radiographer and radiographer's
4 assistant to ensure that this chapter, the license requirements,
5 and the licensee's operating and emergency procedures are
6 followed. The inspection program must:

7 (1) include observation of the performance of
8 each radiographer and radiographer's assistant during an actual
9 industrial radiographic operation, at intervals not to exceed
10 six months; and

11 (2) provide that, if a radiographer or a
12 radiographer's assistant has not participated in an industrial
13 radiographic operation for more than six months since the last
14 inspection, the radiographer must redemonstrate knowledge of the
15 training requirements of subpart 1, item F, and the
16 radiographer's assistant must redemonstrate knowledge of the
17 training requirements of subpart 2, item B, by a practical
18 examination before the individuals can next participate in a
19 radiographic operation.

20 B. The commissioner may consider alternatives to item
21 A in situations where an individual serves as both radiographer
22 and radiation safety officer.

23 C. In those operations where a single individual
24 serves as both radiographer and radiation safety officer, and
25 performs all radiography operations, an inspection program is
26 not required.

27 Subp. 5. Record keeping. A licensee must maintain records

1 of training under this part, including certification documents,
2 written and practical examinations, refresher safety training,
3 and inspections of job performance, according to part 4731.4290.

4 Subp. 6. Required subjects. A radiographer must receive
5 training in:

6 A. the fundamentals of radiation safety, including:

7 (1) characteristics of gamma radiation;

8 (2) units of radiation dose and quantity of
9 radioactivity;

10 (3) hazards of exposure to radiation;

11 (4) levels of radiation from licensed material;

12 and

13 (5) methods of controlling radiation dose (time,
14 distance, and shielding);

15 B. radiation detection instruments, including:

16 (1) use, operation, calibration, and limitations
17 of radiation survey instruments;

18 (2) survey techniques; and

19 (3) use of personnel monitoring equipment;

20 C. equipment to be used, including:

21 (1) operation and control of radiographic
22 exposure equipment, remote handling equipment, and storage
23 containers, including pictures or models of source assemblies
24 (pigtails);

25 (2) storage, control, and disposal of licensed
26 material; and

27 (3) inspection and maintenance of equipment;

1 D. the requirements of pertinent portions of this
2 chapter; and

3 E. case histories of accidents in radiography.

4 Subp. 7. Certification records. Records of radiographer
5 certification maintained according to part 4731.4290, subpart 1,
6 must provide appropriate affirmation of the certification
7 requirements specified in subpart 1, item C.

8 4731.4150 OPERATING AND EMERGENCY PROCEDURES.

9 Subpart 1. Required procedures. A licensee must establish
10 operating and emergency procedures that include, as a minimum,
11 instructions in:

12 A. appropriate handling and use of licensed sealed
13 sources and radiographic exposure devices so that no person is
14 likely to be exposed to radiation doses in excess of the limits
15 established under parts 4731.2000 to 4731.2950;

16 B. methods and occasions for conducting radiation
17 surveys;

18 C. methods for controlling access to radiographic
19 areas;

20 D. methods and occasions for locking and securing
21 radiographic exposure devices, transport and storage containers,
22 and sealed sources;

23 E. personnel monitoring and the use of personnel
24 monitoring equipment;

25 F. transporting sealed sources to field locations,
26 including packing of radiographic exposure devices and storage
27 containers in the vehicles, placarding of vehicles when needed,

1 and control of the sealed sources during transportation;

2 G. inspection, maintenance, and operability checks of
3 radiographic exposure devices, survey instruments, transport
4 containers, and storage containers;

5 H. steps that must be taken immediately by
6 radiography personnel in the event a pocket dosimeter is found
7 to be off-scale or an alarm ratemeter alarms unexpectedly;

8 I. procedures for identifying and reporting defects
9 and noncompliance, as required under Code of Federal
10 Regulations, title 10, part 21;

11 J. procedures for notifying proper persons in the
12 event of an accident;

13 K. minimizing exposure of persons in the event of an
14 accident;

15 L. source recovery procedures, if the licensee will
16 perform source recovery; and

17 M. maintaining records.

18 Subp. 2. Record keeping. A licensee must maintain a copy
19 of current operating and emergency procedures until the
20 commissioner terminates the license. Superseded material must
21 be retained for three years after the change is made. The
22 licensee must maintain copies of current operating and emergency
23 procedures according to part 4731.4330.

24 4731.4160 SUPERVISION OF RADIOGRAPHER'S ASSISTANTS.

25 When a radiographer's assistant uses radiographic exposure
26 devices, associated equipment, or sealed sources or conducts
27 radiation surveys required under part 4731.4180, subpart 1, item

1 B, to determine that the sealed source has returned to the
2 shielded position after an exposure, the assistant must be under
3 the personal supervision of a radiographer. The personal
4 supervision must include:

5 A. the radiographer's physical presence at the site
6 where the sealed sources are being used;

7 B. the availability of the radiographer to give
8 immediate assistance if required; and

9 C. the radiographer's direct observation of the
10 assistant's performance of the operations referred to in this
11 part.

12 4731.4170 PERSONNEL MONITORING.

13 Subpart 1. Monitoring requirements.

14 A. A licensee may not permit an individual to act as
15 a radiographer or a radiographer's assistant unless, at all
16 times during radiographic operations, each individual wears, on
17 the trunk of the body, a combination of direct reading
18 dosimeter, an operating alarm ratemeter, and a personnel
19 dosimeter that is processed and evaluated by an accredited
20 National Voluntary Laboratory Accreditation Program (NVLAP)
21 processor.

22 B. At permanent radiography installations where other
23 appropriate alarm or warning devices are in routine use, wearing
24 an alarm ratemeter is not required.

25 C. Pocket dosimeters must have a range from zero to
26 200 millirems (2 mSv) and must be recharged at the start of each
27 shift. Electronic personal dosimeters may only be used in place

1 of ion-chamber pocket dosimeters.

2 D. Each personnel dosimeter must be assigned to and
3 worn by only one individual.

4 E. Film badges must be replaced at periods not to
5 exceed one month and other personnel dosimeters processed and
6 evaluated by an accredited NVLAP processor must be replaced at
7 periods not to exceed three months.

8 F. After replacement, each personnel dosimeter must
9 be processed as soon as possible.

10 Subp. 2. Direct reading dosimeters. Direct reading
11 dosimeters, such as pocket dosimeters or electronic personal
12 dosimeters, must be read and the exposures recorded at the
13 beginning and end of each shift and records must be maintained
14 according to part 4731.4310.

15 Subp. 3. Pocket dosimeters. Pocket dosimeters, or
16 electronic personal dosimeters, must be checked at periods not
17 to exceed 12 months for correct response to radiation and
18 records must be maintained according to part 4731.4310.
19 Acceptable dosimeters must read within plus or minus 20 percent
20 of the true radiation exposure.

21 Subp. 4. High readings. If an individual's pocket chamber
22 is found to be off-scale, or if the individual's electronic
23 personal dosimeter reads greater than 200 millirems (2 mSv), and
24 the possibility of radiation exposure cannot be ruled out as the
25 cause, the individual's personnel dosimeter must be sent for
26 processing within 24 hours. The individual may not resume work
27 associated with licensed material use until a determination of

1 the individual's radiation exposure has been made. The
2 determination must be made by the radiation safety officer or
3 the radiation safety officer's designee. The results of the
4 determination must be included in the records maintained
5 according to part 4731.4310.

6 Subp. 5. Lost or damaged dosimeters. If the personnel
7 dosimeter that is required under subpart 1 is lost or damaged,
8 the worker must cease work immediately until a replacement
9 personnel dosimeter meeting the requirements of subpart 1 is
10 provided and the exposure is calculated for the time period from
11 issuance to loss or damage of the personnel dosimeter. The
12 results of the calculated exposure and the time period for which
13 the personnel dosimeter was lost or damaged must be included in
14 the records maintained according to part 4731.4310.

15 Subp. 6. Report retention. Dosimetry reports received
16 from the accredited NVLAP personnel dosimeter processor must be
17 retained according to part 4731.4310.

18 Subp. 7. Ratemeter requirements. An alarm ratemeter must:

19 A. be checked to ensure that the alarm functions
20 properly (sounds) before use at the start of each shift;

21 B. be set to give an alarm signal at a preset dose
22 rate of 500 millirems per hour (5 mSv/hr), with an accuracy of
23 plus or minus 20 percent of the true radiation ~~does~~ dose rate;

24 C. require special means to change the preset alarm
25 function; and

26 D. be calibrated at periods not to exceed 12 months
27 for correct response to radiation. A licensee must maintain

1 records of alarm ratemeter calibrations according to part
2 4731.4310.

3 4731.4180 RADIATION SURVEYS.

4 Subpart 1. Survey requirements. A licensee must:

5 A. conduct radiation surveys with a calibrated and
6 operable radiation survey instrument that meets the requirements
7 under part 4731.4060;

8 B. using a survey instrument meeting the requirements
9 of item A, conduct a survey of the radiographic exposure device
10 and the guide tube after each exposure when approaching the
11 device or the guide tube. The survey must determine that the
12 sealed source has returned to its shielded position before
13 exchanging films, repositioning the exposure head, or
14 dismantling equipment;

15 C. conduct a survey of the radiographic exposure
16 device with a calibrated radiation survey instrument any time
17 the source is exchanged and whenever a radiographic exposure
18 device is placed in a storage area to ensure that the sealed
19 source is in its shielded position; and

20 D. maintain records according to subpart 2.

21 Subp. 2. Record keeping. A licensee must maintain a
22 record of each exposure device survey conducted before the
23 device is placed in storage under subpart 1, item C, if that
24 survey is the last one performed in the workday. Each record
25 must be maintained for three years after it is made.

26 4731.4190 SURVEILLANCE.

1 During a radiographic operation, the radiographer, or the
2 other individual present as required under part 4731.4120, must
3 maintain continuous direct visual surveillance of the operation
4 to protect against unauthorized entry into a high radiation area
5 except at permanent radiographic installations where all
6 entryways are locked and the requirements under part 4731.4100
7 are met.

8 4731.4200 POSTING.

9 All areas in which industrial radiography is being
10 performed must be conspicuously posted according to part
11 4731.2310. Exceptions under part 4731.2320 do not apply to
12 industrial radiographic operations.

13 4731.4210 RECORDS; SPECIFIC LICENSE FOR INDUSTRIAL RADIOGRAPHY.

14 A licensee must maintain a copy of its license, license
15 conditions, documents incorporated by reference, and amendments
16 to each of these items until superseded by new documents
17 approved by the commissioner, or until the commissioner
18 terminates the license.

19 4731.4220 RECORDS; RECEIPT AND TRANSFER OF SEALED SOURCES.

20 Subpart 1. Receipt and transfer records. A licensee must
21 maintain records showing the receipts and transfers of sealed
22 sources and devices using depleted uranium for shielding and
23 retain each record for three years after it is made.

24 Subp. 2. Record requirements. Records under subpart 1
25 must include:

26 A. the date;

- 1 B. the name of the individual making the record;
2 C. the radionuclide and number of curies (becquerels)
3 or mass for depleted uranium; and
4 D. the manufacturer, model, and serial number of each
5 sealed source or device, as appropriate.

6 4731.4240 RECORDS; LEAK TESTING.

7 A licensee must maintain records of leak test results for
8 sealed sources and for devices containing depleted uranium. The
9 results must be stated in units of microcuries (becquerels).
10 The licensee must retain each record for three years after it is
11 made or until the source in storage is removed.

12 4731.4250 RECORDS; QUARTERLY INVENTORY.

13 Subpart 1. Quarterly inventory records. A licensee must
14 maintain records of the quarterly inventory of sealed sources
15 and of devices containing depleted uranium as required under
16 part 4731.4080 and retain each record for three years after it
17 is made.

18 Subp. 2. Record requirements. Records required under
19 subpart 1 must include:

- 20 A. the date of the inventory;
21 B. the name of the individual conducting the
22 inventory;
23 C. the radionuclide;
24 D. the number of curies (becquerels) or mass for
25 depleted uranium in each device;
26 E. the location of sealed source or devices; and

1 F. the manufacturer, model, and serial number of each
2 sealed source or device, as appropriate.

3 4731.4260 UTILIZATION LOGS.

4 Subpart 1. Logs required. A licensee must maintain
5 utilization logs showing for each sealed source:

6 A. a description, including the make, model, and
7 serial number, of the radiographic exposure device or transport
8 or storage container in which the sealed source is located;

9 B. the identity and signature of the radiographer to
10 whom assigned; and

11 C. the plant or site where used and dates of use,
12 including the dates removed and returned to storage.

13 Subp. 2. Retention. A licensee must retain the logs
14 required under subpart 1 for three years after the log is made.

15 4731.4270 RECORDS; INSPECTION AND MAINTENANCE.

16 Subpart 1. Inspection and maintenance records. A licensee
17 must maintain records specified under part 4731.4090 of
18 equipment problems found in daily checks and quarterly
19 inspections of radiographic exposure devices, transport and
20 storage containers, associated equipment, source changers, and
21 survey instruments and retain each record for three years after
22 it is made.

23 Subp. 2. Record requirements. The records under subpart 1
24 must include:

25 A. the date of check or inspection;

26 B. the name of inspector;

- C. equipment involved;
- D. any problems found; and
- E. what repair or maintenance, if any, was done.

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.

4731.4310 RECORDS; PERSONNEL MONITORING.

According to part 4731.4170, a licensee must maintain

1 records of:

2 A. direct reading dosimeter readings and yearly
3 operability checks according to part 4731.4170, subparts 2 and
4 3, for three years after the record is made;

5 B. alarming ratemeter calibrations for three years
6 after the record is made;

7 C. personnel dosimeter results received from the
8 accredited NVLAP processor until the commissioner terminates the
9 license; and

10 D. estimates of exposures as a result of off-scale
11 personal direct reading dosimeters or lost or damaged personnel
12 dosimeters until the commissioner terminates the license.

13 4731.4330 LOCATION OF DOCUMENTS AND RECORDS.

14 Subpart 1. Records in one location. A licensee must
15 maintain copies of all records required under this chapter at
16 the location identified under part 4731.4020, item J.

17 Subp. 2. Records at each location. A licensee must
18 maintain copies of the following documents and records,
19 sufficient to demonstrate compliance, at each applicable field
20 station and each temporary job site:

21 A. the license authorizing the use of licensed
22 material;

23 B. a copy of parts 4731.1000 to 4731.2950 and
24 4731.4000 to 4731.4360;

25 C. utilization records for each radiographic exposure
26 device dispatched from that location as required under part
27 4731.4260;

1 D. records of equipment problems identified in daily
2 checks of equipment as required under part 4731.4270, subpart 1;

3 E. records of alarm system and entrance control
4 checks required under part 4731.4100, if applicable;

5 F. records of direct reading dosimeters such as
6 pocket dosimeter or electronic personal dosimeters readings as
7 required under part 4731.4310;

8 G. operating and emergency procedures required under
9 part 4731.4150;

10 H. evidence of the latest calibration of the
11 radiation survey instruments in use at the site, as required
12 under part 4731.4060;

13 I. evidence of the latest calibrations of alarm
14 ratemeters and operability checks of pocket dosimeters or
15 electronic personal dosimeters as required under part 4731.4310;

16 J. the latest survey records required under part
17 4731.4180;

18 K. the shipping papers for the transportation of
19 radioactive materials required under part 4731.0402; and

20 L. when operating under reciprocity according to part
21 4731.0355, a copy of the NRC or agreement state license
22 authorizing the use of licensed materials.

23 4731.4350 NOTIFICATIONS.

24 Subpart 1. Reports required. In addition to the reporting
25 required under part 4731.3110 and under other parts of this
26 chapter, a licensee must provide a written report to the
27 commissioner within 30 days of the occurrence of any of the

1 following incidents involving radiographic equipment:

2 A. unintentional disconnection of the source assembly
3 from the control cable;

4 B. inability to retract the source assembly to its
5 fully shielded position and secure it in the fully shielded
6 position; or

7 C. failure of any component, critical to safe
8 operation of the device, to properly perform its intended
9 function.

10 Subp. 2. Required information. A licensee must include
11 the following information in each report submitted under subpart
12 1 and in each report of overexposure submitted under part
13 4731.2620 that involves failure of safety components of
14 radiography equipment:

15 A. a description of the equipment problem;

16 B. the cause of each incident, if known;

17 C. the name of the manufacturer and model number of
18 equipment involved in the incident;

19 D. the place, date, and time of the incident;

20 E. the actions taken to establish normal operations;

21 F. the corrective actions taken or planned to prevent
22 recurrence; and

23 G. the qualifications of personnel involved in the
24 incident.

25 Subp. 3. Reporting unlisted use. A licensee conducting
26 radiographic operations or storing radioactive material at any
27 location not listed on the license for a period in excess of 180

1 days in a calendar year must notify the commissioner prior to
2 exceeding the 180 days.

3 4731.4360 RADIOGRAPHER CERTIFICATION.

4 Subpart 1. Requirements for an independent certifying
5 organization. An independent certifying organization must:

6 A. be an organization such as a society or
7 association whose members participate in, or have an interest
8 in, the fields of industrial radiography;

9 B. make its membership available to the general
10 public nationwide that is not restricted because of race, color,
11 creed, religion, national origin, sex, age, ~~national origin, or~~
12 disability, sexual orientation, or age;

13 C. have a certification program open to nonmembers as
14 well as members;

15 D. be an incorporated, nationally recognized
16 organization that is involved in setting national standards of
17 practice within its fields of expertise;

18 E. have an adequate staff, a viable system for
19 financing its operations, and a policy and decision-making
20 review board;

21 F. have a set of written organizational bylaws and
22 policies that provide adequate assurance of lack of conflict of
23 interest and a system for monitoring and enforcing those bylaws
24 and policies;

25 G. have a committee, whose members can carry out
26 their responsibilities impartially, to review and approve the
27 certification guidelines and procedures and to advise the

1 organization's staff in implementing the certification program;

2 H. have a committee, whose members can carry out
3 their responsibilities impartially, to review complaints against
4 certified individuals and to determine appropriate sanctions;

5 I. have written procedures describing all aspects of
6 its certification program and maintain records of the current
7 status of each individual's certification and the administration
8 of its certification program;

9 J. have procedures to ensure that certified
10 individuals are provided due process with respect to the
11 administration of its certification program, including the
12 process of becoming certified and any sanctions imposed against
13 certified individuals;

14 K. have procedures for proctoring examinations,
15 including qualifications for proctors. The procedures must
16 ensure that the individuals proctoring each examination are not
17 employed by the same company or corporation, or a wholly-owned
18 subsidiary of such company or corporation, as any of the
19 examinees;

20 L. exchange information about certified individuals
21 with the commissioner, other independent certifying
22 organizations, the NRC, and agreement states and allow periodic
23 review of its certification program and related records; and

24 M. provide a description to the commissioner of its
25 procedures for choosing examination sites and for providing an
26 appropriate examination environment.

27 Subp. 2. Requirements for certification programs. All

1 certification programs must:

2 A. require applicants for certification to:

3 (1) receive training in the topics under part
4 4731.4140, subpart 6, or equivalent NRC or agreement state
5 regulations; and

6 (2) satisfactorily complete a written examination
7 covering these topics;

8 B. require applicants for certification to provide
9 documentation that demonstrates that the applicant has:

10 (1) received training in the topics under part
11 4731.4140, subpart 6, or equivalent NRC or agreement state
12 regulations;

13 (2) satisfactorily completed a minimum period of
14 on-the-job training; and

15 (3) received verification by an NRC or agreement
16 state licensee that the applicant has demonstrated the
17 capability of independently working as a radiographer;

18 C. include procedures to ensure that all examination
19 questions are protected from disclosure;

20 D. include procedures for denying an application and
21 revoking, suspending, and reinstating certification;

22 E. provide a certification period of not less than
23 three years nor more than five years;

24 F. include procedures for renewing certifications
25 and, if the procedures allow renewals without examination,
26 require evidence of recent full-time employment and annual
27 refresher training; and

1 G. provide a timely response to inquiries, by
2 telephone or letter, from members of the public about an
3 individual's certification status.

4 Subp. 3. Requirements for written examinations. All
5 examinations must:

6 A. be designed to test an individual's knowledge and
7 understanding of the topics under part 4731.4140, subpart 6, or
8 equivalent NRC or agreement state requirements;

9 B. be written in a multiple-choice format; and

10 C. have test items drawn from a question bank
11 containing psychometrically valid questions based on the
12 material under part 4731.4140, subpart 6.

13 MEDICAL USE OF RADIOACTIVE MATERIAL

14 4731.4400 APPLICABILITY FOR THE USE OF RADIOACTIVE MATERIALS IN
15 THE HEALING ARTS.

16 Parts 4731.4400 to 4731.4527 apply to the medical use of
17 radioactive material and provide for issuing specific licenses
18 authorizing the medical use of radioactive material. Parts
19 4731.4400 to 4731.4527 provide for the radiation safety of
20 workers, the general public, patients, and human research
21 subjects. Parts 4731.4400 to 4731.4527 are in addition to, and
22 not in substitution for, other requirements in this chapter.
23 All requirements of this chapter apply to applicants and
24 licensees subject to parts 4731.4400 to 4731.4527 unless
25 specifically exempted.

26 4731.4401 PROTECTION OF HUMAN RESEARCH SUBJECTS.

1 A. A licensee may conduct research involving human
2 research subjects only if the licensee uses radioactive
3 materials specified in the license and for the uses authorized
4 in the license.

5 B. If the research is conducted, funded, supported,
6 or regulated by a federal agency that has implemented Code of
7 Federal Regulations, title 45, part 46, subpart A, the federal
8 policy for the protection of human subjects, the licensee must,
9 before conducting research:

10 (1) obtain review and approval of the research
11 from an institutional review board according to Code of Federal
12 Regulations, title 45, section 46.111; and

13 (2) obtain informed consent from the human
14 research subject according to Code of Federal Regulations, title
15 45, section 46.116.

16 C. If the research will not be conducted, funded,
17 supported, or regulated by a federal agency that has implemented
18 the federal policy, the licensee must, before conducting
19 research, apply for and receive a specific amendment to its NRE
20 medical use license. The amendment request must include a
21 written commitment that the licensee will, before conducting
22 research:

23 (1) obtain review and approval of the research
24 from an institutional review board according to Code of Federal
25 Regulations, title 45, section 46.111; and

26 (2) obtain informed consent from the human
27 research subject according to Code of Federal Regulations, title

1 45, section 46.116.

2 D. Nothing in this part relieves licensees from
3 complying with other parts of this chapter.

4 4731.4402 IMPLEMENTATION.

5 Subpart 1. License exemption. If a license condition
6 exempted a licensee from a provision of Code of Federal
7 Regulations, title 10, part 35, on October 24, 2002, then the
8 license condition continues to exempt the licensee from the
9 requirements in the corresponding provision of parts 4731.4400
10 to 4731.4527.

11 Subp. 2. Superseding law. When a requirement in parts
12 4731.4400 to 4731.4527 differs from a requirement in an existing
13 license condition, the requirement in parts 4731.4400 to
14 4731.4527 governs.

15 Subp. 3. Continued compliance. A licensee must continue
16 to comply with any license condition that requires the licensee
17 to implement procedures required under parts 4731.4466 and
18 4731.4472 to 4731.4474 until there is a license amendment or
19 renewal that modifies the license condition.

20 4731.4403 SPECIFIC LICENSE; MEDICAL USE OF RADIOACTIVE MATERIALS.

21 Subpart 1. Specific license required.

22 A. Except as provided in item B, a person may
23 manufacture, produce, acquire, receive, possess, prepare, use,
24 or transfer radioactive material for medical use only under a
25 specific license issued by the NRC or an agreement state.

26 B. A specific license is not needed for an individual

1 who:

2 (1) receives, possesses, uses, or transfers
3 radioactive material according to this chapter under the
4 supervision of an authorized user as provided under part
5 4731.4407, unless prohibited by a license condition; or

6 (2) prepares unsealed radioactive material for
7 medical use according to this chapter under the supervision of
8 an authorized nuclear pharmacist or authorized user as provided
9 under part 4731.4407, unless prohibited by a license condition.

10 Subp. 2. Application for license, amendment, or renewal.

11 A. An application for a specific license under
12 subpart 1 must be signed by the applicant's or licensee's
13 management.

14 B. An application for a license for medical use of
15 radioactive materials as described in parts 4731.4404,
16 4731.4432, 4731.4434, 4731.4440, 4731.4450, 4731.4460, and
17 4731.4463 must include:

18 (1) an original and one copy of an application
19 for radioactive material license form prescribed by the
20 commissioner that includes the facility diagram, equipment, and
21 training and experience qualifications of the radiation safety
22 officer, authorized users, authorized medical physicists, and
23 authorized nuclear pharmacists; and

24 (2) the procedures required under parts 4731.4466
25 and 4731.4472 to 4731.4474, as applicable.

26 C. A request for a license amendment or renewal must
27 include:

1 (1) an original and one copy of the form
2 prescribed by the commissioner under item B or of a letter
3 requesting the amendment or renewal; and

4 (2) the procedures required under parts 4731.4466
5 and 4731.4472 to 4731.4474, as applicable.

6 D. In addition to the requirements under items B and
7 C, an application for a license or amendment for medical use of
8 radioactive material under part 4731.4404 must include
9 information regarding any radiation safety aspects of the
10 medical use of the material that is not addressed in parts
11 4731.4400 to 4731.4427. The applicant must provide specific
12 information on:

13 (1) radiation safety precautions and
14 instructions;

15 (2) methodology for measurement of dosages or
16 doses to be administered to patients or human research subjects;

17 (3) calibration, maintenance, and repair of
18 instruments and equipment necessary for radiation safety; and

19 (4) any other information requested by the
20 commissioner for review of the application.

21 E. An applicant that satisfies the requirements under
22 part 4731.3530 may apply for a Type A specific license of broad
23 scope.

24 Subp. 3. License amendments. A licensee must apply for
25 and receive a license amendment:

26 A. before the licensee receives, prepares, or uses
27 radioactive material for a type of use that is permitted under

1 this chapter, but not authorized under the licensee's current
2 license issued under parts 4731.4400 to 4731.4527;

3 B. before the licensee permits anyone to work as an
4 authorized user, authorized nuclear pharmacist, or authorized
5 medical physicist under the license, except:

6 (1) for an authorized user, an individual who
7 meets the requirements under part 4731.4433, item A; 4731.4436,
8 item A; 4731.4443, item A; 4731.4444, item A; 4731.4445, item A;
9 4731.4458, item A; 4731.4461, item A; or 4731.4479, item A;

10 (2) for an authorized nuclear pharmacist, an
11 individual who meets the requirements under parts 4731.4413,
12 item A, and 4731.4415;

13 (3) for an authorized medical physicist, an
14 individual who meets the requirements under parts 4731.4412,
15 item A, and 4731.4415; or

16 (4) an individual who is identified as an
17 authorized user, an authorized nuclear pharmacist, or authorized
18 medical physicist:

19 (a) on a license issued by the NRC or an
20 agreement state or on an equivalent permit or license recognized
21 by the commissioner, the NRC, or an agreement state that
22 authorizes the use of radioactive material in medical use or in
23 the practice of nuclear pharmacy; or

24 (b) on a permit issued by an NRC or
25 agreement state specific licensee of broad scope that is
26 authorized to permit the use of radioactive material in medical
27 use or in the practice of nuclear pharmacy;

1 C. before the licensee changes radiation safety
2 officers, except as provided under part 4731.4405, subpart 1,
3 item C;

4 D. before the licensee receives radioactive material
5 in excess of the amount or in a form different than authorized
6 in the license or before the licensee receives a radionuclide
7 that is different than the radionuclide authorized in the
8 license;

9 E. before the licensee adds or changes the areas of
10 use identified in the application or in the license, except for
11 areas of use where radioactive material is used only according
12 to part 4731.4432 or 4731.4434;

13 F. before the licensee changes an address identified
14 in the application or on the license; and

15 G. before the licensee revises procedures required
16 under parts 4731.4466 and 4731.4472 to 4731.4474, as applicable,
17 when the revision reduces radiation safety.

18 Subp. 4. Notifications of changes.

19 A. A licensee must provide the commissioner a copy of
20 the board certification, the license issued by the NRC or an
21 agreement state, the permit issued by an NRC or agreement state
22 master material license broad scope permittee, or the permit
23 issued by an NRC or agreement state licensee of broad scope for
24 each individual no later than 30 days after the date that the
25 licensee allows, under subpart 3, item B, the individual to work
26 as:

27 (1) an authorized user;

1 (2) an authorized nuclear pharmacist; or

2 (3) an authorized medical physicist.

3 B. A licensee must notify the commissioner by letter
4 no later than 30 days after:

5 (1) an authorized user, an authorized nuclear
6 pharmacist, a radiation safety officer, or an authorized medical
7 physicist permanently discontinues performance of duties under
8 the license or has a name change;

9 (2) the licensee's mailing address changes;

10 (3) the licensee's name changes, but the name
11 change does not constitute a transfer of control of the license
12 as described under part 4731.3075, subpart 2; or

13 (4) the licensee has added to or changed the
14 areas of use identified in the application or license where
15 radioactive material is used according to part 4731.4432 or
16 4731.4434.

17 C. A licensee must mail required documents to the
18 address under part 4731.0200, subpart 5 4.

19 Subp. 5. Exemptions; broad scope license. A licensee
20 possessing a Type A specific license of broad scope for medical
21 use, issued under parts 4731.3500 to 4731.3580, is exempt from:

22 A. subpart 2, item D, regarding the need to file an
23 amendment to the license for medical use of radioactive
24 materials under part 4731.4404;

25 B. subpart 3, item B;

26 C. subpart 3, item E, regarding additions to or
27 changes in the areas of use at the addresses identified in the

1 application or license;

2 D. subpart 4, item A;

3 E. subpart 4, item B, subitem (1), for an authorized
4 user, an authorized nuclear pharmacist, or an authorized medical
5 physicist;

6 F. subpart 4, item B, subitem (4), regarding
7 additions to or changes in the areas of use identified in the
8 application or license where radioactive material is used under
9 part 4731.4432 or 4731.4434; and

10 G. part 4731.4410, item A.

11 Subp. 6. License issuance.

12 A. The commissioner shall issue a license for the
13 medical use of radioactive material if:

14 (1) the applicant complies with subpart 2;

15 (2) the applicant pays any applicable fee as
16 provided under Minnesota Statutes, section 144.1205;

17 (3) the commissioner finds the applicant equipped
18 and committed to observe the safety standards established by the
19 commissioner in this chapter for the protection of the public
20 health and safety; and

21 (4) the applicant meets the requirements of parts
22 4731.3000 to 4731.3175.

23 B. The commissioner shall issue a license for mobile
24 medical services if the applicant:

25 (1) meets the requirements under item A; and

26 (2) ensures that individuals or human research
27 subjects to whom unsealed radioactive material or radiation from

1 implants containing radioactive material will be administered
2 are released following treatment according to part 4731.4427.

3 Subp. 7. Specific exemptions. The commissioner may, upon
4 application of any interested person or upon the commissioner's
5 own initiative, grant exemptions from parts 4731.4400 to
6 4731.4527 that the commissioner determines are authorized by law
7 and will not endanger life or property or the common defense and
8 security and are otherwise in the public interest.

9 4731.4404 OTHER MEDICAL USES.

10 A licensee may use radioactive material or a radiation
11 source approved for medical use that is not specifically
12 addressed in parts 4731.4432 to 4731.4479 if the applicant or
13 licensee:

14 A. submits the information required under part
15 4731.4403, subpart 2, items B to D; and

16 B. receives written approval from the commissioner in
17 a license or license amendment and uses the material according
18 to rules and specific conditions the commissioner considers
19 necessary for the medical use of the material.

20 4731.4405 RADIATION PROTECTION PROGRAM.

21 Subpart 1. Authority and responsibilities.

22 A. In addition to the radiation protection program
23 requirements under part 4731.2010, a licensee's management must
24 approve in writing:

25 (1) requests for license application, renewal, or
26 amendment before submission to the commissioner;

1 (2) any individual before allowing that
2 individual to work as an authorized user, authorized nuclear
3 pharmacist, or authorized medical physicist; and

4 (3) radiation protection program changes that do
5 not require a license amendment and are permitted under subpart
6 2.

7 B. A licensee's management must appoint a radiation
8 safety officer, who agrees, in writing, to be responsible for
9 implementing the radiation protection program. The licensee,
10 through the radiation safety officer, must ensure that radiation
11 safety activities are being performed according to
12 licensee-approved procedures and this chapter.

13 C. For up to 60 days each year, a licensee may permit
14 an authorized user or an individual qualified to be a radiation
15 safety officer under parts 4731.4411 and 4731.4415 to function
16 as a temporary radiation safety officer and to perform the
17 functions of a radiation safety officer, as provided in item G,
18 if the licensee takes the actions required by items B, E, G, and
19 H, and notifies the commissioner according to part 4731.4403,
20 subpart 4, item B.

21 D. A licensee may simultaneously appoint more than
22 one temporary radiation safety officer according to item C if
23 needed to ensure that the licensee has a temporary radiation
24 safety officer that satisfies the requirements to be a radiation
25 safety officer for each of the different types of uses of
26 radioactive material permitted by the license.

27 E. A licensee must establish in writing the

1 authority, duties, and responsibilities of the radiation safety
2 officer.

3 F. Licensees that are authorized for two or more
4 different types of uses of radioactive materials under parts
5 4731.4440 to 4731.4459 and 4731.4463 to 4731.4479, or two or
6 more types of units under parts 4731.4463 to 4731.4479 must
7 establish a radiation safety committee to oversee all uses of
8 radioactive material permitted by the license. The committee
9 must include an authorized user of each type of use permitted by
10 the license, the radiation safety officer, a representative of
11 the nursing service, and a representative of management who is
12 neither an authorized user nor a radiation safety officer. The
13 committee may include other members the licensee considers
14 appropriate.

15 G. A licensee must provide the radiation safety
16 officer sufficient authority, organizational freedom, time
17 resources, and management prerogative to:

- 18 (1) identify radiation safety problems;
19 (2) initiate, recommend, or provide corrective
20 actions;
21 (3) stop unsafe operations; and
22 (4) verify implementation of corrective actions.

23 H. A licensee must retain a record of actions taken
24 under items A, B, and E, according to part 4731.4500, subpart 1.

25 Subp. 2. Program changes.

26 A. A licensee may revise its radiation protection
27 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.

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.

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

1 microcuries (1.11 MBq);

2 (2) any therapeutic dosage of unsealed
3 radioactive material; or

4 (3) any therapeutic dose of radiation from
5 radioactive material.

6 B. If, because of the emergent nature of a patient's
7 condition, a delay to provide a written directive would
8 jeopardize the patient's health, an oral directive is
9 acceptable. The information contained in the oral directive
10 must be documented as soon as possible in writing in the
11 patient's record. A written directive must be prepared within
12 48 hours of the oral directive.

13 Subp. 2. Content requirements. The written directive
14 under subpart 1 must contain the patient or human research
15 subject's name and:

16 A. for an administration of quantities greater than
17 30 microcuries (1.11 MBq) of sodium iodide I-131, the dosage;

18 B. for an administration of a therapeutic dosage of
19 an unsealed radioactive material other than sodium iodide I-131,
20 the radioactive drug, dosage, and route of administration;

21 C. for gamma stereotactic radiosurgery, the total
22 dose, treatment site, and values for the target coordinate
23 settings per treatment for each anatomically distinct treatment
24 site;

25 D. for teletherapy, the total dose, dose per
26 fraction, number of fractions, and treatment site;

27 E. for high dose-rate remote afterloading

1 brachytherapy, the radionuclide, treatment site, dose per
2 fraction, number of fractions, and total dose; or

3 F. for all other brachytherapy, including low,
4 medium, and pulsed dose-rate remote afterloaders:

5 (1) before implantation, the treatment site,
6 radionuclide, and dose; and

7 (2) after implantation but before completion of
8 the procedure, the radionuclide, treatment site, number of
9 sources, and total source strength and exposure time or the
10 total dose.

11 Subp. 3. Revisions.

12 A. A written revision to an existing written
13 directive may be made if the revision is dated and signed by an
14 authorized user before the administration of the dosage of
15 unsealed radioactive material, the brachytherapy dose, the gamma
16 stereotactic radiosurgery dose, the teletherapy dose, or the
17 next fractional dose.

18 B. If, because of a patient's condition, a delay to
19 provide a written revision to an existing written directive
20 would jeopardize the patient's health, an oral revision to an
21 existing written directive is acceptable. The oral revision
22 must be documented as soon as possible in the patient's record.
23 A revised written directive must be signed by the authorized
24 user within 48 hours of the oral revision.

25 Subp. 4. Retention. A licensee must retain a copy of the
26 written directive according to part 4731.4501, subpart 1.

27 4731.4409 PROCEDURES FOR ADMINISTRATIONS REQUIRING WRITTEN

1 DIRECTIVE.

2 A. For any administration requiring a written
3 directive, a licensee must develop, implement, and maintain
4 written procedures to provide high confidence that:

5 (1) the patient's or human research subject's
6 identity is verified before each administration; and

7 (2) each administration is in accordance with the
8 written directive.

9 B. At a minimum, the procedures required by item A
10 must address the following that are applicable to the licensee's
11 use of radioactive material:

12 (1) verifying the identity of the patient or
13 human research subject;

14 (2) verifying that the administration is in
15 accordance with the treatment plan, if applicable, and the
16 written directive;

17 (3) checking both manual and computer-generated
18 dose calculations; and

19 (4) verifying that any computer-generated dose
20 calculations are correctly transferred into the consoles of
21 therapeutic medical units authorized under part 4731.4463.

22 C. A licensee must retain a copy of the procedures
23 required under item A according to part 4731.4501, subpart 2.

24 4731.4410 SUPPLIERS OF MEDICAL USE SEALED SOURCES OR DEVICES.

25 For medical use, a licensee may use only:

26 A. sealed sources or devices manufactured, labeled,
27 packaged, and distributed according to a license issued under

1 parts 4731.3000 to 4731.3175 and 4731.3400 or equivalent
2 requirements of the NRC or an agreement state;

3 B. sealed sources or devices noncommercially
4 transferred from a licensee licensed under parts 4731.4400 to
5 4731.4527; or

6 C. teletherapy sources manufactured and distributed
7 according to a license issued under parts 4731.3000 to 4731.3175
8 or equivalent requirements of the NRC or an agreement state.

9 4731.4411 RADIATION SAFETY OFFICER TRAINING.

10 Except as provided under part 4731.4414, a licensee must
11 require an individual fulfilling the responsibilities of a
12 radiation safety officer as provided under part 4731.4405 to be
13 an individual who:

14 A. is certified by a specialty board whose
15 certification process includes all of the requirements in item B
16 and whose certification has been recognized by the commissioner,
17 the NRC, or an agreement state;

18 B. has completed a structured educational program
19 consisting of:

20 (1) 200 hours of didactic training in the
21 following areas:

22 (a) radiation physics and instrumentation;

23 (b) radiation protection;

24 (c) mathematics pertaining to the use and
25 measurement of radioactivity;

26 (d) radiation biology; and

27 (e) radiation dosimetry;

(2) 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 or-agreement-state master material licensee that authorizes similar types of uses of radioactive material involving:

(a) shipping, receiving, and performing related radiation surveys;

(b) using and performing checks for proper operation of instruments used to determine the activity of dosages, survey meters, and instruments used to measure radionuclides;

(c) securing and controlling radioactive material;

(d) using administrative controls to avoid mistakes in the administration of radioactive material;

(e) using procedures to prevent or minimize radioactive contamination and using proper decontamination procedures;

(f) using emergency procedures to control radioactive material; and

(g) disposing of radioactive material; and

(3) written certification, signed by a preceptor radiation safety officer, that the individual has satisfactorily completed the requirements in subitem (1) and has achieved a level of radiation safety knowledge sufficient to function independently as a radiation safety officer for a medical use

1 licensee; or

2 C. is an authorized user, authorized medical
3 physicist, or authorized nuclear pharmacist identified on the
4 licensee's license and has experience with the radiation safety
5 aspects of similar types of use of radioactive material for
6 which the individual has radiation safety officer
7 responsibilities.

8 4731.4412 AUTHORIZED MEDICAL PHYSICIST TRAINING.

9 A. Except as provided in part 4731.4414, a licensee
10 must require an authorized medical physicist to be an individual
11 who:

12 (1) is certified by a specialty board whose
13 certification process includes all of the training and
14 experience required under subitem (2) and whose certification
15 has been recognized by the commissioner, the NRC, or an
16 agreement state; or

17 (2) holds a master's or doctor's degree in
18 physics, biophysics, radiological physics, medical physics, or
19 health physics and has completed one year of full-time training
20 in therapeutic radiological physics and an additional year of
21 full-time work experience under the supervision of an authorized
22 medical physicist at a medical institution that includes the
23 tasks listed in parts 4731.4424, 4731.4456, 4731.4469 to
24 4731.4474, and 4731.4476, as applicable.

25 B. An individual under item A, subitem (2), must
26 obtain written certification that the individual has
27 satisfactorily completed the requirements in item A, subitem

1 (2), and has achieved a level of competency sufficient to
2 function independently as an authorized medical physicist for
3 each type of therapeutic medical unit for which the individual
4 is requesting authorized medical physicist status. The written
5 certification must be signed by a preceptor authorized medical
6 physicist who meets the requirements under this part or
7 equivalent NRC or agreement state requirements for an authorized
8 medical physicist for each type of therapeutic medical unit for
9 which the individual is requesting authorized medical physicist
10 status.

11 4731.4413 AUTHORIZED NUCLEAR PHARMACIST TRAINING.

12 A. Except as provided in part 4731.4414, a licensee
13 must require an authorized nuclear pharmacist to be a pharmacist
14 who:

15 (1) is certified as a nuclear pharmacist by a
16 specialty board whose certification process includes all of the
17 requirements in subitem (2) and whose certification has been
18 recognized by the commissioner, the NRC, or an agreement state;
19 or

20 (2) has completed 700 hours in a structured
21 educational program that includes:

22 (a) didactic training in:

23 i. radiation physics and
24 instrumentation;

25 ii. radiation protection;

26 iii. mathematics pertaining to the use
27 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.

B. An individual under item A, subitem (2), must
obtain written certification, signed by a preceptor authorized
nuclear pharmacist, that the individual has satisfactorily
completed the requirements in item A, subitem (2), and has
achieved a level of competency sufficient to function
independently as an authorized nuclear pharmacist.

4731.4414 TRAINING; EXPERIENCED RADIATION SAFETY OFFICER,
TELETHERAPY OR MEDICAL PHYSICIST, AUTHORIZED USER, AND NUCLEAR

1 PHARMACIST.

2 A. An individual identified as a radiation safety
3 officer, a teletherapy or medical physicist, or a nuclear
4 pharmacist on a license issued by the NRC or an agreement state;
5 a permit issued by an NRC or agreement state broad scope
6 licensee; a master material license permit; or a permit issued
7 by a master material license permittee of broad scope before
8 October 24, 2002, need not comply with the training requirements
9 under parts 4731.4411, 4731.4412, or 4731.4413, respectively.

10 B. Physicians, dentists, or podiatrists identified as
11 authorized users for the medical use of radioactive material on
12 a license issued by the NRC or an agreement state; a permit
13 issued by an NRC master material licensee; a permit issued by an
14 NRC or agreement state broad scope licensee; or a permit issued
15 by an NRC master material license broad scope permittee before
16 October 24, 2002, who perform only those medical uses for which
17 they were authorized on that date, need not comply with the
18 training requirements of parts 4731.4432 to 4731.4479.

19 4731.4415 RECENTNESS OF TRAINING.

20 The training and experience specified under parts 4731.4405
21 to 4731.4414 and 4731.4432 to 4731.4479 must have been obtained
22 within the seven years preceding the date of application or the
23 individual must have had related continuing education and
24 experience since the required training and experience was
25 completed.

26 4731.4420 MEASURING ACTIVITY OF UNSEALED RADIOACTIVE MATERIAL;

1 INSTRUMENTS REQUIRED.

2 A. For direct measurements performed according to
3 part 4731.4422, a licensee must possess and use instrumentation
4 to measure the activity of unsealed radioactive material before
5 it is administered to a patient or human research subject.

6 B. A licensee must calibrate the instrumentation
7 required under item A according to nationally recognized
8 standards or the manufacturer's instructions.

9 C. A licensee must retain a record of each instrument
10 calibration required under item B according to part 4731.4502,
11 subpart 1.

12 4731.4421 CALIBRATION OF SURVEY INSTRUMENTS.

13 A. A licensee must calibrate the survey instruments
14 used to show compliance with parts 4731.2000 to 4731.2950 and
15 4731.4400 to 4731.4527 before first use, annually, and following
16 a repair that affects the calibration. A licensee must:

17 (1) calibrate all scales with readings up to
18 1,000 millirems (10 mSv) per hour with a radiation source;

19 (2) calibrate two separate readings on each scale
20 or decade that will be used to show compliance; and

21 (3) conspicuously note on the instrument the date
22 of calibration.

23 B. A licensee may not use survey instruments if the
24 difference between the indicated exposure rate and the
25 calculated exposure rate is more than 20 percent.

26 C. A licensee must retain a record of each survey
27 instrument calibration according to part 4731.4502, subpart 2.

1 4731.4422 DETERMINATION OF DOSAGES; UNSEALED RADIOACTIVE
2 MATERIAL.

3 A. A licensee must determine and record the activity
4 of each dosage before medical use.

5 B. For a unit dosage, the determination under item A
6 must be made by:

7 (1) direct measurement of radioactivity; or

8 (2) a decay correction, based on the activity or
9 activity concentration determined by:

10 (a) a manufacturer or preparer licensed
11 under part 4731.3395 or equivalent requirements of the NRC or an
12 agreement state; or

13 (b) an NRC or agreement state licensee for
14 use in research according to the radioactive drug research
15 committee-approved protocol or an investigational new drug
16 protocol accepted by the Food and Drug Administration.

17 C. For other than unit dosages, the determination
18 under item A must be made by:

19 (1) direct measurement of radioactivity;

20 (2) a combination of measurement of radioactivity
21 and mathematical calculations; or

22 (3) a combination of volumetric measurements and
23 mathematical calculations, based on the measurement made by a
24 manufacturer or preparer licensed under part 4731.3395 or
25 equivalent requirements of the NRC or an agreement state.

26 D. Unless otherwise directed by the authorized user,
27 a licensee may not use a dosage if the dosage does not fall

1 within the prescribed dosage range or if the dosage differs from
2 the prescribed dosage by more than 20 percent.

3 E. A licensee must retain a record of the dosage
4 determination required under this part according to part
5 4731.4503.

6 4731.4423 AUTHORIZATION FOR CALIBRATION, TRANSMISSION, AND
7 REFERENCE USE.

8 A person authorized under part 4731.4403, subpart 1, for
9 medical use of radioactive material may receive, possess, and
10 use the following radioactive material for check, calibration,
11 transmission, and reference use:

12 A. sealed sources that do not exceed 30 millicuries
13 (1.11 GBq) each and that are manufactured and distributed by a
14 person licensed under part 4731.3400 or equivalent requirements
15 of the NRC or an agreement state;

16 B. sealed sources that do not exceed 30 millicuries
17 (1.11 GBq) each and that are redistributed by a licensee
18 authorized to redistribute the sealed sources manufactured and
19 distributed by a person licensed under part 4731.3400, providing
20 the redistributed sealed sources are in the original packaging
21 and shielding and are accompanied by the manufacturer's approved
22 instructions;

23 C. any radioactive material with a half-life not
24 longer than 120 days in individual amounts not to exceed 15
25 millicuries (0.56 GBq);

26 D. any radioactive material with a half-life longer
27 than 120 days in individual amounts not to exceed the smaller of

1 200 microcuries (7.4 MBq) or 1,000 times the quantities in part
2 4731.2750; and

3 E. technetium-99m in amounts as needed.

4 4731.4424 POSSESSION OF SEALED SOURCES AND BRACHYTHERAPY
5 SOURCES; REQUIREMENTS.

6 A. A licensee in possession of any sealed source or
7 brachytherapy source must follow the radiation safety and
8 handling instructions supplied by the manufacturer.

9 B. A licensee in possession of a sealed source must:

10 (1) test the source for leakage before its first
11 use unless the licensee has a certificate from the supplier
12 indicating that the source was tested within six months before
13 transfer to the licensee; and

14 (2) test the source for leakage at intervals not
15 to exceed six months or at other intervals approved by the NRC
16 or an agreement state in the sealed source and device registry.

17 C. To satisfy the leak test requirements under item
18 B, a licensee must measure the sample so that the leak test can
19 detect the presence of 0.005 microcurie (185 Bq) of radioactive
20 material on the sample.

21 D. A licensee must retain leak test records according
22 to part 4731.4504, subpart 1.

23 E. If the leak test reveals the presence of 0.005
24 microcurie (185 Bq) or more of removable contamination, the
25 licensee must:

26 (1) immediately withdraw the sealed source from
27 use and store, dispose, or cause it to be repaired according to

1 parts 4731.2000 to 4731.2950 and 4731.3000 to 4731.3175; and

2 (2) file a report within five days of the leak
3 test according to part 4731.4527.

4 F. A licensee need not perform a leak test on:

5 (1) sources containing only radioactive material
6 with a half-life of less than 30 days;

7 (2) sources containing only radioactive material
8 as a gas;

9 (3) sources containing 100 microcuries (3.7 MBq)
10 or less of beta- or gamma-emitting material or ten microcuries
11 (0.37 MBq) or less of alpha-emitting material;

12 (4) seeds of iridium-192 encased in nylon ribbon;
13 or

14 (5) sources stored and not being used. The
15 licensee must, however, test each source under this subitem for
16 leakage before any use or transfer, unless it has been
17 leak-tested within six months before the date of use or transfer.

18 G. A licensee in possession of sealed sources or
19 brachytherapy sources, except for gamma stereotactic
20 radiosurgery sources, must conduct a semiannual physical
21 inventory of all such sources in the licensee's possession. The
22 licensee must retain each inventory record according to part
23 4731.4504, subpart 2.

24 4731.4425 LABELING VIALS AND SYRINGES.

25 Each syringe and vial that contains unsealed radioactive
26 material must be labeled to identify the radioactive drug. Each
27 syringe shield and vial shield must also be labeled unless the

1 label on the syringe or vial is visible when shielded.

2 4731.4426 SURVEYS OF AMBIENT RADIATION EXPOSURE RATE.

3 A. In addition to the surveys required under parts
4 4731.2000 to 4731.2950, a licensee must survey with a radiation
5 detection survey instrument at the end of each day of use all
6 areas where unsealed radioactive materials requiring a written
7 directive were prepared for use or administered.

8 B. A licensee need not perform the surveys required
9 under item A in an area where patients or human research
10 subjects are confined when they cannot be released under part
11 4731.4427.

12 C. A licensee must retain a record of each survey
13 according to part 4731.4505.

14 4731.4427 RELEASE OF INDIVIDUALS CONTAINING UNSEALED RADIOACTIVE
15 MATERIAL OR IMPLANTS.

16 A. A licensee may authorize release from licensee
17 control of an individual who has been administered unsealed
18 radioactive material or implants containing radioactive material
19 if the total effective dose equivalent to any other individual
20 from exposure to the released individual is not likely to exceed
21 0.5 rem (5 mSv). "Regulatory Guide for the Release of Patients
22 Administered Radioactive Materials," Minnesota Department of
23 Health, describes methods for calculating doses to other
24 individuals and contains tables of activities not likely to
25 cause doses exceeding 0.5 rem (5 mSv). The guide is
26 incorporated by reference, is not subject to frequent change,

1 and is available through the Minitex interlibrary loan system.

2 B. A licensee must provide the released individual,
3 or the individual's parent or guardian, with instructions,
4 including written instructions, on actions recommended to
5 maintain doses to other individuals as low as is reasonably
6 achievable if the total effective dose equivalent to any other
7 individual is likely to exceed 0.1 rem (1 mSv). If the total
8 effective dose equivalent to a nursing infant or child could
9 exceed 0.1 rem (1 mSv), assuming there were no interruption of
10 breast-feeding, the instructions must also include guidance on
11 the interruption or discontinuation of breast-feeding and
12 information on the potential consequences, if any, of failure to
13 follow the guidance.

14 C. A licensee must maintain a record of the basis for
15 authorizing the release of the individual according to part
16 4731.4506, subpart 1.

17 D. A licensee must maintain a record of instructions
18 provided to a breast-feeding woman according to part 4731.4506,
19 subpart 2.

20 4731.4428 MOBILE MEDICAL SERVICE.

21 A. A licensee providing mobile medical service must:

22 (1) obtain a letter signed by the management of
23 each client for which services are rendered that permits the use
24 of radioactive material at the client's address and clearly
25 delineates the authority and responsibility of the licensee and
26 the client;

27 (2) check instruments used to measure the

1 activity of unsealed radioactive material for proper function
2 before medical use at each client's address or on each day of
3 use, whichever is more frequent. At a minimum, the check for
4 proper function required by this subitem must include a
5 constancy check;

6 (3) check survey instruments for proper operation
7 with a dedicated check source before use at each client's
8 address; and

9 (4) before leaving a client's address, survey all
10 areas of use to ensure compliance with parts 4731.2000 to
11 4731.2950.

12 B. A mobile medical service may not have radioactive
13 material delivered from the manufacturer or the distributor to
14 the client unless the client has a license allowing possession
15 of the radioactive material. Radioactive material delivered to
16 the client must be received and handled in conformance with the
17 client's license.

18 C. A licensee providing mobile medical services must
19 retain the letter required under item A, subitem (1), and the
20 record of each survey required under item A, subitem (4),
21 according to part 4731.4507.

22 4731.4429 DECAY-IN-STORAGE.

23 A. A licensee may hold radioactive material with a
24 physical half-life of less than 120 days for decay-in-storage
25 before disposal without regard to its radioactivity, if the
26 licensee:

7 (1) monitors radioactive material at the surface

1 before disposal;

2 (2) determines that its radioactivity cannot be
3 distinguished from the background radiation level with an
4 appropriate radiation detection survey meter set on its most
5 sensitive scale and with no interposed shielding; and

6 (3) removes or obliterates all radiation labels,
7 except for radiation labels on materials that are within
8 containers and that will be managed as biomedical waste after
9 they are released from the licensee.

10 B. A licensee must retain a record of each disposal
11 under item A according to part 4731.4508.

12 4731.4432 UNSEALED RADIOACTIVE MATERIAL; UPTAKE, DILUTION, AND
13 EXCRETION STUDIES.

14 Except for quantities that require a written directive
15 under part 4731.4408 or 4731.4409, a licensee may use any
16 unsealed radioactive material prepared for medical use for
17 uptake, dilution, or excretion studies that is:

18 A. obtained from a manufacturer or preparer licensed
19 under part 4731.3395 or equivalent requirements of the NRC or an
20 agreement state;

21 B. prepared by an authorized nuclear pharmacist, a
22 physician who is an authorized user and meets the requirements
23 of part 4731.4436 or 4731.4443, or an individual under the
24 supervision of either, according to part 4731.4407;

25 C. obtained from and prepared for a commissioner,
26 NRC, or agreement state licensee for use in research according
27 to a radioactive drug research committee-approved protocol or in

1 an investigational new drug protocol accepted by the Food and
2 Drug Administration; or

3 D. prepared by the licensee for use in research
4 according to a radioactive drug research committee-approved
5 application or an investigational new drug protocol accepted by
6 the Food and Drug Administration.

7 4731.4433 UPTAKE, DILUTION, AND EXCRETION STUDIES; TRAINING.

8 Except as provided under part 4731.4414, a licensee must
9 require the authorized user of unsealed radioactive material for
10 the uses authorized under part 4731.4432 to be a physician who:

11 A. is certified by a medical specialty board whose
12 certification process includes all of the requirements in item C
13 and whose certification has been recognized by the commissioner,
14 the NRC, or an agreement state;

15 B. is an authorized user under part 4731.4436 or
16 4731.4443 or under equivalent requirements of the NRC or an
17 agreement state; or

18 C. has training and experience as follows:

19 (1) has completed 60 hours of training and
20 experience in basic radionuclide handling techniques applicable
21 to the medical use of unsealed radioactive material for uptake,
22 dilution, and excretion studies. The training and experience
23 must include:

24 (a) classroom and laboratory training in the
25 following areas:

26 i. radiation physics and

27 instrumentation;

- 1 ii. radiation protection;
- 2 iii. mathematics pertaining to the use
- 3 and measurement of radioactivity;
- 4 iv. chemistry of radioactive material
- 5 for medical use; and
- 6 v. radiation biology; and
- 7 (b) work experience, under the supervision
- 8 of an authorized user who meets the requirements under this
- 9 part, part 4731.4436 or 4731.4443, or equivalent requirements of
- 10 the NRC or an agreement state, involving:
- 11 i. ordering, receiving, and unpacking
- 12 radioactive materials safely and performing the related
- 13 radiation surveys;
- 14 ii. calibrating instruments used to
- 15 determine the activity of dosages and performing checks for
- 16 proper operation of survey meters;
- 17 iii. calculating, measuring, and
- 18 safely preparing patient or human research subject dosages;
- 19 iv. using administrative controls to
- 20 prevent a medical event involving the use of unsealed
- 21 radioactive material;
- 22 v. using procedures to safely contain
- 23 spilled radioactive material and using proper decontamination
- 24 procedures; and
- 25 vi. administering dosages of
- 26 radioactive drugs to patients or human research subjects; and
- 27 (2) has obtained written certification, signed by

1 a preceptor authorized user who meets the requirements of this
2 part, part 4731.4432 or 4731.4436 ~~or-4731-4443~~, or equivalent
3 requirements of the NRC or an agreement state, that the
4 individual has satisfactorily completed the requirements in this
5 item and has achieved a level of competency sufficient to
6 function independently as an authorized user for the medical
7 uses authorized under part 4731.4443.

8 4731.4434 UNSEALED RADIOACTIVE MATERIAL; IMAGING AND
9 LOCALIZATION STUDIES.

10 Except for quantities that require a written directive
11 under part 4731.4408, a licensee may use any unsealed
12 radioactive material prepared for medical use for imaging and
13 localization studies that is:

14 A. obtained from a manufacturer or preparer licensed
15 under part 4731.3395 or equivalent requirements of the NRC or an
16 agreement state;

17 B. prepared by an authorized nuclear pharmacist, a
18 physician who is an authorized user and meets the requirements
19 under part 4731.4436 or 4731.4443, or an individual under the
20 supervision of either, according to part 4731.4407;

21 C. obtained from and prepared by a commissioner, NRC,
22 or agreement state licensee for use in research according to a
23 radioactive drug research committee-approved protocol or an
24 investigational new drug protocol accepted by the Food and Drug
25 Administration; or

26 D. prepared by the licensee for use in research
27 according to a radioactive drug research committee-approved

1 application or an investigational new drug protocol accepted by
2 the Food and Drug Administration.

3 4731.4435 PERMISSIBLE MOLYBDENUM-99 CONCENTRATION.

4 A. A licensee may not administer to humans a
5 radiopharmaceutical that contains more than 0.15 microcurie of
6 molybdenum-99 per millicurie of technetium-99m (0.15
7 kilobecquerel of molybdenum-99 per megabecquerel of
8 technetium-99m).

9 B. A licensee that uses molybdenum-99/technetium-99m
10 generators for preparing a technetium-99m radiopharmaceutical
11 must measure the molybdenum-99 concentration of the first eluate
12 after receipt of a generator to demonstrate compliance with item
13 A.

14 C. If a licensee is required to measure the
15 molybdenum-99 concentration, the licensee must retain a record
16 of each measurement according to part 4731.4509.

17 4731.4436 IMAGING AND LOCALIZATION STUDIES; TRAINING.

18 Except as provided under part 4731.4414, a licensee must
19 require an authorized user of unsealed radioactive material for
20 the uses authorized under part 4731.4434 to be a physician who:

21 A. is certified by a medical specialty board whose
22 certification process includes all of the requirements in item C
23 and whose certification has been recognized by the commissioner,
24 the NRC, or an agreement state;

25 B. is an authorized user under part 4731.4443 or
26 equivalent requirements of the NRC or an agreement state; or

1 C. has training and experience as follows:

2 (1) has completed 700 hours of training and
3 experience in basic radionuclide handling techniques applicable
4 to the medical use of unsealed radioactive material for imaging
5 and localization studies. The training and experience must
6 include, at a minimum:

7 (a) classroom and laboratory training in the
8 following areas:

- 9 i. radiation physics and
10 instrumentation;
11 ii. radiation protection;
12 iii. mathematics pertaining to the use
13 and measurement of radioactivity;
14 iv. chemistry of radioactive material
15 for medical use; and
16 v. radiation biology; and

17 (b) work experience, under the supervision
18 of an authorized user who meets the requirements under this
19 part, part 4731.4443, or equivalent requirements of the NRC or
20 an agreement state, involving:

- 21 i. ordering, receiving, and unpacking
22 radioactive materials safely and performing the related
23 radiation surveys;
24 ii. calibrating instruments used to
25 determine the activity of dosages and performing checks for
26 proper operation of survey meters;
27 iii. calculating, measuring, and

1 safely preparing patient or human research subject dosages;

2 iv. using administrative controls to

3 prevent a medical event involving the use of unsealed

4 radioactive material;

5 v. using procedures to safely contain

6 spilled radioactive material and using proper decontamination

7 procedures;

8 vi. administering dosages of

9 radioactive drugs to patients or human research subjects; and

10 vii. eluting generator systems,

11 appropriate for preparation of radioactive drugs for imaging and

12 localization studies, measuring and testing the eluate for

13 radionuclidic purity, and processing the eluate with reagent

14 kits to prepare labeled radioactive drugs; and

15 (2) has obtained written certification, signed by

16 a preceptor authorized user who meets the requirements in this

17 part, part 4731.4443, or equivalent requirements of the NRC or

18 an agreement state, that the individual has satisfactorily

19 completed the requirements in subitem (1) and has achieved a

20 level of competency sufficient to function independently as an

21 authorized user for the medical uses authorized under parts

22 4731.4432 and 4731.4434.

23 4731.4440 UNSEALED RADIOACTIVE MATERIAL; WRITTEN DIRECTIVE

24 REQUIRED.

25 A licensee may use any unsealed radioactive material

26 prepared for medical use and for which a written directive is

27 required that is:

1 A. obtained from a manufacturer or preparer licensed
2 under part 4731.3395 or equivalent requirements of the NRC or an
3 agreement state;

4 B. prepared by an authorized nuclear pharmacist, a
5 physician who is an authorized user and meets the requirements
6 under part 4731.4436 or 4731.4443, or an individual under the
7 supervision of either, as specified under part 4731.4407;

8 C. obtained from and prepared by a commissioner, NRC,
9 or agreement state licensee for use in research according to an
10 investigational new drug protocol accepted by the Food and Drug
11 Administration; or

12 D. prepared by the licensee for use in research
13 according to an investigational new drug protocol accepted by
14 the Food and Drug Administration.

15 4731.4441 SAFETY INSTRUCTIONS.

16 A. In addition to the requirements of part 4731.1020,
17 a licensee must provide radiation safety instruction, initially
18 and at least annually, to personnel caring for patients or human
19 research subjects who cannot be released under part 4731.4427.

20 To satisfy this requirement, the instruction must be
21 commensurate with the duties of the personnel and include:

22 (1) patient or human research subject control;

23 (2) visitor control, including:

24 (a) routine visitation of hospitalized
25 individuals according to part 4731.2090, subpart 1, item A; and

26 (b) visitation authorized under part

27 4731.2090, subpart 3;

- 1 (3) contamination control;
- 2 (4) waste control; and
- 3 (5) notification of the radiation safety officer
- 4 or the officer's designee and the authorized user if the patient
- 5 or human research subject has a medical emergency or dies.

6 B. A licensee must retain a record of individuals
7 receiving instruction according to part 4731.4510.

8 4731.4442 SAFETY PRECAUTIONS.

9 A. For each patient or human research subject who
10 cannot be released under part 4731.4427, a licensee must:

11 (1) quarter the patient or the human research
12 subject in:

13 (a) a private room with a private sanitary
14 facility; or

15 (b) a room, with a private sanitary
16 facility, with another individual who also has received therapy
17 with unsealed radioactive material and who also cannot be
18 released under part 4731.4427;

19 (2) visibly post the patient's or the human
20 research subject's room with a "Radioactive Materials" sign;

21 (3) note on the door or in the patient's or human
22 research subject's chart where and how long visitors may stay in
23 the patient's or human research subject's room; and

24 (4) either:

25 (a) monitor material and items removed from
26 the patient's or human research subject's room to determine that
27 their radioactivity cannot be distinguished from the natural

1 background radiation level with a radiation detection survey
2 instrument set on its most sensitive scale and with no
3 interposed shielding; or

4 (b) handle the material and items as
5 radioactive waste.

6 B. A licensee must notify the radiation safety
7 officer or the officer's designee and the authorized user as
8 soon as possible if the patient or human research subject has a
9 medical emergency or dies.

10 4731.4443 UNSEALED RADIOACTIVE MATERIAL; WRITTEN DIRECTIVE
11 REQUIRED; TRAINING.

12 Except as provided under part 4731.4414, a licensee must
13 require an authorized user of unsealed radioactive material for
14 the uses authorized under part 4731.4440 to be a physician who:

15 A. is certified by a medical specialty board whose
16 certification process includes all of the requirements in item B
17 and whose certification has been recognized by the commissioner,
18 the NRC, or an agreement state; or

19 B. has training and experience as follows:

20 (1) has completed 700 hours of training and
21 experience in basic radionuclide handling techniques applicable
22 to the medical use of unsealed radioactive material requiring a
23 written directive. The training and experience must include:

24 (a) classroom and laboratory training in:

25 i. radiation physics and

26 instrumentation;

27 ii. radiation protection;

1 iii. mathematics pertaining to the use
2 and measurement of radioactivity;

3 iv. chemistry of radioactive material
4 for medical use; and

5 v. radiation biology; and

6 (b) work experience, under the supervision
7 of an authorized user who meets the requirements in this part or
8 equivalent requirements of the NRC or an agreement state. A
9 supervising authorized user qualifying under this item must have
10 experience in administering dosages in the same dosage category
11 or categories under subunit vii as the individual requesting
12 authorized user status. The work experience must involve:

13 i. ordering, receiving, and unpacking
14 radioactive materials safely and performing the related
15 radiation surveys;

16 ii. calibrating instruments used to
17 determine the activity of dosages and performing checks for
18 proper operation of survey meters;

19 iii. calculating, measuring, and
20 safely preparing patient or human research subject dosages;

21 iv. using administrative controls to
22 prevent a medical event involving the use of radioactive
23 material;

24 v. using procedures to safely contain
25 spilled radioactive material and using proper decontamination
26 procedures;

27 vi. eluting generator systems,

1 measuring and testing the eluate for radionuclidic purity, and
2 processing the eluate with reagent kits to prepare labeled
3 radioactive drugs; and

4 vii. administering dosages of
5 radioactive drugs to patients or human research subjects
6 involving a minimum of three cases in each of the following
7 categories for which the individual is requesting authorized
8 user status: oral administration of less than or equal to 33
9 millicuries (1.22 GBq) of sodium iodide (I-131); oral
10 administration of greater than 33 millicuries (1.22 GBq) of
11 sodium iodide (I-131) (experience with at least three cases also
12 satisfies the requirement of oral administration of less than or
13 equal to 33 millicuries of I-131); parenteral administration of
14 any beta emitter or a photon-emitting radionuclide with a photon
15 energy less than 150 kilo electron volts; or parenteral
16 administration of any other radionuclide; and

17 (2) has obtained written certification that the
18 individual has satisfactorily completed the requirements in this
19 item and has achieved a level of competency sufficient to
20 function independently as an authorized user for the medical
21 uses authorized under part 4731.4440. The written certification
22 must be signed by a preceptor authorized user who meets the
23 requirements of this part or equivalent requirements of the NRC
24 or an agreement state. A preceptor authorized user qualifying
25 under this item must have experience in administering dosages in
26 the same dosage category or categories under subitem 1, unit
27 (b), subunit vii, as the individual requesting authorized user

1 status.

2 4731.4444 ADMINISTRATION OF SODIUM IODIDE; QUANTITIES LESS THAN
3 OR EQUAL TO 33 MILLICURIES (1.22 GBQ); TRAINING.

4 Except as provided under part 4731.4414, a licensee must
5 require an authorized user for the oral administration of sodium
6 iodide (I-131) requiring a written directive in quantities less
7 than or equal to 33 millicuries (1.22 GBq) to be a physician who:

8 A. is certified by a medical specialty board whose
9 certification process includes all of the requirements of item C
10 and whose certification has been recognized by the commissioner,
11 the NRC, or an agreement state;

12 B. is an authorized user under part 4731.4443 for the
13 oral administration of I-131 in any quantity under part
14 4731.4443, item B, subitem (1), unit (b), subunit vii, under
15 part 4731.4445, or under equivalent requirements of the NRC or
16 an agreement state; or

17 C. has training and experience as follows:

18 (1) has successfully completed 80 hours of
19 classroom and laboratory training, applicable to the medical use
20 of I-131 for procedures requiring a written directive. The
21 training must include:

22 (a) radiation physics and instrumentation;

23 (b) radiation protection;

24 (c) mathematics pertaining to the use and
25 measurement of radioactivity;

26 (d) chemistry of radioactive material for
27 medical use; and

1 (e) radiation biology;

2 (2) has work experience under the supervision of
3 an authorized user who meets the requirements of this part, part
4 4731.4443 or 4731.4445, or equivalent requirements of the NRC or
5 an agreement state. A supervising authorized user qualifying
6 under part 4731.4443, item B, must have experience in the oral
7 administration of I-131 in any quantity under part 4731.4443,
8 item B, subitem (1), unit (b), subunit vii. The work experience
9 must involve:

10 (a) ordering, receiving, and unpacking
11 radioactive materials safely and performing the related
12 radiation surveys;

13 (b) calibrating instruments used to
14 determine the activity of dosages and performing checks for the
15 proper operation of survey meters;

16 (c) calculating, measuring, and safely
17 preparing patient or human research subject dosages;

18 (d) using administrative controls to prevent
19 a medical event involving the use of radioactive materials;

20 (e) using procedures to safely contain
21 spilled radioactive material and using proper decontamination
22 procedures; and

23 (f) administering dosages to patients or
24 human research subjects that include at least three cases
25 involving the oral administration of less than or equal to 33
26 millicuries (1.22 GBq) of sodium iodide I-131; and

27 (3) has obtained written certification that the

1 individual has satisfactorily completed the requirements of
2 subitems (1) and (2) and has achieved a level of competency
3 sufficient to function independently as an authorized user for
4 medical uses authorized under part 4731.4440. The written
5 certification must be signed by a preceptor authorized user who
6 meets the requirements of this part, part 4731.4443 or
7 4731.4445, or equivalent requirements of the NRC or an agreement
8 state. A preceptor authorized user qualifying under part
9 4731.4443, item B, must have experience in the oral
10 administration of I-131 in any quantity under part 4731.4443,
11 item B, subitem (1), unit (b), subunit vii.

12 4731.4445 ADMINISTRATION OF SODIUM IODIDE; QUANTITIES GREATER
13 THAN 33 MILLICURIES (1.22 GBQ); TRAINING.

14 Except as provided under part 4731.4414, a licensee must
15 require an authorized user for the oral administration of sodium
16 iodide (I-131) requiring a written directive in quantities
17 greater than 33 millicuries (1.22 GBq) to be a physician who:

18 A. is certified by a medical specialty board whose
19 certification process includes all of the requirements of item C
20 and whose certification has been recognized by the commissioner,
21 the NRC, or an agreement state;

22 B. is an authorized user under part 4731.4443 for the
23 oral administration of I-131 in quantities greater than 33
24 millicuries under part 4731.4443, item B, subitem (1), unit (b),
25 subunit vii, or equivalent requirements of the NRC or an
26 agreement state; or

27 C. has training and experience as follows:

1 (1) has successfully completed 80 hours of
2 classroom and laboratory training, applicable to the medical use
3 of I-131 for procedures requiring a written directive. The
4 training must include:

5 (a) radiation physics and instrumentation;

6 (b) radiation protection;

7 (c) mathematics pertaining to the use and
8 measurement of radioactivity;

9 (d) chemistry of radioactive materials for
10 medical use; and

11 (e) radiation biology;

12 (2) has work experience, under the supervision of
13 an authorized user who meets the requirements under this part,
14 part 4731.4443, or equivalent requirements of the NRC or an
15 agreement state. A supervising authorized user qualifying under
16 part 4731.4443, item B, must have experience in the oral
17 administration of I-131 in quantities greater than 33
18 millicuries under part 4731.4443, item B, subitem (1), unit (b),
19 subunit vii. The work experience must involve:

20 (a) ordering, receiving, and unpacking
21 radioactive materials safely and performing the related
22 radiation surveys;

23 (b) calibrating instruments used to
24 determine the activity of dosages and performing checks for
25 proper operation of survey meters;

26 (c) calculating, measuring, and safely
27 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) has obtained written certification that the individual has satisfactorily completed the requirements of subitems (1) and (2) and has achieved a level of competency sufficient to function independently as an authorized user for medical uses authorized under part 4731.4440. The written certification must be signed by a preceptor authorized user who meets the requirements in this part, part 4731.4443, or equivalent requirements of the NRC or an agreement state. A preceptor authorized user qualifying under part 4731.4443, item B, must have experience in the oral administration of I-131 in quantities greater than 33 millicuries under part 4731.4443, item B, subitem (1), unit (b), subunit vii.

4731.4450 USE OF BRACHYTHERAPY SOURCES.

A licensee must use only brachytherapy sources for therapeutic medical uses:

A. as approved in the sealed source and device registry; or

B. in research, according to an active

1 investigational device exemption application accepted by the
2 Food and Drug Administration, provided the requirements of part
3 4731.4410, item A, are met.

4 4731.4451 SURVEYS AFTER SOURCE IMPLANT AND REMOVAL.

5 A. Immediately after implanting sources in a patient
6 or human research subject, a licensee must make a survey to
7 locate and account for all sources that have not been implanted.

8 B. Immediately after removing the last temporary
9 implant source from a patient or human research subject, a
10 licensee must make a survey of the patient or human research
11 subject with a radiation detection survey instrument to confirm
12 that all sources have been removed.

13 C. A licensee must retain a record of the surveys
14 required under this part according to part 4731.4511.

15 4731.4452 BRACHYTHERAPY SOURCES ACCOUNTABILITY.

16 A. A licensee must maintain accountability at all
17 times for all brachytherapy sources in storage or use.

18 B. As soon as possible after removing sources from a
19 patient or human research subject, a licensee must return
20 brachytherapy sources to a secure storage area.

21 C. A licensee must maintain a record of the
22 brachytherapy source accountability according to part 4731.4512.

23 4731.4453 BRACHYTHERAPY; SAFETY INSTRUCTIONS.

24 A. In addition to the requirements of part 4731.1020,
25 a licensee must provide radiation safety instruction, initially
26 and at least annually, to personnel caring for patients or human

1 research subjects who are receiving brachytherapy and cannot be
2 released under part 4731.4427. To satisfy this requirement, the
3 instruction must be commensurate with the duties of the
4 personnel and include:

5 (1) the size and appearance of the brachytherapy
6 source;

7 (2) safe handling and shielding instructions;

8 (3) patient or human research subject control;

9 (4) visitor control, including:

10 (a) routine visitation of hospitalized
11 individuals according to part 4731.2090, subpart 1, item A; and

12 (b) visitation authorized under part
13 4731.2090, subpart 3; and

14 (5) notification of the radiation safety officer
15 or the officer's designee and an authorized user if the patient
16 or human research subject has a medical emergency or dies.

17 B. A licensee must retain a record of individuals
18 receiving instruction according to part 4731.4510.

19 4731.4454 BRACHYTHERAPY; SAFETY PRECAUTIONS.

20 A. For each patient or human research subject who is
21 receiving brachytherapy and cannot be released under part
22 4731.4427, a licensee must:

23 (1) not quarter the patient or human research
24 subject in the same room as an individual who is not receiving
25 brachytherapy;

26 (2) visibly post the patient's or human research
27 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.

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

1 according to item A.

2 C. A licensee must mathematically correct the outputs
3 or activities determined under item A for physical decay at
4 intervals consistent with one percent physical decay.

5 D. A licensee must retain a record of each
6 calibration according to part 4731.4513.

7 4731.4456 DECAY OF STRONTIUM-90 SOURCES FOR OPHTHALMIC
8 TREATMENTS.

9 A. Only an authorized medical physicist shall
10 calculate the activity of each strontium-90 source that is used
11 to determine the treatment times for ophthalmic treatments. The
12 decay must be based on the activity determined under part
13 4731.4455.

14 B. A licensee must maintain a record of the activity
15 of each strontium-90 source according to part 4731.4514.

16 4731.4457 THERAPY-RELATED COMPUTER SYSTEMS.

17 A licensee must perform acceptance testing on the treatment
18 planning system of therapy-related computer systems according to
19 published protocols accepted by nationally recognized bodies.
20 At a minimum, the acceptance testing must include, as
21 applicable, verification of:

22 A. the source-specific input parameters required by
23 the dose calculation algorithm;

24 B. the accuracy of dose, dwell time, and treatment
25 time calculations at representative points;

26 C. the accuracy of isodose plots and graphic

1 displays; and

2 D. the accuracy of the software used to determine
3 sealed source positions from radiographic images.

4 4731.4458 MANUAL BRACHYTHERAPY TRAINING.

5 Except as provided under part 4731.4414, a licensee must
6 require an authorized user of a manual brachytherapy source for
7 the uses authorized under part 4731.4450 to be a physician who:

8 A. is certified by a medical specialty board whose
9 certification process includes all of the requirements in item B
10 and whose certification has been recognized by the commissioner,
11 the NRC, or an agreement state; or

12 B. has training and experience as follows:

13 (1) has completed a structured educational
14 program in basic radionuclide handling techniques applicable to
15 the use of manual brachytherapy sources that includes:

16 (a) 200 hours of classroom and laboratory
17 training in:

18 i. radiation physics and
19 instrumentation;

20 ii. radiation protection;

21 iii. mathematics pertaining to the use
22 and measurement of radioactivity; and

23 iv. radiation biology; and

24 (b) 500 hours of work experience, under the
25 supervision of an authorized user who meets the requirements
26 under this part or equivalent requirements of the NRC or an
27 agreement state at a medical institution, involving:

i. ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

ii. checking survey meters for proper operation;

iii. preparing, implanting, and removing brachytherapy sources;

iv. maintaining running inventories of material on hand;

v. using administrative controls to prevent a medical event involving the use of radioactive material; and

vi. using emergency procedures to control radioactive material;

(2) has obtained three years of supervised clinical experience in radiation oncology, under an authorized user who meets the requirements of this part 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 or the Committee 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) has obtained written certification, signed by a preceptor authorized user who meets the requirements of this part or equivalent requirements of the NRC or an agreement

1 state, that the individual has satisfactorily completed the
2 requirements of subitem (1) and has achieved a level of
3 competency sufficient to function independently as an authorized
4 user of manual brachytherapy sources for the medical uses
5 authorized under part 4731.4450.

6 4731.4459 OPHTHALMIC USE OF STRONTIUM-90; TRAINING.

7 Except as provided under part 4731.4414, a licensee must
8 require an authorized user of strontium-90 for ophthalmic
9 radiotherapy to be a physician who:

10 A. is an authorized user under part 4731.4458 or
11 equivalent requirements of the NRC or an agreement state; or

12 B. has training and experience as follows:

13 (1) has completed 24 hours of classroom and
14 laboratory training applicable to the medical use of
15 strontium-90 for ophthalmic radiotherapy. The training must
16 include:

17 (a) radiation physics and instrumentation;

18 (b) radiation protection;

19 (c) mathematics pertaining to the use and
20 measurement of radioactivity; and

21 (d) radiation biology;

22 (2) has had supervised clinical training in
23 ophthalmic radiotherapy under the supervision of an authorized¹
24 user at a medical institution that includes the use of
25 strontium-90 for the ophthalmic treatment of at least five
26 individuals. The supervised clinical training must involve:

27 (a) examination of each individual to be

1 treated;

2 (b) calculation of the dose to be
3 administered;

4 (c) administration of the dose; and

5 (d) follow up and review of each
6 individual's case history; and

7 (3) has obtained written certification, signed by
8 a preceptor authorized user who meets the requirements of this
9 part, part 4731.4458, or equivalent requirements of the NRC or
10 an agreement state, that the individual has satisfactorily
11 completed the requirements in subitems (1) and (2) and has
12 achieved a level of competency sufficient to function
13 independently as an authorized user of strontium-90 for
14 ophthalmic use.

15 4731.4460 USE OF SEALED SOURCES FOR DIAGNOSIS.

16 A licensee must use only sealed sources for diagnostic
17 medical uses as approved in the sealed source and device
18 registry.

19 4731.4461 SEALED SOURCES FOR DIAGNOSIS; TRAINING.

20 Except as provided under part 4731.4414, a licensee must
21 require an authorized user of a diagnostic sealed source for use
22 in a device authorized under part 4731.4460 to be a physician,
23 dentist, or podiatrist who:

24 A. is certified by a specialty board whose
25 certification process includes all of the requirements of item B
26 and whose certification has been recognized by the commissioner,

1 the NRC, or an agreement state; or

2 B. has had eight hours of classroom and laboratory
3 training in basic radionuclide handling techniques specifically
4 applicable to the use of the device. The training must include:

5 (1) radiation physics and instrumentation;

6 (2) radiation protection;

7 (3) mathematics pertaining to the use and

8 measurement of radioactivity;

9 (4) radiation biology; and

10 (5) training in the use of the device for the

11 uses requested.

12 4731.4463 USE OF A SEALED SOURCE; REMOTE AFTERLOADER UNIT,
13 TELETHERAPY UNIT, OR GAMMA STEREOTACTIC RADIOSURGERY UNIT.

14 A licensee must use sealed sources in photon-emitting
15 remote afterloader units, teletherapy units, or gamma
16 stereotactic radiosurgery units for therapeutic medical uses:

17 A. as approved in the sealed source and device
18 registry; or

19 B. in research, according to an active
20 investigational device exemption application accepted by the
21 Food and Drug Administration, provided the requirements of part
22 4731.4410, item A, are met.

23 4731.4464 TREATMENT WITH REMOTE AFTERLOADER UNIT; SURVEYS.

24 A. Before releasing a patient or human research
25 subject who has been treated with a remote afterloader unit from
26 licensee control, a licensee must survey the patient or human

1 research subject and the remote afterloader unit with a portable
2 radiation detection survey instrument to confirm that the source
3 has been removed from the patient or human research subject and
4 returned to the safe shielded position.

5 B. A licensee must retain a record of the required
6 surveys according to part 4731.4511.

7 4731.4465 INSTALLATION, MAINTENANCE, ADJUSTMENT, AND REPAIR
8 REQUIREMENTS.

9 A. Only a person specifically licensed by the
10 commissioner, the NRC, or an agreement state shall install,
11 maintain, adjust, or repair a remote afterloader unit,
12 teletherapy unit, or gamma stereotactic radiosurgery unit that
13 involves work on the source shielding, the source driving unit,
14 or other electronic or mechanical component that could expose
15 the source, reduce the shielding around the source, or
16 compromise the radiation safety of the unit or the source.

17 B. Except for low dose-rate remote afterloader units,
18 only a person specifically licensed by the commissioner, the
19 NRC, or an agreement state shall install, replace, relocate, or
20 remove a sealed source or source contained in other remote
21 afterloader units, teletherapy units, or gamma stereotactic
22 radiosurgery units.

23 C. For a low dose-rate remote afterloader unit, only
24 a person specifically licensed by the commissioner, the NRC, or
25 an agreement state or an authorized medical physicist shall
26 install, replace, relocate, or remove a sealed source contained
27 in the unit.

1 D. A licensee must retain a record of the
2 installation, maintenance, adjustment, and repair of remote
3 afterloader units, teletherapy units, and gamma stereotactic
4 radiosurgery units according to part 4731.4515.

5 4731.4466 REMOTE AFTERLOADER UNITS, TELETHERAPY UNITS, AND GAMMA
6 STEREOTACTIC RADIOSURGERY UNITS; SAFETY PROCEDURES AND
7 INSTRUCTIONS.

8 A. This part applies to remote afterloader units,
9 teletherapy units, and gamma stereotactic radiosurgery units.

10 B. A licensee must:

11 (1) secure the unit, the console, the console
12 keys, and the treatment room when not in use or unattended;

13 (2) permit only individuals approved by the
14 authorized user, radiation safety officer, or authorized medical
15 physicist to be present in the treatment room during treatment
16 with the source;

17 (3) prevent dual operation of more than one
18 radiation-producing device in a treatment room, if applicable;
19 and

20 (4) develop, implement, and maintain written
21 procedures for responding to an abnormal situation when the
22 operator is unable to place the source in the shielded position
23 or remove the patient or human research subject from the
24 radiation field with controls from outside the treatment room.

25 These procedures must include:

26 (a) instructions for responding to equipment
27 failures and the names of the individuals responsible for

1 implementing corrective actions;

2 (b) the process for restricting access to
3 and posting the treatment area to minimize the risk of
4 inadvertent exposure; and

5 (c) the names and telephone numbers of the
6 authorized user, authorized medical physicist, and radiation
7 safety officer to be contacted if the unit or console operates
8 abnormally.

9 C. A copy of the procedures required under item B,
10 subitem (4), must be physically located at the unit console.

11 D. A licensee must post instructions at the unit
12 console to inform the operator of:

13 (1) the location of the procedures required under
14 item B, subitem (4); and

15 (2) the names and telephone numbers of the
16 authorized user, authorized medical physicist, and radiation
17 safety officer to be contacted if the unit or console operates
18 abnormally.

19 E. A licensee must provide instruction, initially and
20 at least annually, to all individuals who operate the unit, as
21 appropriate to the individual's assigned duties, in:

22 (1) the procedures identified under item B,
23 subitem (4); and

24 (2) the operating procedures of the unit.

25 F. A licensee must ensure that operators, authorized
26 medical physicists, and authorized users participate in drills
27 of the emergency procedures, initially and at least annually.

1 G. A licensee must retain a record of individuals
2 receiving instruction required under item E according to part
3 4731.4510.

4 H. A licensee must retain a copy of the procedures
5 required under item B, subitem (4), and item E, subitem (2),
6 according to part 4731.4516.

7 4731.4467 REMOTE AFTERLOADER UNITS, TELETHERAPY UNITS, AND GAMMA
8 STEREOTACTIC RADIOSURGERY UNITS; SAFETY PRECAUTIONS.

9 A. This part applies to remote afterloader units,
10 teletherapy units, and gamma stereotactic radiosurgery units.

11 B. A licensee must control access to the treatment
12 room by a door at each entrance.

13 C. A licensee must equip each entrance to the
14 treatment room with an electrical interlock system that:

15 (1) prevents the operator from initiating the
16 treatment cycle unless each treatment room entrance door is
17 closed;

18 (2) causes the source to be shielded when an
19 entrance door is opened; and

20 (3) prevents the source from being exposed
21 following an interlock interruption until all treatment room
22 entrance doors are closed and the source on-off control is reset
23 at the console.

24 D. A licensee must require any individual entering
25 the treatment room to ensure, through the use of appropriate
26 radiation monitors, that radiation levels have returned to
27 ambient levels.

1 E. Except for low-dose remote afterloader units, a
2 licensee must construct or equip each treatment room with
3 viewing and intercom systems to permit continuous observation of
4 the patient or human research subject from the treatment console
5 during irradiation.

6 F. For licensed activities where sources are placed
7 within the patient's or human research subject's body, a
8 licensee must only conduct treatments that allow for expeditious
9 removal of a decoupled or jammed source.

10 G. A licensee must:

11 (1) for medium dose-rate and pulsed dose-rate
12 remote afterloader units, require:

13 (a) an authorized medical physicist and
14 either an authorized user or a physician, under the supervision
15 of an authorized user, who has been trained in the operation and
16 emergency response for the unit, to be physically present during
17 the initiation of all patient treatments involving the unit; and

18 (b) an authorized medical physicist and
19 either an authorized user or an individual, under the
20 supervision of an authorized user, who has been trained to
21 remove the source applicator in the event of an emergency
22 involving the unit, to be immediately available during
23 continuation of all patient treatments involving the unit;

24 (2) for high dose-rate remote afterloader units,
25 require:

26 (a) an authorized user and an authorized
27 medical physicist to be physically present during the initiation

1 of all patient treatments involving the unit; and

2 (b) an authorized medical physicist and
3 either an authorized user or a physician, under the supervision
4 of an authorized user, who has been trained in the operation and
5 emergency response for the unit, to be physically present during
6 continuation of all patient treatments involving the unit;

7 (3) for gamma stereotactic radiosurgery units,
8 require an authorized user and an authorized medical physicist
9 to be physically present throughout all patient treatments
10 involving the unit; and

11 (4) notify the radiation safety officer or the
12 officer's designee and an authorized user as soon as possible if
13 the patient or human research subject has a medical emergency or
14 dies.

15 H. A licensee must have applicable emergency response
16 equipment available near each treatment room to respond to a
17 source:

18 (1) remaining in the unshielded position; or

19 (2) lodged within the patient following
20 completion of the treatment.

21 4731.4468 DOSIMETRY EQUIPMENT.

22 Subpart 1. Required equipment. Except for low dose-rate
23 remote afterloader sources where the source output or activity
24 is determined by the manufacturer, a licensee must have a
25 calibrated dosimetry system available for use. To satisfy this
26 requirement:

27 A. the system must have been calibrated by a

1 calibration laboratory accredited by the American Association of
2 Physicists in Medicine (AAPM) or by using a source or system
3 traceable to the National Institute of Standards and Technology
4 (NIST) and published protocols accepted by nationally recognized
5 bodies:

6 (1) within the previous two years; and

7 (2) after any servicing that may have affected
8 system calibration; or

9 B. the system must have been calibrated within the
10 previous four years. Eighteen to 30 months after that
11 calibration:

12 (1) the system must have been intercompared with
13 another dosimetry system that was calibrated within the past 24
14 months by NIST or by a calibration laboratory accredited by the
15 AAPM; and

16 (2) the results of the intercomparison must have
17 indicated that the calibration factor of the licensee's system
18 had not changed by more than two percent. The licensee may not
19 use the intercomparison result to change the calibration
20 factor. When intercomparing dosimetry systems to be used for
21 calibrating sealed sources for therapeutic units, the licensee
22 must use a comparable unit with a beam attenuator or
23 collimators, as applicable, and sources of the same radionuclide
24 as the source used at the licensee's facility.

25 Subp 2. Spot check measurements. A licensee must have a
26 dosimetry system available for spot check output measurements,
27 if applicable. To satisfy this requirement, the system may be

1 compared with a system that has been calibrated according to
2 subpart 1. The comparison must have been performed within the
3 previous year and after each servicing that may have affected
4 system calibration. The spot check system may be the same
5 system used to meet the requirement under subpart 1.

6 Subp. 3. Record retention. A licensee must retain a
7 record of each calibration, intercomparison, and comparison
8 according to part 4731.4517.

9 4731.4469 TELETHERAPY UNITS; FULL CALIBRATION.

10 Subpart 1. Calibration required. A licensee authorized to
11 use a teletherapy unit for medical use must perform full
12 calibration measurements on each teletherapy unit:

13 A. before the first medical use of the unit;

14 B. before medical use under the following conditions:

15 (1) whenever spot check measurements indicate
16 that the output differs by more than five percent from the
17 output obtained at the last full calibration corrected
18 mathematically for radioactive decay;

19 (2) following replacement of the source or
20 following reinstallation of the teletherapy unit in a new
21 location; and

22 (3) following any repair of the teletherapy unit
23 that includes removal of the source or major repair of the
24 components associated with the source exposure assembly; and

25 C. at intervals not exceeding one year.

26 Subp. 2. Required determinations. To satisfy subpart 1,
27 full calibration measurements must include determination of:

1 A. the output within plus or minus three percent for
2 the range of field sizes and for the distance or range of
3 distances used for medical use;

4 B. the coincidence of the radiation field and the
5 field indicated by the light beam localizing device;

6 C. the uniformity of the radiation field and its
7 dependence on the orientation of the useful beam;

8 D. timer accuracy and linearity over the range of
9 use;

10 E. on-off error; and

11 F. the accuracy of all distance-measuring and
12 localization devices in medical use.

13 Subp. 3. Required system. A licensee must use the
14 dosimetry system described in part 4731.4468, subpart 1, to
15 measure the output for one set of exposure conditions. The
16 remaining radiation measurements required under subpart 2 may be
17 made using a dosimetry system that indicates relative dose rates.

18 Subp. 4. Required protocols. A licensee must make full
19 calibration measurements required under subpart 1 according to
20 published protocols accepted by nationally recognized bodies.

21 Subp. 5. Required corrections. A licensee must
22 mathematically correct the outputs determined in subpart 2, item
23 A, for physical decay for intervals not exceeding one month for
24 cobalt-60, six months for cesium-137, or at intervals consistent
25 with one percent decay for all other nuclides.

26 Subp. 6. Authorized medical physicist. Full calibration
27 measurements required under subpart 1 and physical decay

1 corrections required under subpart 5 must be performed by the
2 authorized medical physicist.

3 Subp. 7. Record retention. A licensee must retain a
4 record of each calibration according to part 4731.4518.

5 4731.4470 REMOTE AFTERLOADER UNITS; FULL CALIBRATION.

6 Subpart 1. Calibration required. A licensee authorized to
7 use a remote afterloader unit for medical use must perform full
8 calibration measurements on each unit:

9 A. before the first medical use of the unit;

10 B. before medical use under the following conditions:

11 (1) following replacement of the source or
12 following reinstallation of the unit in a new location outside
13 the facility; and

14 (2) following any repair of the unit that
15 includes removal of the source or major repair of the components
16 associated with the source exposure assembly;

17 C. at intervals not exceeding one quarter for high
18 dose-rate, medium dose-rate, and pulsed dose-rate remote
19 afterloader units with sources whose half-life exceeds 75 days;
20 and

21 D. at intervals not exceeding one year for low
22 dose-rate remote afterloader units.

23 Subp. 2. Required determinations. To satisfy subpart 1,
24 full calibration measurements must include, as applicable,
25 determination of:

26 A. the output within plus or minus five percent;

27 B. source positioning accuracy to within plus or

1 minus one millimeter;

2 C. source retraction with backup battery upon power
3 failure;

4 D. length of the source transfer tubes;

5 E. timer accuracy and linearity over the typical
6 range of use;

7 F. length of the applicators; and

8 G. function of the source transfer tubes,
9 applicators, and transfer tube-applicator interfaces.

10 Subp. 3. Required system. A licensee must use the
11 dosimetry system described in part 4731.4468, subpart 1, to
12 measure the output.

13 Subp. 4. Required protocols. A licensee must make full
14 calibration measurements required under subpart 1 according to
15 published protocols accepted by nationally recognized bodies.

16 Subp. 5. Autoradiograph required. In addition to the
17 requirements for full calibrations for low dose-rate remote
18 afterloader units under subpart 2, a licensee must perform an
19 autoradiograph of the source to verify inventory and source
20 arrangement at intervals not exceeding one quarter.

21 Subp. 6. Measurements by manufacturer. For low dose-rate
22 remote afterloader units, a licensee may use measurements
23 provided by the source manufacturer that are made according to
24 subparts 1 to 5.

25 Subp. 7. Required corrections. A licensee must
26 mathematically correct the outputs determined in subpart 2, item
27 A, for physical decay at intervals consistent with one percent

1 physical decay.

2 Subp. 8. Authorized medical physicist. Full calibration
3 measurements required under subpart 1 and physical decay
4 corrections required under subpart 7 must be performed by the
5 authorized medical physicist.

6 Subp. 9. Record retention. A licensee must retain a
7 record of each calibration according to part 4731.4518.

8 4731.4471 GAMMA STEREOTACTIC RADIOSURGERY UNITS; FULL
9 CALIBRATION.

10 Subpart 1. Calibration required. A licensee authorized to
11 use a gamma stereotactic radiosurgery unit for medical use must
12 perform full calibration measurements on each unit:

13 A. before the first medical use of the unit;

14 B. before medical use under the following conditions:

15 (1) whenever spot check measurements indicate
16 that the output differs by more than five percent from the
17 output obtained at the last full calibration corrected
18 mathematically for radioactive decay;

19 (2) following replacement of the sources or
20 following reinstallations of the gamma stereotactic radiosurgery
21 unit in a new location; and

22 (3) following any repair of the gamma
23 stereotactic radiosurgery unit that includes removal of the
24 sources or major repair of the components associated with the
25 source assembly; and

26 C. at intervals not exceeding one year, except that
27 relative helmet factors need only be determined before the first

1 medical use of a helmet and following any damage to a helmet.

2 Subp. 2. Required determinations. To satisfy subpart 1,
3 full calibration measurements must include determination of:

4 A. the output within plus or minus three percent;

5 B. relative helmet factors;

6 C. isocenter coincidence;

7 D. timer accuracy and linearity over the range of
8 use;

9 E. on-off error;

10 F. trunnion centricity;

11 G. treatment table retraction mechanism, using backup
12 battery power or hydraulic backups with the unit off;

13 H. helmet microswitches;

14 I. emergency timing circuits; and

15 J. stereotactic frames and localization devices
16 (trunnions).

17 Subp. 3. Required system. A licensee must use the
18 dosimetry system described in part 4731.4468, subpart 1, to
19 measure the output for one set of exposure conditions. The
20 remaining radiation measurements required under subpart 2 may be
21 made using a dosimetry system that indicates relative dose rates.

22 Subp. 4. Required protocols. A licensee must make full
23 calibration measurements required under subpart 1 according to
24 published protocols accepted by nationally recognized bodies.

25 Subp. 5. Required corrections. A licensee must
26 mathematically correct the outputs determined under subpart 2,
27 item A, at intervals not exceeding one month for cobalt-60 and

1 at intervals consistent with one percent physical decay for all
2 other radionuclides.

3 Subp. 6. Authorized medical physicist. Full calibration
4 measurements required under subpart 1 and physical decay
5 corrections required under subpart 5 must be performed by the
6 authorized medical physicist.

7 Subp. 7. Record retention. A licensee must retain a
8 record of each calibration according to part 4731.4518.

9 4731.4472 TELETHERAPY UNITS; PERIODIC SPOT CHECKS.

10 Subpart 1. Output spot checks required. A licensee
11 authorized to use teletherapy units for medical use must perform
12 output spot checks on each teletherapy unit once in each
13 calendar month that include determination of:

14 A. timer accuracy and timer linearity over the range
15 of use;

16 B. on-off error;

17 C. the coincidence of the radiation field and the
18 field indicated by the light beam localizing device;

19 D. the accuracy of all distance-measuring and
20 localization devices used for medical use;

21 E. the output for one typical set of operating
22 conditions measured with the dosimetry system described in part
23 4731.4468, subpart 2; and

24 F. the difference between the measurement made in
25 item E and the anticipated output, expressed as a percentage of
26 the anticipated output, that is, the value obtained at last full
27 calibration corrected mathematically for physical decay.

1 Subp. 2. Written procedures. A licensee must perform
2 measurements required under subpart 1 according to written
3 procedures established by the authorized medical physicist. The
4 authorized medical physicist need not actually perform the spot
5 check measurements.

6 Subp. 3. Review. A licensee must have the authorized
7 medical physicist review the results of each spot check within
8 15 days. The authorized medical physicist must notify the
9 licensee as soon as possible in writing of the results of each
10 spot check.

11 Subp. 4. Safety spot checks required. A licensee
12 authorized to use a teletherapy unit for medical use must
13 perform safety spot checks of each teletherapy facility once in
14 each calendar month and after each source installation to ensure
15 proper operation of:

16 A. electrical interlocks at each teletherapy room
17 entrance;

18 B. electrical or mechanical stops installed to limit
19 use of the primary beam of radiation, including restriction of
20 source housing angulation or elevation, carriage or stand
21 travel, and operation of the beam on-off mechanism;

22 C. source exposure indicator lights on the
23 teletherapy unit, on the control console, and in the facility;

24 D. viewing and intercom systems;

25 E. treatment room doors from inside and outside the
26 treatment room; and

27 F. electrically assisted treatment room doors with

1 the teletherapy unit electrical power turned off.

2 Subp. 5. Malfunctions. If the results of the checks
3 required under subpart 4 indicate the malfunction of any system,
4 a licensee must lock the control console in the off position and
5 not use the unit except as may be necessary to repair, replace,
6 or check the malfunctioning system.

7 Subp. 6. Record retention. A licensee must retain a
8 record of each spot check required under subparts 1 and 4 and a
9 copy of the procedures required under subpart 2 according to
10 part 4731.4519.

11 4731.4473 REMOTE AFTERLOADER UNITS; PERIODIC SPOT CHECKS.

12 Subpart 1. Spot check required. A licensee authorized to
13 use remote afterloader units for medical use must perform spot
14 checks of each remote afterloader facility and on each unit:

15 A. before the first use of a high dose-rate, medium
16 dose-rate, or pulsed dose-rate remote afterloader unit on a
17 given day;

18 B. before each patient treatment with a low dose-rate
19 remote afterloader unit; and

20 C. after each source installation.

21 Subp. 2. Written procedures. A licensee must perform the
22 measurements required under subpart 1 according to written
23 procedures established by the authorized medical physicist. The
24 authorized medical physicist need not actually perform the spot
25 check measurement.

26 Subp. 3. Review. A licensee must have the authorized
27 medical physicist review the results of each spot check within

1 15 days. The authorized medical physicist must notify the
2 licensee as soon as possible in writing of the results of the
3 spot check.

4 Subp. 4. Minimum requirements. To satisfy subpart 1, spot
5 checks must, at a minimum, ensure proper operation of:

6 A. electrical interlocks at each remote afterloader
7 unit room entrance;

8 B. source exposure indicator lights on the remote
9 afterloader unit, on the control console, and in the facility;

10 C. viewing and intercom systems in each high
11 dose-rate, medium dose-rate, and pulsed dose-rate remote
12 afterloader facility;

13 D. emergency response equipment;

14 E. radiation monitors used to indicate the source
15 position;

16 F. timer accuracy;

17 G. date and time in the unit's computer; and

18 H. decayed source activity in the unit's computer.

19 Subp. 5. Malfunctions. If the results of the checks
20 required under subpart 4 indicate the malfunction of any system,
21 a licensee must lock the control console in the off position and
22 not use the unit except as may be necessary to repair, replace,
23 or check the malfunctioning system.

24 Subp. 6. Record retention. A licensee must retain a
25 record of each check required under subpart 4 and a copy of the
26 procedures required under subpart 2 according to part 4731.4520.

27 4731.4474 GAMMA STEREOTACTIC RADIOSURGERY UNITS; PERIODIC SPOT

1 CHECKS.

2 Subpart 1. Spot checks required. A licensee authorized to
3 use gamma stereotactic radiosurgery units for medical use must
4 perform spot checks of each gamma stereotactic radiosurgery
5 facility and on each unit:

6 A. monthly;

7 B. before the first use of the unit on a given day;

8 and

9 C. after each source installation.

10 Subp. 2. Written procedures; review. A licensee must:

11 A. perform the spot checks required under subpart 1
12 according to written procedures established by the authorized
13 medical physicist. The authorized medical physicist need not
14 actually perform the spot check measurements; and

15 B. have the authorized medical physicist review the
16 results of each spot check within 15 days. The authorized
17 medical physicist must notify the licensee as soon as possible
18 in writing of the results of each spot check.

19 Subp. 3. Monthly requirements. To satisfy subpart 1, item
20 A, monthly spot checks must, at a minimum:

21 A. ensure proper operation of:

22 (1) the treatment table retraction mechanism,
23 using backup battery power or hydraulic backups with the unit
24 off;

25 (2) helmet microswitches;

26 (3) emergency timing circuits; and

27 (4) stereotactic frames and localizing devices

1 (trunnions); and

2 B. determine:

3 (1) the output for one typical set of operating
4 conditions measured with the dosimetry system described under
5 part 4731.4468, subpart 2;

6 (2) the difference between the measurement made
7 in subitem (1) and the anticipated output, expressed as a
8 percentage of the anticipated output, that is, the value
9 obtained at last full calibration corrected mathematically for
10 physical decay;

11 (3) source output against computer calculation;

12 (4) timer accuracy and linearity over the range
13 of use;

14 (5) on-off error; and

15 (6) trunnion centricity.

16 Subp. 4. Other requirements. To satisfy subpart 1, items
17 B and C, spot checks must ensure proper operation of:

18 A. electrical interlocks at each gamma stereotactic
19 radiosurgery room entrance;

20 B. source exposure indicator lights on the gamma
21 stereotactic radiosurgery unit, on the control console, and in
22 the facility;

23 C. viewing and intercom systems;

24 D. timer termination;

25 E. radiation monitors used to indicate room
26 exposures; and

27 F. emergency off buttons.

1 Subp. 5. Repair. A licensee must arrange for repair of
2 any system identified under subpart 3 that is not operating
3 properly as soon as possible.

4 Subp. 6. Malfunctions. If the results of the checks
5 required under subpart 4 indicate the malfunction of any system,
6 a licensee must lock the control console in the off position and
7 not use the unit except as may be necessary to repair, replace,
8 or check the malfunctioning system.

9 Subp. 7. Record retention. A licensee must retain a
10 record of each check required under subparts 3 and 4 and a copy
11 of the procedures required under subpart 2 according to part
12 4731.4521.

13 4731.4475 MOBILE REMOTE AFTERLOADER UNITS; ADDITIONAL
14 REQUIREMENTS.

15 Subpart 1. General requirements. A licensee providing
16 mobile remote afterloader service must:

17 A. check survey instruments before medical use at
18 each address of use or on each day of use, whichever is more
19 frequent; and

20 B. account for all sources before departure from a
21 client's address of use.

22 Subp. 2. Check requirements. In addition to the periodic
23 spot checks required under part 4731.4473, a licensee authorized
24 to use mobile afterloaders for medical use must perform checks
25 on each remote afterloader unit before use at each address of
26 use. At a minimum, checks must be made to verify the operation
27 of:

- 1 A. electrical interlocks on treatment area access
2 points;
- 3 B. source exposure indicator lights on the remote
4 afterloader unit, on the control console, and in the facility;
- 5 C. viewing and intercom systems;
- 6 D. applicators, source transfer tubes, and transfer
7 tube-applicator interfaces;
- 8 E. radiation monitors used to indicate room
9 exposures;
- 10 F. source positioning (accuracy); and
- 11 G. radiation monitors used to indicate whether the
12 source has returned to a safe shielded position.

13 Subp. 3. Simulated treatment cycle. In addition to the
14 requirements for checks under subpart 2, a licensee must ensure
15 proper overall operation of the remote afterloader unit by
16 conducting a simulated cycle of treatment before use at each
17 address of use.

18 Subp. 4. Malfunctions. If the results of the checks
19 required under subpart 2 indicate the malfunction of any system,
20 a licensee must lock the control console in the off position and
21 not use the unit except as may be necessary to repair, replace,
22 or check the malfunctioning system.

23 Subp. 5. Record retention. A licensee must retain a
24 record of each check required under subpart 2 according to part
25 4731.4522.

26 4731.4476 RADIATION SURVEYS.

27 Subpart 1. Surveys required. In addition to the survey

1 requirement under part 4731.2200, a licensee must make surveys
2 to ensure that the maximum radiation levels and average
3 radiation levels from the surface of the main source safe with
4 the source in the shielded position do not exceed the levels
5 stated in the sealed source and device registry.

6 Subp. 2. When required. A licensee must make the survey
7 required under subpart 1 upon installation of a new source and
8 following repairs to the source shielding, the source driving
9 unit, or other electronic or mechanical component that could:

- 10 A. expose the source;
- 11 B. reduce the shielding around the source; or
- 12 C. compromise the radiation safety of the unit or the
13 source.

14 Subp. 3. Record retention. A licensee must retain a
15 record of the radiation surveys required under subpart 1
16 according to part 4731.4523.

17 4731.4477 TELETHERAPY AND GAMMA STEREOTACTIC RADIOSURGERY UNITS;
18 FIVE-YEAR INSPECTION.

19 Subpart 1. Inspection required. A licensee must have each
20 teletherapy unit and gamma stereotactic radiosurgery unit fully
21 inspected and serviced during source replacement or at intervals
22 not to exceed five years, whichever comes first, to ensure
23 proper functioning of the source exposure mechanism.

24 Subp. 2. Qualified inspectors. The inspection and
25 servicing may be performed only by persons specifically licensed
26 to do so by the commissioner, the NRC, or an agreement state.

27 Subp. 3. Record retention. A licensee must keep a record

1 of the inspection and servicing according to part 4731.4524.

2 4731.4478 TELETHERAPY AND GAMMA STEREOTACTIC COMPUTER SYSTEMS.

3 A licensee must perform acceptance testing on the treatment
4 planning system of teletherapy and gamma stereotactic computer
5 systems according to published protocols accepted by nationally
6 recognized bodies. At a minimum, the acceptance testing must
7 include, as applicable, verification of:

8 A. the source-specific input parameters required by
9 the dose calculation algorithm;

10 B. the accuracy of dose, dwell time, and treatment
11 time calculations at representative points;

12 C. the accuracy of isodose plots and graphic
13 displays;

14 D. the accuracy of the software used to determine
15 sealed source positions from radiographic images; and

16 E. the accuracy of electronic transfer of the
17 treatment delivery parameters to the treatment delivery unit
18 from the treatment planning system.

19 4731.4479 REMOTE AFTERLOADER UNITS, TELETHERAPY UNITS, AND GAMMA
20 STEREOTACTIC RADIOSURGERY UNITS; TRAINING.

21 Except as provided under part 4731.4414, a licensee must
22 require an authorized user of a sealed source for a use
23 authorized under part 4731.4463 to be a physician who:

24 A. is certified by a medical specialty board whose
25 certification process includes all of the requirements of item B
26 and whose certification has been recognized by the commissioner,

1 the NRC, or an agreement state; or

2 B. has training and experience as follows:

3 (1) has completed a structured educational
4 program in basic radionuclide techniques applicable to the use
5 of a sealed source in a therapeutic medical unit that includes:

6 (a) 200 hours of classroom and laboratory
7 training in the following areas:

8 i. radiation physics and
9 instrumentation;

10 ii. radiation protection;

11 iii. mathematics pertaining to the use
12 and measurement of radioactivity; and

13 iv. radiation biology; and

14 (b) 500 hours of work experience, under the
15 supervision of an authorized user who meets the requirements of
16 this part or equivalent requirements of the NRC or an agreement
17 state, at a medical institution involving:

18 i. reviewing full calibration
19 measurements and periodic spot check;

20 ii. preparing treatment plans and
21 calculating treatment doses and times;

22 iii. using administrative controls to
23 prevent a medical event involving the use of radioactive
24 materials;

25 iv. implementing emergency procedures
26 to be followed in the event of an abnormal operation of the
27 medical unit or console;

1 v. checking and using survey meters;

2 and

3 vi. selecting the proper dose and how

4 it is to be administered;

5 (2) has completed three years of supervised
6 clinical experience in radiation oncology, under an authorized
7 user who meets the requirements of this part or equivalent
8 requirements of the NRC or an agreement state, as part of a
9 formal training program approved by the Residency Review
10 Committee for Radiation Oncology of the Accreditation Council
11 for Graduate Medical Education or the Committee on Postdoctoral
12 Training of the American Osteopathic Association. The
13 experience may be obtained concurrently with the supervised work
14 experience required under subitem (1), unit (b); and

15 (3) has obtained written certification that the
16 individual has satisfactorily completed the requirements of
17 subitem (1) and has achieved a level of competency sufficient to
18 function independently as an authorized user of each type of
19 therapeutic medical unit for which the individual is requesting
20 authorized user status. The written certification must be
21 signed by a preceptor authorized user who meets the requirements
22 of this part or equivalent requirements of the NRC or an
23 agreement state for an authorized user for each type of
24 therapeutic medical unit for which the individual is requesting
25 authorized user status.

26 4731.4500 RADIATION PROTECTION PROGRAM RECORDS.

27 Subpart 1. Records of authority and responsibilities;

1 radiation protection programs. A licensee must retain:

2 A. a record of actions taken by the licensee's
3 management according to part 4731.4405, subpart 1, item A, for
4 five years. The record must include a summary of the actions
5 taken and a signature of licensee management; and

6 B. a copy of the authorities, duties, and
7 responsibilities of the radiation safety officer, as required
8 under part 4731.4405, subpart 1, item E, and a signed copy of
9 the radiation safety officer's agreement to be responsible for
10 implementing the radiation safety program, as required under
11 part 4731.4405, subpart 1, item B. The records must include the
12 signature of the radiation safety officer and licensee
13 management.

14 Subp. 2. Protection program changes. A licensee must
15 retain a record of each radiation protection program change made
16 under part 4731.4405, subpart 2, for five years. The record
17 must include a copy of the old and new procedures, the effective
18 date of the change, and the signature of the licensee's
19 management that reviewed and approved the change.

20 4731.4501 WRITTEN DIRECTIVE RECORDS.

21 Subpart 1. Written directive. A licensee must retain a
22 copy of each written directive required under part 4731.4408 for
23 three years.

24 Subp. 2. Administration procedures. A licensee must
25 retain a copy of the procedures required under part 4731.4409,
26 item A, for the duration of the license.

1 4731.4502 INSTRUMENT CALIBRATION RECORDS.

2 Subpart 1. Activity measurement instruments. A licensee
3 must maintain a record of instrument calibrations required under
4 part 4731.4420 for three years. The record must include:

- 5 A. the model and serial numbers of the instrument;
- 6 B. the date of the calibration;
- 7 C. the results of the calibration; and
- 8 D. the name of the individual who performed the
9 calibration.

10 Subp. 2. Survey instruments. A licensee must maintain a
11 record of radiation survey instrument calibrations required
12 under part 4731.4421 for three years. The record must include:

- 13 A. the model and serial number of the instrument;
- 14 B. the date of the calibration;
- 15 C. the results of the calibration; and
- 16 D. the name of the individual who performed the
17 calibration.

18 4731.4503 DOSAGE RECORDS.

19 A licensee must maintain a record of dosage determinations
20 required under part 4731.4422 for three years. The record must
21 contain:

- 22 A. the identity of the radiopharmaceutical;
- 23 B. the patient's or human research subject's name or
24 identification number, if one has been assigned;
- 25 C. the prescribed dosage, the determined dosage, or a
26 notation that the total activity is less than 30 microcuries
27 (1.1 MBq);

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- 1 D. the date and time of the dosage determination; and
- 2 E. the name of the individual who determined the
- 3 dosage.

4 4731.4504 LEAKS TEST AND INVENTORY RECORDS.

5 Subpart 1. Leak tests. A licensee must retain records of
6 leak tests required under part 4731.4424, item B, for three
7 years. The records must contain:

8 A. the model number and serial number, if one has
9 been assigned, of each source tested;

10 B. the identity of each source radionuclide and its
11 estimated activity;

12 C. the results of the test;

13 D. the date of the test; and

14 E. the name of the individual who performed the test.

15 Subp. 2. Inventories. A licensee must retain records of
16 the semiannual physical inventory of sealed sources and
17 brachytherapy sources required under part 4731.4424, item G, for
18 three years. The inventory records must contain:

19 A. the model number and serial number, if one has
20 been assigned, of each source;

21 B. the identity of each source radionuclide and its
22 nominal activity;

23 C. the location of each source; and

24 D. the name of the individual who performed the
25 inventory.

26 4731.4505 SURVEY RECORDS; AMBIENT RADIATION EXPOSURE.

1 A licensee must retain a record of each survey required
2 under part 4731.4426 for three years. The record must include:

- 3 A. the date of the survey;
4 B. the results of the survey;
5 C. the instrument used to make the survey; and
6 D. the name of the individual who performed the
7 survey.

8 4731.4506 RELEASE RECORDS; INDIVIDUALS CONTAINING RADIOACTIVE
9 MATERIAL OR IMPLANTS.

10 Subpart 1. Release basis. A licensee must retain a record
11 of the basis for authorizing the release of an individual
12 according to part 4731.4427, if the total effective dose
13 equivalent is calculated by:

- 14 A. using the retained activity rather than the
15 activity administered;
16 B. using an occupancy factor less than 0.25 at one
17 meter;
18 C. using the biological or effective half-life; or
19 D. considering the shielding by tissue.

20 Subp. 2. Instructions to mothers. A licensee must retain
21 a record that the instructions required under part 4731.4427,
22 item B, were provided to a breast-feeding woman if the radiation
23 dose to the infant or child from continued breast-feeding could
24 result in a total effective dose equivalent exceeding 0.5 rem (5
25 mSv).

26 Subp. 3. Retention period. The records required under
27 this part must be retained for three years after the date of

1 release of the individual.

2 4731.4507 MOBILE MEDICAL SERVICE RECORDS.

3 A. A licensee must retain a copy of each letter that
4 permits the use of radioactive material at a client's address of
5 use, according to part 4731.4428, item A, subitem (1). Each
6 letter must clearly delineate the authority and responsibility
7 of the licensee and the client and must be retained for three
8 years after the last provision of service.

9 B. A licensee must retain the record of each survey
10 required under part 4731.4428, item A, subitem (4), for three
11 years. The record must include:

- 12 (1) the date of the survey;
13 (2) the results of the survey;
14 (3) the instrument used to make the survey; and
15 (4) the name of the individual who performed the
16 survey.

17 4731.4508 DECAY-IN-STORAGE RECORDS.

18 A licensee must maintain records of the disposal of
19 licensed materials, as required under part 4731.4429, for three
20 years. The records must include:

- 21 A. the date of the disposal;
22 B. the survey instrument used;
23 C. the background radiation level;
24 D. the radiation level measured at the surface of
25 each waste container; and
26 E. the name of the individual who performed the

1 survey.

2 4731.4509 MOLYBDENUM-99 RECORDS.

3 A licensee must maintain a record of the molybdenum-99
4 concentration tests required under part 4731.4435, item B, for
5 three years. The record for each measured elution of
6 technetium-99m must include:

7 A. the ratio of the measures, expressed as
8 microcuries of molybdenum per millicurie of technetium or
9 kilobecquerel of molybdenum-99 per megabecquerel of
10 technetium-99m;

11 B. the time and date of the measurement; and

12 C. the name of the individual who made the
13 measurement.

14 4731.4510 SAFETY INSTRUCTION RECORDS.

15 A licensee must maintain a record of safety instructions
16 required under parts 4731.4441, 4731.4453, and 4731.4466 for
17 three years. The record must include:

18 A. a list of the topics covered;

19 B. the date of the instruction;

20 C. the names of the attendees; and

21 D. the names of the individuals who provided the
22 instruction.

23 4731.4511 SURVEY RECORDS; SOURCE IMPLANT AND REMOVAL.

24 A licensee must maintain a record of the surveys required
25 under parts 4731.4451 and 4731.4464 for three years. The record
26 must include:

- 1 A. the date and results of the survey;
- 2 B. the survey instrument used; and
- 3 C. the name of the individual who made the survey.

4 4731.4512 BRACHYTHERAPY SOURCE ACCOUNTABILITY RECORDS.

5 A licensee must maintain a record of brachytherapy source
6 accountability required under part 4731.4452 for three years as
7 follows:

- 8 A. for temporary implants, the record must include:
 - 9 (1) the number and activity of sources removed
 - 10 from storage;
 - 11 (2) the time and date they were removed from
 - 12 storage;
 - 13 (3) the name of the individual who removed them
 - 14 from storage; and
 - 15 (4) the location of use;
- 16 B. for sources being returned to storage, the record
17 must include:
 - 18 (1) the number and activity of sources returned
 - 19 to storage;
 - 20 (2) the time and date they were returned to
 - 21 storage; and
 - 22 (3) the name of the individual who returned them
 - 23 to storage;
- 24 C. for permanent implants, the record must include:
 - 25 (1) the number and activity of sources removed
 - 26 from storage;
 - 27 (2) the date they were removed from storage;

1 (3) the name of the individual who removed them
2 from storage; and

3 (4) the number and activity of sources
4 permanently implanted in the patient or human research subject;
5 and

6 D. for sources that were not implanted, the record
7 must include:

8 (1) the number and activity of sources not
9 implanted;

10 (2) the date they were returned to storage; and

11 (3) the name of the individual who returned them
12 to storage.

13 4731.4513 BRACHYTHERAPY SOURCE CALIBRATION RECORDS.

14 A licensee must maintain a record of the calibrations of
15 brachytherapy sources required under part 4731.4455 for three
16 years after the last use of the source. The records must
17 include:

18 A. the date of the calibration;

19 B. the manufacturer's name, the model number and
20 serial number for the source, and instruments used to calibrate
21 the source;

22 C. the source output or activity;

23 D. the source positioning accuracy within the
24 applicators; and

25 E. the signature of the authorized medical physicist.

26 4731.4514 STRONTIUM-90 DECAY RECORDS.

1 A licensee must maintain a record of the activity of a
2 strontium-90 source required under part 4731.4456 for the life
3 of the source. The record must include:

4 A. the date and initial activity of the source as
5 determined under part 4731.4455; and

6 B. for each decay calculation, the date and the
7 source activity as determined under part 4731.4456.

8 4731.4515 INSTALLATION, MAINTENANCE, ADJUSTMENT, AND REPAIR
9 RECORDS.

10 A licensee must retain a record of the installation,
11 maintenance, adjustment, and repair of remote afterloader units,
12 teletherapy units, and gamma stereotactic radiosurgery units as
13 required under part 4731.4465 for three years. For each
14 installation, maintenance, adjustment, and repair, the record
15 must include:

16 A. the date;

17 B. a description of the service; and

18 C. the name of the individual who performed the work.

19 4731.4516 SAFETY PROCEDURES RECORDS.

20 A licensee must retain a copy of the procedures required
21 under part 4731.4466, items B, subitem (4), and E, subitem (2),
22 until the licensee no longer possesses the remote afterloader
23 unit, teletherapy unit, or gamma stereotactic radiosurgery unit.

24 4731.4517 DOSIMETRY EQUIPMENT RECORDS.

25 A licensee must retain a record of the calibrations,
26 intercomparisons, and comparisons of dosimetry equipment

1 required under part 4731.4468 for the duration of the license.

2 For each calibration, intercomparison, or comparison, the record
3 must include:

4 A. the date;

5 B. the manufacturer's name, model number, and serial
6 number for the instrument that was calibrated, intercompared, or
7 compared;

8 C. the correction factor that was determined from the
9 calibration or comparison or the apparent correction factor that
10 was determined from an intercomparison; and

11 D. the name of the individual who performed the
12 calibration, intercomparison, or comparison.

13 4731.4518 CALIBRATION RECORDS; TELETHERAPY, REMOTE AFTERLOADER,
14 AND GAMMA STEREOTACTIC RADIOSURGERY UNITS.

15 A licensee must maintain a record of the teletherapy unit,
16 remote afterloader unit, and gamma stereotactic radiosurgery
17 unit full calibrations required under parts 4731.4469 to
18 4731.4471 for three years. The record must include:

19 A. the date of the calibration;

20 B. the unit manufacturer's name;

21 C. the model number and serial number of the
22 teletherapy, remote afterloader, and gamma stereotactic
23 radiosurgery unit;

24 D. the model number, serial number, and identity of
25 the source;

26 E. the model number, serial number, and identity of
27 the source instruments used to calibrate the units;

1 F. the results and an assessment of the full
2 calibrations;

3 G. the results of the autoradiograph required for low
4 dose-rate remote afterloader units; and

5 H. the signature of the authorized medical physicist
6 who performed the full calibration.

7 4731.4519 SPOT CHECK RECORDS; TELETHERAPY UNITS.

8 A. A licensee must retain a record of each periodic
9 spot check for teletherapy units required under part 4731.4472
10 for three years. The record must include:

11 (1) the date of the spot check;

12 (2) the unit manufacturer's name;

13 (3) the model number and serial number for the
14 teletherapy unit;

15 (4) the model number, serial number, and identity
16 of the source;

17 (5) instruments used to measure the output of the
18 teletherapy unit;

19 (6) an assessment of time linearity and
20 constancy;

21 (7) the calculated on-off error;

22 (8) a determination of the coincidence of the
23 radiation field and the field indicated by the light beam
24 localizing device;

25 (9) the determined accuracy of each distance
26 measuring and localization device;

27 (10) the difference between the anticipated

1 output and the measured output;

2 (11) notations indicating the operability of each
3 entrance door electrical interlock, electrical or mechanical
4 stop, source exposure indicator light, and viewing and intercom
5 system and doors;

6 (12) the name of the individual who performed the
7 periodic spot check; and

8 (13) the signature of the authorized medical
9 physicist who reviewed the record of the spot check.

10 B. A licensee must retain a copy of the procedures
11 required under part 4731.4472, subpart 2, until the licensee no
12 longer possesses the teletherapy unit.

13 4731.4520 SPOT CHECK RECORDS; REMOTE AFTERLOADER UNITS.

14 A. A licensee must retain a record of each spot check
15 for remote afterloader units required under part 4731.4473 for
16 three years. The record must include, as applicable:

17 (1) the date of the spot check;

18 (2) the unit manufacturer's name;

19 (3) the model number and serial number for the
20 remote afterloader unit;

21 (4) the model number, serial number, and identity
22 of the source;

23 (5) an assessment of timer accuracy;

24 (6) notations indicating the operability of each
25 entrance door electrical interlock, radiation monitor, source
26 exposure indicator light, viewing and intercom system, and clock
27 and decayed source activity in the unit's computer;

1 (7) the name of the individual who performed the
2 periodic spot check; and

3 (8) the signature of the authorized medical
4 physicist who reviewed the record of the spot check.

5 B. A licensee must retain a copy of the procedures
6 required under part 4731.4473, subpart 2, until the licensee no
7 longer possesses the remote afterloader unit.

8 4731.4521 SPOT CHECK RECORDS; GAMMA STEREOTACTIC RADIOSURGERY
9 UNITS.

10 A. A licensee must retain a record of each spot check
11 for gamma stereotactic radiosurgery units required under part
12 4731.4474 for three years. The record must include:

13 (1) the date of the spot check;

14 (2) the manufacturer's name, model number, and
15 serial number for the gamma stereotactic radiosurgery unit;

16 (3) the model number, serial number, and identity
17 of the instrument used to measure the output of the unit;

18 (4) an assessment of timer linearity and
19 accuracy;

20 (5) the calculated on-off error;

21 (6) a determination of trunnion centrlicity;

22 (7) the difference between the anticipated output
23 and the measured output;

24 (8) an assessment of source output against
25 computer calculations;

26 (9) notations indicating the operability of
27 radiation monitors, helmet microswitches, emergency timing

1 circuits, emergency off buttons, electrical interlocks, source
2 exposure indicator lights, viewing and intercom systems, timer
3 termination, treatment table retraction mechanisms, and
4 stereotactic frames and localizing devices (trunnions);

5 (10) the name of the individual who performed the
6 periodic spot check; and

7 (11) the signature of the authorized medical
8 physicist who reviewed the record of the spot check.

9 B. A licensee must retain a copy of the procedures
10 required under part 4731.4474, subpart 2, until the licensee no
11 longer possesses the gamma stereotactic radiosurgery unit.

12 4731.4522 OPERABILITY RECORDS; MOBILE REMOTE AFTERLOADER UNITS.

13 A licensee must retain a record of each check for mobile
14 remote afterloader units required under part 4731.4475 for three
15 years. The record must include:

16 A. the date of the check;

17 B. the manufacturer's name, model number, and serial
18 number for the remote afterloader unit;

19 C. notations accounting for all sources before the
20 licensee departs from a facility;

21 D. notations indicating the operability of each
22 entrance door electrical interlock, radiation monitor, source
23 exposure indicator light, viewing and intercom system,
24 applicator, source transfer tube, and transfer tube applicator
25 interface and the source positioning accuracy; and

26 E. the signature of the individual who performed the
27 check.

1 4731.4523 SURVEY RECORDS; THERAPEUTIC TREATMENT UNITS.

2 A licensee must maintain a record of radiation surveys of
3 treatment units made according to part 4731.4476 for the
4 duration of use of the unit. The record must include:

5 A. the date of the measurements;

6 B. the manufacturer's name, model number, and serial
7 number for the treatment unit, source, and instrument used to
8 measure radiation levels;

9 C. each dose rate measured around the source while
10 the unit is in the off position and the average of all
11 measurements; and

12 D. the signature of the individual who performed the
13 test.

14 4731.4524 INSPECTION RECORDS; TELETHERAPY AND GAMMA STEREOTACTIC
15 RADIOSURGERY UNITS.

16 A licensee must maintain a record of the five-year
17 inspections for teletherapy and gamma stereotactic radiosurgery
18 units required under part 4731.4477 for the duration of use of
19 the unit. The record must contain:

20 A. the inspector's radioactive material license
21 number;

22 B. the date of inspection;

23 C. the manufacturer's name, model number, and serial
24 number for both the treatment unit and source;

25 D. a list of components inspected and serviced and
26 the type of service; and

E. the signature of the inspector.

4731.4525 MEDICAL EVENT; REPORT AND NOTIFICATION.

Subpart 1. Report required. A licensee must report any event, except for an event that results from patient intervention, in which the administration of radioactive material or radiation from radioactive material results in:

A. 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:

(1) the total dose delivered differs from the prescribed dose by 20 percent or more;

(2) the total dose dosage delivered differs from the prescribed dosage by 20 percent or more or falls outside the prescribed dosage range; or

(3) the fractionated dose delivered differs from the prescribed dose, for a single fraction, by 50 percent or more;

B. 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:

(1) an administration of a wrong radioactive drug containing radioactive material;

(2) an administration of a radioactive drug containing radioactive material by the wrong route of administration;

1 (3) an administration of a dose or dosage to the
2 wrong individual or human research subject;

3 (4) an administration of a dose or dosage
4 delivered by the wrong mode of treatment; or

5 (5) a leaking sealed source; or

6 C. a dose to the skin or an organ or tissue other
7 than the treatment site that exceeds by 50 rems (0.5 Sv) to an
8 organ or tissue and exceeds 50 percent or more of the dose
9 expected from the administration defined in the written
10 directive, excluding, for permanent implants, seeds that were
11 implanted in the correct site but migrated outside the treatment
12 site.

13 Subp. 2. Events from patient intervention. A licensee
14 must report any event resulting from intervention of a patient
15 or human research subject in which the administration of
16 radioactive material or radiation from radioactive material
17 results or will result in unintended permanent functional damage
18 to an organ or a physiological system, as determined by a
19 physician.

20 Subp. 3. Telephone notification. A licensee must notify
21 the commissioner by telephone no later than the next calendar
22 day after discovery of a medical event.

23 Subp. 4. Written report. A licensee must submit a written
24 report to the commissioner within 15 days after discovery of a
25 medical event. The report must not contain an individual's name
26 or any other information that could lead to identification of an
27 individual. The report must include:

- 1 A. the licensee's name;
- 2 B. the name of the prescribing physician;
- 3 C. a brief description of the event;
- 4 D. why the event occurred;
- 5 E. the effect, if any, on the individual who received
- 6 the administration;
- 7 F. what actions, if any, have been taken or are
- 8 planned to prevent recurrence; and
- 9 G. certification that the licensee notified the
- 10 individual or the individual's responsible relative or guardian
- 11 and, if not, why.

12 Subp. 5. Notification of individual.

13 A. A licensee must provide notification of a medical
14 event to the referring physician and also notify the individual
15 who is the subject of the medical event no later than 24 hours
16 after its discovery, unless the referring physician personally
17 informs the licensee either that the physician will inform the
18 individual or that, based on medical judgment, telling the
19 individual would be harmful.

20 B. A licensee is not required to notify the
21 individual without first consulting the referring physician. If
22 the referring physician or the affected individual cannot be
23 reached within 24 hours, the licensee must notify the individual
24 as soon as possible thereafter.

25 C. A licensee may not delay any appropriate medical
26 care for the individual, including any necessary remedial care
27 as a result of the medical event, because of any delay in

1 notification.

2 D. To meet the notification requirements in this
3 subpart, notification of the individual who is the subject of
4 the medical event may be made instead to that individual's
5 responsible relative or guardian.

6 E. If a verbal notification is made, the licensee
7 must inform the individual, or appropriate responsible relative
8 or guardian, that a written description of the event can be
9 obtained from the licensee upon request. The licensee must
10 provide a written description if requested.

11 Subp. 6. Construction. Aside from the notification
12 requirement, nothing in this part affects any rights or duties
13 of licensees and physicians in relation to each other, to
14 individuals affected by a medical event, or to that individual's
15 responsible relatives or guardians.

16 Subp. 7. Individual identification. A licensee must:

17 A. annotate a copy of the report provided to the
18 commissioner with:

19 (1) the name of the individual who is the subject
20 of the event; and

21 (2) the social security number or other
22 identification number, if one has been assigned, of the
23 individual who is the subject of the event; and

24 B. provide a copy of the annotated report to the
25 referring physician, if other than the licensee, no later than
26 15 days after the discovery of the medical event.

7 4731.4526 DOSE TO AN EMBRYO/FETUS OR CHILD; REPORT AND

1 NOTIFICATION.

2 Subpart 1. Report required; embryo/fetus. A licensee must
3 report any dose to an embryo/fetus that is greater than five
4 rems (50 mSv) dose equivalent that is a result of an
5 administration of radioactive material or radiation from
6 radioactive material to a pregnant woman unless the dose to the
7 embryo/fetus was specifically approved, in advance, by the
8 authorized user.

9 Subp. 2. Report required; nursing child. A licensee must
10 report a dose to a nursing child that is a result of an
11 administration of radioactive material to a breast-feeding woman
12 that:

13 A. is greater than five rems (50 mSv) total effective
14 dose equivalent; or

15 B. has resulted in unintended permanent functional
16 damage to an organ or a physiological system of the child, as
17 determined by a physician.

18 Subp. 3. Telephone notification. A licensee must notify
19 the commissioner by telephone no later than the next calendar
20 day after discovery of a dose to an embryo/fetus or nursing
21 child that requires a report under subpart 1 or 2.

22 Subp. 4. Written report. A licensee must submit a written
23 report to the commissioner within 15 days after discovery of a
24 dose to an embryo/fetus or nursing child that requires a report
25 under subpart 1 or 2. The report must not contain the
26 individual's or child's name or any other information that could
27 lead to identification of the individual or child. The report

1 must include:

- 2 A. the licensee's name;
- 3 B. the name of the prescribing physician;
- 4 C. a brief description of the event;
- 5 D. why the event occurred;
- 6 E. the effect, if any, on the embryo/fetus or the
- 7 nursing child;
- 8 F. what actions, if any, have been taken or are
- 9 planned to prevent recurrence; and
- 10 G. certification that the licensee notified the
- 11 pregnant woman or mother, or the mother's or child's responsible
- 12 relative or guardian, and if not, why.

13 Subp. 5. Notification of individual.

14 A. A licensee must provide notification of an event
15 requiring a report under subpart 1 or 2 to the referring
16 physician and to the pregnant woman or mother, both hereafter
17 referred to as the mother, no later than 24 hours after
18 discovery of the event, unless the referring physician
19 personally informs the licensee either that the physician will
20 inform the mother or that, based on medical judgment, telling
21 the mother would be harmful.

22 B. A licensee is not required to notify the mother
23 without first consulting with the referring physician. If the
24 referring physician or mother cannot be reached within 24 hours,
25 the licensee must make the appropriate notifications as soon as
26 possible thereafter.

27 C. A licensee may not delay any appropriate medical

1 care for the embryo/fetus or for the nursing child, including
2 any necessary remedial care as a result of the event, because of
3 any delay in notification.

4 D. To meet the requirements of this subpart,
5 notification may be made to the mother's or child's responsible
6 relative or guardian instead of the mother.

7 E. If a verbal notification is made, the licensee
8 must inform the mother, or the mother's or child's responsible
9 relative or guardian, that a written description of the event
10 can be obtained from the licensee upon request. The licensee
11 must provide a written description if requested.

12 Subp. 6. Individual identification. A licensee must:

13 A. annotate a copy of the report provided to the
14 commissioner with:

15 (1) the name of the pregnant woman or the nursing
16 child who is the subject of the event; and

17 (2) the social security number or other
18 identification number, if one has been assigned, of the pregnant
19 woman or the nursing child who is the subject of the event; and

20 B. provide a copy of the annotated report to the
21 referring physician, if other than the licensee, no later than
22 15 days after the discovery of the event.

23 4731.4527 REPORT OF LEAKING SOURCE.

24 A licensee must file a report within five days if a leak
25 test required under part 4731.4424 reveals the presence of 0.005
26 microcurie (185 Bq) or more of removable contamination. The
27 report must be filed with the commissioner. The written report

1 must include:

2 A. the model number and serial number, if assigned,
3 of the leaking source;

4 B. the identity of the radionuclide and its estimated
5 activity;

6 C. the results of the test;

7 D. the date of the test; and

8 E. the action taken.

9 IRRADIATORS

10 4731.6000 PURPOSE AND SCOPE.

11 Subpart 1. Applicability. Parts 4731.6000 to 4731.6270
12 apply to the issuance of a license authorizing the use of and
13 the radiation safety requirements for sealed sources containing
14 radioactive materials used to irradiate objects or materials
15 using gamma radiation in the following types of irradiators:

16 A. panoramic irradiators that have either dry or wet
17 storage of the radioactive sealed sources;

18 B. underwater irradiators in which both the source
19 and the product being irradiated are underwater; and

20 C. irradiators for which dose rates exceed five grays
21 (500 rads) per hour at one meter from the radioactive sealed
22 sources in air or in water, as applicable for the irradiator
23 type.

24 Subp. 2. Exemptions. Parts 4731.6000 to 4731.6270 do not
25 apply to:

26 A. self-contained dry-source-storage irradiators
27 (those in which both the source and the area subject to

1 irradiation are contained within a device and are not accessible
2 by personnel);

3 B. medical radiology;

4 C. teletherapy;

5 D. radiography (the irradiation of materials for
6 nondestructive testing purposes);

7 E. gauging; or

8 F. open-field (agricultural) irradiations.

9 Subp. 3. Other law. Parts 4731.6000 to 4731.6270 are in
10 addition to other requirements of this chapter. Nothing in
11 parts 4731.6000 to 4731.6270 relieves a licensee from complying
12 with other applicable federal, state, and local regulations
13 governing the siting, zoning, land use, and building code
14 requirements for industrial facilities.

15 4731.6010 SPECIFIC LICENSE; APPLICATION.

16 A person must file an application for a specific license
17 authorizing the use of sealed sources in an irradiator on the
18 application for material license form prescribed by the
19 commissioner. An application for a license, other than a
20 license exempted from Code of Federal Regulations, title 10,
21 part 170, must be accompanied by a fee according to Minnesota
22 Statutes, section 144.1205. The application and one copy must
23 be sent to the commissioner.

24 4731.6020 SPECIFIC LICENSE; APPROVAL.

25 The commissioner shall approve an application for a
26 specific license for the use of licensed material in an

1 irradiator if the applicant meets the general requirements under
2 part 4731.3070 and if the application includes:

3 A. a description of the training provided to
4 irradiator operators including:

5 (1) classroom training;

6 (2) on-the-job or simulator training;

7 (3) safety reviews;

8 (4) methods used by the applicant to test each
9 operator's understanding of and ability to comply with this
10 chapter, licensing requirements, and the irradiator operating
11 and emergency procedures; and

12 (5) minimum training and experience of personnel
13 who may provide training;

14 B. an outline of written operating and emergency
15 procedures listed in part 4731.6170 that describes the radiation
16 safety aspects of the procedures;

17 C. a description of the organizational structure for
18 managing the irradiator, including:

19 (1) the radiation safety responsibilities and
20 authorities of the radiation safety officer; and

21 (2) who, within the management structure, has the
22 authority to stop unsafe operations and management personnel who
23 have important radiation safety responsibilities or authorities;

24 D. a description of the training and experience
25 required for the position of radiation safety officer;

26 E. a description of:

27 (1) access control systems required under part

1 4731.6060;

2 (2) radiation monitors required under part

3 4731.6090; and

4 (3) the method of detecting leaking sources

5 required under part 4731.6200, including the sensitivity of the
6 method;

7 F. a diagram of the facility that shows the locations
8 of all required interlocks and radiation monitors;

9 G. if the applicant intends to perform leak testing
10 of dry-source-storage sealed sources, a description of the
11 applicant's established procedures for leak testing. The
12 description must include the:

13 (1) instruments to be used;

14 (2) methods of performing the analysis; and

15 (3) pertinent experience of the individual who
16 analyzes the samples;

17 H. if the applicant's personnel are to load or unload
18 sources, a description of the qualifications and training of the
19 personnel and the procedures to be used. If the applicant
20 intends to contract for source loading and unloading at the
21 applicant's facility, the loading or unloading must be done by
22 an organization specifically authorized by the commissioner, the
23 NRC, or an agreement state to load or unload irradiator sources;
24 and

25 I. a description of the inspection and maintenance
26 checks, including the frequency of the checks, required under
27 part 4731.6210.

1 4731.6030 START OF CONSTRUCTION.

2 An applicant may not begin construction of a new irradiator
3 before submitting to the commissioner an application for a
4 license for the irradiator and the fee required under Minnesota
5 Statutes, section 144.1205. Activities undertaken before the
6 issuance of a license are entirely at the risk of the applicant
7 and have no bearing on the issuance of a license with respect to
8 the requirements of this chapter. For purposes of this part,
9 construction includes the construction of any portion of the
10 permanent irradiator structure on the site, but does not include:

- 11 A. engineering and design work;
- 12 B. purchase of a site;
- 13 C. site surveys or soil testing;
- 14 D. site preparation, site excavation, or construction
15 of warehouse or auxiliary structures; or
- 16 E. other preconstruction tasks.

17 4731.6040 APPLICATIONS FOR EXEMPTIONS.

18 An application for a license or for amendment of a license
19 authorizing use of a teletherapy-type unit for industrial
20 irradiation of materials or objects may include proposed
21 alternatives to the requirements under parts 4731.6000 to
22 4731.6270. The commissioner shall approve the proposed
23 alternatives if the applicant provides adequate rationale for
24 the proposed alternatives and demonstrates that the alternatives
25 are likely to provide an adequate level of safety for workers
26 and the public.

1 4731.6050 PERFORMANCE CRITERIA; SEALED SOURCES.

2 Subpart 1. Applicability. Sealed sources installed after
3 July 1, 1993, must meet the performance criteria of subparts 2
4 to 4.

5 Subp. 2. General requirements. Sealed sources must:

6 A. have a certificate of registration issued by the
7 NRC under Code of Federal Regulations, title 10, section 32.210,
8 or by an agreement state;

9 B. be doubly encapsulated; and

10 C. use radioactive material that is as nondispersible
11 as practical and that is as insoluble as practical if the source
12 is used in a wet-source-storage or wet-source-change irradiator.

13 Subp. 3. Irradiator pools. If sealed sources are to be
14 used in irradiator pools, the sealed sources must be
15 encapsulated in a material resistant to general corrosion and to
16 localized corrosion, such as 316L stainless steel or other
17 material with equivalent resistance.

18 Subp. 4. Required leak testing. In prototype testing of a
19 sealed source, the sealed source must have been leak tested and
20 found leak-free after each of the following tests:

21 A. temperature test. The test source must be held at
22 -40 degrees Celsius for 20 minutes, 600 degrees Celsius for one
23 hour, and then subjected to a thermal shock test with a
24 temperature drop from 600 degrees Celsius to 20 degrees Celsius
25 within 15 seconds;

26 B. pressure test. The test source must be twice
27 subjected for at least five minutes to an external pressure

1 (absolute) of 2,000,000 newtons per square meter;

2 C. impact test. A two-kilogram steel weight, 2.5
3 centimeters in diameter, must be dropped from a height of one
4 meter onto the test source;

5 D. vibration test. The test source must be subjected
6 three times for ten minutes each to vibrations sweeping from 25
7 hertz to 500 hertz with a peak amplitude of five times the
8 acceleration of gravity. The test source must be vibrated for
9 30 minutes at each resonant frequency found;

10 E. puncture test. A 50-gram weight and pin,
11 0.3-centimeter pin diameter, must be dropped from a height of
12 one meter onto the test source; and

13 F. bend test. If the length of the source is more
14 than 15 times larger than the minimum cross-sectional dimension,
15 the test source must be subjected to a force of 2,000 newtons at
16 its center equidistant from two support cylinders, the distance
17 between which is ten times the minimum cross-sectional dimension
18 of the source.

19 4731.6060 ACCESS CONTROL.

20 Subpart 1. Panoramic irradiators.

21 A. Each entrance to a radiation room at a panoramic
22 irradiator must have a door or other physical barrier to prevent
23 entry of personnel if the sources are not in the shielded
24 position. Product conveyor systems may serve as barriers, as
25 long as they reliably and consistently function as a barrier.
26 It must not be possible to move the sources out of their
27 shielded position if the door or barrier is open. Opening the

1 door or barrier while the sources are exposed must cause the
2 sources to return promptly to their shielded position. The
3 personnel entrance door or barrier must have a lock that is
4 operated by the same key used to move the sources. The doors
5 and barriers must not prevent an individual in the radiation
6 room from leaving.

7 B. Each entrance to a radiation room at a panoramic
8 irradiator must have an independent backup access control to
9 detect personnel entry while the sources are exposed. Detection
10 of entry while the sources are exposed must cause the sources to
11 return to their fully shielded position and must also activate a
12 visible and audible alarm to make the individual entering the
13 room aware of the hazard. The alarm must also alert at least
14 one other individual who is on site of the entry. That
15 individual must be trained on how to respond to the alarm and
16 prepared to promptly render or summon assistance.

17 C. A radiation monitor must be provided to detect the
18 presence of high radiation levels in the radiation room of a
19 panoramic irradiator before personnel entry. The monitor must
20 be integrated with personnel access door locks to prevent room
21 access when radiation levels are high. Attempted personnel
22 entry while the monitor measures high radiation levels must
23 activate the alarm described in item B. The monitor may be
24 located in the entrance, normally referred to as the maze, but
25 not in the direct radiation beam.

26 D. Before the sources move from their shielded
27 position in a panoramic irradiator, the source control must

1 automatically activate conspicuous visible and audible alarms to
2 alert people in the radiation room that the sources will be
3 moved from their shielded position. The alarms must give
4 individuals enough time to leave the room before the sources
5 leave the shielded position.

6 E. Each radiation room at a panoramic irradiator must
7 have a clearly visible and readily accessible control that
8 allows an individual in the room to make the sources return to
9 their fully shielded position.

10 F. Each radiation room of a panoramic irradiator must
11 contain a control that prevents the sources from moving from the
12 shielded position unless the control has been activated and the
13 door or barrier to the radiation room has been closed within a
14 preset time after activation of the control.

15 G. Each entrance to the radiation room of a panoramic
16 irradiator must be posted according to part 4731.2310.
17 Radiation postings for panoramic irradiators must comply with
18 part 4731.2310, except that signs may be removed, covered, or
19 otherwise made inoperative when the sources are fully shielded.

20 H. After entering the panoramic irradiator, if the
21 radiation room of a panoramic irradiator has roof plugs or other
22 movable shielding, it must not be possible to operate the
23 irradiator unless the shielding is in its proper location. This
24 requirement may be met:

25 (1) by interlocks that prevent operation if
26 shielding is not placed properly; or

27 (2) by an operating procedure requiring

1 inspection of shielding before operating.

2 Subp. 2. Underwater irradiators.

3 A. Each entrance to the area within the personnel
4 access barrier of an underwater irradiator must be posted
5 according to part 4731.2310.

6 B. There must be a personnel access barrier around
7 the pool, which must be locked to prevent access when the
8 irradiator is not attended.

9 C. Only operators and facility management may have
10 access to keys to the personnel access barrier.

11 D. There must be an intrusion alarm to detect
12 unauthorized entry when the personnel access barrier is locked.
13 Activation of the intrusion alarm must alert an individual, not
14 necessarily on site, who is prepared to respond or summon
15 assistance.

16 4731.6070 SHIELDING.

17 Subpart 1. Panoramic irradiators. For panoramic
18 irradiators, the radiation dose rate in areas that are normally
19 occupied during operation may not exceed two millirems (0.02
20 mSv) per hour at any location 30 centimeters or more from the
21 wall of the room when the sources are exposed. The dose rate
22 must be averaged over an area not to exceed 100 square
23 centimeters having no linear dimension greater than 20
24 centimeters. Areas where the radiation dose rate exceeds two
25 millirems (0.02 mSv) per hour must be locked, roped off, or
26 posted.

27 Subp. 2. Dry-source-storage panoramic irradiators. For

1 dry-source-storage panoramic irradiators, the radiation dose
2 rate at one meter from the shield when the source is shielded
3 may not exceed two millirems (0.02 mSv) per hour and at five
4 centimeters from the shield may not exceed 20 millirems (0.2
5 mSv) per hour.

6 Subp. 3. Pool irradiators. For pool irradiators, the
7 radiation dose at 30 centimeters over the edge of the pool may
8 not exceed two millirems (0.02 mSv) per hour when the sources
9 are in the fully shielded position.

10 4731.6080 FIRE PROTECTION.

11 For panoramic irradiators, the radiation room must have:

12 A. heat and smoke detectors, which must activate an
13 audible alarm. The alarm must be capable of alerting a person
14 who is prepared to summon assistance promptly;

15 B. a system whereby the sources automatically become
16 fully shielded if a fire is detected; and

17 C. a fire extinguishing system capable of
18 extinguishing a fire without the entry of personnel into the
19 room. The system for the radiation room must have a shut-off
20 valve to control flooding into unrestricted areas.

21 4731.6090 RADIATION MONITORS.

22 Subpart 1. Automatic product conveyor systems.

23 A. Irradiators with automatic product conveyor
24 systems must have a radiation monitor with an audible alarm
25 located to detect loose radioactive sources that are carried
26 toward the product exit. The alarms must comply with items B to

1 D.

2 B. If the monitor detects a source, an alarm must
3 sound and product conveyors must stop automatically.

4 C. The alarm must be capable of alerting an
5 individual in the facility who is prepared to summon assistance.

6 D. Underwater irradiators in which the product moves
7 within an enclosed stationary tube are exempt from the
8 requirements of this subpart.

9 Subp. 2. Underwater irradiators.

10 A. Underwater irradiators that are not in a shielded
11 radiation room must have a radiation monitor over the pool to
12 detect abnormal radiation levels. The monitor must comply with
13 items B to D.

14 B. The monitor must have an audible alarm and a
15 visible indicator at entrances to the personnel access barrier
16 around the pool.

17 C. The audible alarm may have a manual shut-off.

18 D. The alarm must be capable of alerting an
19 individual who is prepared to respond promptly.

20 4731.6100 CONTROL OF SOURCE MOVEMENT; PANORAMIC IRRADIATORS.

21 A. Items B to E apply to panoramic irradiators.

22 B. The mechanism that moves the sources must:

23 (1) require a key to activate. Only one key may
24 be in use at any time and only operators or facility management
25 may possess it. The key must be attached to a portable
26 radiation survey meter by a chain or cable. The lock for source
27 control must be designed so that the key may not be removed if

1 the sources are in an unshielded position. The door to the
2 radiation room must require the same key; and

3 (2) cause an audible signal to indicate that the
4 sources are leaving the shielded position.

5 C. The console must have a source position indicator
6 that indicates when the sources are in the fully shielded
7 position, when they are in transit, and when the sources are
8 exposed.

9 D. The control console must have a control that
10 promptly returns the sources to the shielded position.

11 E. Each control must be clearly marked as to its
12 function.

13 4731.6110 IRRADIATOR POOLS.

14 Irradiator pools initially licensed after July 1, 1993,
15 must:

16 A. have a watertight stainless steel liner or a liner
17 metallurgically compatible with other components in the pool or
18 be constructed so that there is a low probability of substantial
19 leakage and have a surface designed to facilitate
20 decontamination;

21 B. have a method to safely store sources during
22 repairs of the pool;

23 C. have no outlets greater than 0.5 meter below the
24 normal low water level that could allow water to drain out of
25 the pool. Pipes that have intakes more than 0.5 meter below the
26 normal low water level and that could act as siphons must have
27 siphon breakers to prevent the siphoning of pool water;

1 D. be provided with a means to replenish water losses
2 from the pool;

3 E. be provided with a water level indicator in a
4 clearly visible location to indicate if the pool water level is
5 below the normal low water level or above the normal high water
6 level;

7 F. be equipped with a purification system designed to
8 be capable of maintaining the water during normal operation at a
9 conductivity of 20 microsiemens per centimeter or less and with
10 a clarity so that the sources can be seen clearly;

11 G. be provided with a physical barrier, such as a
12 railing or cover, around or over irradiator pools during normal
13 operation to prevent personnel from accidentally falling into
14 the pool. The barrier may be removed during maintenance,
15 inspection, and service operations; and

16 H. not expose handling areas of tools or poles to
17 radiation dose rates greater than two millirems (0.02 mSv) per
18 hour.

19 4731.6120 SOURCE RACK PROTECTION.

20 If the product to be irradiated moves on a product conveyor
21 system, the source rack and the mechanism that moves the rack
22 must be protected by a barrier or guides to prevent products and
23 product carriers from hitting or touching the rack or mechanism.

24 4731.6130 POWER FAILURES.

25 A. If electrical power at a panoramic irradiator is
26 lost for longer than ten seconds, the sources must automatically

1 return to the shielded position.

2 B. The lock on the door of the radiation room of a
3 panoramic irradiator may not be deactivated by a power failure.

4 C. During a power failure, the area of any irradiator
5 where sources are located may be entered only when using an
6 operable and calibrated radiation survey meter.

7 4731.6140 DESIGN REQUIREMENTS.

8 Subpart 1. Applicability. This part applies to
9 irradiators whose construction began after July 1, 1993.

10 Subp. 2. Panoramic irradiators. For panoramic
11 irradiators, a licensee must:

12 A. design shielding walls to meet generally accepted
13 building code requirements for reinforced concrete and design
14 the walls, wall penetrations, and entranceways to meet the
15 radiation shielding requirements of part 4731.6070. If the
16 irradiator will use more than 5,000,000 curies (2×10^{17}
17 becquerels) of activity, the licensee must evaluate the effects
18 of heating of the shielding walls by the irradiator sources;

19 B. design the foundation, with consideration given to
20 soil characteristics, to ensure it is adequate to support the
21 weight of the facility shield walls;

22 C. verify from the design and logic diagram that the
23 access control system will meet the requirements of part
24 4731.6060;

25 D. verify that the number, location, and spacing of
26 the smoke and heat detectors are appropriate to detect fires and
27 that the detectors are protected from mechanical and radiation

1 damage;

2 E. verify that the design of the fire extinguishing
3 system provides the necessary discharge patterns, densities, and
4 flow characteristics for complete coverage of the radiation room
5 and that the system is protected from mechanical and radiation
6 damage;

7 F. verify that the source rack will automatically
8 return to the fully shielded position if off-site power is lost
9 for more than ten seconds;

10 G. if the irradiator is to be built in seismic areas,
11 design the reinforced concrete radiation shields to retain their
12 integrity in the event of an earthquake by designing to the
13 seismic requirements of an appropriate source, including:

14 (1) "Building Code Requirements for Reinforced
15 Concrete (ACI318-89)," American Concrete Institute, chapter 21
16 (1989). The chapter is incorporated by reference, is not
17 subject to frequent change, and is available from the Minitex
18 interlibrary loan system; or

19 (2) local building codes;

20 H. verify that electrical wiring and electrical
21 equipment in the radiation room are selected to minimize
22 failures due to prolonged exposure to radiation;

23 I. determine that source rack drops due to loss of
24 power will not damage the source rack and that source rack drops
25 due to failure of cables (or alternate means of support) will
26 not cause loss of integrity of sealed sources; and

27 J. review the design of the mechanism that moves the

1 sources to ensure that the likelihood of a stuck source is low
2 and that, if the rack sticks, a means exists to free it with
3 minimal risk to personnel.

4 Subp. 3. Pool and underwater irradiators. For pool and
5 underwater irradiators, a licensee must:

6 A. design the pool to ensure that:

7 (1) it is leak resistant;

8 (2) it is strong enough to bear the weight of the
9 pool water and shipping casks;

10 (3) a dropped cask would not fall on sealed
11 sources;

12 (4) all outlets or pipes meet the requirements
13 under part 4731.6110, item C; and

14 (5) metal components are metallurgically
15 compatible with other components in the pool;

16 B. verify that the design of the water purification
17 system is adequate to meet the requirements of part 4731.6110,
18 item F. The system must be designed so that water leaking from
19 the system does not drain to unrestricted areas without being
20 monitored;

21 C. when using radiation monitoring systems to detect
22 contamination under part 4731.6200, subpart 2, verify that the
23 design of radiation monitoring systems to detect pool
24 contamination includes sensitive detectors located close to
25 where contamination is likely to concentrate; and

26 D. verify that there are no crevices on the source or
27 between the source and source holder that would promote

1 corrosion on a critical area of the source.

2 Subp. 4. All irradiators. For all irradiators, a licensee
3 must:

4 A. evaluate the location and sensitivity of the
5 monitor to detect sources carried by the product conveyor system
6 as required under part 4731.6090, subpart 1; and

7 B. verify that the product conveyor is designed to
8 stop before a source on the product conveyor would cause a
9 radiation overexposure to any person.

10 4731.6150 CONSTRUCTION MONITORING AND ACCEPTANCE TESTING.

11 Subpart 1. Applicability. This part applies to
12 irradiators whose construction began after July 1, 1993. The
13 requirements of this part must be met prior to loading sources.

14 Subp. 2. Panoramic irradiators. For panoramic
15 irradiators, a licensee must:

16 A. monitor the construction of the shielding to
17 verify that its construction meets design specifications and
18 generally accepted building code requirements for reinforced
19 concrete;

20 B. monitor the construction of the foundations to
21 verify that their construction meets design specifications;

22 C. test the movement of the source racks for proper
23 operation prior to source loading. Testing must include source
24 rack lowering due to simulated loss of power;

25 D. test the completed access control system to ensure
26 that it functions as designed and that all alarms, controls, and
27 interlocks work properly;

1 E. test the ability of the heat and smoke detectors
2 to detect a fire, to activate alarms, and to cause the source
3 rack to automatically become fully shielded;

4 F. test the operability of the fire extinguishing
5 system;

6 G. demonstrate that the source racks can be returned
7 to their fully shielded positions without off-site power;

8 H. if a computer system is used to control the access
9 control system, verify that the access control system will
10 operate properly if off-site power is lost and verify that the
11 computer has security features that prevent an irradiator
12 operator from commanding the computer to override the access
13 control system when it is required to be operable; and

14 I. verify that the electrical wiring and electrical
15 equipment that were installed meet the design specifications.

16 Subp. 3. Pool and underwater irradiators. For pool and
17 underwater irradiators, a licensee must verify:

18 A. that the pool meets design specifications and must
19 test the integrity of the pool;

20 B. that outlets and pipes meet the requirements under
21 part 4731.6110, item C;

22 C. that the water purification system, the
23 conductivity meter, and the water level indicators operate
24 properly;

25 D. for pool irradiators, the proper operation of the
26 radiation monitors and the related alarm if used to comply with
27 part 4731.6190, subpart 2; and

1 E. for underwater irradiators, the proper operation
2 of the over-the-pool monitor, alarms, and interlocks required
3 under part 4731.6090, subpart 2.

4 Subp. 4. All irradiators. For all irradiators, a licensee
5 must verify the proper operation of the monitor to detect
6 sources carried on the product conveyor system and the related
7 alarms and interlocks required under part 4731.6090, subpart 1.

8 Subp. 5. Irradiators with product conveyor systems. For
9 all irradiators with product conveyor systems, a licensee must
10 observe and test the operation of the conveyor system to ensure
11 that the requirements under part 4731.6120 are met for
12 protection of the source rack and the mechanism that moves the
13 rack. Testing must include tests of any limit switches and
14 interlocks used to protect the source rack and mechanism that
15 moves the rack from moving product carriers.

16 4731.6160 TRAINING.

17 Subpart 1. Required instruction. Before an individual is
18 permitted to operate an irradiator without a supervisor present,
19 the individual must be instructed in:

20 A. the fundamentals of radiation protection applied
21 to irradiators, including:

22 (1) the differences between external radiation
23 and radioactive contamination;

24 (2) units of radiation dose;

25 (3) dose limits under this chapter;

26 (4) why large radiation doses must be avoided;

27 (5) how shielding and access controls prevent

1 large doses;

2 (6) how an irradiator is designed to prevent
3 contamination;

4 (7) the proper use of survey meters and personnel
5 dosimeters;

6 (8) other radiation safety features of an
7 irradiator; and

8 (9) the basic function of the irradiator;

9 B. the requirements of parts 4731.1000 to 4731.1090
10 and 4731.6000 to 4731.6270 that are relevant to the irradiator;

11 C. the operation of the irradiator;

12 D. those operating and emergency procedures under
13 part 4731.6170 that the individual is responsible for
14 performing; and

15 E. case histories of accidents or problems involving
16 irradiators.

17 Subp. 2. Required qualifications. Before an individual is
18 permitted to operate an irradiator without a supervisor present,
19 the individual must:

20 A. pass a written test on the instruction received
21 consisting primarily of questions based on the licensee's
22 operating and emergency procedures that the individual is
23 responsible for performing and other operations necessary to
24 safely operate the irradiator without supervision;

25 B. have received on-the-job training or simulator
26 training in the use of the irradiator as described in the
27 license application; and

1 C. demonstrate the ability to perform those portions
2 of the operating and emergency procedures that the individual is
3 to perform.

4 Subp. 3. Safety reviews. A licensee must conduct safety
5 reviews for irradiator operators at least annually. The
6 licensee must give each operator a brief written test on the
7 information. Each safety review must include, to the extent
8 appropriate:

9 A. changes in operating and emergency procedures
10 since the last review, if any;

11 B. changes in rules and license conditions since the
12 last review, if any;

13 C. reports on recent accidents, mistakes, or problems
14 that have occurred at irradiators, if any;

15 D. relevant results of inspections of operator safety
16 performance;

17 E. relevant results of the facility's inspection and
18 maintenance checks; and

19 F. a drill to practice an emergency or abnormal event
20 procedure.

21 Subp. 4. Safety performance. A licensee must evaluate the
22 safety performance of each irradiator operator at least annually
23 to ensure that rules, license conditions, and operating and
24 emergency procedures are followed. The licensee must discuss
25 the results of the evaluation with the operator and must
26 instruct the operator on how to correct any mistakes or
27 deficiencies observed.

1 Subp. 5. Individuals with access. Individuals who will be
2 permitted unescorted access to the radiation room of an
3 irradiator or the area around the pool of an underwater
4 irradiator, but who have not received the training required for
5 operators or radiation safety officers, must be instructed and
6 tested in any precautions they should take to avoid radiation
7 exposure, any procedures or parts of procedures under part
8 4731.6170 that they are expected to perform or comply with, and
9 their proper response to alarms required under parts 4731.6000
10 to 4731.6270. Tests may be oral.

11 Subp. 6. Response training. Individuals who must be
12 prepared to respond to alarms required under parts 4731.6060,
13 subparts 1, item B, and 2, item D; 4731.6080; 4731.6090; and
14 4731.6200, subpart 2, must be trained and tested on how to
15 respond. Each individual must be retested at least once a
16 year. Tests may be oral.

17 4731.6170 OPERATING AND EMERGENCY PROCEDURES.

18 Subpart 1. Operating procedures. A licensee must have and
19 follow written operating procedures for:

20 A. operation of the irradiator, including entering
21 and leaving the radiation room;

22 B. use of personnel dosimeters;

23 C. surveying the shielding of panoramic irradiators;

24 D. monitoring pool water for contamination while the
25 water is in the pool and before release of pool water to
26 unrestricted areas;

27 E. leak testing of sources;

1 F. inspection and maintenance checks required under
2 part 4731.6210;

3 G. loading, unloading, and repositioning sources, if
4 the operations will be performed by the licensee; and

5 H. inspection of movable shielding required under
6 part 4731.6060, subpart 1, item H, if applicable.

7 Subp. 2. Emergency procedures. A licensee must have and
8 follow emergency or abnormal event procedures, appropriate for
9 the irradiator type, for:

10 A. sources stuck in the unshielded position;

11 B. personnel overexposures;

12 C. a radiation alarm from the product exit portal
13 monitor or pool monitor;

14 D. detection of leaking sources, pool contamination,
15 or an alarm caused by contamination of pool water;

16 E. a low or high water level indicator, an abnormal
17 water loss, or leakage from the source storage pool;

18 F. a prolonged loss of electrical power;

19 G. a fire alarm or explosion in the radiation room;

20 H. an alarm indicating unauthorized entry into the
21 radiation room, area around the pool, or another alarmed area;

22 I. natural phenomena, including an earthquake, a
23 tornado, flooding, or other phenomena as appropriate for the
24 geographical location of the facility; and

25 J. the jamming of automatic conveyor systems.

26 Subp. 3. Revision of procedures. A licensee may revise
27 operating and emergency procedures without commissioner approval

1 only if:

2 A. the revisions do not reduce the safety of the
3 facility;

4 B. the revisions are consistent with the outline or
5 summary of procedures submitted with the license application;

6 C. the revisions have been reviewed and approved by
7 the radiation safety officer; and

8 D. the users or operators have been instructed and
9 tested on the revised procedures before the procedures are put
10 into use.

11 4731.6180 PERSONNEL MONITORING.

12 Subpart 1. Irradiator operators. Irradiator operators
13 must wear a personnel dosimeter that is processed and evaluated
14 by an accredited National Voluntary Laboratory Accreditation
15 Program (NVLAP) processor while operating a panoramic irradiator
16 or while in the area around the pool of an underwater
17 irradiator. The personnel dosimeter processor must be
18 accredited for high energy photons in the normal and accident
19 dose ranges under part 4731.2200, subpart 3. Each personnel
20 dosimeter must be assigned to and worn by only one individual.
21 Film badges must be processed at least monthly and other
22 personnel dosimeters must be processed at least quarterly.

23 Subp. 2. Other personnel. Other individuals who enter the
24 radiation room of a panoramic irradiator must wear a dosimeter,
25 which may be a pocket dosimeter. For groups of visitors, only
26 two people who enter the radiation room are required to wear
27 dosimeters. If pocket dosimeters are used to meet the

1 requirements of this subpart, a check of their response to
2 radiation must be done at least annually. Acceptable dosimeters
3 must read within plus or minus 30 percent of the true radiation
4 dose.

5 4731.6190 RADIATION SURVEYS.

6 Subpart 1. Panoramic irradiators. For panoramic
7 irradiators, the following radiation surveys must be conducted:

8 A. before the facility starts to operate, in the area
9 outside the shielding of the radiation room, with the sources in
10 the exposed position;

11 B. at intervals not to exceed three years, by the
12 shielding of the irradiator;

13 C. before resuming operation after addition of new
14 sources; and

15 D. after any modification to the radiation room
16 shielding or structure that might increase dose rates.

17 Subp. 2. Pool irradiators. For pool irradiators, the
18 following radiation surveys must be conducted:

19 A. before the facility starts to operate, in the area
20 above the pool, after the sources are loaded;

21 B. at intervals not to exceed three years, by the
22 shielding of the irradiator;

23 C. before resuming operation after addition of new
24 sources;

25 D. after any modification to the radiation room
26 shielding or structure that might increase dose rates; and

27 E. before release to unrestricted areas, water from

1 the irradiator pool, other potentially contaminated liquids, and
2 sediments from pool vacuuming must be monitored for radioactive
3 contamination. Radioactive concentrations must not exceed those
4 specified in part 4731.2750, subpart 7, Table 2 or 3.

5 Subp. 3. All irradiators.

6 A. For all irradiators, radiation surveys must:

7 (1) be modified to comply with part 4731.6070, if
8 the radiation levels specified under part 4731.6070 are
9 exceeded; and

10 (2) be conducted with portable radiation survey
11 meters that are calibrated at least annually to an accuracy of
12 plus or minus 20 percent for the gamma energy of the sources in
13 use. The calibration must be done at two points on each scale
14 or, for digital instruments, at one point per decade over the
15 range that will be used. Portable radiation survey meters must
16 be of a type that does not saturate and read zero at high
17 radiation dose rates.

18 B. Before releasing resins for unrestricted use, the
19 resins must be monitored before release in an area with a
20 background level less than 0.05 millirem (0.5 μ Sv) per hour.
21 The resins may be released only if the survey does not detect
22 radiation levels above background radiation levels. The survey
23 meter used must be capable of detecting radiation levels of 0.05
24 millirem (0.5 μ Sv) per hour.

25 4731.6200 DETECTION OF LEAKING SOURCES.

26 Subpart 1. Dry-source-storage sealed sources. Each
27 dry-source-storage sealed source must be tested for leakage at

1 intervals not to exceed six months using a leak test kit or
2 method approved by the commissioner, the NRC, or an agreement
3 state. In the absence of a certificate from a transferor that a
4 test has been made within the six months before the transfer,
5 the sealed source may not be used until tested. The test must
6 be capable of detecting the presence of 0.005 microcurie (200
7 becquerels) of radioactive material and must be performed by a
8 person approved by the commissioner, the NRC, or an agreement
9 state to perform the test.

10 Subp. 2. Pool irradiators.

11 A. This subpart applies to pool irradiators.

12 B. Sources may not be put into the pool unless the
13 licensee tests the sources for leaks or has a certificate from a
14 transferor that a leak test has been done within six months
15 before the transfer.

16 C. Water from the pool must be checked for
17 contamination each day the irradiator operates. The check may
18 be done by using:

19 (1) a radiation monitor on a pool water
20 circulating system; or

21 (2) analysis of a sample of pool water.

22 D. If a check for contamination under item C is done
23 by analysis of a sample of pool water, the results of the
24 analysis must be available within 24 hours.

25 E. If a licensee uses a radiation monitor on a pool
26 water circulating system under item C, the detection of above
27 normal radiation levels must activate an alarm. The alarm

1 set-point must be set as low as practical, but high enough to
2 avoid false alarms. The licensee may reset the alarm set-point
3 to a higher level if necessary to operate the pool water
4 purification system to clean up contamination in the pool if
5 specifically provided for in written emergency procedures.

6 Subp. 3. All irradiators.

7 A. If a leaking source is detected:

8 (1) the licensee must arrange to remove the
9 leaking source from service and have it decontaminated,
10 repaired, or disposed of by a licensee of the commissioner, the
11 NRC, or an agreement state that is authorized to perform these
12 functions;

13 (2) the licensee must promptly check the
14 licensee's personnel, equipment, facilities, and irradiated
15 product for radioactive contamination;

16 (3) no product may be shipped until the product
17 has been checked and found free of contamination. If a product
18 has been shipped that may have been inadvertently contaminated,
19 the licensee must arrange to locate and survey the product for
20 contamination;

21 (4) if any personnel are found to be
22 contaminated, decontamination must be performed promptly;

23 (5) if contaminated equipment, facilities, or
24 products are found, the licensee must arrange to have the
25 equipment, facilities, or products decontaminated or disposed of
26 by a licensee of the commissioner, the NRC, or an agreement
27 state that is authorized to perform these functions; and

1 (6) if a pool is contaminated, the licensee must
2 arrange to clean the pool until the contamination levels do not
3 exceed the appropriate concentration under part 4731.2750,
4 subpart 7, Table 2, column 2.

5 B. Records must be maintained according to part
6 4731.3110.

7 4731.6210 INSPECTION AND MAINTENANCE.

8 Subpart 1. Required checks. A licensee must perform
9 inspection and maintenance checks that include, as a minimum,
10 each of the following at the frequency specified in the license
11 or license application:

12 A. operability of each aspect of the access control
13 system required under part 4731.6060;

14 B. functioning of the source position indicator
15 required under part 4731.6100, item C;

16 C. operability of the radiation monitor for
17 radioactive contamination in pool water required under part
18 4731.6200, subpart 2, using a radiation check source, if
19 applicable;

20 D. operability of the over-the-pool radiation monitor
21 at underwater irradiators as required under part 4731.6090,
22 subpart 2;

23 E. operability of the product exit monitor required
24 under part 4731.6090, subpart 1;

25 F. operability of the emergency source return control
26 required under part 4731.6100, item D;

27 G. leak-tightness of systems through which pool water

1 circulates, by visual inspection;

2 H. operability of the heat and smoke detectors and
3 extinguisher system required under part 4731.6080, but without
4 turning extinguishers on;

5 I. operability of the means of pool water
6 replenishment required under part 4731.6110, item D;

7 J. operability of the indicators of high and low pool
8 water levels required under part 4731.6110, item E;

9 K. operability of the intrusion alarm required under
10 part 4731.6060, subpart 2, if applicable;

11 L. functioning and wear of the system, mechanisms,
12 and cables used to raise and lower sources;

13 M. condition of the barrier to prevent products from
14 hitting the sources or source mechanism as required under part
15 4731.6120;

16 N. amount of water added to the pool to determine if
17 the pool is leaking;

18 O. electrical wiring on required safety systems for
19 radiation damage; and

20 P. pool water conductivity measurements and analysis
21 as required under part 4731.6220, item B.

22 Subp. 2. Repair. Malfunctions and defects found during
23 inspection and maintenance checks must be repaired without undue
24 delay.

25 4731.6220 POOL WATER PURITY.

26 A. A pool water purification system must be run
27 sufficiently to maintain the conductivity of the pool water

1 below 20 microsiemens per centimeter under normal
2 circumstances. If pool water conductivity rises above 20
3 microsiemens per centimeter, a licensee must take prompt actions
4 to lower the pool water conductivity and take corrective actions
5 to prevent future recurrences.

6 B. A licensee must measure the pool water
7 conductivity frequently enough, but no less than weekly, to
8 ensure that the conductivity remains below 20 microsiemens per
9 centimeter. Conductivity meters must be calibrated at least
10 annually.

11 4731.6230 ATTENDANCE DURING OPERATION.

12 A. An irradiator operator and at least one other
13 individual who is trained in how to respond and prepared to
14 promptly render or summon assistance if the access control alarm
15 sounds must be present on site:

16 (1) whenever the irradiator is operated using an
17 automatic product conveyor system; and

18 (2) whenever the product is moved into or out of
19 the radiation room when the irradiator is operated in a batch
20 mode.

21 B. At a panoramic irradiator at which static
22 irradiations, when there is no movement of the product, occur, a
23 person who has received the training on how to respond under
24 part 4731.6160, subpart 6, must be on site.

25 C. At an underwater irradiator, an irradiator
26 operator must be present at the facility whenever the product is
27 moved into or out of the pool. Individuals who move the product

1 into or out of the pool of an underwater irradiator need not be
2 qualified as irradiator operators, but must have received the
3 training under part 4731.6160, subparts 5 and 6. Static
4 irradiations may be performed at an underwater irradiator
5 without a person present at the facility.

6 4731.6240 ENTERING AND LEAVING THE RADIATION ROOM.

7 Subpart 1. Entry. Upon first entering the radiation room
8 of a panoramic irradiator after an irradiation, the irradiator
9 operator must use a survey meter to determine that the source
10 has returned to its fully shielded position. The operator must
11 check the functioning of the survey meter with a radiation check
12 source before entry.

13 Subp. 2. Exit. Before exiting from and locking the door
14 to the radiation room of a panoramic irradiator prior to a
15 planned irradiation, the irradiator operator must:

16 (1) visually inspect the entire radiation room to
17 verify that no one else is in it; and

18 (2) activate a control in the radiation room that
19 permits the sources to be moved from the shielded position only
20 if the door to the radiation room is locked within a preset time
21 after setting the control.

22 Subp. 3. Entry during power failure. During a power
23 failure, the area around the pool of an underwater irradiator
24 may not be entered without using an operable and calibrated
25 radiation survey meter, unless the over-the-pool monitor
26 required under part 4731.6090, subpart 2, is operating with
27 backup power.

1 4731.6250 IRRADIATION OF EXPLOSIVE OR FLAMMABLE MATERIALS.

2 A. Irradiation of explosive material is prohibited
3 unless a licensee has received prior written authorization from
4 the commissioner. Authorization shall not be granted unless the
5 licensee can demonstrate that detonation of the explosive would
6 not rupture the sealed sources, injure personnel, damage safety
7 systems, or cause radiation overexposures of personnel.

8 B. Irradiation of more than small quantities of
9 flammable material, with a flash point below 140 degrees
10 Fahrenheit, is prohibited in panoramic irradiators unless a
11 licensee has received prior written authorization from the
12 commissioner. Authorization shall not be granted unless the
13 licensee can demonstrate that a fire in the radiation room could
14 be controlled without damage to sealed sources or safety systems
15 and without radiation overexposures of personnel.

16 4731.6260 RECORDS AND RETENTION PERIODS.

17 A licensee must maintain the following records at the
18 irradiator for the periods specified:

19 A. a copy of the license, license conditions,
20 documents incorporated into a license by reference, and
21 amendments thereto, until superseded by new documents or until
22 the commissioner terminates the license for documents not
23 superseded;

24 B. records of each individual's training, tests, and
25 safety reviews provided to comply with part 4731.6160, subparts
26 1, 2, 3, 5, and 6, for three years after the individual

1 terminates work;

2 C. records of the annual evaluations of the safety
3 performance of irradiator operators required under part
4 4731.6160, subpart 4, for three years after the evaluation;

5 D. a copy of the current operating and emergency
6 procedures required under part 4731.6170, until superseded or
7 the commissioner terminates the license;

8 E. records of the radiation safety officer's review
9 and approval of changes in procedures as required under part
10 4731.6170, subpart 3, item C, for three years from the date of
11 the change;

12 F. evaluations of personnel dosimeters required under
13 part 4731.6180, until the commissioner terminates the license;

14 G. records of radiation surveys required under part
15 4731.6190, for three years from the date of the survey;

16 H. records of radiation survey meter calibrations
17 required under part 4731.6190 and pool water conductivity meter
18 calibrations required under part 4731.6220, item B, for three
19 years from the date of calibration;

20 I. records of the results of leak tests required
21 under part 4731.6200, subpart 1, and the results of
22 contamination checks required under part 4731.6200, subpart 2,
23 for three years from the date of each test;

24 J. records of inspection and maintenance checks
25 required under part 4731.6210, for three years;

26 K. records of major malfunctions, significant
27 defects, operating difficulties or irregularities, and major

1 operating problems that involve required radiation safety
2 equipment, for three years after repairs are completed;

3 L. records of the receipt, transfer, and disposal of
4 all licensed sealed sources as required under parts 4731.3105
5 and 4731.3115;

6 M. records on the design checks required under part
7 4731.6140 and the construction control checks as required under
8 part 4731.6150, until the license is terminated. The records
9 must be signed and dated. The title or qualification of the
10 person signing must be included; and

11 N. records relating to decommissioning of the
12 irradiator as required under part 4731.3080, subpart 7.

13 4731.6270 REPORTS.

14 Subpart 1. Required reports. If not reported under other
15 parts of this chapter, a licensee must report the following
16 events:

17 A. source stuck in an unshielded position;

18 B. any fire or explosion in a radiation room;

19 C. damage to the source racks;

20 D. failure of the cable or drive mechanism used to
21 move the source racks;

22 E. inoperability of the access control system;

23 F. detection of radiation source by the product exit
24 monitor;

25 G. detection of radioactive contamination
26 attributable to licensed radioactive material;

27 H. structural damage to the pool liner or walls;

1 I. abnormal water loss or leakage from the source
2 storage pool; and

3 J. pool water conductivity exceeding 100 microsiemens
4 per centimeter.

5 Subp. 2. Content. A report under subpart 1 must include a
6 telephone report within 24 hours according to part 4731.3110,
7 subpart 3, item A, and a written report within 30 days according
8 to part 4731.3110, subpart 3, item B.

9 WELL LOGGING

10 4731.7000 LICENSES AND RADIATION SAFETY REQUIREMENTS FOR WELL
11 LOGGING.

12 Subpart 1. Applicability. Parts 4731.7000 to 4731.7280
13 provide for the issuance of a license authorizing the use of
14 licensed materials including sealed sources, radioactive
15 tracers, radioactive markers, and uranium sinker bars in well
16 logging in a single well and prescribe radiation safety
17 requirements for persons using licensed materials in these
18 operations. Parts 4731.7000 to 4731.7280 are in addition to,
19 and not in substitution for, other requirements of this chapter.

20 Subp. 2. Exemptions. Parts 4731.7000 to 4731.7280 do not
21 apply to the issuance of a license authorizing the use of
22 licensed material in tracer studies involving multiple wells,
23 such as field flooding studies, or to the use of sealed sources
24 auxiliary to well logging but not lowered into wells.

25 4731.7010 APPLICATION.

26 A person must file an application for a specific license

1 authorizing the use of licensed material in well logging on an
2 application for material license form prescribed by the
3 commissioner. An application for a license, other than a
4 license exempted from Code of Federal Regulations, title 10,
5 part 170, must be accompanied by the fee prescribed in Minnesota
6 Statutes, section 144.1205. The application must be sent to the
7 Radioactive Materials Unit, Minnesota Department of Health, St.
8 Paul, Minnesota.

9 4731.7020 SPECIFIC LICENSE; WELL LOGGING.

10 The commissioner shall approve an application for a
11 specific license for the use of licensed material in well
12 logging if the applicant:

13 A. satisfies the general licensing requirements under
14 parts 4731.0595 for special nuclear material, 4731.0765 for
15 source material, and 4731.3070 for radioactive material, as
16 appropriate, and any special requirements under parts 4731.7000
17 to 4731.7280;

18 B. develops a program for training logging
19 supervisors and logging assistants and submits to the
20 commissioner a description of the program that specifies:

21 (1) initial training;

22 (2) on-the-job training;

23 (3) annual safety reviews provided by the
24 licensee;

25 (4) the means of demonstrating the logging
26 supervisor's knowledge of, understanding of, and ability to
27 comply with this chapter, licensing requirements, and the

1 applicant's written operating and emergency procedures; and

2 (5) the means of demonstrating the logging
3 assistant's knowledge of, understanding of, and ability to
4 comply with the applicant's written operating and emergency
5 procedures;

6 C. creates and submits written operating and
7 emergency procedures according to part 4731.7210 or an outline
8 summary of the procedures that includes the important radiation
9 safety aspects of the procedures;

10 D. establishes and submits a description of the
11 applicant's program for annual inspections of the job
12 performance of each logging supervisor to ensure that this
13 chapter, license requirements, and the applicant's written
14 operating and emergency procedures are followed. Inspection
15 records must be retained for three years after each annual
16 internal inspection;

17 E. submits a description of the applicant's overall
18 organizational structure as it applies to the radiation safety
19 responsibilities in well logging, including specified
20 delegations of authority and responsibility;

21 F. identifies the manufacturers and the model numbers
22 of the leak test kits to be used if the applicant wants to
23 perform leak testing of sealed sources; and

24 G. establishes and submits a description of
25 procedures to be followed if the applicant wants to analyze its
26 own wipe samples. The description must include:

27 (1) the instruments to be used;

1 (2) the methods of performing the analysis; and
2 (3) the pertinent experience of the person who
3 will analyze the wipe samples.

4 4731.7030 AGREEMENT WITH WELL OWNER OR OPERATOR.

5 Subpart 1. Agreement required.

6 A. A licensee may perform well logging with a sealed
7 source only after the licensee has a written agreement with the
8 employing well owner or operator. The written agreement must be
9 kept for three years after completion of the well logging
10 operation. The agreement must include the terms in items B to F
11 and identify who will perform the requirements in items B to F.

12 B. If a sealed source becomes lodged in the well, a
13 reasonable effort must be made to recover it.

14 C. A person may not attempt to recover a sealed
15 source in a manner that, in the licensee's opinion, could result
16 in its rupture.

17 D. The radiation monitoring required under part
18 4731.7240 must be performed.

19 E. If the environment, any equipment, or personnel
20 are contaminated with licensed material, they must be
21 decontaminated before release from the site or release for
22 unrestricted use.

23 F. If the sealed source is classified as
24 irretrievable after reasonable efforts at recovery have been
25 expended, the following requirements must be implemented within
26 30 days:

27 (1) each irretrievable well logging source must

1 be immobilized and sealed in place with a cement plug;

2 (2) a means to prevent inadvertent intrusion on
3 the source must be set at some point in the well, unless the
4 source is not accessible to any subsequent drilling operations;
5 and

6 (3) a permanent identification plaque,
7 constructed of a long-lasting material, such as stainless steel,
8 brass, bronze, or Monel, must be mounted at the surface of the
9 well, unless mounting the plaque is not practical. The size of
10 the plaque must be at least seven inches (17 cm) square and
11 one-eighth inch (3 mm) thick. The plaque must contain:

12 (a) the word "CAUTION";

13 (b) the radiation symbol, except the color
14 requirement under part 4731.2300 need not be met;

15 (c) the date the source was abandoned;

16 (d) the name of the well owner or well
17 operator, as appropriate;

18 (e) the well name and well identification
19 number or other designation;

20 (f) identification of the sealed source by
21 radionuclide and quantity;

22 (g) the depth of the source and depth to the
23 top of the plug; and

24 (h) an appropriate warning, such as, "DO NOT
25 RE-ENTER REENTER THIS WELL."

26 Subp. 2. Variance. A licensee may apply, under part
27 4731.0200, for commissioner approval, on a case-by-case basis,

1 of proposed procedures to abandon an irretrievable well logging
2 source in a manner not otherwise authorized in subpart 1, item F.

3 Subp. 3. Exemption. The written agreement between the
4 licensee and the well owner or operator is not required if the
5 licensee and the well owner or operator are part of the same
6 corporate structure or otherwise similarly affiliated, but the
7 licensee must still comply with subpart 1, items B to F.

8 4731.7040 REQUEST FOR WRITTEN STATEMENTS.

9 A license is issued with the condition that the licensee
10 shall, at any time before expiration of the license, upon the
11 commissioner's request, submit written statements, signed under
12 oath or affirmation, to enable the commissioner to determine
13 whether the license should be modified, suspended, or revoked.

14 4731.7050 LABELS, SECURITY, AND TRANSPORTATION PRECAUTIONS.

15 Subpart 1. Labeling.

16 A. A licensee may not use a source, source holder, or
17 logging tool that contains licensed material unless the smallest
18 component that is transported as a separate piece of equipment
19 with the licensed material inside bears a durable, legible, and
20 clearly visible marking or label. The marking or label must
21 contain:

22 (1) the radiation symbol, except the color
23 requirement under part 4731.2300 need not be met; and

24 (2) the words "DANGER (or CAUTION), RADIOACTIVE
25 MATERIAL."

26 B. A licensee may not use a container to store

1 licensed material unless the container has securely attached to
2 it a durable, legible, and clearly visible label. The label
3 must contain:

4 (1) the radiation symbol specified under part
5 4731.2300; and

6 (2) the words "CAUTION (or DANGER), RADIOACTIVE
7 MATERIAL. NOTIFY CIVIL AUTHORITIES (or name of company)."

8 C. A licensee may not transport licensed material
9 unless the material is packaged, labeled, marked, and
10 accompanied with appropriate shipping papers according to parts
11 4731.0400 to 4731.0424.

12 Subp. 2. Storage and transportation.

13 A. A licensee must store each source containing
14 licensed material in a storage container or transportation
15 package that is locked and physically secured to prevent
16 tampering or removal of licensed material from storage by
17 unauthorized personnel.

18 B. A licensee must store licensed material in a
19 manner that minimizes danger from explosion or fire.

20 C. A licensee must lock and physically secure the
21 transport package containing licensed material in the
22 transporting vehicle to prevent:

23 (1) accidental loss;

24 (2) tampering; or

25 (3) unauthorized removal of the licensed material
26 from the vehicle.

27 4731.7060 RADIATION DETECTION INSTRUMENTS.

1 Subpart 1. Required survey instruments. A licensee must
2 keep a calibrated and operable radiation survey instrument
3 capable of detecting beta and gamma radiation at each field
4 station and temporary job site to make the radiation surveys
5 required under parts 4731.2000 to 4731.2950 and 4731.7000 to
6 4731.7280. The radiation survey instrument must be capable of
7 measuring 0.1 millirem (0.001 mSv) per hour through at least 50
8 millirems (0.5 mSv) per hour.

9 Subp. 2. Availability. A licensee must have available
10 additional calibrated and operable radiation detection
11 instruments sensitive enough to detect the low radiation and
12 contamination levels that could be encountered if a sealed
13 source ruptured. A licensee may own the instruments or may have
14 a procedure to obtain them quickly from a second party.

15 Subp. 3. Required calibrations. A licensee must have each
16 radiation survey instrument required under subpart 1 calibrated:

17 A. at intervals not to exceed six months and after
18 instrument servicing;

19 B. for linear scale instruments, at two points
20 located approximately one-third and two-thirds of full-scale on
21 each scale; for logarithmic scale instruments, at midrange of
22 each decade and at two points of at least one decade; and for
23 digital instruments, at appropriate points; and

24 C. so that an accuracy within plus or minus 20
25 percent of the calibration standard can be demonstrated on each
26 scale.

27 Subp. 4. Record retention. A licensee must retain

1 calibration records for three years after the date of
2 calibration for inspection by the commissioner.

3 4731.7070 LEAK TESTING; SEALED SOURCES.

4 Subpart 1. Testing and record keeping requirements. A
5 licensee that uses a sealed source must have the source
6 periodically tested for leakage. The licensee must keep a
7 record of leak test results in units of microcuries and retain
8 the record for inspection by the commissioner for three years
9 after the leak test is performed.

10 Subp. 2. Method of testing. The wipe of a sealed source
11 must be performed using a leak test kit or method approved by
12 the commissioner, the NRC, or an agreement state. The wipe
13 sample must be taken from the nearest accessible point to the
14 sealed source where contamination might accumulate. The wipe
15 sample must be analyzed for radioactive contamination. The
16 analysis must be capable of detecting the presence of 0.005
17 microcuries (185 Bq) of radioactive material on the test sample
18 and must be performed by a person approved by the commissioner,
19 the NRC, or an agreement state to perform the analysis.

20 Subp. 3. Test frequency.

21 A. Each sealed source, except an energy compensation
22 source (ECS), must be tested at intervals not to exceed six
23 months. In the absence of a certificate from a transferor that
24 a test has been made within the six months before the transfer,
25 the sealed source may not be used until tested.

26 B. Each ECS that is not exempt from testing under
27 subpart 5 must be tested at intervals not to exceed three years.

1 In the absence of a certificate from a transferor that a test
2 has been made within the three years before the transfer, the
3 ECS may not be used until tested.

4 Subp. 4. Removal of leaking source from service.

5 A. If the test conducted under subparts 1 and 2
6 reveals the presence of 0.005 microcuries (185 Bq) or more of
7 removable radioactive material, the licensee must remove the
8 sealed source from service immediately and have it
9 decontaminated, repaired, or disposed of by a person licensed by
10 the commissioner, the NRC, or an agreement state to perform
11 these functions. The licensee must check the equipment
12 associated with the leaking source for radioactive contamination
13 and, if contaminated, have it decontaminated or disposed of by a
14 person licensed by the commissioner, the NRC, or an agreement
15 state to perform these functions.

16 B. The licensee must submit a report to the
17 commissioner within five days of receiving the test results.
18 The report must:

- 19 (1) describe the equipment involved in the leak;
20 (2) include the test results;
21 (3) ~~include~~ describe any contamination that
22 resulted from the leaking source; and
23 (4) describe the corrective actions taken up to
24 the time the report is made.

25 Subp. 5. Exemptions. The following sealed sources are
26 exempt from the periodic leak test requirements under this part:

27 A. hydrogen-3 (tritium) sources;

- 1 B. sources containing licensed material with a
2 half-life of 30 days or less;
- 3 C. sealed sources containing licensed material in
4 gaseous form;
- 5 D. sources of beta- or gamma-emitting radioactive
6 material with an activity of 100 microcuries (3.7 MBq) or less;
7 and
- 8 E. sources of alpha- or neutron-emitting radioactive
9 material with an activity of ten microcuries (0.37 MBq) or less.

10 4731.7080 PHYSICAL INVENTORY.

- 11 A. A licensee must conduct a semiannual physical
12 inventory to account for all licensed material received and
13 possessed under the license. The licensee must retain records
14 of the inventory for three years from the date of the inventory
15 for inspection by the commissioner. The inventory must include:
- 16 (1) the quantity and kind of licensed material;
- 17 (2) the location of the licensed material;
- 18 (3) the date of the inventory; and
- 19 (4) the name of the individual conducting the
20 inventory.

- 21 B. The physical inventory records may be combined
22 with leak test records.

23 4731.7090 RECORDS OF MATERIAL USE.

- 24 Subpart 1. Use records. A licensee must maintain records
25 for each use of licensed material showing:

- 26 A. the make, model number, and a serial number or a

1 description of each sealed source used;

2 B. in the case of unsealed licensed material used for
3 subsurface tracer studies, the radionuclide and quantity of
4 activity used in a particular well and the disposition of any
5 unused tracer materials;

6 C. the identity of the logging supervisor who is
7 responsible for the licensed material and the identity of
8 logging assistants present; and

9 D. the location and date of use of the licensed
10 material.

11 Subp. 2. Record retention. A licensee must make the
12 records required under subpart 1 available for inspection by the
13 commissioner. A licensee must retain the records for three
14 years from the date of the recorded event.

15 4731.7100 DESIGN AND PERFORMANCE CRITERIA FOR SOURCES.

16 Subpart 1. General requirements. A licensee may only use
17 sealed sources in well logging applications that:

18 A. are doubly encapsulated;

19 B. contain licensed material whose chemical and
20 physical forms are as insoluble and nondispersible as practical;
21 and

22 C. meet the requirements of subparts 2 to 4, as
23 applicable.

24 Subp. 2. Pre-1989 sources. For a sealed source
25 manufactured on or before July 14, 1989, a licensee may use the
26 sealed source for use in well logging applications if it meets
27 the requirements of USASI N5.10-1968, "Classification of Sealed

1 Radioactive Sources," American Institute of Chemical Engineers,
2 or the requirements in subpart 3 or 4. The standard is
3 incorporated by reference, is not subject to frequent change,
4 and is available through the Minitex interlibrary loan system.

5 Subp. 3. Post-1989 sources; ANSI standard. For a sealed
6 source manufactured after July 14, 1989, a licensee may use the
7 sealed source for use in well logging applications if it meets
8 the oil-well logging requirements of "Sealed Radioactive
9 Sources-Classification" ANSI/HPS N43.6-1997, American National
10 Standards Institute (1997). The standard is incorporated by
11 reference, is not subject to frequent change, and is available
12 through the Minitex interlibrary loan system.

13 Subp. 4. Post-1989 sources; prototype testing. For a
14 sealed source manufactured after July 14, 1989, a licensee may
15 use the sealed source for use in well logging applications if
16 the sealed source's prototype has been tested and found to
17 maintain its integrity after each of the following tests:

18 A. temperature test. The test source must be held at
19 -40 degrees Celsius for 20 minutes, 600 degrees Celsius for one
20 hour, and then be subject to a thermal shock test with a
21 temperature drop from 600 degrees Celsius to 20 degrees Celsius
22 within 15 seconds;

23 B. impact test. A five kilogram steel hammer, 2.5
24 centimeters in diameter, must be dropped from a height of one
25 meter onto the test source;

26 C. vibration test. The test source must be subjected
27 to a vibration from 25 hertz to 500 hertz at an amplitude of

1 five times the acceleration of gravity for 30 minutes;

2 D. puncture test. A one gram hammer and pin, 0.3
3 centimeters pin diameter, must be dropped from a height of one
4 meter onto the test source; and

5 E. pressure test. The test source must be subjected
6 to an external pressure of 24,600 pounds per square inch
7 absolute (1.695×10^7 pascals).

8 Subp. 5. Exemptions.

9 A. Subparts 1 to 4 do not apply to sealed sources
10 that contain licensed material in gaseous form.

11 B. Subparts 1 to 4 do not apply to energy
12 compensation sources. An energy compensation source must be
13 registered with the NRC under Code of Federal Regulations, title
14 10, section 32.210, or with an agreement state.

15 4731.7110 INSPECTION AND MAINTENANCE; OPENING SOURCE OR SOURCE
16 HOLDER.

17 Subpart 1. Checks before use.

18 A. Before each use, a licensee must visually check
19 source holders, logging tools, and source handling tools for
20 defects to ensure that the equipment is in good working
21 condition and that required labeling is present.

22 B. If defects are found, the equipment must be
23 removed from service until repaired and a record must be made
24 listing:

- 25 (1) the date of the check;
26 (2) the name of the inspector;
27 (3) the equipment involved and what defects were

1 found; and

2 (4) what repairs were made.

3 C. Records made under item B must be retained for
4 three years after the defect is found.

5 Subp. 2. Semiannual inspections.

6 A. A licensee must have a program to ensure that
7 required labeling is legible and that no physical damage is
8 visible. This must be done by semiannual visual inspections and
9 routine maintenance of:

- 10 (1) source holders;
- 11 (2) logging tools;
- 12 (3) injection tools;
- 13 (4) source handling tools;
- 14 (5) storage containers;
- 15 (6) transport containers; and
- 16 (7) uranium sinker bars.

17 B. If defects are found, the equipment must be
18 removed from service until repaired, and a record must be made
19 and retained for three years after the defect is found, listing:

- 20 (1) the date of the inspection;
- 21 (2) the equipment involved;
- 22 (3) inspection and maintenance operations
23 performed;
- 24 (4) any defects found; and
- 25 (5) any actions taken to correct the defects.

26 Subp. 3. Written procedure for removal. Removal of a
27 sealed source from a source holder or logging tool and

1 maintenance on sealed sources or holders in which sealed sources
2 are contained may not be performed by the licensee unless a
3 written procedure developed under part 4731.7210 has been
4 approved by the commissioner under part 4731.7020, item C, or by
5 the NRC or an agreement state.

6 Subp. 4. Stuck source requirements. If a sealed source is
7 stuck in the source holder, the licensee may not perform any
8 operation, such as drilling, cutting, or chiseling, on the
9 source holder unless the licensee is specifically approved by
10 the commissioner, the NRC, or an agreement state to perform the
11 operation.

12 Subp. 5. Opening; repair; modification. The opening,
13 repair, or modification of any sealed source must be performed
14 by persons specifically approved to do so by the commissioner,
15 the NRC, or an agreement state.

16 4731.7120 SUBSURFACE TRACER STUDIES.

17 A. A licensee must require all personnel handling
18 radioactive tracer material to use protective gloves and, if
19 required by the license, other protective clothing and
20 equipment. The licensee must take precautions to avoid
21 ingestion or inhalation of radioactive tracer material and to
22 avoid contamination of field stations and temporary job sites.

23 B. A licensee may not knowingly inject licensed
24 material into freshwater aquifers unless a variance to chapter
25 4725 or 4727 has been specifically authorized by the
26 commissioner to do so.

1 4731.7130 RADIOACTIVE MARKERS.

2 A licensee may use radioactive markers in wells only if the
3 individual markers contain quantities of licensed material not
4 exceeding the quantities specified under part 4731.3145. The
5 use of markers is subject only to the requirements of part
6 4731.7080.

7 4731.7140 URANIUM SINKER BARS.

8 A licensee may use a uranium sinker bar in well logging
9 applications only if it is legibly impressed with the words
10 "CAUTION: RADIOACTIVE-DEPLETED URANIUM. NOTIFY CIVIL
11 AUTHORITIES (or company name) IF FOUND."

12 4731.7150 USE WITHOUT A SURFACE CASING.

13 A licensee may use a sealed source in a well without a
14 surface casing for protecting freshwater aquifers only if the
15 licensee follows a procedure for reducing the probability of the
16 source becoming lodged in the well. The procedure must be
17 approved by the commissioner according to part 4731.7020, item
18 C, or by the NRC or an agreement state.

19 4731.7160 ENERGY COMPENSATION SOURCE.

20 A. A licensee may use an energy compensation source
21 (ECS) that is contained within a logging tool or other tool
22 components only if the ECS contains quantities of licensed
23 material not exceeding 100 microcuries (3.7 MBq).

24 B. For well logging applications with a surface
25 casing for protecting freshwater aquifers, use of the ECS is
26 subject only to parts 4731.7070 to 4731.7090.

1 C. For well logging applications without a surface
2 casing for protecting freshwater aquifers, use of the ECS is
3 subject only to parts 4731.7030, 4731.7070 to 4731.7090,
4 4731.7150, and 4731.7280.

5 4731.7170 TRITIUM NEUTRON GENERATOR TARGET SOURCE.

6 A. Use of a tritium neutron generator target source,
7 containing quantities not exceeding 30 curies (1,110 MBq) and in
8 a well with a surface casing to protect freshwater aquifers, is
9 subject to parts 4731.7000 to 4731.7270, except parts 4731.7030
10 and 4731.7100.

11 B. Use of a tritium neutron generator target source,
12 containing quantities exceeding 30 curies (1,110 MBq) or in a
13 well without a surface casing to protect freshwater aquifers, is
14 subject to parts 4731.7000 to 4731.7280, except part 4731.7100.

15 4731.7200 TRAINING.

16 Subpart 1. Logging supervisor. A licensee must not permit
17 an individual to act as a logging supervisor until the
18 individual:

19 A. completes training in the subjects under subpart
20 5;

21 B. receives copies of and instruction in:

22 (1) the applicable provisions of parts 4731.1000
23 to 4731.2950 and 4731.7000 to 4731.7280;

24 (2) the license under which the logging
25 supervisor will perform well logging; and

26 (3) the licensee's operating and emergency

1 procedures required under part 4731.7210;

2 C. completes on-the-job training and demonstrates
3 competence in the use of licensed materials, remote handling
4 tools, and radiation survey instruments by a field evaluation;
5 and

6 D. demonstrates understanding of the materials under
7 items A and B by successfully completing a written test.

8 Subp. 2. Logging assistant. A licensee must not permit an
9 individual to act as a logging assistant until the individual:

10 A. receives instruction in applicable provisions of
11 parts 4731.1000 to 4731.2950;

12 B. receives copies of and instruction in the
13 licensee's operating and emergency procedures required under
14 part 4731.7210;

15 C. demonstrates understanding of the materials under
16 items A and B by successfully completing a written or oral test;
17 and

18 D. receives instruction in the use of licensed
19 materials, remote handling tools, and radiation survey
20 instruments, as appropriate for the logging assistant's intended
21 job responsibilities.

22 Subp. 3. Safety reviews. A licensee must provide safety
23 reviews for logging supervisors and logging assistants at least
24 once during each calendar year.

25 Subp. 4. Records. A licensee must maintain a record on
26 each logging supervisor's and logging assistant's training and
27 annual safety review. The training records must include copies

1 of written tests and dates of oral tests given after July 14,
2 1987. The training records must be retained for three years
3 following the termination of employment. Records of annual
4 safety reviews must list the topics discussed and must be
5 retained for three years.

6 Subp. 5. Training subjects. A licensee must include the
7 following subjects in the training required under subpart 1,
8 item A:

- 9 A. fundamentals of radiation safety, including:
- 10 (1) characteristics of radiation;
 - 11 (2) units of radiation dose and quantity of
 - 12 radioactivity;
 - 13 (3) hazards of exposure to radiation;
 - 14 (4) levels of radiation from licensed material;
 - 15 (5) methods of controlling radiation dose,
 - 16 including time, distance, and shielding; and
 - 17 (6) radiation safety practices, including
 - 18 prevention of contamination, and methods of decontamination;

- 19 B. radiation detection instruments, including:
- 20 (1) use, operation, calibration, and limitations
 - 21 of radiation survey instruments;
 - 22 (2) survey techniques; and
 - 23 (3) use of personnel monitoring equipment;

- 24 C. equipment to be used, including:
- 25 (1) operation of equipment, including source
 - 26 handling equipment and remote handling tools;
 - 27 (2) storage, control, and disposal of licensed

1 material; and

2 (3) maintenance of equipment;

3 D. the requirements of pertinent state rules; and

4 E. case histories of accidents in well logging.

5 4731.7210 OPERATING AND EMERGENCY PROCEDURES.

6 Subpart 1. Requirement. A licensee must develop and
7 follow written operating and emergency procedures.

8 Subp. 2. Operating and emergency procedures. A licensee's
9 written operating and emergency procedures must address:

10 A. the handling and use of licensed materials,
11 including the use of sealed sources in wells without surface
12 casing for protecting freshwater aquifers, if appropriate;

13 B. the use of remote handling tools for handling
14 sealed sources and radioactive tracer material, except
15 low-activity calibration sources;

16 C. methods and occasions for conducting radiation
17 surveys, including surveys for detecting contamination, as
18 required under part 4731.7230, subpart 2, items B to D;

19 D. minimizing personnel exposure, including exposures
20 from inhalation and ingestion of licensed tracer materials;

21 E. methods and occasions for locking and securing
22 stored licensed materials;

23 F. personnel monitoring and the use of personnel
24 monitoring equipment;

25 G. transportation of licensed materials to field
26 stations or temporary job sites, packaging of licensed materials
27 for transport in vehicles, placarding of vehicles when needed,

1 and physically securing licensed materials in transport vehicles
2 during transportation to prevent accidental loss, tampering, or
3 unauthorized removal;

4 H. picking up, receiving, and opening packages
5 containing licensed materials, according to part 4731.2350;

6 I. for the use of tracers, decontamination of the
7 environment, equipment, and personnel;

8 J. maintenance of records generated by logging
9 personnel at temporary job sites;

10 K. inspection and maintenance of sealed sources,
11 source holders, logging tools, injection tools, source handling
12 tools, storage containers, transport containers, and uranium
13 sinker bars as required under part 4731.7110;

14 L. identifying and reporting to the commissioner and
15 the NRC regarding defects and noncompliance, as required under
16 Code of Federal Regulations, title 10, part 21;

17 M. notifying proper persons, including the licensee's
18 radiation safety officer and the commissioner, in the event of
19 an accident or incident or abandonment of a source;

20 N. actions to be taken if a sealed source is lodged
21 or damaged in a well; and

22 O. actions to be taken if a sealed source is
23 ruptured, including:

24 (1) prevention of the spread of contamination;

25 (2) minimization of inhalation and ingestion of
26 licensed materials; and

27 (3) obtaining and using suitable radiation survey

1 instruments as required under part 4731.7060, subpart 2.

2 4731.7220 PERSONNEL MONITORING.

3 A. A licensee may not permit an individual to act as
4 a logging supervisor or logging assistant unless the individual
5 wears, at all times during the handling of licensed radioactive
6 materials, a personnel dosimeter that is processed and evaluated
7 by an accredited National Voluntary Laboratory Accreditation
8 Program (NVLAP) processor. Each personnel dosimeter must be
9 assigned to and worn by only one individual. Film badges must
10 be replaced at least monthly and other personnel dosimeters
11 replaced at least quarterly. After replacement, each personnel
12 dosimeter must be promptly processed.

13 B. A licensee must provide bioassay services to
14 individuals using licensed materials in subsurface tracer
15 studies if required by the license.

16 C. A licensee must retain records of personnel
17 dosimeters required under item A and bioassay results for
18 inspection until the commissioner authorizes disposition of the
19 records.

20 4731.7230 RADIATION SURVEYS.

21 Subpart 1. Requirement. A licensee must make radiation
22 surveys, including but not limited to the surveys required under
23 subpart 2, of each area where licensed materials are used and
24 stored.

25 Subp. 2. Safety surveys.

26 A. Before transporting licensed materials, a licensee

1 must make a radiation survey of the position occupied by each
2 individual in the vehicle and of the exterior of each vehicle
3 used to transport the licensed materials.

4 B. If the sealed source assembly is removed from the
5 logging tool before departure from the temporary job site, a
6 licensee must confirm that the logging tool is free of
7 contamination by energizing the logging tool detector or by
8 using a survey meter.

9 C. If a licensee has reason to believe that, as a
10 result of any operation involving a sealed source, the
11 encapsulation of the sealed source could be damaged by the
12 operation, the licensee must conduct a radiation survey,
13 including a contamination survey, during and after the operation.

14 D. A licensee must make a radiation survey at the
15 temporary job site before and after each subsurface tracer study
16 to confirm the absence of contamination.

17 Subp. 3. Records.

18 A. The results of surveys required under this part
19 must be recorded and must include:

- 20 (1) the date of the survey;
21 (2) the name of the individual making the survey;
22 (3) the identification of the survey instrument
23 used; and
24 (4) the location of the survey.

25 B. A licensee must retain records of surveys for
26 inspection by the commissioner for three years after they are
27 made.

1 4731.7240 RADIOACTIVE CONTAMINATION CONTROL.

2 A. If a licensee detects evidence that a sealed
3 source has ruptured or licensed materials have caused
4 contamination, the licensee must immediately initiate the
5 emergency procedures required under part 4731.7210.

6 B. If contamination results from the use of licensed
7 material in well logging, the licensee must decontaminate all
8 work areas, equipment, and unrestricted areas.

9 C. During efforts to recover a sealed source lodged
10 in a well, a licensee must continuously monitor, with an
11 appropriate radiation detection instrument or a logging tool
12 with a radiation detector, the circulating fluids from the well,
13 if any, to check for contamination resulting from damage to the
14 sealed source.

15 4731.7250 SECURITY.

16 A. A logging supervisor must be physically present at
17 a temporary job site whenever licensed materials are being
18 handled or are not stored and locked in a vehicle or storage
19 place. The logging supervisor may leave the job site to obtain
20 assistance if a source becomes lodged in a well.

21 B. During well logging, except when radiation sources
22 are below ground or in shipping or storage containers, the
23 logging supervisor or other individual designated by the logging
24 supervisor must maintain direct surveillance of the operation to
25 prevent unauthorized entry into a restricted area.

26 4731.7260 DOCUMENTS AND RECORDS; FIELD STATIONS.

1 A licensee must maintain the following documents and
2 records at a field station:

3 A. a copy of parts 4731.1000 to 4731.2950 and
4 4731.7000 to 4731.7280;

5 B. the license authorizing the use of licensed
6 material;

7 C. the operating and emergency procedures required
8 under part 4731.7210;

9 D. the record of radiation survey instrument
10 calibrations required under part 4731.7060;

11 E. the record of leak test results required under
12 part 4731.7070;

13 F. physical inventory records required under part
14 4731.7080;

15 G. utilization records required under part 4731.7090;

16 H. records of inspection and maintenance required
17 under part 4731.7110;

18 I. training records required under part 4731.7200,
19 subpart 4; and

20 J. survey records required under part 4731.7230.

21 4731.7270 DOCUMENTS AND RECORDS; TEMPORARY JOB SITES.

22 A licensee conducting operations at a temporary job site
23 must maintain the following documents and records at the
24 temporary job site until the well logging operation is completed:

25 A. the operating and emergency procedures required
26 under part 4731.7210;

27 B. evidence of the latest calibration of the

1 radiation survey instruments in use at the site as required
2 under part 4731.7060;

3 C. the latest survey records required under part
4 4731.7230, subpart 2, items A, B, and D;

5 D. the shipping papers for the transportation of
6 radioactive materials required under part 4731.0402; and

7 E. when operating under reciprocity according to part
8 4731.0355, a copy of the NRC or agreement state license
9 authorizing the use of licensed materials.

10 4731.7280 NOTIFICATION OF INCIDENTS AND LOST SOURCES;
11 ABANDONMENT PROCEDURES.

12 Subpart 1. Notification; ruptured source. A licensee must
13 immediately notify the commissioner by telephone and
14 subsequently, within 30 days, by confirmatory letter if the
15 licensee knows or has reason to believe that a sealed source has
16 been ruptured. The letter must:

17 A. designate the well or other location;

18 B. describe the magnitude and extent of the escape of
19 licensed materials;

20 C. assess the consequences of the rupture; and

21 D. explain efforts planned or being taken to mitigate
22 these consequences.

23 Subp. 2. Notification; other incidents. A licensee must
24 notify the commissioner of the theft or loss of radioactive
25 materials, radiation overexposures, excessive levels and
26 concentrations of radiation, and certain other accidents as
27 required under parts 4731.2600 to 4731.2620 and 4731.3110.

1 Subp. 3. Abandonment and sealing procedures. If a sealed
2 source becomes lodged in a well, and when it becomes apparent
3 that efforts to recover the sealed source will not be
4 successful, the licensee must:

5 A. notify the commissioner by telephone of the
6 circumstances that resulted in the inability to retrieve the
7 source;

8 B. obtain commissioner approval to implement
9 abandonment procedures;

10 C. obtain a variance from the sealing requirements of
11 chapter 4725 or 4727 and comply with the conditions of the
12 variance;

13 D. if applicable, inform the commissioner that the
14 licensee implemented abandonment before receiving commissioner
15 approval because the licensee believed there was an immediate
16 threat to public health and safety;

17 E. advise the well owner or operator, as appropriate,
18 of the abandonment procedures under part 4731.7030, subpart 1 or
19 2; and

20 F. ensure that abandonment procedures are implemented
21 within 30 days after the sealed source has been classified as
22 irretrievable or request of the commissioner an extension of
23 time if unable to complete the abandonment procedures.

24 Subp. 4. Report of irretrievable source. A licensee must,
25 within 30 days after a sealed source has been classified as
26 irretrievable, make a report in writing to the commissioner.
27 The licensee must send a copy of the report to each appropriate

1 state or federal agency that issued permits or otherwise
2 approved of the drilling operation. The report must contain:

3 A. the date of occurrence;

4 B. a description of the irretrievable well logging
5 source involved, including the radionuclide and its quantity,
6 chemical, and physical form;

7 C. surface location and identification of the well;

8 D. results of efforts to immobilize and seal the
9 source in place;

10 E. a brief description of the attempted recovery
11 effort;

12 F. depth of the source;

13 G. depth of the top of the cement plug;

14 H. depth of the well;

15 I. the immediate threat to public health and safety
16 justification for implementing abandonment if prior commissioner
17 and variance approval was not obtained according to subpart 3,
18 item D;

19 J. any other information, such as a warning
20 statement, contained on the permanent identification plaque; and

21 K. the identity of state and federal agencies
22 receiving a copy of this report.

23 **REPEALER.** Minnesota Rules, parts 4730.0100, subparts 5a, 7b,
24 22, 22a, 24, 50, 52a, 58, 63, 73a, 106b, 106c, 115, 116, 119a,
25 121a, 129, 151, 152, 155, 169a, 181a, 187a, 188, 201a, 206, and
26 213a; 4730.1000; 4730.2580; 4730.2600, 4730.2710; 4730.2750;
27 4730.2800; 4730.3400; 4730.3500; and 4730.3610, are repealed.