10/22/07 [REVISOR] SGS/CA AR3618 1 Department of Health 2 Adopted Permanent Rules Relating to Radiation Safety 3 4731.0100 DEFINITIONS. 4 [For text of subps 1 to 21, see M.R.] 5 Subp. 22. Authorized medical physicist. "Authorized medical physicist" means an individual who: 6 meets the requirements in parts 4731.4412 and 7 Α. 8 4731.4415; or 9 в. is identified as an authorized medical physicist 10 or teletherapy physicist on: 11 [For text of subitems (1) to (3), see M.R.] 12 (4) a permit issued by an NRC master material 13 licensee license broad scope medical use permittee. 14 Subp. 23. Authorized nuclear pharmacist. "Authorized 15 nuclear pharmacist" means a pharmacist who: 16 meets the requirements in parts 4731.4413 and Α. 17 4731.4415; [For text of items B to D, see M.R.] 18 19 Subp. 24. Authorized user. "Authorized user" means a 20 licensed practitioner of the healing arts who: 21 Α. meets the requirements in part 4731.4415 and in 22 parts 4731.4433, 4731.4436, 4731.4443 to 4731.4445, 4731.4458, 23 4731.4461, or 4731.4479; or 24 is identified as an authorized user on: в. 25 (1) an NRC or agreement state license that 26 authorizes the medical use of radioactive material; 27 (2) a permit issued by an NRC master material

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10/22/07 [REVISOR] SGS/CA AR3618 1 licensee that is authorized to permit the medical use of 2 radioactive material; 3 (3) a permit issued by an NRC or agreement state specific licensee of broad scope that is authorized to permit 4 the medical use of radioactive material; or 5 6 (4) a permit issued by an NRC master material license broad scope permittee that is authorized to permit the 7 8 medical use of radioactive material. 9 [For text of subps 25 to 33, see M.R.] 10 Subp. 33a. Certificate holder. "Certificate holder" means 11 a person who has been issued a certificate of compliance or 12 other package approval by the NRC. 13 Subp. 33b. Certificate of compliance. "Certificate of 14 compliance" means the certificate issued by the NRC under Code 15 of Federal Regulations, title 10, part 71, subpart D, which 16 approves the design of a package for transportation of 17 radioactive material. 18 [For text of subps 34 to 43, see M.R.] 19 Subp. 43a. Consignment. "Consignment" means each shipment of a package or groups of packages or load of radioactive 20 21 material offered by a shipper for transport. 22 [For text of subp 44, see M.R.] 23 Subp. 44a. Containment system. "Containment system" means 24 the assembly of components of the packaging intended to retain 25 the radioactive material during transport. 26 [For text of subps 45 to 49, see M.R.] Subp. 49a. Conveyance. "Conveyance" means: 27

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10/22/07 [REVISOR] SGS/CA AR3618 1 for transport by public highway or rail, any Α. 2 transport vehicle or large freight container; 3 в. for transport by water, any vessel or any hold, 4 compartment, or defined deck area of a vessel, including any 5 transport vehicle on board the vessel; and 6 C. for transport by air, any aircraft. 7 [For text of subp 50, see M.R.] Subp. 50a. Criticality safety index or CSI. 8 "Criticality 9 safety index" or "CSI" means the dimensionless number, rounded 10 up to the next tenth, assigned to and placed on the label of a fissile material package, to designate the degree of control of 11 12 accumulation of packages containing fissile material during 13 transportation. Determination of the criticality safety index 14 is described in parts 4731.0410 and 4731.0411 and Code of 15 Federal Regulations, title 10, section 71.59. 16 [For text of subps 51 to 59, see M.R.] Subp. 59a. Deuterium. 17 "Deuterium" means, for purposes of parts 4731.0403, subpart 4, and 4731.0410, deuterium and any 18 19 deuterium compounds, including heavy water, in which the ratio 20 of deuterium atoms to hydrogen atoms exceeds 1:5000. 21 [For text of subps 60 to 83, see M.R.] Subp. 84. Fissile material. "Fissile material" means the 22 radionuclides plutonium-239, plutonium-241, uranium-233, 23 24 uranium-235, or any combination of these radionuclides. Fissile 25 material means the fissile nuclides themselves, not material 26 containing fissile nuclides. Unirradiated natural uranium and depleted uranium and natural uranium or depleted uranium, that 27

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1 has been irradiated in thermal reactors only, are not included
2 in this definition. Certain exclusions from fissile material
3 controls are provided in parts 4731.0400 to 4731.0455.

4 [For text of subps 85 to 90, see M.R.]
5 Subp. 90a. Graphite. "Graphite" means graphite with a
6 boron equivalent content less than five parts per million and
7 density greater than 1.5 grams per cubic centimeter.

8 [For text of subps 91 to 128, see M.R.] Subp. 129. Low specific activity material or LSA. 9 "LOW specific activity material" or "LSA" means radioactive material 10 11 with limited specific activity which is nonfissile or is 12 excepted under part 4731.0403, subpart 3, and that satisfies the 13 descriptions and limits in subpart 130, 131, or 132. Shielding materials surrounding the LSA material may not be considered in 14 15 determining the estimated average specific activity of the 16 package contents. LSA material must be in group I, group II, or 17 group III.

18 Subp. 130. Low specific activity material group I. "Low 19 specific activity material group I" means:

A. uranium and thorium ores, concentrates of uranium and thorium ores, and other ores containing naturally occurring radioactive radionuclides which are not intended to be processed for the use of these radionuclides;

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

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C. radioactive material for which the A₂ value is

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1 unlimited; or

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

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

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

10 B. other material in which the activity is 11 distributed throughout and the average specific activity does 12 not exceed 10^{-4} A₂/g for solids and gases or 10^{-5} A₂/g for 13 liquids.

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

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

B. the radioactive material is relatively insoluble or it is intrinsically contained in a relatively insoluble material, so that even under loss of packaging, the loss of radioactive material per package by leaching, when placed in water for seven days, would not exceed 0.1 A₂; and

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10/22/07 [REVISOR] SGS/CA AR3618 1 C. the estimated average specific activity of the 2 solid does not exceed 2 x 10^{-3} A₂/g.

3 [For text of subps 133 to 158, see M.R.]
4 Subp. 159. Package. "Package" means the packaging
5 together with its radioactive contents as presented for
6 transport.

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

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

15 С. "Type B package" means a Type B packaging together 16 with its radioactive contents. On approval, a Type B package 17 design is designated by the NRC as B(U) unless the package has a maximum normal operating pressure of more than 100 lb/in² (700 18 19 kPascal) gauge or a pressure relief device that would allow the 20 release of radioactive material to the environment under the 21 tests specified in Code of Federal Regulations, title 10, 22 section 71.73, for hypothetical accident conditions, in which 23 case it will receive a designation B(M). B(U) refers to the 24 need for unilateral approval of international shipments. B(M) refers to the need for multilateral approval of international 25 26 shipments. There is no distinction made in how packages with 27 these designations may be used in domestic transportation. To

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10/22/07 [REVISOR] SGS/CA AR3618 1 determine their distinction for international transportation, 2 see DOT regulations in Code of Federal Regulations, title 49, 3 part 173. A Type B package approved before September 6, 1983, 4 was designated only as Type B. Limitations on its use are 5 specified in Code of Federal Regulations, title 10, section 6 71.19.

7 [For text of subps 160 to 173, see M.R.] 8 Subp. 174. Preceptor. "Preceptor" means an individual who 9 provides, directs, or verifies the training and experience 10 required for an individual to become an authorized user, an 11 authorized medical physicist, an authorized nuclear pharmacist, 12 or a radiation safety officer.

13 [For text of subps 175 to 192, see M.R.]
14 Subp. 193. Radiation safety officer or RSO. "Radiation
15 safety officer" or "RSO" is an individual who:

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

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

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

(2) a medical use permit issued by an NRC master26 material licensee.

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[For text of subps 194 to 223, see M.R.]

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1	Subp. 224. Special form radioactive material. "Special
2	form radioactive material" means radioactive material that
3	satisfies the following conditions:
4	[For text of item A, see M.R.]
5	B. the piece or capsule has at least one dimension
6	not less than 0.2 inches (5 mm); and
7	[For text of item C, see M.R.]
8	[For text of subps 225 to 234, see M.R.]
9	Subp. 235. Surface contaminated object or SCO. "Surface
10	contaminated object" or "SCO" means a solid object that is not
11	itself classed as radioactive material, but that has radioactive
12	material distributed on any of its surfaces. SCO must be in one
13	of two groups, with surface activity not exceeding the following
14	<pre>\limits: \limits: </pre>
15	A. SCO-I is a solid object on which:
16	[For text of subitems (1) and (2), see M.R.]
17	(3) the nonfixed contamination plus the fixed
18	contamination on the inaccessible surface averaged over 300 ${ m cm}^2$,
19	or the area of the surface if less than 300 cm ² , does not exceed:
20	(a) 1.0 μ Ci/cm ² (4 x 10 ⁴ Bq/cm ²) for beta
21	and gamma and low toxicity alpha emitters; or
22	(b) 0.1 μ Ci/cm ² (4 x 10 ³ Bq/cm ²) for all
23	other alpha emitters; and
24	[For text of item B, see M.R.]
25	[For text of subps 236 to 245, see M.R.]
26	Subp. 246. Transport index. "Transport index" means the
27	dimensionless number, rounded up to the next tenth, placed on

10/22/07 [REVISOR] SGS/CA AR3618 1 the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport 2 index is the number determined by multiplying the maximum 3 radiation level in millisievert (mSv) per hour at 3.3 feet (one 4 meter) from the external surface of the package by 100 5 (equivalent to the maximum radiation level in millirem per hour 6 at 3.3 feet (one meter)). 7 [For text of subps 247 to 253, see M.R.] 8 9 Subp. 253a. Unirradiated uranium. "Unirradiated uranium"

10 means uranium containing not more than 2×10^3 Bq of plutonium 11 per gram of uranium-235, not more than 9×10^6 Bq of fission 12 products per gram of uranium-235, and not more than 5×10^{-3} 13 gram of uranium-236 per gram of uranium-235.

14 [For text of subps 254 to 269, see M.R.]

15 4731.0200 GENERAL APPLICATIONS.

16

[For text of subps 1 to 3, see M.R.]

Subp. 4. Submissions. Except as otherwise specified in
this chapter, all communications and reports under this chapter
must be addressed to or delivered in person to: <u>Radioactive</u>
<u>Materials Unit</u>, Minnesota Department of Health, Radiation
Control₇ 625 Robert Street N, P.O. Box 64975, St. Paul, MN
55164-0975.

23 4731.0280 DELIBERATE MISCONDUCT.

Subpart 1. Applicability. This part applies to:
A. a licensee, registrant, industrial radiography
certificate holder, or quality assurance program approval

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10/22/07 1 holder;

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

5 C. a contractor, including a supplier or consultant, 6 or subcontractor to any person identified in this subpart; or

D. an employee of any person identified in this8 subpart.

9 Subp. 2. Prohibition. A person identified in subpart 1 10 who knowingly provides to any entity listed in subpart 1, any 11 components, equipment, materials, or other goods or services 12 that relate to a licensee's, industrial radiography certificate 13 holder's, quality assurance program approval holder's, 14 registrant's, or applicant's activities in this chapter may not:

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

20 Β. deliberately submit to the commissioner, a 21 licensee, a registrant, an industrial radiography certificate 22 holder, a quality assurance program approval holder, an 23 applicant for a license, certificate, or quality assurance 24 program approval, or a licensee's, registrant's, or applicant's 25 contractor or subcontractor, any information that the person submitting the information knows to be incomplete or inaccurate 26 27 in some respect material to the commissioner.

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[REVISOR] SGS/CA AR3618 10/22/07 1 Subp. 3. Enforcement. A person who violates this part may be subject to enforcement action under part 4731.0260. 2 3 Subp. 4. Definition. For purposes of this part, 4 deliberate misconduct by a person means an intentional act or omission that the person knows: 5 6 would cause a licensee, registrant, or applicant Α. to be in violation of a rule, an order, or a term, condition, or 7 limitation of a license issued by the commissioner; or 8 9 B. constitutes a violation of a requirement, 10 procedure, instruction, contract, purchase order, or policy of a 11 licensee, registrant, applicant, contractor, or subcontractor. 12 4731.0355 RECIPROCITY. 13 Subpart 1. Application; recognition. 14 Α. Applications for reciprocal recognition of 15 licenses issued by the NRC or other agreement states may be made 16 by completing a report of proposed activity reciprocity form 17 prescribed by the commissioner. The form may be obtained by 18 contacting the Radioactive Materials Unit, Minnesota Department 19 of Health, Radiation-Control, 625 Robert Street N, P.O. Box 20 64975, St. Paul, MN 55164-0975. 21 [For text of item B, see M.R.] 22 [For text of subps 2 to 4, see M.R.] 4731.0400 SCOPE; ENFORCEMENT NOTICE. 23 24 Subpart 1. Scope. Parts 4731.0400 to 4731.0455 establish 25 requirements for the packaging, preparation for shipment, and 26 transportation of licensed material.

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1 Application of other law. The packaging and Subp. 2. 2 transport of licensed material are subject to this chapter; Code 3 of Federal Regulations, title 10, parts 21, 70, and 73; and the regulations of other agencies, such as the NRC, DOT, and United 4 5 States Postal Service, having jurisdiction over means of transport. The requirements of parts 4731.0400 to 4731.0455 are 6 7 in addition to, and not in substitution for, other requirements. 8 Subp. 3. Applicability.

9 Parts 4731.0400 to 4731.0455 apply to any licensee Α. 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 4731.0455 16 do not authorize possession of licensed material.

B. Parts 4731.0400 to 4731.0455 apply to any person
required to obtain a certificate of compliance if the person
delivers radioactive material to a common or contract carrier
for transport or transports the material outside the confines of
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 certificate holder; quality assurance program approval holder; 25 applicant for a license, radiographer certificate, or quality 26 assurance program approval; or contractor or subcontractor of 27 any of them components, equipment, materials, or other goods or

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1 services, that relate to a licensee's, certificate holder's, 2 quality assurance program approval holder's, or applicant's 3 activities subject to parts 4731.0400 to 4731.0455, that they 4 may be individually subject to the commissioner's enforcement 5 action for violation of part 4731.0280.

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6 4731.0401 REQUIREMENT FOR LICENSE.

7 No licensee shall deliver licensed material to a carrier 8 for transport or transport licensed material, except as 9 authorized in a general license or a specific license issued by 10 the commissioner or as exempted under parts 4731.0400 to 11 4731.0455.

12 4731.0402 TRANSPORTATION OF LICENSED MATERIAL.

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Subpart 1. DOT regulations.

14 A licensee who transports licensed material Α. outside of the site of usage, as specified in a license issued 15 16 by the NRC or an agreement state, or where transport is on 17 public highways or a licensee who delivers licensed material to 18 a carrier for transport must comply with the applicable DOT 19 regulations in Code of Federal Regulations, title 49, parts 107, 171 to 180, and 390 to 397, appropriate to the mode of transport. 20 21 A licensee must particularly note DOT regulations в. 22 in the following areas: 23 (1) packaging, Code of Federal Regulations, title

24 49, part 173, subparts A, B, and I;

25 (2) marking and labeling, Code of Federal
26 Regulations, title 49, part 172, subparts D and E, sections

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1	172.400 to 172.407 and 172.436 to 172.441;
2	[For text of subitems (3) to (5), see M.R.]
3	(6) hazardous material employee training, Code of
4	Federal Regulations, title 49, part 172, subpart H;
5	(7) security plans, Code of Federal Regulations,
6	title 49, part 172, subpart I; and
7	(8) hazardous material shipper and carrier
8	registration, Code of Federal Regulations, title 49, part 107,
9	subpart G.
10	[For text of item C, see M.R.]
11	[For text of subp 2, see M.R.]
10	
12	4/31.0403 SPECIFIC EXEMPTIONS.
13	Subpart 1. Physicians. A physician licensed by a state to
14	dispense drugs in the practice of medicine is exempt from part
15	4731.0402 with respect to transport by the physician of licensed
16	material for use in the practice of medicine. A physician
17	operating under this exemption must be licensed under parts
18	4731.4400 to 4731.4527 or equivalent regulations of the NRC or
19	an agreement state.
20	Subp. la. Grounds. On application of any interested
21	person or on the commissioner's own initiative, the commissioner
22	may grant any exemption from parts 4731.0400 to 4731.0455 that
23	the commissioner determines is authorized by law and will not
24	endanger life or property nor the common defense and security.
25	Subp. 2. Low-level materials. A licensee is exempt from
26	the requirements of parts 4731.0400 to 4731.0455 with respect to
27	shipment or carriage of a package of the following low-level

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10/22/07 1 material:

A. natural material and ores containing naturally occurring radionuclides that are not intended to be processed for use of these radionuclides, provided the activity concentration of the material does not exceed ten times the values specified in part 4731.0422, subpart 3; and

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

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

A. an individual package containing two grams or less20 of fissile material;

B. individual or bulk packaging containing 15 grams or less of fissile material, provided the package has at least 23 200 grams of solid nonfissile material for every gram of fissile 24 material. Lead, beryllium, graphite, and hydrogenous material 25 enriched in deuterium may be present in the package but must not 26 be included in determining the required mass for solid 27 nonfissile material;

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

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

9 (2) there is no more than 180 grams of fissile 10 material distributed within 360 kilograms of contiguous 11 nonfissile material. Lead, beryllium, graphite, and hydrogenous 12 material enriched in deuterium may be present in the package but 13 may not be included in determining the required mass of solid 14 nonfissile material;

D. uranium enriched in uranium-235 to a maximum of one percent by weight, and with total plutonium and uranium-233 content of up to one percent of the mass of uranium-235, provided that the mass of any beryllium, graphite, and hydrogenous material enriched in deuterium constitutes less than five percent of the uranium mass;

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

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F. packages containing, individually, a total

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10/22/07 [REVISOR] SGS/CA AR3618 1 plutonium mass of not more than 1,000 grams, of which not more 2 than 20 percent by mass may consist of plutonium-239, 3 plutonium-241, or any combination of these radionuclides. 4731.0406 GENERAL LICENSE; NRC-APPROVED PACKAGE. 4 5 [For text of subpart 1, see M.R.] 6 Subp. 2. Approved quality assurance program. The general 7 license issued under subpart 1 applies only to a licensee who has a quality assurance program approved by the NRC as complying 8 9 with Code of Federal Regulations, title 10, part 71, subpart H. 10 Subp. 3. Compliance with conditions. 11 Α. The general license issued under subpart 1 applies 12 only to a licensee who: 13 [For text of subitem (1), see M.R.] 14 (2) complies with the terms and conditions of the 15 license, certificate, or other approval, as applicable, and the 16 applicable requirements of this chapter and Code of Federal 17 Regulations, title 10, part 71, subpart H; and 18 [For text of subitem (3), see M.R.] 19 [For text of item B, see M.R.] 20 For a Type B or fissile material package, the C. 21 design of which was approved by the NRC before April 1, 1996, 22 the general license under subpart 1 is subject to the additional 23 restrictions of Code of Federal Regulations, title 10, section 24 71.19. 25 4731.0408 GENERAL LICENSE; DOT SPECIFICATION CONTAINER. 26 [For text of subpart 1, see M.R.]

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

[For text of subp 3, see M.R.]

6 Subp. 4. Use within United States. The general license 7 issued under subpart 1 is subject to the limitation that the 8 specification container may not be used for a shipment to a 9 location outside the United States except by multilateral 10 approval, as defined under DOT regulations, Code of Federal 11 Regulations, title 49, section 173.403.

12 Subp. 5. Expiration date. This part expires October 1,13 2008.

14 4731.0409 GENERAL LICENSE; FOREIGN-APPROVED PACKAGE.

Subp. 2. Approved quality assurance program. Except as otherwise provided in parts 4731.0400 to 4731.0455, the general license issued under subpart 1 applies only to a licensee who has a quality assurance program approved by the NRC as complying with Code of Federal Regulations, title 10, part 71, subpart H. [For text of subp 3, see M.R.]

[For text of subpart 1, see M.R.]

Subp. 4. Certificate conditions. The general license
issued under subpart 1 applies only to a licensee who:
[For text of item A, see M.R.]
B. complies with the terms and conditions of the
certificate and revalidation and with the applicable
requirements of this chapter. With respect to the quality

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1 assurance provisions of Code of Federal Regulations, title 10,
2 part 71, subpart H, the licensee is exempt from design,
3 construction, and fabrication considerations.

4 4731.0410 GENERAL LICENSE; FISSILE MATERIAL.

Subpart 1. License to transport or deliver fissile 5 material. A general license is issued to any licensee of the 6 commissioner to transport fissile material, or to deliver 7 fissile material to a carrier for transport, if the material is 8 9 shipped according to this part. The fissile material need not 10 be contained in a package that meets the standards of part 4731.0412 and Code of Federal Regulations, title 10, sections 11 12 71.41 to 71.77, if the material is shipped according to this part. However, the material must be contained in a Type A 13 14 package. The Type A package must also meet the DOT requirements 15 in Code of Federal Regulations, title 49, section 173.417(a).

16 Subp. 2. Approved quality assurance program. The general 17 license issued under subpart 1 applies only to a licensee who 18 has a quality assurance program approved by the NRC as complying 19 with Code of Federal Regulations, title 10, part 71, subpart H. 20 Subp. 3. Type A quantity limits. The general license 21 issued under subpart 1 applies only when a package's contents:

A. contain less than a Type A quantity of fissile23 material; and

B. contain less than 500 total grams of beryllium,
graphite, or hydrogenous material enriched in deuterium.
Subp. 4. Fissile material labeled with a criticality
safety index.

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1	A. The general license applies only to packages
2	containing fissile material that are labeled with a criticality
3	safety index that:
4	(1) has been determined according to subpart 7;
5	and
-	(2) has a value less than or equal to ten.
7	B. For a shipment of multiple packages containing
, ,	figgile material the sum of the criticality appets indices much
0	he less the second by 50 for the criticality safety indices must
9	be less than or equal to 50 for shipment on a nonexclusive use
10	conveyance and less than or equal to 100 for shipment on an
11	exclusive use conveyance.
12	Subp. 5. [See repealer.]
13	Subp. 6. [See repealer.]
14	Subp. 7. Criticality safety index values.
15	A. The value for the criticality safety index must be
16	greater than or equal to the number calculated by the following
17	equation:
18 19 20 21 22 23 24	$CSI=10\left[\frac{grams of ^{235}U}{X} + \frac{grams of ^{233}U}{Y} + \frac{grams of Pu}{Z}\right]$ B. The calculated criticality safety index must be
25	rounded up to the first decimal place.
26	C. The values of X, Y, and Z used in the criticality
27	safety index equation must be taken from subpart 8 or 9, as
28	appropriate.
29	D. If subpart 9 is used to obtain the value of X,
30	then the values for the terms in the equation for uranium-233

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1	and plutonium must be assumed to be zero.
2	E. The values in subpart 8 for X, Y, and Z must be
3	used to determine the criticality safety index if:
4	(1) uranium-233 is present in the package;
5	(2) the mass of plutonium exceeds one percent of
6	the mass of uranium-235;
7	(3) the uranium is of unknown uranium-235
8	enrichment or greater than 24 weight percent enrichment; or
9	(4) substances having a moderating effectiveness,
10	that is, an average hydrogen density greater than H_2^0 , for
11	example certain hydrocarbon oils or plastics, are present in any
12	form, except as polyethylene used for packing or wrapping.
13	Subp. 8. Mass limits for general license packages
14	containing mixed quantities of fissile material of uranium-235
15	of unknown enrichment.
16	THE FOLLOWING IS AN ALL NEW TABLE:
17 18 19 20 21 22 23	Fissile materialFissile materialmass mixed withmass mixed withmoderating substancesmoderating substanceshaving an averagehaving an averagehydrogen densityhydrogen densityless than or equalgreater thanto H_2O (grams) H_2O (grams)
24 25	235 ₂₃₃ U (X) 60
26 27 28	239 ^U (Y) 241 Pu or Pu (Z) 37 24
29	^a When mixtures of moderating substances are present, the
30	lower mass limits shall be used if more than 15 percent of the
31	moderating substance has an average hydrogen density greater
32	than H ₂ O.
33	Subp. 9. Mass limits for general license packages

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1 containing uranium-235 of known enrichment.

2	Uranium	enrichment	in weight	Fissile r	naterial	mass c	f
3	nercent	of ²³⁵ _{II} not	exceeding	235_{11} (X)	(grame)		
5	percent		exceeding	U (A)	(grams)		
6		24		60			
7		20		63	, see		
8		$\overline{15}$		67			
9		ii		72			
10		īō		76			
11		9.5		78			
12		9		81			
13		8.5		82			
14		8		85			
15		7.5		88			
16		7		90			
17		6.5		93			
18		6		97			
19		5.5		102	2		
20		5		108	5		
21		4.5		114	1		
22		4		12(
23		3.5		13/			
24		3 9 E		10L 10/			
20		2.J 2		10U			
20		4		240	2		
28		1 35		400	,		
20		1			20		
30		0.92		· · · · · · · · · · · · · · · · · · ·	300		
20		· · · · · · · · · · · · · · · · · · ·			~~~		

31 4731.0411 GENERAL LICENSE; PLUTONIUM-BERYLLIUM SPECIAL FORM 32 MATERIAL.

33 Subpart 1. Transport of plutonium-beryllium. A general license is issued to any licensee of the commissioner to 34 transport fissile material in the form of plutonium-beryllium 35 36 (Pu-Be) special form sealed sources, or to deliver Pu-Be sealed sources to a carrier for transport, if the material is shipped 37 according to this part. The material need not be contained in a 38 package that meets the requirements of part 4731.0412 and Code 39 of Federal Regulations, title 10, sections 71.41 to 71.77; 40 41 however, the material must be contained in a Type A package.

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[REVISOR] SGS/CA AR3618 10/22/07 The Type A package must also meet the DOT requirements of Code 1 of Federal Regulations, title 49, section 173.417(a). 2 Subp. 2. Approved quality assurance program. The general 3 license issued under subpart 1 applies only to a licensee who 4 has a quality assurance program approved by the NRC as complying 5 with part 4731.0412 and Code of Federal Regulations, title 10, 6 part 71, subpart H. 7 Subp. 3. Package contents. The general license issued 8 under subpart 1 applies only when a package's contents: 9 contain no more than a Type A quantity of 10 Α. 11 radioactive material; and 12 contain less than 1,000 grams of plutonium, в. provided that plutonium-239, plutonium-241, or any combination 13 14 of these radionuclides, constitutes less than 240 grams of total quantity of plutonium in the package. 15 Subp. 4. Packages labeled with criticality safety index. 16 The general license issued under subpart 1 applies only to 17 packages labeled with a criticality safety index that: 18 19 Α. has been determined according to subpart 5; 20 has a value less than or equal to 100; and в. for a shipment of multiple packages containing 21 С. 22 Pu-Be sealed sources, the sum of the criticality safety indices must be less than or equal to 50 (for shipment on a nonexclusive 23 use conveyance) and less than or equal to 100 (for shipment on 24 25 an exclusive use conveyance). 26 Subp. 5. Criticality safety index. 27 Α. The value for the criticality safety index must be

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10/22/07 [REVISOR] SGS/CA AR3618 1 greater than or equal to the number calculated by the following 2 equation:

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

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

9 4731.0415 ROUTINE DETERMINATIONS.

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Before each shipment of licensed material, a licensee must lensure that the package with its contents satisfies the applicable requirements of the license and parts 4731.0400 to 13 4731.0455. The licensee must determine that:

[For text of items A to K, see M.R.]

15 4731.0416 AIR TRANSPORT OF PLUTONIUM.

Subpart 1. Limitations for plutonium transport. 16 Notwithstanding the provisions of any general license and 17 notwithstanding any exemptions stated directly in parts 18 4731.0400 to 4731.0455 or included indirectly by citation to 19 20 Code of Federal Regulations, title 49, chapter I, as may be applicable, a licensee must ensure that plutonium in any form, 21 whether for import, export, or domestic shipment, is not 22 23 transported by air, or delivered to a carrier for air transport, 24 unless:

B. the plutonium is contained in a material in which
the specific activity is less than or equal to the activity
concentration values for plutonium specified in part 4731.0422,

[For text of item A, see M.R.]

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[REVISOR] SGS/CA AR3618 10/22/07 1 subpart 3, and in which the radioactivity is essentially uniformly distributed; 2 [For text of items C and D, see M.R.] 3 [For text of subp 2, see M.R.] 4 4731.0419 ADVANCE NOTIFICATION OF SHIPMENT OF IRRADIATED REACTOR 5 FUEL AND NUCLEAR WASTE. 6 [For text of subpart 1, see M.R.] 7 8 Subp. 2. Shipments requiring notice. Advance notification 9 is required under this part for shipments of irradiated reactor 10 fuel in quantities less than that subject to the advance notification requirements of Code of Federal Regulations, title 11 10, section 73.37, paragraph (f). Advance notification is also 12 required under this part for shipments of licensed material, 13 14 other than irradiated fuel, meeting the following three conditions: 15 16 Α. the licensed material is required by parts 4731.0400 to 4731.0455 to be in Type B packaging for 17 18 transportation; 19 [For text of item B, see M.R.] 20 the quantity of licensed material in a single C. package exceeds the least of the following: 21 22 [For text of subitems (1) and (2), see M.R.] 23 (3) 27,000 Ci (1,000 TBq). 24 Subp. 3. Procedures for submitting notification. The notification required under this part must: 25 Α. [For text of subitems (1) and (2), see M.R.] 26 (3) if delivered by any other means than mail, 27

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[REVISOR] SGS/CA AR3618 10/22/07 1 reach the office of the commissioner and the governor or governor's designee at least four days before the beginning of 2 the seven-day period during which departure of the shipment is 3 estimated to occur. 4 [For text of item B, see M.R.] 5 C. The licensee must retain a copy of the 6 notification as a record for three years. 7 Subp. 4. Information to be furnished in advance 8 9 notification of shipment. An advance notification of shipment of irradiated reactor fuel or nuclear waste must contain the 10 11 following information: 12 [For text of items A to F, see M.R.] Subp. 5. Revision notice. A licensee who finds that 13 14 schedule information, previously furnished under this part to 15 the commissioner and a governor or governor's designee, will not 16 be met must telephone a responsible individual in the commissioner's office and the governor or governor's designee 17 18 and inform the individual of the extent of the delay beyond the 19 schedule originally reported. 20 Record retained. The licensee must maintain a Subp. 5a. record of the name of the individual contacted for three years. 21 22 Subp. 6. Cancellation notice. A licensee who cancels an irradiated reactor fuel 23 Α. or nuclear waste shipment for which advance notification has 24 been sent must send a cancellation notice to the commissioner, 25 the governor of each state or the governor's designee previously 26 27 notified, and the director of the Division of Nuclear Security,

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10/22/07 [REVISOR] SGS/CA AR3618 Office of Nuclear Security and Incident Response, NRC. 1 2 в. The licensee must state in the notice that it is a cancellation and identify the advance notification that is being 3 4 canceled. The licensee must retain a copy of the notice as a 5 C. record for three years. 6 4731.0421 QUALITY ASSURANCE ORGANIZATION. 7 [For text of subps 1 to 7, see M.R.] 8 9 Subp. 8. Access to management. Irrespective of the 10 organizational structure, the individuals assigned the 11 responsibility for ensuring effective execution of any portion 12 of the quality assurance program, at any location where 13 activities subject to parts 4731.0400 to 4731.0455 are being 14 performed, must have direct access to the levels of management 15 necessary to perform this function. 16 4731.0422 A1 AND A2 VALUES FOR RADIONUCLIDES. 17 Subpart 1. [See repealer.] 18 Subp. la. A1 and A2 values. THE FOLLOWING IS AN ALL NEW TABLE: 19 20 Element and 21 atomic number 22 and symbol of 23 radionuclide A_l (Ci)^b A_2 (TBq) A_2 (Ci)^b 24 A_1 (TBq) 25 26 Actinium (89) 2.2×10^{1} 2.4 × 10^{1} 1.6 × 10^{1} 8.0×10^{-1} $6.0 \times 10^{-3}_{-5}$ $1.6 \times 10^{-1}_{-3}$ Ac-225^a Ac-227^a 27 2.4×10^{-1} 9.0×10^{-1} 6.0×10^{-1} 9.0×10^{-5} 5.0 x 10^{-1} 28 29 Ac-228 1.4×10^{-1} 30 Silver (47) 31 5.4 x 10^{1}_{1} 5.4 x 10^{1}_{1} 32 Ag-105 2.0 2.0 $\overline{7.0} \times 10^{-1}$ Ag-108m^a 7.0×10^{-1} 1.9×10^{-1} $1.9 \times 10^{\circ}$ 33

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1 2 3	Ag-110m ^a Ag-111	4.0 x 2.0	10 ⁻¹	1.1 5.4	X X	101 101	4.0 6.0	X X	$10^{-1}_{10^{-1}}$	1.1 1.6	$\begin{array}{c} x \ 10 \\ x \ 10 \\ \end{array}$
3 4 5 6	Aluminum (13) Al-26	1.0 x	10 ⁻¹	2.7			1.0	x	10 ⁻¹	2.7	
7 8 9 10	Americium (95) Am-241 Am-242m ^a Am-243	1.0 x 1.0 x 5.0	10 ¹ 10 ¹	2.7 2.7 1.4	x x x	$ \begin{array}{r} 102 \\ 102 \\ 102 \\ 10 \end{array} $	1.0 1.0 1.0	x x x	$10^{-3}_{10^{-3}}_{10^{-3}}_{10^{-3}}$	2.7 2.7 2.7	
12 13 14 15	Argon (18) Ar-37 Ar-39 Ar-41	4.0 x 4.0 x 3.0 x	101 101 10-1	1.1 1.1 8.1	x x	$10^{3}_{10^{3}}$	4.0 2.0 3.0	x x x	101 101 10-1	1.1 5.4 8.1	x 10 ³ x 10 ²
17 18 19 20 21 22	Arsenic (33) As-72 As-73 As-74 As-76 As-77	3.0 x 4.0 x 1.0 3.0 x 2.0 x	101 ⁻¹ 10 ⁻¹ 101 ⁻¹	8.1 1.1 2.7 8.1 5.4	x x x	10 ³ 10 ¹ 10 ²	3.0 4.0 9.0 3.0 7.0	x x x x x x x	$101 \\ 101 \\ 10-1 \\ 10-1 \\ 10-1 \\ 10-1 \\ 10$	8.1 1.1 2.4 8.1 1.9	x 101 x 10 x 1
23 24 25 26	Astatine (85) At-211	2.0 x	: 10 ¹	5.4	x	10 ²	5.0	x	10 ⁻¹	1.4	x 10 ¹
27 28 29 30 31 32	Gold (79) Au-193 Au-194 Au-195 Au-198 Au-199	7.0 1.0 1.0 x 1.0 1.0 x	: 10 ¹ : 10 ¹	1.9 2.7 2.7 2.7 2.7	x x x x x x	101 102 101 102 101 102	2.0 1.0 6.0 6.0 6.0	X	10-1 10-1	5.4 2.7 1.6 1.6 1.6	$ \begin{array}{c} x & 10 \\ \end{array} $
34 35 36 37 38 39	Barium _a (56) Ba-131 Ba-133 Ba-133m Ba-140	2.0 3.0 2.0 x 5.0 x	: 10 ¹ : 10 ⁻¹	5.4 8.1 5.4 1.4	X X X X X	101 102 101 10	2.0 3.0 6.0 3.0	x x	10-1 10-1	5.4 8.1 1.6 8.1	x 101 x 101 x 101 x 10
40 41 42 43	Beryllium (4) Be-7 Be-10	2.0 x 4.0 x	: 101 101	5.4 1.1	x x	10 ² 10 ³	2.0 6.0	x x	10 ¹ 10 ⁻¹	5.4 1.6	x 10 ² x 10 ¹
44 45 46 47 48 49 50	Bismuth (83) Bi-205 Bi-206 Bi-207 Bi-210 Bi-210 Bi-212 ^a	7.0 x 3.0 x 7.0 x 1.0 6.0 x 7.0 x	$ \begin{array}{c} 10^{-1} \\ 10^{-1} $	1.9 8.1 1.9 2.7 1.6 1.9	x x x x x x	10 ¹ 101 101 101 101	7.0 3.0 7.0 6.0 2.0 6.0	x x x x x x x x x	10-1 10-1 10-1 10-2 10-1 10	1.9 8.1 1.9 1.6 5.4 1.6	
51 52 53 54	Berkelium (97) Bk-247 Bk-249 ^a	8.0 4.0 x	: 10 ¹	2.2 1.1	x x	$10\frac{2}{10}$	8.0 3.0	x x	$10^{-4}_{10^{-1}}$	2.2 8.1	x 10 ⁻²

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1 2 3 4 5 6	Bromine (35) Br-76 Br-77 Br-82	$\begin{array}{c} 4.0 \times 10^{-1} \\ 3.0 \\ 4.0 \times 10^{-1} \end{array}$	$1.1 \times 10^{1}_{1} 48.1 \times 10^{1}_{1} 31.1 \times 10^{1}_{1} 4$	0×10^{-1} 0×10^{-1} 0×10^{-1}	$1.1 \times 101 \\ 8.1 \times 101 \\ 1.1 \times 10$
0 7 8 9	Carbon (6) C-11 C-14	$1.0 \\ 4.0 \times 10^{1}$	$\begin{array}{c} 2.7 \times 10^{1} \\ 1.1 \times 10^{3} \\ 3 \end{array}$.0 × 10 ⁻¹ .0	1.6×10^{1} 8.1 x 10 ¹
11 12 13 14 15	Calcium (20) Ca-41 Ca-45 _a Ca-47	Unlimited 4.0 x 10 3.0	Unlimited U 1.1 x 101 1 8.1 x 10 3	nlimited .0 .0 x 10 ⁻¹	Unlimited 2.7 x 10 8.1
16 17 18 19 20	Cadmium (48) Cd-109 Cd-113m Cd-115 Cd-115m	$3.0 \times 10^{1}_{1}$ $4.0 \times 10^{1}_{1}$ 3.0 $5.0 \times 10^{-1}_{1}$	$\begin{array}{cccc} 8.1 & \times & 10 & 2 & 2 \\ 1.1 & \times & 10 & 5 \\ 8.1 & \times & 10 & 4 \\ 1.4 & \times & 10 & 5 \end{array}$	$\begin{array}{c} .0 \\ .0 \\ .0 \\ .0 \\ .0 \\ .0 \\ .0 \\ .0 $	5.4 x 101 1.4 x 101 1.1 x 101 1.4 x 10
21 22 23 24 25 26	Cerium (58) Ce-139 Ce-141 Ce-143 Ce-144	$7.0 \\ 2.0 \times 10^{-1}_{-1} \\ 9.0 \times 10^{-1}_{-1} \\ 2.0 \times 10^{-1}_{-1}$	$\begin{array}{cccc} 1.9 \times 10 & 2 & 2 \\ 5.4 \times 10 & 6 \\ 2.4 \times 10 & 6 \\ 5.4 & 2 \end{array}$	$ \begin{array}{c} .0 \\ .0 \\ .0 \\ .0 \\ .0 \\ .0 \\ .0 \\ .0 $	5.4 x 10^{1} 1.6 x 10^{1} 1.6 x 10^{1} 5.4
27 28 29 30 31 32 33 34 35	Californium (9 Cf-248 Cf-249 Cf-250 Cf-251 Cf-252h Cf-253a Cf-253 Cf-254	$\begin{array}{c} 98) \\ 4.0 \times 10^{1} \\ 3.0 \\ 2.0 \times 10^{1} \\ 7.0 \\ 5.0 \times 10^{-2} \\ 4.0 \times 10^{-3} \\ 1.0 \times 10 \end{array}$	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{c} 0 \\ x \\ 0 \\ x \\ 0 \\ x \\ 10 \\ -3 \end{array}$	1.6×10^{-1} 2.2×10^{-2} 5.4×10^{-2} 1.9×10^{-2} 8.1×10^{-2} 1.1 2.7×10^{-2}
36 37 38 39 40	Chlorine (17) C1-36 C1-38	1.0×10^{1} 2.0 × 10 ⁻¹	2.7×10^2 6 5.4 2	0×10^{-1} 0×10^{-1}	1.6 x 10 ¹ 5.4
40 41 42 43 44 45 46 47 48 49 50	Curium (96) Cm-240 Cm-241 Cm-242 Cm-243 Cm-244 Cm-245 Cm-245 Cm-246 Cm-247 Cm-248	4.0×10^{1} 2.0 4.0×10^{1} 9.0 2.0×10^{1} 9.0 9.0 3.0 2.0×10^{-2}	$\begin{array}{cccccccc} 1.1 & \times & 10 & 2 \\ 5.4 & \times & 10 & 1 \\ 1.1 & \times & 10 & 1 \\ 2.4 & \times & 10 & 2 \\ 5.4 & \times & 10 & 2 \\ 2.4 & \times & 10 & 2 \\ 2.4 & \times & 10 & 2 \\ 2.4 & \times & 10 & 2 \\ 9 \\ 2.4 & \times & 10 & 1 \\ 5.4 & \times & 10 & 1 \\ 5.4 & \times & 10 & 3 \end{array}$	$\begin{array}{c} 0 \times 10^{-2} \\ 0 & -2 \\ 0 \times 10^{-3} \\ 0 \times 10^{-3} \\ 0 \times 10^{-4} \\ 0 \times 10^{-4} \\ 0 \times 10^{-3} \\ 0 \times 10^{-4} \\ 0 \times 10^{-4} \\ 0 \times 10 \end{array}$	5.4×10^{-1} 2.7×10^{-1} 2.7×10^{-2} 2.7×10^{-2} 2.7×10^{-2} 5.4×10^{-2} 2.4×10^{-2} 2.4×10^{-2} 2.4×10^{-2} 2.7×10^{-3} 8.1×10^{-3}
52 53 54	Cobalt (27) Co-55 Co-56	5.0×10^{-1} 3.0 x 10	1.4×10^{1} 5 8.1 3	$.0 \times 10^{-1}$.0 x 10	1.4 x 10 ¹ 8.1

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1 2 3 4 5	Co-57 Co-58 Co-58m Co-60	1.0 x 1.0 4.0 x 4.0 x	10 ¹ 10 ¹ 10 ⁻¹	2.7 2.7 1.1 1.1	x x x x	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	• 0 • 0 • 0	X X	10 ¹ 10 ¹ 10 ⁻¹	2.7 2.7 1.1 1.1	X X X X	$101 \\ 103 \\ 101 \\ 101 \\ 101$
6 7 8	Chromium (24) Cr-51	3.0 x	10 ¹	8.1	x	10 ² 3	8.0	x	10 ¹	8.1	x	10 ²
9 10 11 12 13 14 15 16 17 18	Cesium (55) Cs-129 Cs-131 Cs-132 Cs-134 Cs-134m Cs-135 Cs-136 Cs-137 ^a	4.0 3.0 x 1 1.0 7.0 x 1 4.0 x 1 4.0 x 1 5.0 x 1 2.0	10 ¹ 10 ⁻¹ 101 10-1 10-1	1.1 8.1 2.7 1.9 1.1 1.1 1.4 5.4	x x x x x x x x x x	$\begin{array}{cccccccc} 102 & 4\\ 101 & 3\\ 101 & 1\\ 103 & 7\\ 103 & 6\\ 101 & 1\\ 101 & 5\\ 101 & 5\\ 101 & 6\end{array}$		X X X X	10^{1} 10^{-1} 10^{-1} 10^{-1} 10^{-1}	1.1 8.1 2.7 1.9 1.6 2.7 1.4 1.6	x x x x x x x x x x x x	102 101 101 101 101 101 101 101
19 20 21	Copper (29) Cu-64 Cu-67	6.0 1.0 x :	101	1.6 2.7	x x	10 ² 10 ² 7	.0	x	10 ⁻¹	2.7 1.9	x x	101 101
22 23 24 25 26 27	Dysprosium (60 Dy-159 Dy-165 Dy-166 Dy-166	6) 2.0 x 9.0 x 9.0 x	10 ¹ 10-1 10-1	5.4 2.4 2.4	X X X	$\begin{array}{ccc} 10^2 & 2 \\ 10^1 & 6 \\ 10^1 & 3 \end{array}$	2.0	x x x	$10^{1}_{10^{-1}}_{10^{-1}}_{10^{-1}}$	5.4 1.6 8.1	x x	10 ² 10 ¹
28 29 30 31	Erbium (68) Er-169 Er-171	4.0 x 8.0 x	10 ¹ 10 ⁻¹	1.1 2.2	x x	10 ³ 10 ¹ 5	.0	x	10 ⁻¹	2.7 1.4	x x	101 101
32 33 34 35 36	Europium (63) Eu-147 Eu-148 Eu-149 Eu-150	2.0 5.0 x 1 2.0 x 1	10 ⁻¹ 10 ¹	5.4 1.4 5.4	x x x	$\begin{array}{ccc} 10 \\ 10 \\ 10 \\ 10 \\ 2 \end{array}$	2.0 5.0 2.0	x	10 ⁻¹ 10 ¹	5.4 1.4 5.4	x x x	101 102 102
37 38 39	(short- lived) Eu-150	2.0		5.4	x	10 ¹ 7	.0	x	10 ⁻¹	1.9	x	10 ¹
40 41 42 43 44 45 46	(long- lived) Eu-152 Eu-152m Eu-154 Eu-155 Eu-156	7.0 x 1.0 8.0 x 9.0 x 2.0 x 7.0 x	10^{-1} 10^{-1} 10^{1} 10^{1} 10^{-1}	1.9 2.7 2.2 2.4 5.4 1.9	x x x x x x x x	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	· 0 · 0 · 0 · 0 · 0	x x x x	10^{-1} 10^{-1} 10^{-1} 10^{-1}	1.9 2.7 2.2 1.6 8.1 1.9	x x x x x x x x	101 101 101 101 101 101 101
47 48 49 50	Fluorine (9) F-18	1.0		2.7	x	10 ¹ 6	5.0	x	10 ⁻¹	1.6	x	10 ¹
51 52 53 54	Iron (26) Fe-52 Fe-55 Fe-59	3.0 x 4.0 x 9.0 x	10 ⁻¹ 101 10-1	8.1 1.1 2.4	x x		. 0 . 0 . 0	x x x	$10^{-1}_{10}_{10^{-1}}_{10^{-1}}$	8.1 1.1 2.4	x x	10 ³ 10 ¹

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1	Fe-60 ^a	4.0×10^{1}	1.1×10^3 2.0×10^{-1}	5.4
3 4 5 6 7	Gallium (31) Ga-67 Ga-68 Ga-72	$\begin{array}{c} 7.0 \\ 5.0 \times 10^{-1} \\ 4.0 \times 10 \end{array}$	$\begin{array}{cccccc} 1.9 & \times & 10 \\ 1.4 & \times & 10 \\ 1.1 & \times & 10 \end{array} & \begin{array}{c} 3.0 \\ 5.0 & \times & 10 \\ 4.0 & \times & 10 \end{array}$	$8.1 \times 10^{1} \\ 1.4 \times 10^{1} \\ 1.1 \times 10^{1} $
8 9 10 11 12	Gadolipium (Gd-146 Gd-148 Gd-153 Gd-159	$\begin{array}{c} 64) \\ 5.0 \times 10 \\ 2.0 \times 10 \\ 1.0 \times 10 \\ 3.0 \end{array}$	$\begin{array}{ccccccc} 1.4 & \times & 10 \\ 5.4 & \times & 10 \\ 2.7 & \times & 10 \\ 8.1 & \times & 10 \end{array} & \begin{array}{c} 5.0 & \times & 10 \\ 5.0 & \times & 10 \\ 2.0 & \times & 10 \\ 9.0 \\ 6.0 & \times & 10 \end{array} ^{-1}$	$1.4 \times 10^{-1}_{-2}$ 5.4 × 102 2.4 × 101 1.6 × 101
14 15 16 17	Germanium (3 Ge-68 Ge-71 Ge-77	2) 5.0×10^{-1} 4.0×10^{-1} 3.0×10^{-1}	$\begin{array}{cccccc} 1.4 & \times & 10 \\ 1.4 & \times & 10 \\ 1.1 & \times & 10 \\ 8.1 \end{array} & \begin{array}{c} 5.0 & \times & 10 \\ 4.0 & \times & 10 \\ 3.0 & \times & 10 \end{array}$	1.4×10^{1} 1.1×10^{3} 8.1
19 20 21 22 23	Hafnium (72) Hf-172 Hf-175 Hf-181 Hf-182	6.0 x 10 ⁻¹ 3.0 2.0 Unlimited	$\begin{array}{cccc} 1.6 \times 10 \\ 8.1 \times 10 \\ 5.4 \times 10 \\ 0nlimited \end{array} \begin{array}{c} 6.0 \times 10^{-1} \\ 3.0 \\ 5.0 \times 10^{-1} \\ 0nlimited \end{array}$	1.6×10^{1} 8.1 x 101 1.4 x 10 Unlimited
24 25 26 27 28 29 30	Mercury (80) Hg-194 Hg-195m ^a Hg-197 Hg-197m Hg-203	1.0 3.0 2.0 \times 10 1.0 \times 10 5.0	$\begin{array}{ccccccc} 2.7 & \times & 10 \\ 8.1 & \times & 10 \\ 5.4 & \times & 10 \\ 2.7 & \times & 10 \\ 1.4 & \times & 10 \end{array}$ $\begin{array}{ccccc} 1.0 & & -1 \\ 7.0 & \times & 10 \\ 1.0 & \times & 10 \\ 1.0 \end{array}$	2.7×10^{1} 1.9×10^{2} 2.7×10^{1} 1.1×10^{1} 2.7×10^{1}
31 32 33 34 35	Holmium (67) Ho-166 Ho-166m	$4.0 \times 10^{-1}_{-1}$ 6.0×10^{-1}	$1.1 \times 10^{1}_{1.6 \times 10^{-1}} \qquad 4.0 \times 10^{-1}_{-1} \\ 5.0 \times 10^{-1}_{-1}$	1.1×10^{1} 1.4×10^{1}
36 37 38 39 40 41 42 43 44 45 46 47	Iodine (53) I-123 I-124 I-125 I-126 I-129 I-131 I-132 I-133 I-134 I-135 ^a	$\begin{array}{c} 6.0\\ 1.0\\ 2.0 \times 10^{1}\\ 2.0\\ \text{Unlimited}\\ 3.0\\ 4.0 \times 10^{-1}\\ 7.0 \times 10^{-1}\\ 3.0 \times 10^{-1}\\ 3.0 \times 10^{-1}\\ 6.0 \times 10 \end{array}$	1.6 x 101 3.0 2.7 x 102 1.0 5.4 x 101 3.0 5.4 x 101 1.0 Unlimited Unlimited1 8.1 x 101 7.0 x 10-1 1.1 x 101 4.0 x 10-1 1.9 x 101 6.0 x 10-1 8.1 3.0 x 10-1 8.1 6.0 x 10-1	8.1 x 101 2.7 x 101 8.1 x 101 2.7 x 10 Unlimited 1.9 x 101 1.1 x 101 1.6 x 10 8.1 1.6 x 10 ¹
48 49 50 51 52 53 54	Indium (49) In-111 In-113m In-114m ^a In-115m Iridium (77)	3.04.01.0 × 1017.0	$\begin{array}{cccccc} 8.1 & \times & 10^{1}_{2} & & 3.0 \\ 1.1 & \times & 10^{2}_{2} & & 2.0 \\ 2.7 & \times & 10^{2}_{2} & & 5.0 & \times & 10^{-1} \\ 1.9 & \times & 10^{2} & & 1.0 \end{array}$	$8.1 \times 101 \\ 5.4 \times 101 \\ 1.4 \times 101 \\ 2.7 \times 10$

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1 2 3 4 5	Ir-189 ^a Ir-190 Ir-192 ^c Ir-194	1.0×10^{1} 7.0 × 10 1.0 3.0 × 10^{-1}	2.7×10^{2} 1.9 × 10 ¹ 2.7 × 10 ¹ 8.1	1.0 7.0 6.0 3.0		2.7×10^{2} 1.9×10^{1} 1.6×10^{1} 8.1
6 7 8 9 10	Potassium (19 K-40 K-42 K-43) 9.0 \times 10 ⁻¹ 2.0 \times 10 ⁻¹ 7.0 \times 10 ⁻¹	2.4×10^{1} 5.4 1.9 x 10^{1}	9.0 2.0 6.0		$2.4 \times 10^{1} \\ 5.4 \\ 1.6 \times 10^{1}$
11 12 13 14 15	Krypton (36) Kr-81 Kr-85 Kr-85m Kr-87	$\begin{array}{c} 4.0 \times 10^{1} \\ 1.0 \times 10^{1} \\ 8.0 \\ 2.0 \times 10^{-1} \end{array}$	$1.1 \times 1032.7 \times 1022.2 \times 1025.4$	4.0 1.0 3.0 2.0		$1.1 \times 1032.7 \times 1018.1 \times 1015.4$
17 18 19 20	Lanthanum (57 La-137 La-140) 3.0×10^{1} 4.0×10^{-1}	8.1×10^{2} 1.1 x 10 ¹	6.0 4.0	x 10 ⁻¹	1.6×10^{2} 1.1 x 10 ¹
20 21 22 23 24 25 26	Lutetium (71) Lu-172 Lu-173 Lu-174 Lu-174m Lu-177	$\begin{array}{c} 6.0 \times 10^{-1} \\ 8.0 \\ 9.0 \\ 2.0 \times 10^{1} \\ 3.0 \times 10^{1} \end{array}$	1.6×10^{1} 2.2 x 10 ² 2.4 x 10 ² 5.4 x 10 ² 8.1 x 10 ²	6.0 8.0 9.0 1.0 7.0	$ x 10^{-1} $ $ x 10^{1} $ $ x 10^{-1} $	1.6×10^{1} 2.2 × 102 2.4 × 102 2.7 × 101 1.9 × 10
27 28 29 30	Magneşium (12 Mg-28) 3.0 x 10 ⁻¹	8.1	3.0	x 10 ⁻¹	8.1
31 32 33 34 35 36	Manganese (25 Mn-52 Mn-53 Mn-54 Mn-56) 3.0×10^{-1} Unlimited 1.0 3.0×10^{-1}	8.1 Unlimited 2.7 x 10 8.1	3.0 Unl: 1.0 3.0		8.1 Unlimited 2.7 x 10 8.1
37 38 39 40	Molybdenum (4 Mo-93 Mo-99 ^a ,i	2) 4.0 x 10 ¹ 1.0	1.1×10^{3} 2.7 x 10 ¹	2.0 6.0	$\begin{array}{c} x & 10 \\ x & 10 \\ x & 10 \end{array}$	5.4×10^{2} 1.6 x 10 ¹
41 42 43	Nitrogen (7) N-13	9.0 x 10 ⁻¹	2.4 x 10 ¹	6.0	× 10 ⁻¹	1.6 x 10 ¹
44 45 46 47	Sodium (11) Na-22 Na-24	$5.0 \times 10^{-1}_{-1}$ 2.0 x 10	1.4 x 10 ¹ 5.4	5.0		1.4 x 10 ¹ 5.4
48 49 50 51 52 53	Niobium (41) Nb-93m Nb-94 Nb-95 Nb-97	$\begin{array}{c} 4.0 \times 10^{1} \\ 7.0 \times 10^{-1} \\ 1.0 \\ 9.0 \times 10^{-1} \end{array}$	$1.1 \times 10^{3}_{1}$ 1.9 × 101 2.7 × 101 2.4 × 10	3.0 7.0 1.0 6.0		8.1×10^{2} 1.9×10^{1} 2.7×10^{1} 1.6×10^{1}
54	Neodymium (60					

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1 2 3	Nd-147 Nd-149	6.0 6.0 x 10 ⁻¹	1.6×10^{2} 1.6×10^{1}	$6.0 \times 10^{-1}_{-1}$ 5.0 x 10	1.6×10^{1} 1.4 x 10 ¹
4 5 6 7	Nickel (28) Ni-59 Ni-63 Ni-65	Unlimited 4.0 x 10^{1}_{-1} 4.0 x 10	Unlimited 1.1 x 101 1.1 x 10 ¹	Unlimited 3.0×10^{1} 4.0×10^{1}	Unlimited 8.1 x 10 1.1 x 10
8 9 10 11	Neptunium (9 Np-235 Np-236	3) 4.0 x 10 ¹	1.1 x 10 ³	4.0 x 10 ¹	1.1 x 10 ³
12 13 14	(short- lived) Np-236	2.0 x 10 ¹	5.4 x 10^2	2.0	5.4 x 10^{1}
15 16 17 18	(long- lived) Np-237 Np-239	9.0 \times 10 ⁰ 2.0 \times 10 ¹ 7.0	$2.4 \times 102 \\ 5.4 \times 102 \\ 1.9 \times 102$	$2.0 \times 10^{-2}_{-3} \\ 2.0 \times 10^{-3}_{-1} \\ 4.0 \times 10^{-1}$	$5.4 \times 10^{-1}_{-2}$ 5.4 x 10 ¹ 1.1 x 10 ¹
20 21 22 23 24 25	Osmium (76) Os-185 Os-191 Os-191m Os-193 Os-194	$1.0 \\ 1.0 \\ \times 10^{1} \\ 4.0 \\ \times 10^{1} \\ 2.0 \\ 3.0 \\ \times 10^{-1}$	$2.7 \times 10^{1}_{2}$ 2.7 × 10^{3}_{1.1 × 10^{1}_{1}} 5.4 × 10 8.1	1.0 2.0 3.0 x 101 6.0 x 10-1 3.0 x 10	$2.7 \times 10^{1}_{1} \\ 5.4 \times 10^{2}_{2} \\ 8.1 \times 10^{2}_{1.6} \\ 1.6 \times 10^{1}_{1.6} \\ 8.1$
26 27 28 29 20	Phosphorus (P-32 P-33	$\begin{array}{c} 15) \\ 5.0 \times 10^{-1} \\ 4.0 \times 10^{1} \end{array}$	1.4×10^{1} 1.1 x 10 ³	5.0×10^{-1} 1.0	1.4×10^{1} 2.7 x 10 ¹
30 31 32 33 34 35	Protactinium Pa-230 Pa-231 Pa-233	(91) 2.0 4.0 5.0	5.4×10^{1} 1.1 x 102 1.4 x 10	$7.0 \times 10^{-2}_{-4} 4.0 \times 10^{-1}_{-1} 7.0 \times 10^{-1}_{-1}$	$1.9 \\ 1.1 \times 10^{-2} \\ 1.9 \times 10^{1}$
36 37 38 39 40 41 42	Lead (82) Pb-201 Pb-202 Pb-203 Pb-205 Pb-210 Pb-212	1.0 4.0 x 10^{1} 4.0 Unlimited 1.0 7.0 x 10^{-1}	2.7 x 10^{1}_{3} 1.1 x 10^{2}_{2} 1.1 x 10^{2}_{1} Unlimited 2.7 x 10^{1}_{1} 1.9 x 10^{1}_{2}	1.0 2.0 x 10 ¹ 3.0 Unlimited_2 5.0 x 10_1 2.0 x 10	2.7 x 10^{1}_{2} 5.4 x 10^{1}_{1} 8.1 x 10^{1}_{1} Unlimited 1.4 5.4
43 44 45 46 47 48	Palladium (4 Pd-103 Pd-107 Pd-109	6) 4.0 x 10 ¹ Unlimited 2.0	1.1×10^3 Unlimited 5.4 x 10 ¹	4.0×10^{1} Unlimited 5.0 x 10	1.1×10^{3} Unlimited 1.4 x 10 ¹
48 49 50 51 52 53 54	Promethium (Pm-143 Pm-144 Pm-145 Pm-147 Pm-148m ^a	$ \begin{array}{c} 3.0 \\ 7.0 \times 10^{-1} \\ 3.0 \times 10^{1} \\ 4.0 \times 10^{-1} \\ 8.0 \times 10 \end{array} $	$8.1 \times 101 \\ 1.9 \times 102 \\ 8.1 \times 103 \\ 1.1 \times 101 \\ 2.2 \times 10$	$\begin{array}{c} 3.0 \\ 7.0 \times 10^{-1} \\ 1.0 \times 10^{1} \\ 2.0 \\ 7.0 \times 10^{-1} \end{array}$	8.1×10^{1} 1.9×10^{2} 2.7×10^{1} 5.4×10^{1} 1.9×10^{1}
			33	Approved by Reviso	pr

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٦	Pm-149	2.0	5.4×10^{1}	6.0	$x 10^{-1}$	1.6×10^{1}
2	Pm-151	2.0	5.4×10^{1}	6.0	$x 10^{-1}$	1.6×10^{1}
3						
4	Polonium (84)				•	
5	Po-210	$4.0 \times 10^{\perp}$	1.1×10^{3}	2.0	$x 10^{-2}$	5.4 x 10^{-1}
6	이번 유민 전체에서 이미가 가지 않는다. 클라이지 아이지 아이가 가지 않는다. 같은 아이지 아이지 아이가 하는 것을 받았다.					
7	Praseodymium	(59) -			_ _	
8	Pr-142	4.0×10^{-1}	1.1 x 10^{1}_{1}	4.0	x 10^{-1}	1.1×10^{1}
9	Pr-143	3.0	8.1 x 10^{-1}	6.0	$x 10^{-1}$	1.6×10^{-1}
10	상황을 한 것은 것이 가지는 것을 것 같다. 이 같은 것 같은 것이 가지는 것은 것을 것 같다. 같은 것 같은 것이 가지는 것은 것을 것 같은 것을 것 같다.					
11	Platinum (78)					
12	Pt-188	1.0	2.7×10^{1}	8.0	$x 10^{-1}$	2.2×10^{1}
13	Pt-191	4.0 ,	1.1×10^{2}	3.0	-	8.1×10^{1}
14	Pt-193	4.0 x 10^{1}_{1}	1.1×10^{3}	4.0	$x 10^{+}_{-1}$	$1.1 \times 10^{3}_{1}$
15	Pt-193m	4.0 x 10^{1}_{1}	1.1×10^{3}	5.0	$x 10^{-1}_{-1}$	1.4×10^{1}
16	Pt-195m	1.0×10^{1}	2.7 x 10^{2}_{2}	5.0	$x 10_{1}^{1}$	$1.4 \times 10^{1}_{1}$
17	Pt-197	2.0 x 10^{1}_{1}	5.4 x 10^{2}_{2}	6.0	$x 10_{1}$	$1.6 \times 10^{1}_{1}$
18	Pt-197m	1.0×10^{-1}	2.7×10^{2}	6.0	x 10 ¹	1.6×10^{-1}
19						
20	Plutonium (94) – – – – – – – – – – – – – – – – – – –	,		-3	-2
21	Pu-236	3.0×10^{-1}	8.1×10^{2}	3.0	$x 10_{1}$	8.1×10^{-1}
22	Pu-237	2.0×10^{-1}	5.4 x 10^{2}_{2}	2.0	$x 10^{-}_{-3}$	5.4 x 10_{-2}^{2}
23	Pu-238	1.0×10^{-1}	2.7×10^{2}	1.0	$x 10_{-3}$	$2.7 \times 10_{-2}^{-2}$
24	Pu-239	1.0×10^{-1}	2.7×10^{2}	1.0	$x 10_{-3}$	$2.7 \times 10^{-2}_{-2}$
25	Pu-240	1.0×10^{-1}	$2.7 \times 10^{-4}_{3}$	1.0	$x 10_{-2}$	2.7 x 10 ⁴
26	Pu-241	$4.0 \times 10^{-}_{1}$	$1.1 \times 10^{5}_{2}$	6.0	$x \ 10_{3}$	1.6 -2
27	$Pu-242_a$	1.0×10^{-1}	$2.7 \times 10^{-1}_{1}$	1.0	$x 10_{-3}$	2.7×10^{-2}
28	Pu-244~	4.0 x 10 -	1.1 x 10 ⁻	1.0	x 10 ~	2.7 x 10 -
29						
30	Radium _a (88)	알림물 전 걸릴 것 두 것	1		-3	-1
31	Ra-223	4.0×10^{-1}	$1.1 \times 10^{-}_{1}$	7.0	x 10 - 2	$1.9 \times 10_{-1}$
32	Ra-224	$4.0 \times 10_{-1}$	1.1×10^{-1}	2.0	$ x 10_{-3} $	5.4 x 10_{-1}
33	Ra-225 a	2.0×10^{-1}	5.4	4.0	$x 10_{-3}$	$1 \cdot 1 \times 10 - 2$
34	Ra-226	2.0×10^{-1}	5.4	3.0	$x \pm 0 - 2$	8.1×10^{-1}
35	Ra-228	6.0 X 10	1.6 X 10	2.0	X IU	5.4 X 10
36						
3/	Rubialum $(3/)$	^ ^		~ ~	1	$2 - 2 - 10^{1}$
38		2.0	5.4×101	8.0	X IU	2.2×10^{1}
39	RD-83	2.0	5.4×10^{1}	2.0		5.4×10^{1}
40	RD=84 Db=86	$\frac{1}{5}$ 0 $\frac{1}{5}$ $\frac{1}{5}$ $\frac{-1}{5}$	2.7×10^{1}	T.0	w 10 ⁻¹	$\frac{2.7 \times 10}{1.4 \times 10^{1}}$
41 10	RD-00 Db-07	J.U X LU	L.4 X LU		x IU imitod	L.4 X LU
42	RD=0/	Uniimited	UNIImited		imited	Unlimited
43	RD (Mat)	UIIIIIIIII	UIIIIIIILEU	UIIT.	LIMITCEU	OUTTINTCER
44	Phonium (75)					
45	$R_{0} = 184$	1 0	2.7×10^{1}	٦ n		2.7×10^{1}
47	Re - 184m	÷•• 3 0	8.1×10^{-10}	1 0		2.7×10^{1}
48	Re-186	2.0	5.4×10^{1}	6.0	$x 10^{-1}$	1.6×10^{1}
10	Re-187	Inlimited	Unlimited	[In]	imited_	Unlimited
50	Re-188	4.0×10^{-1}	1.1×10^{1}	4.0	$x 10^{-1}$	1.1×10^{1}
51	Re-189 ^a	3.0	8.1×10^{1}	6.0	$x 10^{-1}$	1.6×10^{1}
52	Re (nat)	Unlimited	Unlimited	Unl	imited	Unlimited
53						
54	Rhodium (45)					
1111						

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1	Rh-99	2.0		5.4 x	10^{1}_{2} 2	2.0		5.4 x	101
2	Rh-101	4.0		1.1 x	10^2 3	3.0	_	8.1 x	10^{-1}
ิจ	Bh = 102	5.0 x	10 ⁻¹	1.4 v	10^{1} 5	. 0	$x 10^{-1}$	1.4 x	10^{\perp}
1	Ph-102m	20		5 / v	$\frac{101}{10}$ 2		A 10	5 / v	10^{1}
- 4	$R_{11} = 102m$	4.0	1,1		103 4		- 10 ¹	J.4 A	103
5	Rn-103m	4.0 X	101	T.T X	102 4		x 10 - 1	T.T X	
6 7	Rh-105	1.0 x	Τ0	2.7 X	T0 8	5.0	X TO	2.2 X	10
8	Radon (86)		1				3		1
9 10	Rn-222	3.0 x	10 -	8.1	4	.0	x 10	1.1 X	10 -
11	Ruthenium (44))			2				2
12	Ru-97	5.0		1.4 x	10_{1}^{-} 5	i. 0		1.4 x	10^{-}_{1}
13	Ru-1034	2.0		5.4 x	10^{\perp}_{1} 2	2.0		5.4 x	10
14	Ru-105	1.0		2.7 x	10 6	i.0	$x 10^{-1}$	1.6 x	10
15	$Ru-106^{a}$	2.0 x	10 ⁻¹	5.4	2	2.0	$x 10^{-1}$	5.4	
16									
17	Sulphur (16)								
10	G_35	10.	101	1 1 v	103 3	2		8 1 v	101
10		4.V X	тv	төт х	TO 3	•••		O'T V	ΤŪ
19	and the second second								
20	Antimony (51)		1		l		10-1		- 1
21	SD-122	4.0 X	10-1	т•т х	10_{1} 4	.0	$x \perp 0 - 1$	T•T X	101
22	Sb-124	6.0 x	10 -	1.6 x	10^{-}_{1} 6	••0	x 10 -	1.6 x	107
23	Sb-125	2.0	_1	5.4 x	107 1	0		2.7 x	10^{-}_{1}
24	Sb-126	4.0 x	10 -	1.1 x	10 4	.0	x 10 ⁻	1.1 x	10-
25									
26	Scandium (21)						-1		7
27	Sc-44	5.0 x	10 1	1.4 x	10^{+}_{1} 5	.0	$x 10_{1}^{+}$	1.4 x	10^{+}_{1}
28	Sc-46	5.0 x	10^{-1}	1.4 x	10 5	.0	$x 10^{-1}$	1.4 x	10^{+}_{1}
29	Sc-47	1.0 x	10^{1}	2.7 x	10^{2} 7	.0	$x 10^{-1}$	1.9 x	10 ¹
30	Sc-48	3.0 x	10 ⁻¹	8.1	3	3.0	$\times 10^{-1}$	8.1	
31	지정 이 같은 것이 있는 것이 같아요.								
32	Selenium (34)								
22	Setentum (34)	2 0		0 1	101 2	2		0 1	101
22	$3e^{-73}$	3.0	1,01	0.1 X	103 3				
34	Se-79	4.0 X	τU	T•T X	10 2	•••		J.4 X	ΤU
35									
36	Silicon(14)		1		1		1	222 ¹ 2	1
37	Si-31	6.0 x	10 ₁ -	1.6 x	$10\frac{1}{3}$ 6	. 0.	$x 10_{-1}$	1.6 x	10^{-}_{1}
38	Si-32	4.0 x	10-	1.1 x	10 5	.0	x 10 ⁻	1.4 x	10-
39									
40	Samarium (62)				`		-		2
41	Sm-145	1.0 x	10 ¹	2.7 x	10^{2} 1	. 0	$\times 10^{\perp}$	2.7 x	102
42	Sm-147	Unlim	ited	Unlim	ited D	In]i	mited	Unlimi	ted
43	Sm-151	4 0 x	-10^{I}	1 1 v	10^3 1	0	\mathbf{x} 10 ^T	2.7 x	102
10	G_{m-153}	1.0	- 	2 / v	$\frac{102}{10}$. 0	$\frac{1}{2}$ $\frac{1}{10}$ -1	1.6 v	101
44	9III T 2 2	2.0		4.4 A	TO 0		V IO	T.O.V	Τ0
45									
46	<u>Tin (50)</u>				- 2 -			-	- 1
47	Su-113	4.0		1.1 X	10_{2} 2	.0	1	5.4 X	101
48	Sn-117m	7.0	- -	1.9 x	10^{-}_{3} 4	• 0	x 10 ₁ -	1.1 X	10^{-}_{2}
49	Sn-119m	4.0 x	101	1.1 x	10 3	.0	x 10 <u>-</u> 1	8.1 x	107
50	Sn-121m ^a	4.0 x	10 ¹ ,	1.1 x	10, 9	.0	$x 10^{-1}$	2.4 x	101
51	Sn-123	8.0 x	10 -	2.2 x	$10\frac{1}{2}$ 6	.0	$x 10^{-1}$	1.6 x	10-
52	Sn-125	4.0 x	10	1.1 y	10^{\perp}_{-} 4	. 0	$x 10^{-1}$	1.1 x	101
52	$Sn-126^a$	6.0 2	10^{-1}	1.6 v		Ň	$\frac{1}{2}$ $\frac{1}{10}$ -1		10^{1}
54		J. V A	- ·			•••	4, TA		- V
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	10/22/07	n 1997 - _{Al} derica A	[REVISO	R]	SGS/CA	AR3618
1 2 3 4	Strontium (38 Sr-82 Sr-85 Sr-85m Sr-85m) 2.0 \times 10 ⁻¹ 2.0 5.0 2.0	5.4 5.4 \times 10 ¹ 1.4 \times 10 ¹	2.0 2.0 5.0	x 10 ⁻¹	5.4 1 5.4 x 10 ² 1.4 x 10 ¹
5 6 7 8 9	Sr-89 Sr-90a Sr-91a Sr-91a Sr-92	5.0×10^{-1} 6.0×10^{-1} 3.0×10^{-1} 3.0×10^{-1} 1.0	$\begin{array}{c} 0.1 \times 10 \\ 1.6 \times 10 \\ 8.1 \\ 2.7 \times 10 \\ \end{array}$	5.0 6.0 3.0 3.0 3.0	$ \begin{array}{c} x & 10 \\ x & 10 \end{array} $	8.1 x 101 1.6 x 10 8.1 8.1 8.1
10 11 12 13	Tritium (l) T (H-3)	4.0 x 10^{1}	1.1 x 10 ³	4.0	x 10 ¹	1.1×10^3
14 15	Tantalum (73) Ta-178					
16	(long-				1	1
17	lived)	1.0	$2.7 \times 10^{-}_{2}$	8.0	$\times 10^{-}$	2.2×10^{-2}
18	Ta-1/9	3.0×10^{-1}	8.1×10	3.0	$x 10_{-1}$	8.1×10^{1}
19	Ta-182	9.0 X 10	2.4 x 10	5.0	x 10	1.4 x 10
20						
21	Terbium (65)		3		1	
22	TD-15/	4.0 x 10	1.1×10^{-1}	4.0	x 10 ⁻	$1.1 \times 10_{1}$
23	TD-158	1.0	$2.7 \times 10_{1}$	1.0	-1 ·	2.7×10^{-1}
24	Tb-160	1.0	2.7 x 10 ⁻	6.0	x 10 ⁻	1.6 x 10 ⁻
25						
26	Technetium (4	3)				1
27	Tc-95m	2.0 _1	5.4 x 10^{+}_{1}	2.0		5.4 x 10^{+}_{1}
28	Тс-96	4.0×10^{-1}	1.1×10^{-1}	4.0	$x 10^{-1}$	1.1×10^{1}
29	Tc-96m ^a	4.0×10^{-1}	1.1×10^{1}	4.0	$x 10^{-1}$	1.1×10^{1}
30	Tc-97	Unlimited	Unlimited	Unl	imited	Unlimited
31	Ψc-97m	4.0×10^{1}	1.1×10^{3}	1.0		2.7×10^{1}
32	то-98	80×10^{-1}	22×10^{1}	7 0	$v 10^{-1}$	10×10^{1}
22	TC 90	10^{10} 10^{1}	$1 1 \times 10^{3}$	0 0	$\frac{1}{2}$ $\frac{10}{10}$ -1	$\frac{1}{2}$ $\frac{1}{4}$ $\frac{1}{2}$ $\frac{10}{10}$
27		4.0×10^{-1}	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	9.0	X IU	2.4×102
24	10-991	TO X TO	Z•/ X 10	4.0		T•T X TO
36	Tollurium (52					
37		΄	$5 1 \times 10^{1}$	2 0		$5/\sqrt{10^{1}}$
20	TC 121 To-121m	2.0	3.4×10^{2}	2.0		3.4×101
20		J • U	1.4×102	3.0		$\begin{array}{c} 0 \cdot 1 \\ 2 \\ 7 \\ \end{array}$
39		$\frac{0.0}{0.0} = 10^{1}$	$\frac{2 \cdot 2 \times 10}{5 \cdot 4}$	1.0	1,-1	$2 \cdot 7 \times 10^{1}$
40		2.0×10	5.4×10^{2}	9.0	x + 10 - 1	2.4×101
41 40	Te-12/	2.0×10^{1}	5.4 $\times 10_{2}$	1.0	x 10 - 1	$1.9 \times 10_{1}$
42	Te-12/m	2.0×10^{-1}	5.4 x 10_1	5.0	$x \pm 0_{-1}$	$1.4 \times 10_{1}$
43	Te-129 a	$7.0 \times 10_{-1}$	1.9×10^{-1}	6.0	$\times 10_{-1}$	$1.6 \times 10_{1}$
44	Te-129m	$8.0 \times 10_{-1}$	$2.2 \times 10^{-}_{1}$	4.0	$\times 10_{-1}$	1.1×10^{-1}
45	Te-131m ⁻	$7.0 \times 10_{-1}$	$1.9 \times 10^{-}_{1}$	5.0	$x 10_{-1}$	$1.4 \times 10^{-}_{1}$
46	Te-132~	5.0 x 10 ⁺	1.4×10^{-1}	4.0	x 10 -	1.1×10^{-1}
47	분들 산업감사가 이 것들 것같 					
48	Thorium (90)	1	2	_	3	
49	Th-227 a	1.0×10^{-1}	2.7 x 10_{1}	5.0	$x 10_{-3}$	$1.4 \times 10_{-2}$
50	Th-228	5.0 x 10 -	$1.4 \times 10^{-}_{2}$	1.0	$\times 10_{\Lambda}$	2.7 x 10_5
51	Th-229	5.0 1	1.4 x 105	5.0	x 10_2	1.4×10^{-2}
52	Th-230	$1.0 \times 10^{+}_{1}$	2.7×10^{2}	1.0	x 10_5	$2.7 \times 10_{-1}^{-2}$
53	Th-231	4.0×10^{-1}	1.1 x 10 ³	2.0	x 10 ⁻²	5.4 x 10^{-1}
54	Th-232	Unlimited	Unlimited	Unli	mited	Unlimited
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1 2 3	Th-234 ^a Th (nat)	3.0×10^{-1} Unlimited	8.1 Unlimited	3.0×10^{-1} Unlimited	8.1 Unlimited	
4 5 6	Titanium (22) Ti-44	5.0 \times 10 ⁻¹	1.4×10^{1}	4.0×10^{-1}	1.1 x 10 ¹	
7 8 9 10	Thallium (81) T1-200 T1-201 T1-202	9.0×10^{-1} 1.0 x 10 2.0	2.4×10^{1} 2.7 × 10^{1} 5.4 × 10^{1}	9.0×10^{-1} 4.0 2.0	2.4×10^{1} 1.1 x 10 ¹ 5.4 x 10 ¹	
11 12 13	T1-204	1.0×10^{1}	2.7×10^2	7.0 x 10^{-1}	1.9×10^{1}	
14 15 16 17	Tm-167 Tm-170 Tm-171	7.0 3.0 4.0 x 10 ¹	$1.9 \times 10^{2}_{1}\\8.1 \times 10^{3}_{1.1 \times 10}$	$8.0 \times 10^{-1}_{-1} 6.0 \times 10^{-1}_{1} 4.0 \times 10^{-1}_{1}$	$2.2 \times 10^{1}_{1.6 \times 10^{3}_{3}_{1.1 \times 10^{3}_{3}}}$	
18 19 20	Uranium (92) U-230 (fast lung _ /					
21 22 23	absorption) ^{2,0} U-230 (medium	4.0 x 10 ⁺	1.1 x 10 ³	1.0 x 10 ⁻¹	2.7	
24 25 26	absorption) ^{a,6} U-230	^e 4.0 x 10 ¹	1.1 x 10 ³	4.0 x 10^{-3}	1.1 x 10 ⁻¹	
27 28 29	(slow lung absorption) ^{a,1} U-232	^E 3.0 x 10 ¹	8.1 x 10^2	3.0×10^{-3}	8.1 x 10^{-2}	
30 31 32 33	(fast lung d absorption) ^d U-232 (medium	4.0 x 10 ¹	1.1 x 10 ³	1.0×10^{-2}	2.7×10^{-1}	
34 35 36	lung absorption) ^e U-232	4.0 x 10 ¹	1.1×10^3	7.0×10^{-3}	1.9×10^{-1}	
37 38 39	(slow lung absorption) ^f U-233	1.0 x 10 ¹	2.7×10^2	1.0×10^{-3}	2.7×10^{-2}	
40 41 42 43	(fast lung absorption) ^d U-233 (medium	4.0 x 10 ¹	1.1 x 10 ³	9.0 x 10^{-2}	2.4	
44 45 46	absorption) ^e U-233	4.0 x 10 ¹	l.l x 10 ³	2.0×10^{-2}	5.4 x 10^{-1}	
47 48 49	(slow lung absorption)f U-234	4.0 x 10 ¹	1.1 × 10 ³	6.0×10^{-3}	1.6×10^{-1}	
50 51 52 53	(fast lung absorption) ^d U-234 (medium	4.0 x 10 ¹	1.1 x 10 ³	9.0 x 10^{-2}	2.4	
54	lung					

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1 2	absorption) ^e U-234	4.0 x 10 ¹	1.1 x 10 ³	2.0×10^{-2}	5.4 x 10^{-1}
3 4 5	(slow lung f absorption) U-235	4.0×10^{1}	1.1 x 10 ³	6.0×10^{-3}	1.6×10^{-1}
6 7	(all lung absorption f				
8 9	types) U-236	Unlimited	Unlimited	Unlimited	Unlimited
10 11 12	absorption) ^d U-236	Unlimited	Unlimited	Unlimited	Unlimited
13	(medium				
14 15 16	absorption) ^e U-236	4.0×10^{1}	1.1 x 10 ³	2.0×10^{-2}	5.4 x 10^{-1}
17 18 19	(slow lung absorption)f U-238	4.0 x 10 ¹	1.1 x 10 ³	6.0×10^{-3}	1.6×10^{-1}
20	(all lung				
21	absorption tupog d, e, f	IInlimited	IInlimited	IInlimitod	Unlimitod
22 23 24	U (nat)	Unlimited	Unlimited	Unlimited	Unlimited
25	(enriched				
20	to 20% or	IIn] imited	[In] imited	IInlimi+od	IInlimi+od
28	U (dep)	Unlimited	Unlimited	Unlimited	Unlimited
29 30	Vanadium (23)				2014년 1월 1915년 1월 1917년 1월 1918년 1월 1919년 1월 1917년 1월 191
31	V-48	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
32	V-49	4.0×10^{1}	1.1 x 10 ³	4.0×10^{1}	1.1 x 10 ³
34	Tungsten (74)				
35	W-178 ^a	9.0	2.4×10^{2}	5.0 ,	1.4×10^{2}
36	W-181	3.0×10^{1}	8.1 x 10^{2}_{3}	$3.0 \times 10^{\perp}_{-1}$	8.1 x 10^{2}_{1}
37	W-185	4.0 x 10 ⁻	$1.1 \times 10^{-1}_{1}$	8.0×10^{-1}	2.2 x 10^{+}_{1}
38	W-187	2.0	5.4 x 10^{-1}	$6.0 \times 10_{-1}$	1.6 x 10 ⁻
39	M-188	4.0 x 10	1.1 x 10	3.0 x 10	8.1
40	Xenon (54)				
42	X_{e-122}^{a}	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
43	Xe-123	2.0	5.4×10^{1}	7.0×10^{-1}	1.9×10^{1}
44	Xe-127	4.0 ,	1.1×10^{2}	2.0 ,	5.4 x 10^{1}_{2}
45	Xe-131m	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
46	Xe-133	2.0×10^{-1}	5.4 x 10^{2}_{1}	1.0×10^{-1}	2.7 x 10^{2}_{1}
47	Xe-135	3.0	8.1 x 10^{-1}	2.0	5.4 x 10^{-1}
48					
49	Yttrium (39)			1 0	
50	X-8/	1.0	$2 \cdot 7 \times 10$	$1 \cdot 0$ 10^{-1}	$2./ \times 10^{1}$
51 21	V-00	4.0×10^{-1}	T•T X TA	4.0×10^{-1}	т•т х ТО
52	V-91	5.0×10^{-1}	1.6×10^{1}	5.0×10^{-1}	1.6×10^{1}
54	Y-91m	2.0	5.4×10^{1}	2.0	5.4×10^{1}

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1 2 2	Y-92 Y-93	2.0×10^{-1} 3.0×10^{-1}	5.4 8.1		2.0 3.0	$\begin{array}{c} x 10 \\ x 10 \\ x 10 \end{array}$	5.4 8.1
3 4 5 6 7	Ytterbium (70 Yb-169 Yb-175) 4.0 3.0 x 10 ¹	1.1 2	k 102 k 102 k 102	1.0 9.0	x 10 ⁻¹	2.7×10^{1} 2.4 x 10 ¹
7 8 9 10 11	Zinc (30) Zn-65 Zn-69 Zn-69m ^a	2.0 3.0 3.0	5.4 2 8.1 2 8.1 2	<pre>x 101 x 101 x 101 x 10</pre>	2.0 6.0 6.0		5.4 x 101 1.6 x 101 1.6 x 101
12 13 14 15 16 17 18 19	Zirconium (40 Zr-88 Zr-93 Zr-95 Zr-97 a_{A_1} and A_2 va) 3.0 Unlimited 2.0 4.0 x 10 ⁻¹ lues include	8.1 : Unlir 5.4 : 1.1 :	k 10 ¹ nited k 101 k 10 ibutions	3.0 Unl: 8.0 4.0 from	imite <u>d</u> 1 x 10-1 x 10 n daught	8.1 x 10^{1} Unlimited 2.2 x 10^{1} 1.1 x 10^{1} er
20	nuclides with	half-lives l	ess tl	nan ten	days		
21	^b The values o	$f A_1$ and A_2 i	n cur:	ies (Ci)	are	approxi	mate and
22	for informati	on only; the	regula	atory st	andaı	d units	are
23	Terabecquerel	s (TBq). See	Appe	ndix A t	o Cod	le of Fe	deral
24	Regulations,	title 10, Par	t 71 ·	- Determ	inat	ion of A	1 and A ₂ ,
25	Section I.						
26	^C The quantity	may be deter	mined	from a	measu	ırement	of the rate
27	of decay or a	measurement	of the	e radiat	ion I	Level at	a prescribed
28	distance from	the source.					
29	^d These values	apply only t	o comj	pounds o	f ura	anium th	at take the
30	chemical form	of UF ₆ , UO ₂ F	2, and	uo ₂ (no	3) ₂	in both	normal
31	and accident	conditions of	tran	sport.			
32	^e These values	apply only t	o comj	oounds o	f ura	anium th	at take the
33	chemical form	of UO ₃ , UF ₄ ,	and I	JCl_4 and	hexa	avalent	compounds in
34	both normal a	nd accident c	ondit	ions of	trans	sport.	
35	^f These values	apply to all	compo	ounds of	ura	nium oth	er than those
36	specified in	notes d and e	•				

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1	g _{These} values app	ly to unir	radiated ur	canium only.	
2	$h_{A_1} = 0.1 \text{ TBq} (2.$	7 Ci) and	$A_2 = 0.001$	TBq (0.027 Ci) for
3	Cf-252 for domest	ic use.			
^	$\frac{1}{2}$ = 0.74 mp ~ (2)		No OO for	Jomostia uso	
4	$A_2 = 0.74$ TBq (2	• ci) ior	MO-99 IOF C	lomestic use.	
5	Subp. 2. Sp	ecific act	ivity. Thi	is subpart spe	cifies
6	specific activity	for indiv	idual radic	onuclides.	
7 8 9 10 11	Element and Atomi Number and Symbol of Radionuclide	c Spec (Tbq/g)	ific Activi (Ci	ity L/g)	
12	Actinium (89)		3	- 4	
13	AC-225	2.1×10	5.8		
14	AC-22/	2./	4 /.2	$\frac{x}{10}$	
16	AC-220	0.4 X 10	2.2	X TO	
17	Silver (47)				
18	$A_{\alpha} = 105$	1.1×10	³ 3.0	$ x 10^{4} $	
19	Ag-108m	9.7 x 10	-1 2.6	$x 10^{-1}$	
20	Aq-110m	1.8×10	2 4.7	$x 10^{3}$	
21	Ag-111	5.8 x 10	³ 1.6	$x 10^{5}$	
22	전철 방법은 전상 전 가격에 가지 않는 것이다. 가격에 가지 않는 것이다. 이 가입 전 문문을 통한 것은 것이다. 같은 것은 것은 것은 것이다.				
23	Aluminum (13)		-1	-2	
24	A1-26	7.0 x 10	1.9	x 10 ⁴	
25					
26	Americium (95)		-1		
27	Am-241	1.3×10	-1 3.4	1	
28	Am-242m	3.6×10	-3 1.0	$\frac{x}{10}$	
29	AIII-243	/.4 X 10	2.0	X IU	
30	Argon(18)				
32	Ar=37	3.7×10	3 9.9	$x 10^{4}$	
33	Ar-39	1.3	- 3.4	$\frac{1}{x}$ 10 ¹	
34	Ar-41	1.5×10	6 4.2	$\frac{107}{102}$	
35	Ar-42	9.6	2.6	$\frac{1}{x}$ $\frac{1}{10}^{2}$	
36					
37	Arsenic (33)		∧	c	
38	As-72	6.2 x 10	1.7	$x 10^{0}_{1}$	
39	As-73	8.2 x 10	2.2	$x 10\frac{1}{4}$	
40	As-74	3.7 x 10	3 4 9.9	$x 10^{-1}_{6}$	
41	As-76	5.8 x 10	4 1.6	$x 10^{\circ}_{6}$	
42	As-77	3.9 x 10	1.0	x 10ĭ	
43					
44	Astatine (85)		4 _	6	
45	At-211	7.6 x 10	2.1	x 10 ⁻	
46					
4/	GOTO (12)				

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1	Au-193	3.4	x	10^{4}		9.2	x	10 ⁵		
2	Au-194	1.5	x	102		4.1	х	10^{3}_{3}		
3	Au-195	1.4	х	103		3.7	Х	105		
4	Au-196	4.0	x	103		1.1	х	105		
5	Au-198	9.0	x	103		2.4	х	105		
6	Au-199	7.7	x	10		2.1	X	Τ0		
1	Dowing (E6)									
0	$\frac{Bartum}{Ba-131}$	2 1	v	103		8 1	v	104		
10	Ba-133m	2.2	x	$\frac{104}{104}$		6.1	x	105		
11	Ba-133	9.4				2.6	x	10^{2}		
12	Ba-140	2.7	x	103		7.3	x	104		
13										
14	Beryllium (4)			4				5		
15	Be-7	1.3	X	10_{-4}		3.5	x	10_2	2	
16	Be-10	8.3	х	10 -		2.2	X	10 -		
17										
10	BiSmuth (83)	т с	v	10-3		1 2	v	104		
20	Bi = 205 Bi = 206	3.8	x	$\frac{10}{10}3$		1.0	x	105		
21	Bi = 207	1.9	**			5.2	x	10^{1} .		
22	Bi-210m	2.1	x	10^{-5}_{-5}		5.7	x	10-4		
23	Bi-210	4.6	х	$10^{3}_{\rm E}$		1.2	х	107		
24	Bi-212	5.4	х	105		1.5	х	10'		
25	물질 물건은 이 문화 관람을 줄 수									
26	Berkelium (97)			2						
27	BK = 247	3.8	x			1.0		1,3		
28	BK-249	0.L	x	10		Τ.Ο	X	τu		
29	Bromine (35)									
31	Br-76	9.4	x	10^{4}		2.5	x	10^{6}		
32	Br-77	2.6	x	10^{4}		7.1	x	10^{5}_{c}		
33	Br-82	4.0	x	10 ⁴		1.1	х	100		
34										
35	Carbon (6)			- 7				8		
36	C-11	3.1	X	10 - 1		8.4	Х	10-		
3/	C−14	Τ•0	X	10		4.5				
20	Calcium (20)									
40	Ca-41	3.1	x	10^{-3}		8.5	x	10^{-2}	2	
41	Ca-45	6.6	x	10^{2}		1.8	x	10^{4}_{-}		
42	Ca-47	2.3	x	104		6.1	х	105		
43										
44	Cadmium (48)							3		
45	Cd-109	9.6	X	10-		2.6	X	102		
46	Cd-113m	8.3		. 2		2.2	X	10_{4}		
4/	Cd-115m	9.4	X	$10_{10}4$		2.5	X	105		
48		1.9	X	10		D • T	x	τU		
49 50	Cerium (58)							_		
51	Ce-139	2.5	x	10^{2}_{2}		6.8	x	10^{3}		•
52	Ce-141	1.1	x	10,3		2.8	x	10^{-4}		
53	Ce-143	2.5	x	10^{4}_{2}		6.6	х	10^{5}_{2}		
54	Ce-144	1.2	x	102		3.2	х	10		
				۸.			A	pprove	d by Reviso	r

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1 2 3 4	Californium (98) Cf-248 Cf-249	5.8 1.5	x	$10^{1}_{10^{-1}}$	1.6×10^3
5	Cf-250	4.0			1.1×10^2
6	Cf-251	5.9	x	10^{-2}	1.6
7	Cf-252	2.0	x	10^{\perp}	5.4 x 10^{2}
8	Cf-253	1.1	x	103	2.9×10^{4}
9	Cf-254	3.1	x	$\frac{10^2}{10^2}$	8.5×10^3
10	방향 및 14 명령 및 10 11 12 13 12 13 13 13 13 13 19 명령 및 13 13 13 13 13 13 13 13 13 13 13 13 13				가장, 전자, 이번 전자, 전자, 전자, 가지, 가지, 가지, 가지, 가지, 가지, 가지, 가지, 가지, 가지
11	Chlorine (17)				
12	C1-36	1.2	x	10^{-3}	3.3×10^{-2}
13	C1-38	4.9	x	106	1.3×10^8
14	영양(1996년) 2017년 - 1917년 - 1917년 - 1917년 - 1917년 1917년 - 1917년 -				가 같은 것을 위한 지원에 가격할 것 같은 것이다. 사람이는 것은 것은 것은 것이 가지 않는 것이다.
15	Curium (96)			•	
16	Cm-240	7.5	x	10^{2}_{2}	2.0×10^4
17	Cm-241	6.1	x	10^{2}_{2}	1.7×10^{4}
18	Cm-242	1.2	x	10^{2}	3.3×10^{3}
19	Cm-243	1.9	x	10 ⁻³	5.2 x 10^{1}_{1}
20	Cm-244	3.0		•	8.1 x 10^{1}
21	Cm-245	6.4	x	10^{-3}	1.7×10^{-1}
22	Cm-246	1.1	x	10^{-2}	3.1×10^{-1}
23	Cm-247	3.4	x	10 5	9.3×10^{-5}
24	Cm-248	1.6	x	10 ⁻⁵	4.2×10^{-3}
25					
26	Cobalt (27)			_	
27	Co-55	1.1	x	102	3.1×10^{0}
28	Co-56	1.1	x	10^{3}_{2}	3.0×10^4
29	Co-57	3.1	x	10^{2}_{r}	8.4 x 10^{3}
30	Co-58m	2.2	x	10^{5}_{2}	5.9 x 10^{5}
31	Co-58	1.2	x	10^{3}_{1}	3.2×10^4
32	Co-60	4.2	x	10 ¹	1.1×10^{3}
33					
34	Chromium (24)			,	
35	Cr-51	3.4	x	10	9.2 x 10^4
36					
37	Cesium (55)			Λ	
38	Cs-129	2.8	x	107	$7.6 \times 10^{5}_{5}$
39	Cs-131	3.8	x	103	$1.0 \times 10^{3}_{5}$
40	Cs-132	5.7	x	105	$1.5 \times 10^{5}_{6}$
41	Cs-134m	3.0	x	10 ₁	$8.0 \times 10^{\circ}_{3}$
42	Cs-134	4.8	x	10 ¹ 5	1.3×10^{-3}
43	Cs-135	4.3	x	10 ₂	1.2×10^{7}
44	Cs-136	2.7	x	10	7.3×10^{-1}
45	Cs-137	3.2			8.7×10^{-1}
46					
47	Copper (29)			Ę	6
48	Cu-64	1.4	x	104	$3.9 \times 10^{\circ}_{5}$
49	Cu-67	2.8	X	10 -	7.6 x 10
50	말 수로 물었는 것 것을 통하는 것				
51	Dysprosium (66)			2	a (h. 1997) a (h. 1997)
52	Dy-159	2.1	X	105	$5.7 \times 10_{6}$
53	Dy-165	3.0	X	103	$8.2 \times 10^{\circ}_{5}$
54	Dy-166	8.6	X	10~	2.3 x 10

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ı				
2	Erbium (68)		_	An Carlos A constante da la constante da
3	Er-169	3.1 x	10 10	8.3 x 10^4_{c}
4	Er-171	9.0 x	104	$2.4 \times 10^{\circ}$
5				
6	Einsteinium (99)			
7	Es-253			
8	Es-254			
9	Es-254m			
10	Es-255			
11	물질: 물소가 되는 것 같은 것은 문질 물질: 물질: 물질:			
12	Europium (63)		3	4
13	Eu-14/	1.4 x	102	$3.7 \times 10_4$
14	Eu-148	6.0 x	$^{10}_{102}$	$1.6 \times 10_{3}$
15	Eu-149	3.5 X	10_{4}	9.4 x 10_{6}
10	<u>EU-150</u>	6.1 X	10_{104}	$1.6 \times 10_{6}$
1/	Eu-152m	8.2 X	10	2.2×10^{2}
18 18	Eu-152	6.5		$1.8 \times 10_{2}$
19 20	Eu-154	9.8	- 1	$2.6 \times 10_{2}$
20	Eu-155	1.8 x	103	$4.9 \times 10_{4}$
21	EU-156	2.0 X	10	5.5 X 10
22				
23	Fluorine (9)	~ -	- 6	0 5 7
24	5 ₽	3.5 X	10	9.5 X 10
25	T_{2} on (26)			
20	$\frac{11011}{20}$.	105	7 2 4 106
2/	FETD2 To-FE	Z./X	101	7.3×103
20	FC-50	0.0 X	103	2.4×104
23	FE-39 Fo-60	1.0 X	$\frac{10}{10} - 4$	3.0×10^{-2}
21		/•4 X	ΤV	2.0 x 10
33	$\mathbf{Formium}$ (100)			
32	Fm-255			
34	$F_{m} = 255$ $F_{m} = 257$			
35	· · · · · · · · · · · · · · · · · · ·			
36	Gallium (31)			
37	Ga=67	2.2 x	10^{4}	6.0×10^{5}
38	Ga-68	1.5 x	$\frac{106}{10}$	4.1×10^{7}
39	Ga-72	1.1 x	$\frac{-05}{10}$	3.1×10^{6}
40				
41	Gadolinium (64)			
42	Gd-146	6.9 x	10 ²	1.9×10^{4}
43	Gd-148	1.2	•	3.2×10^{1}
44	Gd-153	1.3 x	104	3.5×10^{3}
45	Gd-159	3.9 x	104.	1.1 x 10 ⁶
46				
47	Germanium (32)		•	9
48	Ge-68	2.6 x	10^{2}_{2}	7.1×10^{3}
49	Ge-71	5.8 x	10 ⁵	1.6×10^{5}
50	Ge-77	1.3 x	10 ⁵	3.6×10^{6}
51				
52	Hydrogen (1)		`	Э
53	H-3 (T)	3.6 x	104	9.7 x 10^{3}
54				

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1 2 3	Hafnium (72) Hf-172 Hf-175	$4.1 \times 10^{1}_{2}$ $3.9 \times 10^{2}_{2}$	$1.1 \times 10^{3}_{4}$ $1.1 \times 10^{4}_{4}$
5 6	Hf-182	8.3×10^{-6} 8.1 × 10	$1.7 \times 10_{-4}$ 2.2 × 10
7 8	Mercury (80) Hg-194	1.3×10^{-1}	3.5
9	Hg-195m	1.5×10^{4}	$4.0 \times 10^{5}_{c}$
10	Hg-197m	$2.5 \times 10^{4}_{3}$	$6.7 \times 10^{5}_{5}$
11	Hg-197	9.2 x 10^{3}_{2}	$2.5 \times 10^{5}_{4}$
12 13	Hg−203	5.1 x 10 ⁴	1.4 x 10 ⁻
14	Holmium (67)		슬랫동안 수 있는 것이 가지 않는 것이 있는 것이다. 같은 것은 것은 것은 것이 같은 것이 있는 것이 같은 것이다.
15	Ho-163	2.7	7.6×10^{-1}
16	HO-166m	$6.6 \times 10_4^{-1}$	1.8 s
17	H0-166	2.6 x 10 ⁻	7.0 x 10
18	Toding (E2)		
19	10d1ne (53)	7 1 104	1 0 - 106
20	T-124	7.1 X 103	1.9×105
22	T-125	5.3×10^{2}	2.5×104 1 7 y 10
23	I-126	2.9×10^3	$\frac{1}{8}$, 0×10^4 .
24	I-129	6.5×10^{-6}	1.8×10^{-4}
25	(I-131)	4.6×10^{3}	1.2×10^{-5}
26	I-132	3.8×10^{5}	1.0×10^{7}
27	I-133	$4.2 \times 10^{4}_{5}$	$1.1 \times 10^{\circ}_{7}$
28	I-134	9.9 x 10_5^{3}	$2.7 \times 10_6'$
29	I-135	1.3 x 10	$3.5 \times 10^{\circ}$
30			
31	Indium (49)	4	<u> </u>
22		$1.5 \times 10_{5}$	$4 \cdot 2 \times 10^{-1}$
33		0-2-2-10-	
35	Tn-113m	6.2×10^5	1.7×10^{7}
36			
37	In-114 m	8-6-x-12 ²	2-3-x-14 ⁴
38		9	
39	<u>In-114m</u>	<u>8.6 x 10⁴</u>	<u>2.3 x 10⁻</u>
40		5	6
41	1 n-115 m	2.2 X 10	6.L X 10
42	Tridium (77)		
44	Tr = 189	1.9×10^{3}	5.2×10^4
45	Îr-190	2.3×10^{3}	6.2×10^{4}
46	Ir-192	3.4×10^{2}	9.2×10^3
47	Ir-193m	2.4 x 10^{3}	$6.4 \times 10^4_{\rm F}$
48	Ir-194	3.1×10^4	8.4×10^{2}
49			
50	Potassium (19)	-7	-6
51	K-40	$2.4 \times 10_5'$	$6.4 \times 10_{6}$
52	K-42	2.2×10^{-1}	6.0×10^{-1}
53	K-43	1.2 X 10	$\mathbf{3.3 \times 10}$
0.4			

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1 2 3 4 5 6	Krypton (36) Kr-81 Kr-85m Kr-85 Kr-87	$7.8 \times 10^{-4} \\ 3.0 \times 10^{1} \\ 1.5 \times 10^{1} \\ 1.0 \times 10^{6} \\ 1.0 \times 10^{6} \\ 1.0 \\ $	$2.1 \times 10^{-2} \\ 8.2 \times 10^{2} \\ 3.9 \times 10^{7} \\ 2.8 \times 10^{7} $
7 8 9	Lanthanum (57) La-137 La-140	$1.6 \times 10^{-3}_{4}$ 2.1 x 10 ⁴	$\begin{array}{r} 4.4 \times 10^{-2} \\ 5.6 \times 10^{-2} \end{array}$
10 11 12 13 14 15 16	Lutetium (71) Lu-172 Lu-173 Lu-174m Lu-174 Lu-177	$\begin{array}{r} 4.2 \times 101 \\ 5.6 \times 102 \\ 2.0 \times 101 \\ 2.3 \times 103 \\ 4.1 \times 10 \end{array}$	$1.1 \times 10^{5} \\ 1.5 \times 10^{3} \\ 5.3 \times 10^{2} \\ 6.2 \times 10^{5} \\ 1.1 $
17 18 19 20	Magnesium (12) Mg-28	2.0 x 10 ⁵	5.4 x 10 ⁶
21 22 23 24 25	Manganese (25) Mn-52 Mn-53 Mn-54 Mn-56	$1.6 \times 10^{4}_{-5}$ 6.8 × 10 ² 2.9 × 10 ² 8.0 × 10	$\begin{array}{r} 4.4 \times 10^{5} \\ 1.8 \times 10^{3} \\ 7.7 \times 10^{7} \\ 2.2 \times 10^{7} \end{array}$
26 27 28 29	Molybdenum (42) Mo-93 Mo-99	4.1×10^{-2} 1.8 x 10^{-2}	1.1 4.8 × 10 ⁵
30 31 32	Nitrogen (7) N-13	5.4 x 10 ⁷	1.5×10^9
33 34 35 36 37	Sodium (ll) Na-22 Na-24	2.3×10^2 3.2×10^5	6.3×10^{3} 8.7 x 10 ⁶
38 39 40 41 42 43	Niobium (41) Nb-92m Nb-93m Nb-94 Nb-95 Nb-97	$5.2 \times 10^{3} \\ 8.8 -3 \\ 6.9 \times 10^{3} \\ 1.5 \times 10^{5} \\ 9.9 \times 10^{5} \\ $	1.4×10^{5} 2.4×10^{-1} 1.9×10^{-1} 3.9×10^{-1} 2.7×10^{-1}
44 45 46 47 48	Neodymium (60) Nd-147 Nd-149	$3.0 \times 10^{3}_{5}$ $4.5 \times 10^{5}_{5}$	8.1×10^4 1.2 × 10 ⁷
49 50 51 52 53 54	Nickel (28) Ni-59 Ni-63 Ni-65 Neptunium (93)	3.0×10^{-3} 2.1 7.1 x 10 ⁵	$8.0 \times 10^{-2} \\ 5.7 \times 10^{1} \\ 1.9 \times 10^{7} $
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1	Np-235	5.2 x 10^{1}	1.4×10^3	
2	Np-236	4.7×10^{-4}	1.3×10^{-2}	
3	Np-237	2.6×10^{-5}	$7.1 \times 10^{-4}_{5}$	
4	Np-239	8.6 x 10 ³	2.3 x 10	
5 6	Osmium (76)		· · · · · · · · · · · · · · · · · · ·	
7	Os-185	2.8 x 10^{2}	$7.5 \times 10_{6}^{3}$	
8	Os-191m	$4.6 \times 10^{4}_{3}$	$1.3 \times 10^{\circ}_{1}$	
9	Os-191	$1.6 \times 10^{3}_{4}$	$4.4 \times 10^{-1}_{5}$	
10	Os-193	2.0×10^{-1}	5.3 x 10^{2}_{2}	
11	Os-194	1.1 x 10 ⁻	3.1 x 10 ⁻	
12	경찰을 알았는 것이 있는 것이 가슴을 가지? 같은 것이 있는 것이 있는 것이 가슴을 가지? 같은 것이 있는 것			
13	Phosphorus (15)	1 1 104	2 0 - 105	
14	P 32	$1 \cdot 1 \times 10_3$	2.9×105	
10		D.O X TO	Τ • Ο Χ Τ Ο	
17	Protactinium (91)		물건 : 2011년 1월 2012년 1 1월 2012년 1월 2	
18	Pa=230	1.2×10^{3}	3.3×10^4	
19	Pa-231	1.7×10^{-3}	4.7×10^{-2}	
20	Pa-233	7.7×10^2	2.1×10^4	
21	: 27:27:27:27:27:27:27:27:27:27:27:27:27:2		이 같은 것 같은 사람이 많은 것 같은 것이 있는 것이 같다. 같은 것은 것은 것은 것은 것은 것이 같이 많이 많이 같이	
22	Lead (82)			
23	Pb-201	6.2 x 10^{4}_{-1}	$1.7 \times 10^{\circ}_{3}$	
24	Pb-202	$1.2 \times 10_4^{-2}$	$3.4 \times 10_{5}$	
25	Pb-203	1.1×10^{-6}	$3.0 \times 10_{-4}$	
26	Pb-205	4.5 x 10	$1.2 \times 10_{1}$	
27	Pb-210	2.8	$7.6 \times 10_{6}$	
28	PD-212	5.1 X 10	1.4 X 10	
29	$\mathbf{D}_{\mathbf{a}}$			
30	Paliaulum (40) Pa-103	2 8 v 10 ³	7.5×10^4	
32	Pd-107	10×10^{-5}	$7.3 \times 10-4$	
33	Pd = 109	7.9×10^4	2.1×10^{6}	
34	전철 영상 전철 것이다. 그는 아이지 않는 것을 알았다. 같은 것이 같은 것이다. 그는 아이지 않는 것이 같은 것이다.		2015년 일 ³ 217일 1월 1일 - 일일	
35	Promethium (61)			
36	Pm-143	1.3×10^{2}	3.4×10^{3}	
37	Pm-144	9.2 x 10^{-1}	$2.5 \times 10^{3}_{2}$	
38	Pm-145	5.2	1.4×10^{2}	
39	Pm-147	$3.4 \times 10^{+}_{2}$	9.3 x $10\frac{4}{4}$	
40	Pm-148m	$7.9 \times 10^{-}_{4}$	$2.1 \times 10_{5}$	
41	Pm-149	$1.5 \times 10_4$	$4.0 \times 10_{5}$	
42	Pm-151	2.7 x 10	/.3 x 10	
43	Dolonium (84)			
44	POIOIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	$2 2 \times 10^{1}$	50×10^{2}	
40	PO-208	$\begin{array}{c} 2 \cdot 2 & x & 10 \\ 6 & 2 & y & 10 \end{array}$	17×10^{1}	
40	$P_0 - 210$	1.7×10^{2}	4.5×10^3	
48	· 동국 · 영문 · · · · · · · · · · · · · · · · ·			
49	Praseodvmium (59)		$\mathcal{L}_{\mathrm{rel}}$, $\mathcal{L}_{\mathrm{rel}}$	
50	Pr-142	4.3×10^{4}	1.2×10^{6}	
51	Pr-143	2.5×10^{3}	6.7×10^4	
52				
53	Platinum (78)	3	4	
54	Pt-188	2.5 x 10 ⁻	6.8 x 10 ⁻	

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1 2 3 4 5 6 7	Pt-191 Pt-193m Pt-193 Pt-195m Pt-197m Pt-197	$8.7 \times 10^{3}_{3}_{5.8 \times 10}_{1.4}_{6.2 \times 10^{3}_{5}_{5}_{3.7 \times 10^{4}_{4}}_{3.2 \times 10}$	$\begin{array}{c} 2.4 \times 105 \\ 1.6 \times 101 \\ 3.7 \times 105 \\ 1.7 \times 105 \\ 1.0 \times 105 \\ 8.7 \times 10 \\ 8.7 \times 10 \end{array}$	
8 9 10 11 12 13 14 15 16 17	Plutonium (94) Pu-236 Pu-237 Pu-238 Pu-239 Pu-240 Pu-241 Pu-242 Pu-242 Pu-244	$2.0 \times 10^{1}_{2}$ $4.5 \times 10^{-1}_{-1}$ $6.3 \times 10^{-3}_{-3}$ $2.3 \times 10^{-3}_{-3}$ $8.4 \times 10^{-3}_{-3}$ $3.8 \qquad -4_{1.5 \times 10^{-7}_{-7}}$ $6.7 \times 10^{-7}_{-7}$	$5.3 \times 102 1.2 \times 101 1.7 \times 10-2 6.2 \times 10-1 2.3 \times 102 1.0 \times 10-3 3.9 \times 10-5 1.8 \times 10-5$	
18 19 20 21 22 23 24	Radium (88) Ra-223 Ra-224 Ra-225 Ra-226 Ra-228	$1.9 \times 10^{3}_{3}_{5.9 \times 10^{3}_{3}_{1.5 \times 10^{-2}_{-2}_{3.7 \times 10^{-2}_{1.0 \times 10^{-2}_{-2}}}$	5.1×10^{4} 1.6×10^{4} 3.9×10^{4} 1.0 2.7×10^{2}	
25 26 27 28 29 30 31	Rubidium (37) Rb-81 Rb-83 Rb-84 Rb-86 Rb-87 Rb (natural)	$3.1 \times 10^{5} \\ 6.8 \times 10^{3} \\ 1.8 \times 10^{3} \\ 3.0 \times 10^{-9} \\ 3.2 \times 10^{6} \\ 6.7 \times 10^{6} $	$8.4 \times 10^{6} \\ 1.8 \times 10^{4} \\ 4.7 \times 10^{4} \\ 8.1 \times 10^{-8} \\ 8.6 \times 10^{8} \\ 1.8 \times 10^{-8} $	
32 33 34 35 36 37 38 39 40 41	Rhenium (75) Re-183 Re-184m Re-184 Re-186 Re-187 Re-188 Re-189 Re (natural)	3.8×10^{2} 1.6×10^{2} 6.9×10^{3} 6.9×10^{-9} 1.4×10^{4} 3.6×10^{4} 2.5×10^{4}	1.0×10^{4} 4.3×10^{4} 1.9×10^{5} 1.9×10^{-8} 3.8×10^{5} 9.8×10^{5} 6.8×10^{-8} 2.4×10^{-8}	
42 43 45 46 47 48 49 50	Rhodium (45) Rh-99 Rh-101 Rh-102m Rh-102 Rh-103m Rh-105	3.0×10^{3} 4.1×10^{2} 2.3×10^{1} 4.5×10^{6} 1.2×10^{6} 3.1×10^{4}	8.2×10^{4} 1.1×10^{3} 6.2×10^{3} 1.2×10^{7} 3.3×10^{7} 8.4×10^{5}	
51 52 53	Radon (86) Rn-222	5.7 x 10^3	1.5×10^5	
54	Ruthenium (44)			

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1	Ru-97	1.7	x	10^{4}_{2}		4.6	x	105	
2	Ru-103	1.2	x	10^{3}_{E}		3.2	х	10^{4}_{c}	
3	Ru-105	2.5	x	102		6.7	х	102	
4	Ru-106	1.2	X	102		3.3	x	105	
5 6	Sulfur (16)			2				л	
7	S-35	1.6	X	10		4.3	х	10 4	
8	Datimone (E1)								
10	$\frac{Ancimony}{Sb-122}$	15	v	104		1 0	v	105	
11	SD = 122 Sb = 124	1.J 6 5	A V	$\frac{10}{10}^{2}$		1 7	v	104	
12	Sb-125	3.9	X	$\frac{1}{10}$		1.0	x	103	
13	Sb-126	3.1	x	10^{3}		8.4	x	10^{4}	
14	: 동물은 물문은 이 가격은 관련을 받을 통								
15	Scandium (21)			Ę				7	
16	Sc-44	6.7	X	103		1.8	X	104	
17	Sc-46	1.3	X	104		3.4	X	105	
18	Sc-47	3.1	X	104		8.3	X	106	
19	SC-48	5.5	X	10 -		1.5	X	10-	
20	C_{2}								
2⊥ 22	Selenium (34)	E /	12	102		7 E	17	104	
22	56-75 Se-79	2.4	X	10 - 3		7 0	X	10^{-2}	2
24		~ • •	Î	T A		/	A	τ.	
25	Silicon (14)			,				_	
26	Si-31	1.4	х	100		3.9	х	107	
27	Si-32	3.9				1.1	х	10^{2}	
28									
29	Samarium (62)			1				3	
30	Sm-145	9.8	X	10^{-}_{-1}		2.6	X	10_8	}
31	Sm-147	8.5	X	10 - 1		2.3	X		
32	Sm-151 Cm-152	9./	X	104		2.0	X	105	
34	- 7 7 7 7	τ.υ	X	TA		4.4	X	тU	
35	Tin (50)								
36	Sn-113	3.7	x	10^{2}_{2}		1.0	x	104	
37	Sn-117m	3.0	х	102		8.2	X	10 2	
38	Sn-119m	1.4	х	10 ²		3.7	x	10^{3}_{1}	
39	Sn-121m	2.0		2		5.4	x	103	
40	Sn-123	3.0	X	103		8.2	X	105	
41	Sn-125	4.0	X	10_{-3}		1.1	X	10_2	2
42	Sn-126	1.0	X	10 -		2.8	X	10 -	
43	Ctront:								
44	Strontrum (38)	n n	v	1,03		6 7	v	104	
45	SI - 02 Sr - 85m	2.5	X	106		2.2	X	107	
47	Sr-85	8.8	x	10^{2}		2.4	X	10^{4}	
48	Sr-87m	4.8	x	105		1.3	x	107	
49	Sr-89	1.1	x	103		2.9	x	102	
50	Sr-90	5.1		E		1.4	х	10^{2}_{c}	
51	Sr-91	1.3	x	105		3.6	х	107	
52	Sr-92	4.7	x	105		1.3	х	10'	
53									
54	Tritium (1)								

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$\begin{array}{cccccccccccccccccccccccccccccccccccc$] S(
3Tantalum (73)4Ta-178 $4.2 \times 10_1^6$ 1.1×10^2 5Ta-179 4.1×102 1.1×10^2 6Ta-182 2.3×10^2 6.2×10^2 7Terbium (65) $5.6 \times 10_{-1}^{-1}$ 1.5×10^2 9Tb-157 $5.6 \times 10_{-1}^{-1}$ 1.5×10^2 10Tb-158 5.6×10^2 1.5×10^2 11Tb-160 4.2×10^2 1.1×10^2 13Technetium (43) 2×10^2 1.1×10^2 14Tc-95m $8.3 \times 10_6^2$ 2.2×10^2 15Tc-96m 1.4×104 3.8×10^2 16Tc-96 1.2×10^2 3.2×10^2 17Tc-97m 5.6×10^{-5} 1.5×10^2 18Tc-97 5.2×10^{-5} 1.4×10^2 19Tc-98 3.2×10^5 8.7×10^2 20Tc-99m $1.9 \times 10^2^2$ 5.3×10^2 23Tellurium (52)Tellurium (52)	10 ³
78Terbium (65)9Tb-157 $5.6 \times 10^{-1}_{-1}$ $1.5 \times 10^{-1}_{-1}$ 10Tb-158 $5.6 \times 10^{2}_{-1}$ $1.5 \times 10^{-1}_{-1}$ 11Tb-160 $4.2 \times 10^{2}_{-1}$ $1.1 \times 10^{-1}_{-1}$ 13Technetium (43) $2.2 \times 10^{2}_{-1}$ $1.1 \times 10^{-1}_{-1}$ 14Tc-95m $8.3 \times 10^{6}_{-1}$ $3.8 \times 10^{-1}_{-1}$ 15Tc-96m $1.4 \times 10^{4}_{-1}$ $3.8 \times 10^{-1}_{-1}$ 16Tc-96 $1.2 \times 10^{2}_{-1}$ $3.2 \times 10^{-1}_{-1}$ 17Tc-97m $5.6 \times 10^{-5}_{-5}$ $1.5 \times 10^{-5}_{-5}$ 18Tc-97 $5.2 \times 10^{-5}_{-5}$ $1.4 \times 10^{-1}_{-1}$ 19Tc-98 $3.2 \times 10^{5}_{-5}$ $8.7 \times 10^{-1}_{-5}$ 20Tc-99m $1.9 \times 10^{-4}_{-4}$ $5.3 \times 10^{-1}_{-7}$ 21Tc-99 $6.3 \times 10^{-1}_{-1}$ $1.7 \times 10^{-1}_{-2}$ 23Tellurium (52)Tellurium (52)	$10\frac{8}{103}$ $10\frac{3}{10}$
12Technetium (43)13Technetium (43)14Tc-95m15Tc-96m1.4 $x 10^{4}_{4}$ 16Tc-961.2 $x 10^{2}_{4}$ 17Tc-97m5.6 $x 10^{-5}_{-5}$ 18Tc-975.2 $x 10^{-5}_{-5}$ 18Tc-983.2 $x 10^{5}_{5}$ 20Tc-99m1.9 $x 10^{-4}_{-4}$ 5.3 $x 10^{-4}_{-7}$ 21Tc-996.3 $x 10^{-4}_{-7}$	101 101 104
23 Tellurium (52)	10410710510410-310-410610-2
24Te-118 6.8×10^2_2 1.8×10^2_2 25Te-121m 2.6×10^3_3 7.0×10^2_2 26Te-121 2.4×10^2_2 6.4×10^2_2 27Te-123m 3.3×10^2_2 8.9×10^2_2 28Te-125m 6.7×10^2_2 1.8×10^2_2 29Te-127m 3.5×10^4_2 9.4×10^2_2 30Te-127 9.8×10^3_2 2.6×10^2_2 31Te-129m 1.1×10^5_2 3.0×10^2_4 33Te-131m 3.0×10^4_4 8.0×10^2_2 34Te-132 1.1×10^2_2 8.0×10^2_2	103 104 103 104 103 106 104 107 105 105
36Thorium (90)337Th-227 1.1×10^{1} 3.1×10^{1} 38Th-228 3.0×10^{-3} 8.2×10^{-3} 39Th-229 7.9×10^{-4} 2.1×10^{-4} 40Th-230 7.6×10^{4} 2.1×10^{-4} 41Th-231 2.0×10^{-9} 5.3×10^{-3} 42Th-232 4.0×10^{2} 1.1×10^{-3} 43Th-234 8.6×10^{-9} 2.3×10^{-9} 44Th (natural) 8.1×10^{-9} 2.2×10^{-9}	10410-110-210510-710410-710-7
46 Titanium (22) 47 Ti-44 6.4 1.7 x	10 ²
4049Thallium (81)450 $T1-200$ $2.2 \times 10_3^4$ 6.0×10^4 51 $T1-201$ $7.9 \times 10_3^3$ 2.1×10^4 52 $T1-202$ $2.0 \times 10_1^4$ 5.3×10^4 53 $T1-204$ 1.7×10^4 4.6×10^4 54 54 54 56	105 104 102 10

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l	Thulium (69)			_					
2	Tm-167	3.1	x	103	8.5	х	102		
3	Tm-168	3.1	x	10^{2}_{2}	8.3	х	10^{3}		
4	Tm-170	2.2	x	10^{2}_{1}	6.0	x	103		
5	Tm-171	4.0	x	10	1.1	х	10		
6									
7	Uranium (92)			3			4		
8	U-230	1.0	X	10 ₁	2.7	X	101		
9	U-232	8.3	x	10_{-4}	2.2	X	10_	3	
10	U-233	3.6	X	10 - 4	9.7	X	10_	3	
11	U-234	2.3	x	10 - 8	6.2	X	10_	6	
12	U-235	8.0	X	$\frac{10}{10} - 6$	2.2	X	10-	5	
13	U = 2.36	2.4	X	10-8	0.5	X	10	7	
14	U=230	1.2	X	$\frac{10}{10} - 8$	3.4	X	10	7	
15	U (natural) U (opriched 5%	2.0	x	ΤV	/•1 / • 1	_ X 	T0		
17	or less)				173	= +	JAIL		
18	U (enriched				4/5.	L • \ _ 7	nart	,	
19	more than 5%)				473	- 1	1424	, (1997)	
20	II (depleted)	-			175. (See		hart	 A set of the set of	
21					473	- 1	0424	1	
22									
23	Vanadium (23)			•			_		
24	V-48	6.3	x	10^{3}_{2}	1.7	x	102		
25	V-49	3.0	x	10 ²	8.1	x	103		
26									
27	Tungsten (74)			。			Л		
28	W-178	1.3	x	10^{3}_{2}	3.4	x	10 2		
29	W-181	2.2	х	10^{2}_{2}	6.0	x	102		
30	W-185	3.5	x	101	9.4	X	105		
31	W-187	2.6	x	10^{-}_{2}	7.0	х	104		
32	W-188	3.7	x	10~	1.0	х	10 -		
33									
34	Xenon (54)			4			6		
35	Xe-122	4.8	X	10_{5}	1.3	X	107		
30		4.4	X	103	1.2	X	104		
3/	Xe-12/	1.0	X	103	2.8	X	104		
38		3.1	x	103	8.4	X	105		
39	XC-125	0.9	X	104	1.7 2 5	X	106		
40	XC-133	2.0	Å	ΤV	2.0	X	τu		
41	V + + r i n (39)								
43	Y = 87	1.7	x	10^{4}	4.5	x	105		
44	Y-88	5.2	x	10^{2}	1.4	x	10^{-4}		
45	y -90	2.0	x	10^{-4}_{-1}	5.4	x	10-		
46	Y-91m	1.5	x	100	4.2	x	10/		
47	Y-91	9.1	x	10-2	2.5	х	10^{4}_{c}		
48	Y-92	3.6	x	105	9.6	x	100		
49	Y-93	1.2	x	103	3.3	х	10 ⁰		
50									
51	Ytterbium (70)			२			A.		
52	Yb-169	8.9	x	102	2.4	х	10 -		
53	¥b-175	6.6	х	10	1.8	x	105	· · .	
54									

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1 2 3 4 5	Zinc (30) Zn-65 Zn-69m Zn-69	3.0 × 1.2 × 1.8 ×		$\begin{array}{c} 2 \times 10^{3} \\ 3 \times 10^{6} \\ 9 \times 10^{7} \end{array}$			
6 7 8 9 10 11	Zirconium (40) Zr-88 Zr-93 Zr-95 Zr-97) 9.3 3 7.9 2 7.1 3	$\begin{array}{c} 10^{2}_{-5} \\ 10^{2}_{-5} \\ 10^{2}_{-5} \\ 10^{2}_{-5} \\ 10^{4}_{-5} \\ 10^{4}_{-5} \\ 10^{4}_{-5} \end{array}$	$ \begin{array}{c} 8 \times 10^{4} \\ 5 \times 10^{-3} \\ 1 \times 10^{4} \\ 9 \times 10^{6} \end{array} $			
12	Subp. 3.	Exempt ma	aterial activ	vity concentrat	ions and		
13	exempt consign	nment activ	vity limits.	This subpart	specifies		
14	exempt materia	al activity	v concentrati	ions and exempt	consignment		
15	activity level	ls for radi	onuclides.				
16	THE FOLLO	DWING IS AN	I ALL NEW TAP	3LE :			
17 18 19 20 21 22 23	Element and Activity atomic number concentra- and symbol of tion for radionuclide exempt material (Bq/g)		Activity concentra tion for exempt material (Ci/g)	Activity a- limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)		
24 25 26 27 28	Actinium (89) Ac-225 Ac-227 Ac-228	$1.0 \times 10^{1}_{-1}$ 1.0 × 10^{1}_{-1} 1.0 × 10^{1}_{-1}	$\begin{array}{c} 2.7 \times 10 \\ 2.7 \times 10 \\ 2.7 \times 10 \\ 2.7 \times 10 \end{array}$	$\begin{array}{cccc} -10 & 1.0 \times 10^{4} \\ -12 & 1.0 \times 10^{3} \\ -10 & 1.0 \times 10^{6} \\ 1.0 \times 10^{6} \end{array}$	2.7×10^{-7} 2.7 \times 10^{-8} 2.7 \times 10^{-5} 2.7 \times 10^{-5}		
29 30 31 32 33 34	Silver (47) Ag-105 Ag-108m ^a Ag-110m Ag-111	$1.0 \times 101 \\ 1.0 \times 101 \\ 1.0 \times 103 \\ 1.0 \times 103 \\ 1.0 \times 10$	$\begin{array}{c} 2.7 \times 10 \\ 2.7 \times 10 \end{array}$	$\begin{array}{cccc} -9 & 1.0 \times 106 \\ -10 & 1.0 \times 106 \\ -10 & 1.0 \times 106 \\ -8 & 1.0 \times 106 \\ 1.0 \times 10 \end{array}$	2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5}		
35 36 37	Aluminum (13) Al-26	1.0 x 10 ¹	2.7 x 10 ⁻	⁻¹⁰ 1.0 x 10 ⁵	2.7×10^{-6}		
38 39 40 41	Americium (95) Am-241 Am-242m ^a Am-243 ^a	1.0 1.0 1.0	$2.7 \times 10^{-}$ 2.7 x 10^{-} 2.7 x 10^{-} 2.7 x 10^{-}	$\begin{array}{cccc} 11 & 1.0 \times 10^{4} \\ 11 & 1.0 \times 10^{4} \\ 11 & 1.0 \times 10^{3} \\ 1.0 \times 10^{3} \end{array}$	2.7×10^{-7} 2.7 \times 10^{-7} 2.7 \times 10^{-8} 2.7 \times 10^{-8}		
43 44 45 46	Argon (18) Ar-37 Ar-39 Ar-41	1.0×10^{6} 1.0×10^{7} 1.0×10^{2}	2.7×10^{-1} 2.7 x 10^{-1} 2.7 x 10^{-1}	$\begin{array}{cccc} -5 & 1.0 \times 108 \\ -4 & 1.0 \times 109 \\ -9 & 1.0 \times 10 \end{array}$	2.7×10^{-3} 2.7 \times 10^{-7} 2.7 \times 10^{-2} 2.7 \times 10^{-2}		
47 48 49	Arsenic (33) As-72	1.0 x 10 ¹	2.7 x 10	$^{-10}$ 1.0 x 10 ⁵	2.7×10^{-6}		

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1 2 3 4 5	As-73 As-74 As-76 As-77	1.0 x 1.0 x 1.0 x 1.0 x	$ \begin{array}{r} 103 \\ 101 \\ 102 \\ 103 \\ 10 \end{array} $	2.7 2.7 2.7 2.7	x x x x x	$10^{-8}_{10-10}_{10-9}_{10-8}_{10}$	1.0 1.0 1.0 1.0	x x x x	107 106 105 106 10	2.7 2.7 2.7 2.7	X X X X	10^{-4}_{-5} $10^{-6}_{10}_{-5}$ 10^{-5}_{-5}
6 7 8	Astatine (85) At-211	1.0 x	10 ³	2.7	x	10 ⁻⁸	1.0	x	10 ⁷	2.7	x	10 ⁻⁴
9 10 11 12 13 14	Gold (79) Au-193 Au-194 Au-195 Au-198 Au-199	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	101 102 102 102 102	2.7 2.7 2.7 2.7 2.7 2.7	x x x x x x x	$10^{-9}_{10-10}_{10-9}_{10-9}_{10-9}_{10-9}_{10}$	1.0 1.0 1.0 1.0 1.0	x x x x x x	106 107 106 106 106	2.7 2.7 2.7 2.7 2.7 2.7	x x x x x	10-410-510-410-510-510-5
16 17 18 19 20	Barium (56) Ba-131 Ba-133 Ba-133m Ba-140	1.0 x 1.0 x 1.0 x 1.0 x	102 102 102 101 101	2.7 2.7 2.7 2.7 2.7	x x x x x	10_{-9}^{-9} 10_9 10_9 10_10 10	1.0 1.0 1.0 1.0	x x x x x	106 106 106 105 10	2.7 2.7 2.7 2.7 2.7	X X X X	10^{-5} 10^{-5} 10^{-5} 10^{-6}
21 22 23 24 25	Beryllium (4) Be-7 Be-10	1.0 x 1.0 x	$10\frac{3}{10}$	2.7 2.7	x x	10-8 10-7	1.0 1.0	x x	107 106	2.7 2.7	x x	10^{-4}_{-5}
26 27 28 29 30 31 32	Bismuth (83) Bi-205 Bi-206 Bi-207 Bi-210 Bi-210 Bi-212	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	101 101 103 101 101 101	2.7 2.7 2.7 2.7 2.7 2.7 2.7	x x x x x x x x x	$10^{-10}_{10-10}_{10-10}_{10-8}_{10-10}_{10-10}_{10-10}_{10-10}$	1.0 1.0 1.0 1.0 1.0 1.0	x x x x x x x x	105 106 106 105 105 105	2.7 2.7 2.7 2.7 2.7 2.7 2.7	x x x x x x x x	$10^{-5}_{10-6}_{10-5}_{10-5}_{10-6}_{10-6}_{10-6}$
33 34 35 36	Berkelium (97) Bk-247 Bk-249) 1.0 1.0 x	10 ³	2.7 2.7	x x	10 ⁻¹¹ 10 ⁻⁸	1.0 1.0	x x	10 ⁴ 10 ⁶	2.7	x x	$10^{-7}_{10^{-5}}$
37 38 39 40 41 42	Bromine (35) Br-76 Br-77 Br-82	1.0 x 1.0 x 1.0 x	10 ¹ 10 ² 10 ¹	2.7 2.7 2.7	X X X	10^{-10}_{-9} 10^{-10}_{10}	1.0 1.0 1.0	x x x	105 106 106 10	2.7 2.7 2.7	x x x	10^{-6}_{-5} 10^{-5}_{-5} 10^{-5}_{-5}
43 44 45	Carbon(6) C-11 C-14	1.0 x 1.0 x	10 ¹ 10 ⁴	2.7 2.7	x x	10 ⁻¹⁰ 10 ⁻⁷	1.0 1.0	x x	10 ⁶ 107	2.7 2.7	x x	10^{-5}_{-4}
47 48 49 50 51	Calcium (20) Ca-41 Ca-45 Ca-47	1.0 x 1.0 x 1.0 x	$10\frac{5}{104}$ 101 10	2.7 2.7 2.7	x x x x	$10^{-6}_{-7}_{10^{-10}_{-10}}$	1.0 1.0 1.0	x x x	107 107 106	2.7 2.7 2.7	x x x	$ \begin{array}{r} -4 \\ 10 - 4 \\ 10 - 5 \\ 10 \end{array} $
52 53 54	Cadmium (48) Cd-109 Cd-113m	1.0 x 1.0 x	104 103	2.7 2.7	x x	10^{-7}_{-8}	1.0 1.0	x x	10 ⁶ 10 ⁶	2.7 2.7	x x	10 ⁻⁵ 10 ⁻⁵

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1 2 3	Cd-115 Cd-115m	1.0 x 1.0 x	$ \begin{array}{ccc} 10^{2} & 2.7 \\ 10^{3} & 2.7 \\ 2.7 \\ \end{array} $	7×10^{-9} 7×10^{-8} 7×10^{-8}	1.0 1.0		$2.7 \times 10^{-5}_{-5}$ 2.7 x 10
4 5 6 7 8	Cerium (58) Ce-139 Ce-141 Ce-143 Ce-144 ^a	1.0 x 1.0 x 1.0 x 1.0 x	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	-9 7 x 10_9 7 x 10_9 7 x 10_9 7 x 10_9 7 x 10	1.0 1.0 1.0 1.0	x 10 ⁶ x 107 x 106 x 105 x 10	2.7×10^{-5} 2.7 × 10_4 2.7 × 10_5 2.7 × 10_6 2.7 × 10_6
10 11 12 13 14 15 16 17 18	Californium (9 Cf-248 Cf-249 Cf-250 Cf-251 Cf-252 Cf-253 Cf-253 Cf-254	98) 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$7 \times 10^{-10}_{-12}$ $7 \times 10^{-10}_{-12}$ $7 \times 10^{-10}_{-12}$ $7 \times 10^{-10}_{-12}$ $7 \times 10^{-9}_{-12}$ $7 \times 10^{-12}_{-12}$	$\begin{array}{c} 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \end{array}$	x 103 x 104 x 103 x 104 x 105 x 105 x 103 x 10	2.7×10^{-7} 2.7×10^{-8} 2.7×10^{-7} 2.7×10^{-8} 2.7×10^{-7} 2.7×10^{-6} 2.7×10^{-8} 2.7×10^{-8} 2.7×10^{-8}
19 20 21 22	Chlorine (17) C1-36 C1-38	1.0 x 1.0 x	101 2.7	7×10^{-7} 7×10^{-10}) 1.0 1.0	x 10 ⁶ x 10 ⁵	2.7×10^{-5} 2.7 x 10^{-6}
23 24 25 26 27 28 29 30 31 32 33	Curium (96) Cm-240 Cm-241 Cm-242 Cm-243 Cm-244 Cm-245 Cm-246 Cm-247 Cm-248	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 1.0 1.0	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	7×10^{-9} 7×10^{-9} 7×10^{-12}	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	$ \begin{array}{c} x & 105 \\ x & 105 \\ x & 104 \\ x & 104 \\ x & 103 \\ x & 103 \\ x & 103 \\ x & 104 \\ x & 103 \\ x & 10 \\ x & 10 \end{array} $	2.7×10^{-6} 2.7×10^{-6} 2.7×10^{-7} 2.7×10^{-7} 2.7×10^{-7} 2.7×10^{-8} 2.7×10^{-8} 2.7×10^{-7} 2.7×10^{-8}
34 35 36 37 38 39 40	Cobalt (27) Co-55 Co-56 Co-57 Co-58 Co-58m Co-60	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	7×10^{-10} 7×10^{-10} 7×10^{-9} 7×10^{-10} 7×10^{-7} 7×10^{-10} 7×10^{-10}	$\begin{array}{c} 0 & 1.0 \\ 1.0 \\ 0 & 1.0 \\ 0 & 1.0 \\ 1.0 \\ 0 & 1.0 \\ 1.0 \\ 1.0 \end{array}$	x 105 x 106 x 106 x 106 x 107 x 107 x 105 x 10	2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-4} 2.7×10^{-6}
42 43	Chromium (24) Cr-51	1.0 x	10 ³ 2.7	7 x 10 ⁻⁸	1.0	x 10 ⁷	2.7×10^{-4}
45 46 47 48 49 50 51 52 53 54	Cesium (55) Cs-129 Cs-131 Cs-132 Cs-134 Cs-134 Cs-135 Cs-136 Cs-136 Cs-137	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccc} 7 & x & 10 & -9 \\ 7 & x & 10 & -16 \\ 7 & x & 10 & -16 \\ 7 & x & 10 & -8 \\ 7 & x & 10 & -7 \\ 7 & x & 10 & -16 \\ \end{array}$	$ \begin{array}{c} 1.0\\ 1.0\\ 1.0\\ 1.0\\ 1.0\\ 1.0\\ 1.0\\ 1.0\\$	x 106 x 105 x 104 x 105 x 105 x 107 x 105 x 104 x 10	2.7×10^{-6} 2.7×10^{-5} 2.7×10^{-7} 2.7×10^{-7} 2.7×10^{-6} 2.7×10^{-4} 2.7×10^{-6} 2.7×10^{-7} 2.7×10^{-7}

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1 2 3 4	Copper (29) Cu-64 Cu-67	1.0 x 1.0 x	10 ² 10 ²	2.7 x 2.7 x	x 10-9 x 10-9 x 10	1.0 x 1.0 x	10 ⁶ 10 ⁶	2.7 x 2.7 x	10^{-5}_{-5}
5 6 7 8	Dysprosium (6 Dy-159 Dy-165 Dy-166	6) 1.0 x 1.0 x 1.0 x	10 ³ 103 103	2.7 x 2.7 x 2.7 x		1.0 x 1.0 x 1.0 x	$107 \\ 106 \\ 106 \\ 106 \\ 10$	2.7 x 2.7 x 2.7 x	10^{-4}_{-5} 10^{-5}_{-5} 10^{-5}_{-5}
9 10 11 12 13	Erbium (68) Er-169 Er-171	1.0 x 1.0 x	10 ⁴ 10 ²	2.7 x 2.7 x		1.0 x 1.0 x	107 106	2.7 x 2.7 x	$10^{-4}_{10^{-5}}$
14 15 16 17	Europium (63) Eu-147 Eu-148 Eu-149	1.0 x 1.0 x 1.0 x	$\begin{array}{c} 10\\ 10\\ 10\\ 10\\ 10\end{array}$	2.7 x 2.7 x 2.7 x	$\begin{array}{c} 10^{-9} \\ 10^{-10} \\ 10^{-9} \\ 10 \end{array}$	1.0 x 1.0 x 1.0 x	106 106 107	2.7 x 2.7 x 2.7 x	$10^{-5}_{-5}_{10-4}_{10}$
18 19	Eu-150 (short-lived)	1.0 x	: 10 ³	2.7 x	x 10 ⁻⁸	1.0 x	10 ⁶	2.7 x	10 ⁻⁵
20 21 22 23 24 25 26	Eu-150 (long-lived) Eu-152 Eu-152m Eu-154 Eu-155 Eu-155 Eu-156	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	: 101 : 102 : 101 : 102 : 101 : 101	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	$ \begin{array}{c} $	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	106 106 106 107 107 106	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	$ \begin{array}{r} -5 \\ 10 - 5 \\ 10 - 5 \\ 10 - 5 \\ 10 - 4 \\ 10 - 5 \\ 10 \\ 10 \\ \end{array} $
27 28 29 30	Fluorine (9) F-18	1.0 x	: 10 ¹	2.7 x	¢ 10 ⁻¹⁰	1.0 x	10 ⁶	2.7 x	10 ⁻⁵
31 32 33 34 35 36	Iron (26) Fe-52 Fe-55 Fe-59 Fe-60	1.0 x 1.0 x 1.0 x 1.0 x	10 ¹ 10 ¹ 10 ¹ 10 ²	2.7 2.7 2.7 2.7 2.7	$ \begin{array}{c} 10 \\ -10 \\ -7 \\ 10 \\ -10 \\ 10 \\ -9 \\ 10 \end{array} $	1.0 x 1.0 x 1.0 x 1.0 x	106 106 105 105	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	10^{-5} 10^{-5} 10^{-5} 10^{-6}
37 38 39 40	Gallium (31) Ga-67 Ga-68 Ga-72	1.0 x 1.0 x 1.0 x	: 10 ² : 10 ¹ : 10 ¹	2.7 x 2.7 x 2.7 x	$ \begin{array}{c} 10 \\ -9 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \end{array} $	1.0 x 1.0 x 1.0 x	105 105 105	2.7 x 2.7 x 2.7 x	$10^{-5}_{10-6}_{10-6}_{10}$
42 43 44 45 46	Gadolinium (6 Gd-146 Gd-148 Gd-153 Gd-159	4) 1.0 x 1.0 x 1.0 x 1.0 x	: 101 : 102 : 103 : 10	2.7 x 2.7 x 2.7 x 2.7 x	<pre> 10 -10 10 -10 10 -9 10 -8 10</pre>	1.0 x 1.0 x 1.0 x 1.0 x	106 104 107 106 106	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	$10^{-5}_{10-7}_{10-4}_{10-5}_{10}$
47 48 49 50 51 52	Germanium (32 Ge-68 Ge-71 Ge-77) 1.0 x 1.0 x 1.0 x	$ \begin{array}{c} 101 \\ 104 \\ 101 \\ 10 \end{array} $	2.7 x 2.7 x 2.7 x	$(10^{-10})^{-10}$ $(10^{-7})^{-10}$ $(10^{-10})^{-10}$	1.0 x 1.0 x 1.0 x	10 ⁵ 10 ⁸ 10 ⁵ 10	2.7 x 2.7 x 2.7 x	10^{-6}_{-3} 10^{-6}_{10}
53 54	Tritium (1) H-3 (T)	1.0 x	: 10 ⁶	2.7 >	× 10 ⁻⁵	1.0 x	10 ⁹	2.7 x	10 ⁻²

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1							
2	Hafnium (72)				10	-	-
3	Hf-172	1.0 2	(10^{\perp})	2.7	$x 10^{-10}$ 1	$.0 \times 10^{6}$	2.7×10^{-5}
4	Hf-175	1.0 2	(10^{2})	2.7	$\times 10^{-9}$ 1	$.0 \times 10^{6}$	2.7×10^{-5}
5	Hf-181	1.0 2	10^{\perp}	2.7	$\times 10^{-10}$ 1	$.0 \times 10^{6}$	2.7×10^{-5}
6	Hf-182	1.0 2	10^2	2.7	$\times 10^{-9}$ 1	.0 x 10 ⁶	2.7×10^{-5}
7							
8	Mercury (80)				10	-	
9	Hg-194	1.0 2	(10^{\perp})	2.7	$x 10^{-10}$ 1	$.0 \times 10^{\circ}$	2.7×10^{-5}
10	Hg-195m	1.0 2	(10^{2})	2.7	$x 10^{-9}$ 1	$.0 \times 10^{6}$	2.7×10^{-5}
11	Hg-197	1.0 2	(10^{2})	2.7	$x 10^{-9}$ 1	.0 x 10 c	2.7 x 10^{-4}
12	Hg-197m	1.0 2	(10^{2})	2.7	$x 10^{-9}$ 1	$.0 \times 10^{6}$	2.7×10^{-5}
13	Hg-203	1.0 2	10^{2}	2.7	$\times 10^{-9}$ 1	$.0 \times 10^{5}$	2.7×10^{-6}
14							
15	Holmium (67)		•		0		
16	Ho-166	1.0 :	(10^{3})	2.7	$x 10^{-0} 1$	$.0 \times 10^{5}$	2.7×10^{-6}
17	H0-166m	1.0 2	10^{\perp}	2.7	$\times 10^{-10}$ 1	.0 x 10 ⁰	2.7×10^{-5}
18							
19	Iodine (53)				•		
20	I-123	1.0	(10^{2})	2.7	$x 10^{-9}_{10} 1$	$.0 \times 10'_{c}$	2.7×10^{-4}
21	I-124	1.0	(10^{1})	2.7	$\times 10^{-10}$	$.0 \times 10^{0}$	2.7×10^{-5}
22	I-125	1.0 2	(10^{3})	2.7	$x 10^{-0}$ 1	$.0 \times 10^{\circ}_{c}$	2.7×10^{-5}
23	I-126	1.0 2	(10^{2})	2.7	$x 10^{-9}$ 1	$.0 \times 10^{0}$	2.7×10^{-5}
24	I-129	1.0 2	(10^{2})	2.7	$x 10^{-9}$ 1	$.0 \times 10^{5}$	2.7×10^{-0}
25	I-131	1.0	(10^{2})	2.7	$\times 10^{-9}$ 1	$.0 \times 10^{0}$	2.7×10^{-5}
26	I-132	1.0	(10^{1})	2.7	$x 10^{-10}$ 1	$.0 \times 10^{5}$	2.7×10^{-0}
27	I-133	1.0 2	(10^{1})	2.7	$\times 10^{-10}$ 1	$.0 \times 10^{0}$	2.7×10^{-5}
28	I-134	1.0 2	(10^{1})	2.7	$x 10^{-10}$ 1	$.0 \times 10^{5}$	2.7×10^{-0}
29	I-135	1.0 :	< 10 ¹	2.7	$\times 10^{-10}$ 1	.0 x 10 ⁰	2.7×10^{-5}
30							
31	Indium (49)				0	<i>c</i>	같은 사람의 가격을 높을 <mark>늘</mark>
32	In-111	1.0 2	(10^{2})	2.7	$\times 10^{-9}_{-0}$ 1	$.0 \times 10^{0}_{6}$	2.7×10^{-5}
33	In-113m	1.0 2	(10^{2})	2.7	$x 10_{-0}^{-9}$ 1	$.0 \times 10^{0}$	2.7×10^{-5}
34	In-114m	1.0 :	(10^{2})	2.7	$x 10_{-0}^{-9}$ 1	$.0 \times 10^{0}_{c}$	2.7×10^{-5}
35	In-115m	1.0 2	10^{2}	2.7	x 10 ⁻⁹ 1	.0 x 10 ⁰	2.7×10^{-5}
36							
37	Iridium (77)		,		_0	7	-1
38	Ir-189	1.0 2	(10^{2}_{1})	2.7	$x 10_{10}^{-1}$	$.0 \times 10_{6}^{\prime}$	$2.7 \times 10_{-5}$
39	Ir-190	1.0 :	(10^{\perp}_{1})	2.7	$\times 10^{-10}_{-10}$ 1	$.0 \times 10^{0}$	2.7×10^{-3}
40	Ir-192	1.0 2	(10^{+})	2.7	$x 10_{-0}^{-10} 1$	$.0 \times 10^{4}_{5}$	$2.7 \times 10_{-6}$
41	Ir-194	1.0 2	< 10 ⁴	2.7	x 10 ⁻³ 1	.0 x 10 [°]	2.7 x 10 °
42							
43	Potassium (19)	2		_0	6	_5
44	K-40	1.0 2	< 10 ² / ₂	2.7	$x 10_{-0}^{-1}$	$.0 \times 10^{6}_{6}$	$2.7 \times 10_{-5}$
45	K-42	1.0 2	< 10 ₁	2.7	$x 10_{10}$ 1	$.0 \times 10^{6}_{6}$	$2.7 \times 10_{-5}$
46	K-43	1.0 2	< 10 ⁻	2.7	x 10 ¹⁰ 1	.0 x 10	2.7 x 10
47							
48	Krypton (36)		1		-7	7	- Δ
49	Kr-81	1.0 2	< 10 ⁻	2.7	$\times 10_{-6}$ 1	$.0 \times 10'_{4}$	$2.7 \times 10_{-7}$
50	Kr-85	1.0 2	< 10 ²	2.7	$x 10_{-8}^{-0} 1$	$.0 \times 10^{-1}_{10}$	$2.7 \times 10_{-1}$
51	Kr-85m	1.0 2	× 105	2.7	$x 10_{-0}$ 1	$.0 \times 10^{-7}$	$2.7 \times 10_{-2}$
52	Kr-87	1.0 2	k 10 ⁻	2.7	x 10 1	.0 x 10	2.7 x 10 ²
53							
54	Lanthanum (57	')					

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1 2 3	La-137 La-140	1.0 1.0	x x	10 ³ 10 ¹	2.7 2.7	x x	10^{-8}_{10}	1.0 1.0	X X	10 ⁷ 10 ⁵	2.7 2.7	x x	10^{-4}_{-6}
4 5 6 7 8 9	Lutetium (71) Lu-172 Lu-173 Lu-174 Lu-174m Lu-177	1.0 1.0 1.0 1.0 1.0	x x x x x x	101 102 102 102 103 10	2.7 2.7 2.7 2.7 2.7 2.7	X X X X X X	$\begin{array}{c} -10\\ 10-9\\ 10-9\\ 10-9\\ 10-9\\ 10-8\\ 10\end{array}$	1.0 1.0 1.0 1.0 1.0	X X X X X X	107 107 107 107 107 107	2.7 2.7 2.7 2.7 2.7 2.7	x x x x x x	10^{-5}_{-4} $10^{-4}_{10^{-4}}$ $10^{-4}_{10^{-4}}$
10 11 12 13	Magnesium (12) Mg-28) 1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	10 ⁵	2.7	x	10 ⁻⁶
14	Manganese (25))		이는 동안은 것이다. 같은 것에서 이는 것이다.			-10			E			-6
15	Mn-52	1.0	x	101	2.7	X	10_{-7}^{-10}	1.0	X	100	2.7	х	10^{-0}_{-2}
16	Mn-53	1.0	x	10^{4}_{1}	2.7	x	10_{10}	1.0	X	105	2.7	X	10_{5}^{2}
17	Mn-54	1.0	x	101	2.7	X	10^{-10}_{-10}	1.0	х	105	2.7	х	10^{-5}_{-6}
18 19	Mn-56	1.0	x	101	2.7	x	10-10	1.0	x	105	2.7	х	10 ⁻⁰
20	Molvbdenum (4)	2)					•			•			_
21	Mo-93	í.0	x	10^{3}	2.7	х	10 8	1.0	x	10 6	2.7	x	10-3
22	Мо-99	1.0	x	102	2.7	x	10-9	1.0	x	106	2.7	X	10 ⁻⁵
23	Nitrogen (7)												
25	N-13	1.0	x	10 ²	2.7	x	10 ⁻⁹	1.0	x	10 ⁹	2.7	x	10 ⁻²
26													
27	Sodium (11)			88 4 - 88			-10			6			-5
28	Na-22	1.0	X	101	2.7	X	10_{-10}	1.0	Х	105	2.7	Х	10_{-6}
29	Na-24	1.0	X	10-	2.7	X	10 -0	1.0	X	10	2.7	X	10 0
30													
31	Niobium (41)			4			-7			7			-4
32	Nb-93m	1.0	X	10^{-1}_{1}	2.7	X	10_10	1.0	X	106	2.7	X	10_{-5}^{-1}
33	Nb-94	1.0	X	101	2.7	X	10_{-10}	1.0	Х	106	2.7	X	10_5
34	Nb-95	1.0	х	10^{+}_{1}	2.7	X	10_{-10}	1.0	x	106	2.7	x	10_{-5}
35	Nb-97	1.0	X	10	2.7	X	10-10	1.0	X	100	2.7	X	10_
27	Noodumium (60)												
20	Neouymiium (00) 1 0		102	07		10-9	т о		106	0 7		10 ⁻⁵
20	NG-14/	1.0	X :	102	2.1	X	10-9	1.0	X	¹⁰ ₁₀ 6	2.1	Х. 	$\frac{10}{10} - 5$
39	NG-149	Τ•Ο	x	τu	2.1	X	TO	Τ•Ο	X	TO	2.1	X	τu
40	Nickol (20)												
41 47	NICKEI (20)	л о		1.04	0 7		7 0-7			- 8	0 7		3
42	NI-59	1.0	х 	105	2.1	Х 	10-6	1.0	X	108	4.1	X	$\frac{10}{10} - 3$
43	N1-03	1.0	х 	101	2.1	X	10 - 10	1.0	X	106	2.1	X	$\frac{10}{10}$ - 5
44	N1-05	Τ.Ο	x	10	2.1	X	10	Τ•Ο	x	10	2.1	x	10
45	Nontunium (02)												
40	Neptunitum (93)	1 0		1.03	<u>л</u> -		10-8	1 0		1.07	о О П		10^{-4}
4/	ND 232	Τ•Ο	X	τU	2.1	X	TO	т.О	X	ΤU	2.1	x	τυ
40	NP-230	1 0	.	1.03	о п		10-8	1 0		107	0 7		10^{-4}
49	(SHOLT-TIAG)	т.О	X	τu	2.1	X	τU	Τ.Ο	X	TO	2.1	х	τU
20	NP-230	л <u>л</u>		· · 2			-9	1 0	. -	1.05	0 7		10-6
D T	(roud-tived)	T.0	X	τU	4.1	X	10-11	1.0	X	¹ 03	2./	X	10-8
5Z	ND-23/	1.0	Ň	. 2	2.1	X	10-9	1.0	X	107	2.7	х	$\frac{10}{10} - 4$
53	мр-239	T•0	X	τu	2.1	X	τU	⊥. 0	X	TO	2.7	х	TO
54													

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1 2 3 4 5 6 7	Osmium (76) Os-185 Os-191 Os-191m Os-193 Os-194	$1.0 \times 10^{1}_{2}$ $1.0 \times 10^{3}_{3}$ $1.0 \times 10^{2}_{2}$ $1.0 \times 10^{2}_{2}$ 1.0×10^{2}	$\begin{array}{ccccc} 2.7 & \times & 10 \begin{array}{c} -10 \\ 2.7 & \times & 10 \begin{array}{c} -9 \\ 1.0 \\ 2.7 & \times & 10 \begin{array}{c} -8 \\ 1.0 \\ 2.7 & \times & 10 \begin{array}{c} -9 \\ 2.7 & \times & 10 \end{array} \end{array}$	$ \begin{array}{c} x 10^{6} \\ x 107 \\ x 107 \\ x 106 \\ x 105 \\ x 10 \end{array} $	2.7×10^{-5} 2.7×10^{-4} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-6} 2.7×10^{-6}
, 9 10 11	Phosphorus (1) P-32 P-33	5) 1.0 x 10^3_5 1.0 x 10 ⁵	$\begin{array}{ccc} 2.7 \times 10^{-8} & 1.0 \\ 2.7 \times 10^{-6} & 1.0 \\ 1.0 \end{array}$	$1 \times 10^{5}_{8}$ 1×10^{8}	2.7×10^{-6} 2.7 x 10 ⁻³
12 13 14 15 16	Protactinium Pa-230 Pa-231 Pa-233	(91)1.0 x 1011.01.0 x 102	$\begin{array}{c} 2.7 \times 10^{-10} \\ 2.7 \times 10^{-11} \\ 2.7 \times 10^{-9} \\ 2.7 \times 10 \end{array}$) x 10 ⁶) x 103) x 107) x 10 ⁷	$2.7 \times 10^{-5}_{-8} \\ 2.7 \times 10^{-4}_{-4} \\ 2.7 \times 10^{-4}_{-4}$
17 18 19 20 21 22 23	Lead (82) Pb-201 Pb-202 Pb-203 Pb-205 Pb-210 Pb-210 Pb-212	$1.0 \times 10^{1}_{3} \\ 1.0 \times 10^{2}_{2} \\ 1.0 \times 10^{2}_{4} \\ 1.0 \times 10^{1}_{1} \\ 1.0 \times 10^{1$	$\begin{array}{cccccc} 2.7 \times 10 \begin{array}{c} -10 \\ 2.7 \times 10 \begin{array}{c} -8 \\ 2.7 \times 10 \begin{array}{c} -9 \\ 2.7 \times 10 \begin{array}{c} -7 \\ 2.7 \times 10 \begin{array}{c} -7 \\ 2.7 \times 10 \begin{array}{c} -10 \\ 2.7 \times 10 \begin{array}{c} -10 \\ 2.7 \times 10 \begin{array}{c} -10 \\ 1.0 \\ 2.7 \times 10 \end{array}$	$\begin{array}{c} x & 106 \\ x & 106 \\ x & 106 \\ x & 107 \\ x & 104 \\ x & 105 \\ x & 10 \end{array}$	$\begin{array}{r} -5 \\ 2.7 \times 10^{-5} \\ 2.7 \times 10^{-5} \\ 2.7 \times 10^{-5} \\ 2.7 \times 10^{-4} \\ 2.7 \times 10^{-7} \\ 2.7 \times 10^{-6} \\ 2.7 \times 10 \end{array}$
24 25 26 27 28 29	Palladium (46 Pd-103 Pd-107 Pd-109) $1.0 \times 10^{3}_{5}$ $1.0 \times 10^{3}_{3}$ 1.0×10^{3}	$\begin{array}{cccc} 2.7 \times 10^{-8} & 1.0 \\ 2.7 \times 10^{-6} & 1.0 \\ 2.7 \times 10^{-8} & 1.0 \\ 2.7 \times 10 & 1.0 \end{array}$) x 10 ⁸) x 10 ⁸) x 10 ⁶) x 10 ⁶	$2.7 \times 10^{-3} \\ 2.7 \times 10^{-3} \\ 2.7 \times 10^{-5} \\ 2.7 \times 10^{-5} $
29 30 31 32 33 34 35 36 37	Promethium (6 Pm-143 Pm-144 Pm-145 Pm-147 Pm-147 Pm-148m Pm-149 Pm-151	$\begin{array}{c} 1) & 2 \\ 1.0 \times 101 \\ 1.0 \times 103 \\ 1.0 \times 104 \\ 1.0 \times 101 \\ 1.0 \times 103 \\ 1.0 \times 103 \\ 1.0 \times 102 \\ 1.0 \times 102 \end{array}$	$\begin{array}{c} 2.7 \times 10 \begin{array}{c} -9 \\ 2.7 \times 10 \begin{array}{c} -10 \\ 2.7 \times 10 \begin{array}{c} -8 \\ 2.7 \times 10 \begin{array}{c} -7 \\ 2.7 \times 10 \end{array} \begin{array}{c} 1.0 \\ 2.7 \times 10 \begin{array}{c} -7 \\ 2.7 \times 10 \end{array} \begin{array}{c} 1.0 \\ 2.7 \times 10 \begin{array}{c} -8 \\ 2.7 \times 10 \end{array} \begin{array}{c} -8 \\ 2.7 \times 10 \end{array}$	$\begin{array}{c} x & 106 \\ x & 107 \\ x & 107 \\ x & 107 \\ x & 106 \end{array}$	2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-4} 2.7×10^{-4} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5}
38 39 40 41	Polonium (84) Po-210	1.0 x 10 ¹	2.7×10^{-10} 1.0) x 10 ⁴	2.7×10^{-7}
42 43 44 45	Praseodymium Pr-142 Pr-143	(59) 1.0 x 10 ² 1.0 x 10 ⁴ 1.0 x 10 ⁴	$\begin{array}{cccc} 2.7 \times 10^{-9} & 1.0 \\ 2.7 \times 10^{-7} & 1.0 \\ \end{array}$	$) \times 10^{5}$ $) \times 10^{6}$	2.7×10^{-6} 2.7 x 10
46 47 48 49 50 51 52 53 54	Platinum (78) Pt-188 Pt-191 Pt-193 Pt-193m Pt-195m Pt-197 Pt-197m	$1.0 \times 10^{1}_{2}$ $1.0 \times 10^{2}_{4}$ $1.0 \times 10^{3}_{3}$ $1.0 \times 10^{2}_{2}$ $1.0 \times 10^{3}_{3}$ $1.0 \times 10^{2}_{2}$ $1.0 \times 10^{2}_{3}$	$\begin{array}{c} -10\\ 2.7 \times 10_{-9}\\ 2.7 \times 10_{-7}\\ 2.7 \times 10_{-8}\\ 2.7 \times 10_{-9}\\ 2.7 \times 10_{-9}\\ 2.7 \times 10_{-9}\\ 2.7 \times 10_{-8}\\ 2.7 \times 10_{-9}\\ 2.7 \times 10_{-9}\\ 2.7 \times 10\\ 2.7 \times 10\\ 2.7 \times 10\\ \end{array}$	$\begin{array}{c} x & 106 \\ x & 107 \\ x & 107 \\ x & 107 \\ x & 106 \end{array}$	$\begin{array}{c} 2.7 \times 10^{-5} \\ 2.7 \times 10^{-5} \\ 2.7 \times 10^{-4} \\ 2.7 \times 10^{-4} \\ 2.7 \times 10^{-5} \\ 2.7 \times 10^{-5} \\ 2.7 \times 10^{-5} \\ 2.7 \times 10^{-5} \\ 2.7 \times 10 \end{array}$

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1 2 3 4 5 6 7 8 9	Plutonium (94 Pu-236 Pu-237 Pu-238 Pu-239 Pu-240 Pu-241 Pu-242 Pu-244) 1.0 x 1.0 x 1.0 1.0 1.0 x 1.0 1.0	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$.7 x .7 x .7 x .7 x .7 x .7 x .7 x .7 x	$\begin{array}{ccccccc} & -10 & & 1.0 \\ 10 & -8 & & 1.0 \\ 10 & -11 & & 1.0 \\ 10 & -11 & & 1.0 \\ 10 & -11 & & 1.0 \\ 10 & -11 & & 1.0 \\ 10 & -11 & & 1.0 \\ 10 & & & 1.0 \end{array}$	$\begin{array}{c} x & 10^{4} \\ x & 10^{7} \\ x & 10^{4} \\ x & 10^{3} \\ x & 10^{3} \\ x & 10^{5} \\ x & 10^{4} \\ x & 10^{4} \\ x & 10^{4} \end{array}$	2.7×10^{-7} $2.7 \times 10_{-4}$ $2.7 \times 10_{-7}$ $2.7 \times 10_{-7}$ $2.7 \times 10_{-8}$ $2.7 \times 10_{-6}$ $2.7 \times 10_{-7}$ $2.7 \times 10_{-7}$ $2.7 \times 10_{-7}$ $2.7 \times 10_{-7}$
10 11 12 13 14 15 16 17	Radium _a (88) Ra-223a Ra-224 Ra-225 Ra-226a Ra-228 Ra-228	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	$\begin{array}{cccc} 10&2&&&\\ 10&1&&2\\ 10&2&&2\\ 10&1&&2\\ 10&1&&2\\ 10&&&2 \end{array}$.7 x .7 x .7 x .7 x .7 x	$\begin{array}{cccc} 10 & -9 & 1.0 \\ 10 & -10 & 1.0 \\ 10 & -9 & 1.0 \\ 10 & -10 & 1.0 \\ 10 & -10 & 1.0 \\ 10 & 1.0 \end{array}$	$ \begin{array}{c} x & 105 \\ x & 105 \\ x & 104 \\ x & 105 \\ x & 105 \\ x & 10 \end{array} $	2.7×10^{-6} 2.7×10^{-6} 2.7×10^{-7} 2.7×10^{-7} 2.7×10^{-6} 2.7×10^{-6}
18 19 20 21 22 23 24 25	Rubidium (37) Rb-81 Rb-83 Rb-84 Rb-86 Rb-87 Rb (nat)	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	$\begin{array}{ccccccc} 10&2&2\\ 10&2&2\\ 10&2&2\\ 10&2&2\\ 10&4&2\\ 10&4&2\\ 10&4&2\\ 10&&2 \end{array}$.7 x .7 x .7 x .7 x .7 x .7 x .7 x	$\begin{array}{cccc} 10 & -10 & 1.0 \\ 10 & -9 & 1.0 \\ 10 & -10 & 1.0 \\ 10 & -9 & 1.0 \\ 10 & -7 & 1.0 \\ 10 & -7 & 1.0 \\ 10 & 1.0 \end{array}$	x 106 x 106 x 105 x 107 x 107 x 107 x 107	2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-6} 2.7×10^{-4} 2.7×10^{-4} 2.7×10^{-4}
26 27 28 29 30 31 32 33	Rhenium (75) Re-184 Re-184m Re-186 Re-187 Re-188 Re-189 Re (nat)	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$.7 x .7 x .7 x .7 x .7 x .7 x .7 x .7 x	$\begin{array}{c} -10 \\ 10 -9 \\ 10 -8 \\ 10 -5 \\ 10 -9 \\ 10 -9 \\ 10 -9 \\ 10 -9 \\ 10 -5 \\ 10 \end{array}$	x 106 x 106 x 109 x 109 x 105 x 106 x 109 x 109 x 10	2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-2} 2.7×10^{-6} 2.7×10^{-5} 2.7×10^{-2}
34 35 36 37 38 39 40 41 42	Rhodium (45) Rh-99 Rh-101 Rh-102 Rh-102m Rh-103m Rh-105	1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$.7 x .7 x .7 x .7 x .7 x .7 x .7 x	$\begin{array}{cccc} 10 & -10 & 1.0 \\ 10 & -9 & 1.0 \\ 10 & -10 & 1.0 \\ 10 & -9 & 1.0 \\ 10 & -7 & 1.0 \\ 10 & -9 & 1.0 \\ 10 & 1.0 \end{array}$	$\begin{array}{c} x \ 10^{6} \\ x \ 10^{6} \\ x \ 10^{6} \\ x \ 10^{8} \\ x \ 10^{7} \\ x \ 10^{7} \end{array}$	2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-5} 2.7×10^{-3} 2.7×10^{-4}
43 44	Radon (86) Rn-222 ^a	1.0 x	10 ¹ 2	.7 x	10 ⁻¹⁰ 1.0	x 10 ⁸	2.7×10^{-3}
45 46 47 48 49 50	Ruthenium (44 Ru-97 Ru-103 Ru-105 Ru-106 ^a) 1.0 x 1.0 x 1.0 x 1.0 x	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$.7 x .7 x .7 x .7 x .7 x	$\begin{array}{cccc} 10 & -9 & 1.0 \\ 10 & -9 & 1.0 \\ 10 & -10 & 1.0 \\ 10 & -9 & 1.0 \\ 10 & 1.0 \end{array}$	x 10 ⁷ x 10 ⁶ x 10 ⁶ x 10 ⁵ x 10 ⁵	2.7×10^{-4} 2.7 x 10^{-5} 2.7 x 10^{-5} 2.7 x 10^{-6} 2.7 x 10^{-6}
52 53 54	Sulfur (16) S-35	1.0 x	10 ⁵ 2	•7 x	10 ⁻⁶ 1.0	x 10 ⁸	2.7 x 10^{-3}

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1 2 3 4 5 6	Antimony (51) Sb-122 Sb-124 Sb-125 Sb-126	1.0 2 1.0 2 1.0 2	x 101 x 102 x 101 x 101 x 10	2.7 2.7 2.7 2.7	x 10 x 10 x 10 x 10 x 10	-9 -10 -9 -10	1.0 1.0 1.0 1.0	x 106 x 106 x 105 x 105	2.7 2 2.7 2 2.7 2 2.7 2	
7 8 9 10 11 12	Scandium (21) Sc-44 Sc-46 Sc-47 Sc-48	1.0 2 1.0 2 1.0 2	$\begin{array}{c} 101 \\ 102 \\ 102 \\ 101 \\ 101 \\ 10 \end{array}$	2.7 2.7 2.7 2.7 2.7	x 10 x 10 x 10 x 10 x 10	-10 -10 -9 -10	1.0 1.0 1.0 1.0	x 10 ⁵ x 106 x 106 x 105 x 10	2.7 2 2.7 2 2.7 2 2.7 2	$ 10^{-6} 10^{-5} 10^{-5} 10^{-5} 10^{-6} 10^{-6} $
13 14 15 16	Selenium (34) Se-75 Se-79	1.0 3	$\begin{array}{c} 10\\ 10\\ 10\end{array}^2$	2.7 2.7	x 10 x 10	-9 -7	1.0 1.0	x 10 ⁶ x 10 ⁷	2.7 x 2.7 x	10^{-5}_{-4}
17 18 19 20	Silicon (14) Si-31 Si-32	1.0 2	$\begin{array}{c} 10^{3} \\ 10^{3} \\ 10 \end{array}$	2.7 2.7	x 10 x 10	-8 -8	1.0 1.0	x 10 ⁶ x 10 ⁶	2.7 x 2.7 x	10^{-5}_{-5}
21 22 23 24 25 26	Samarium (62) Sm-145 Sm-147 Sm-151 Sm-153	1.0 x 1.0 x 1.0 x	x 101 x 104 x 102 x 102	2.7 2.7 2.7 2.7 2.7	x 10 x 10 x 10 x 10 x 10	-9 -10 -7 -9	1.0 1.0 1.0	x 107 x 104 x 108 x 106 x 10	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	
27 28 29 30 31 32 33 34 35	Tin (50) Sn-113 Sn-117m Sn-119m Sn-121m Sn-123 Sn-125 Sn-126	1.0 > 1.0 > 1.0 > 1.0 > 1.0 > 1.0 >	$\begin{array}{c} 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\$	2.7 2.7 2.7 2.7 2.7 2.7 2.7 2.7	x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10	-8 -9 -8 -8 -8 -9 -10	1.0 1.0 1.0 1.0 1.0 1.0	x 107 x 107 x 107 x 107 x 106 x 105 x 105 x 105 x 10	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	$ \begin{array}{c} 10 \\ $
36 37 38 39 40 41 42 43 44	Strontium (38 Sr-82 Sr-85 Sr-85m Sr-87m Sr-87m Sr-90 Sr-90 Sr-91 Sr-92) 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	x 10 ¹ x 10 ² x 10 ² x 10 ³ x 10 ³ x 10 ² x 10 ¹ x 10 ¹ x 10 ¹	2.7 2.7 2.7 2.7 2.7 2.7 2.7 2.7 2.7	x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10	-10 -9 -9 -9 -8 -9 -10 -10	1.0 1.0 1.0 1.0 1.0 1.0 1.0	$ \begin{array}{c} x & 106 \\ x & 107 \\ x & 106 \\ x & 106 \\ x & 104 \\ x & 105 \\ x & 106 \\ x & 106 \\ x & 10 \end{array} $	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	$ \begin{array}{c} 10-5\\ 10-4\\ 10-5\\ 10-5\\ 10-5\\ 10-7\\ 10-6\\ 10-5\\ 10-5\\ 10 \end{array} $
45 46 47 48	Tritium (l) T (H-3)	1.0 %	: 10 ⁶	2.7	x 10	-5	1.0	x 10 ⁹	2.7 x	10 ⁻²
49 50 51 52 53 54	Tantalum (73) Ta-178 (long lived) Ta-179 Ta-182	1.0 x 1.0 x 1.0 x	: 10 ¹ : 10 ³ : 10 ¹	2.7 2.7 2.7	x 10 x 10 x 10	-10 -8 -10	1.0 1.0 1.0	x 10 ⁶ x 107 x 104 x 10	2.7 x 2.7 x 2.7 x	10^{-5}_{-4} 10^{-7}_{-7}

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1 2 3 4 5	Terbium (65) Tb-157 Tb-158 Tb-160	1.0 x 1.0 x 1.0 x	101 101 101	2.7 x 2.7 x 2.7 x	$\begin{array}{c} 10^{-7} \\ 10^{-10} \\ 10^{-10} \\ 10 \end{array}$.0 x .0 x .0 x	107 106 106 10	2.7 2.7 2.7	x 10-4 x 10-5 x 10-5 x 10
6 7 8 9 10 11 12 13 14 15	Technetium (4 Tc-95m Tc-96 Tc-96m Tc-97 Tc-97 Tc-97m Tc-98 Tc-99 Tc-99	3) 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	101 103 103 103 101 104 102 10	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	$\begin{array}{cccc} -10 & 1 \\ 10 -10 & 1 \\ 10 -8 & 1 \\ 10 -8 & 1 \\ 10 -8 & 1 \\ 10 -10 & 1 \\ 10 -10 & 1 \\ 10 -7 & 1 \\ 10 -9 & 1 \\ 10 & 1 \end{array}$	0 x 0 x 0 x 0 x 0 x 0 x 0 x	106 107 108 107 106 107 107	2.7 2.7 2.7 2.7 2.7 2.7 2.7 2.7 2.7 2.7	$ \begin{array}{c} x & 10 \\ x \\ x & 10 \\ x \\ x & 10 \\ x \\ x \\ x \\ 10 \\ 4 \\ x \\ 10 \\ 4 \end{array} $
16 17 18 19 20 21 22 23 24 25 26 27	Tellurium (52 Te-121 Te-121m Te-123m Te-125m Te-125m Te-127 Te-127 Te-129 Te-129 Te-129m Te-131m Te-131m) 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	101 102 103 103 103 103 103 103 101 102 10	2.7 x 2.7 x	10-9 1 10-9 1 10-8 1 10-8 1 10-9 1 10-8 1 10-9 1 10-9 1 10-9 1 10-9 1 10-9 1 10-9 1 10-9 1 10-9 1 10-9 1 10-9 1 10<-9	.0 x .0 x .0 x .0 x .0 x .0 x .0 x .0 x	105 107 107 106 106 106 106 106 106	2.7 2 2.7 2	$ \begin{array}{c} & -5 \\ & 10 - 6 \\ & 10 - 4 \\ & 10 - 4 \\ & 10 - 5 \\ & 10 - 5 \\ & 10 - 5 \\ & 10 - 5 \\ & 10 - 5 \\ & 10 - 5 \\ & 10 - 4 \\ & 10 \\ & 10 \end{array} $
28 29 30 31 32 33 34 35 36	Thorium (90) Th-227 Th-228a Th-229a Th-230 Th-231 Th-231 Th-232 Th-234 Th (nat) ^a	1.0 x 1.0 1.0 1.0 x 1.0 x 1.0 x 1.0 x 1.0 x	10 ¹ 10 ³ 101 103	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	$\begin{array}{c} 10 \\ 10 \\ -11 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 $.0 x .0 x .0 x .0 x .0 x .0 x .0 x .0 x	$104 \\ 103 \\ 104 \\ 107 \\ 104 \\ 105 \\ 103 \\ 10$	2.7 2 2.7 2 2.7 2 2.7 2 2.7 2 2.7 2 2.7 2 2.7 2 2.7 2	$ \begin{array}{c} & 10 \\ & 10 \\ & 10 \\ & 10 \\ & 10 \\ & 10 \\ & 10 \\ & 10 \\ & 10 \\ & 10 \\ & 10 \\ & 6 \\ & 10 \\ & 8 \\ & 10 \end{array} $
38 39 40	Titanium (22) Ti-44	1.0 x	101	2.7 x	10 ⁻¹⁰ 1	.0 x	10 ⁵	2.7 3	x 10 ⁻⁶
41 42 43 44 45 46	Thallium (81) T1-200 T1-201 T1-202 T1-204	1.0 x 1.0 x 1.0 x 1.0 x	101 102 102 104 10	2.7 x 2.7 x 2.7 x 2.7 x 2.7 x	10^{-10}_{-9} 1 10_9 1 10_7 1 10_7 1	.0 x .0 x .0 x .0 x	106 106 106 104 10	2.7 2 2.7 2 2.7 2 2.7 2	
47 48 49 50 51	Thulium (69) Tm-167 Tm-170 Tm-171	1.0 x 1.0 x 1.0 x	102 103 104 10	2.7 x 2.7 x 2.7 x	10-9 1 10-8 1 10-7 1 10 1	.0 x .0 x .0 x	$10^{6}_{10}_{10}_{8}_{10}$	2.7 x 2.7 x 2.7 x	$\begin{array}{c} 10^{-5} \\ 10^{-5} \\ 10^{-3} \\ 10 \end{array}$
52 53 54	Uranium (92) U-230 (fast lung absorp-						ч.		

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1 2	tion) ^{a,b} U-230 (medium	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	10 ⁵	2.7	x	10-6
3 4 5	lung absorp- tion) U-230 (slow	1.0	X	10 ¹	2.7	x	10-10	1.0	x	104	2.7	x	10 ⁻⁷
6 7 8	lung absorp- tion) U-232 (fast	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	104	2.7	x	10 ⁻⁷
9 10 11	lung absorp- tion) U-232 (medium	1.0			2.7	x	10 ⁻¹¹	1.0	x	10 ³	2.7	x	10 ⁻⁸
12 13 14	lung absorp- tion) U-232 (slow	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	104	2.7	x	10 ⁻⁷
15 16 17	lung absorp- tion) U-233 (fast	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	10 ⁴	2.7	x	10 ⁻⁷
18 19 20	lung absorp- tion) U-233 (medium	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	104	2.7	x	10 ⁻⁷
21 22 23	lung absorp- tion) U-233 (slow	1.0	x	10 ²	2.7	x	10 ⁻⁹	1.0	x	10 ⁵	2.7	x	10 ⁻⁶
24 25 26	tion) U-234 (fast	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	10 ⁵	2.7	x	10 ⁻⁶
27 28 29 20	tion) U-234 (medium	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	104	2.7	x	10 ⁻⁷
31 32 33	tion) U-234 (slow	1.0	x	10 ²	2.7	x	10 ⁻⁹	1.0	x	10 ⁵	2.7	x	10 ⁻⁶
34 35 36	tion) U-235 (all lung absorptio	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	10 ⁵	2.7	x	10 ⁻⁶
37 38 39	types) U-236 (fast lung absorp-	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	104	2.7	x	10 ⁻⁷
40 41 42	tion) U-236 (medium lung absorp-	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	10 ⁴	2.7	x	10 ⁻⁷
43 44 45	tion) U-236 (slow lung absorp-	1.0	x	10 ²	2.7	x	10 ⁻⁹	1.0	x	10 ⁵	2.7	x	10 ⁻⁶
46 47 48	tion) U-238 (all lung absorptio	1.0	x	10 ¹	2.7	x	10 ⁻¹⁰	1.0	x	104	2.7	x	10 ⁻⁷
49 50 51	types) ^{a,b,c,d} U (nat) ^a U (enriched	1.0 1.0	x	10 ¹	2.7 2.7	x x	10^{-10}_{10}	1.0 1.0	X X	$10\frac{4}{10}$	2.7 2.7	X X	10^{-7}_{-8}
52 53 54	to 20% or less) U (dep)	1.0 1.0			2.7 2.7	x x	$10^{-11}_{10^{-11}}$	1.0 1.0	x x	$10^{3}_{10^{3}}$	2.7	X X	10 ⁻⁸ 10 ⁻⁸
					(51		Approve	d k	y Revisor			

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1									
2	Vanadium (23)					E		c
3	V-48	1.0 :	$\times 10^{\perp}$	2.7	$x 10^{-10}_{-7}$	1.0	$\times 10^{3}$	2.7 x	10 0
4	V-49	1.0 :	x 10 ⁴	2.7	$x 10^{-7}$	1.0	x 10'	2.7 x	10 4
5									
6	Tungsten (74)			-10		c		
7	W-178	1.0 :	$x 10^{+}_{2}$	2.7	$x 10_{0}^{-10}$	1.0	$\times 10^{0}_{7}$	2.7 x	10^{-5}_{-4}
8	W-181	1.0 :	$\times 10^{3}_{\Lambda}$	2.7	$x \ 10_{-7}^{-0}$	1.0	$x 10'_{7}$	2.7 x	10^{-4}_{-4}
9	W-185	1.0 :	$x 10^{-1}_{2}$	2.7	$x 10_{-0}^{-1}$	1.0	$x 10_{c}^{\prime}$	2.7 x	10^{-4}_{-5}
10	W-187	1.0 :	x 105	2.7	$x 10_{-0}$	1.0	$x 10_{5}^{0}$	2.7 x	10^{-5}_{-6}
11	W-188	1.0 :	x 10 ⁴	2.7	x 10 ⁻⁵	1.0	x 10 ⁷	2.7 x	10 0
12									
13	Xenon (54)		9		-0		a		_2
14	Xe-122	1.0 :	$x 10^{2}_{2}$	2.7	$x 10_{-0}$	1.0	$x 10^{9}$	2.7 x	10^{-2}_{-2}
15	Xe-123	1.0 :	$x 10^{2}_{3}$	2.7	$x 10_{-8}^{-9}$	1.0	$x 10_{5}^{9}$	2.7 x	10^{-2}_{-6}
16	Xe-127	1.0 :	$x 10^{3}$	2.7	$x 10_{-7}^{-0}$	1.0	$x 10^{3}_{4}$	2.7 x	10^{-0}_{-7}
17	Xe-131m	1.0 :	$x 10\frac{1}{3}$	2.7	$x 10_{-8}$	1.0	$x 10^{4}_{4}$	2.7 x	10_7
18	Xe-133	1.0 :	$x 10^{3}_{3}$	2.7	$x 10_{8}^{-0}$	1.0	$x 10^{4}_{10}$	2.7 x	10_{1}^{-1}
19	Xe-135	1.0 :	x 10 J	2.7	x 10 °	1.0	$x 10^{10}$	2.7 x	10 1
20									
21	Yttrium (3	39)			-10		6		-5
22	Y-87	1.0 :	x 10 ⁺	2.7	$x 10_{-10}$	1.0	$x 10_{6}^{0}$	2.7 x	10_{5}
23	Y-88	1.0 :	$\times 10\frac{1}{3}$	2.7	$x 10_{-8}^{+0}$	1.0	$x 10_{5}^{0}$	2.7 x	10_{-6}
24	Y-90	1.0 :	$\times 10^{3}$	2.7	$x 10_{-8}$	1.0	$x 10_{6}^{3}$	2.7 x	10_{-5}
25	Y-91	1.0 :	$\times 10^{\circ}_{2}$	2.7	$x 10_{q}$	1.0	$x 10_{6}^{\circ}$	2.7 x	10_{-5}
26	Y-91m	1.0 :	$\times 10^{-}_{2}$	2.7	$x 10_{-9}$	1.0	$\times 10^{\circ}_{5}$	2.7 x	10_{-6}
27	Y-92	1.0 :	$\times 10^{-}_{2}$	2.7	$x 10_{-9}$	1.0	$\times 10_5$	2.7 x	10_{-6}
28	Y-93	1.0 :	ĸ 10 ⁻	2.7	x 10 -	1.0	x 10 ~	2.7 x	10 0
29									
30	Ytterbium	(70)	2		9		- 7		-4
31	YD-169	1.0 2	^k 10 ₃	2.7	$x 10_{-8}$	1.0		2.7 x	10_{-4}
32	YD-1/5	1.0 3	к ТО	2.7	x 10	1.0	x 10	2.7 x	10 -
33	7: (20)								
34	Zinc(30)	7 0	- 1		10-10		1.6		5
35	2n-65		$\frac{10}{104}$	2./	$\frac{10}{10}$	1.0	$\frac{10}{106}$	2.7 X	10 - 5
20	211-09 Zo 60m	1.0	K 102	2.1	$x \pm 0 - 9$	1.0	x 106	2./ X	10 - 5
20	211-0911	Ι Ο 2	K TU	2.1	X 10	1.U	X IU	2./ X	Τ0
30	7 i roon ium	(10)							
10	ZTICOIIIUII		· 10 ²	2 7	v 10 ⁻⁹	1 0	. 106	7 74	10-5
40	7r-03a		; <u>10</u> 3	2.1	$\frac{10}{10} - 8$	1.0	$\frac{107}{107}$	2./X	$\frac{10}{10} - 4$
41	2r - 95	1.0		2.1	10 - 10	1.0	$\frac{10}{2}$	2./X	10-5
43	$\frac{a}{2r-97}a$	10		2.1	10 - 10	1.0	$ \frac{105}{210} $	2.1 4	$\frac{10}{10} - 6$
40	··· · /			4•1	~ IV	Τ•Ο	A TA	4./ A	то
45	a _{Parent nu}	clides ar	nd their	. prod	env incl	5e5u	in secu	lar	
46	equilibriu	m are lis	sted in	the f	ollowing	:	III SECU	141	
17	ara - 00	V-00							
4/	DI-90 7r-03	1-90 Nh-02-							
40	41-93 7r-07	NP-02							
47 50	41 - 2/	ND = 3/							
51	Ca = 1.37	R_{2}							
52	Ce-134	$J_{a} = 13/11$							
53	Ce-144	Pr-144							
	1. T.T. (1971)	ㅋㅋ 이야 하는 것 같아.							

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10/22/07 [REVISOR] SGS/CA AR3618 Ba-140 1 La-140 2 Bi-212 T1-208(0.36), Po-212(0.64) 3 Pb-210 Bi-210, Po-210 4 Pb-212 Bi-212, T1-208 (0.36), Po-212 (0.64) Rn-220 5 Po-216 Rn-222 Po-218, Pb-214, Bi-214, Po-214 6 7 Ra-223 Rn-219, Po-215, Pb-211, Bi-211, T1-207 8 Ra-224 Rn-220, Po-216, Pb-212, Bi-212, 9 T1-208 (0.36), Po-212 (0.64) 10 Ra-226 Rn-222, Po-218, Pb-214, Bi-214, Po-214, 11 Pb-210, Bi-210, Po-210 Ra-228 12 Ac-228 Th-226 Ra-222, Rn-218, Po-214 13 Ra-224, Rn-220, Po-216, Pb-212, 14 Th-228 15 Bi-212, T1-208 (0.36), Po-212 (0.64) Ra-225, Ac-225, Fr-221, At-217, 16 Th-229 17 Bi-213, Po-213, Pb-209 18 Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Th (nat) 19 Po-216, Pb-212, Bi-212, T1-208 (0.64) (0.36), Po-212 20 (0.64)21 Th-234 Pa-234m 22 U-230 Th-226, Ra-222, Rn-218, Po-214 23 U-232 Th-228, Ra-224, Rn-220, Po-216, Pb-212, 24 Bi-212, T1-208 (0.36), Po-212 (0.64) 25 U-235 Th-231 26 U-238 Th-234, Pa-234m Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, 27 U (nat) 28 Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210 29 U-240 Np-240m30 Np-237 Pa-233 31 Am-242mAm-242 32 Am-243 Np-239 33 ^bThese values apply only to compounds of uranium that take the 34 chemical form of UF_6 , UO_2F_2 and $UO_2(NO_3)_2$ in both normal and 35 36 accident conditions of transport. ^CThese values apply only to compounds of uranium that take the 37 chemical form of UO_3 , UF_4 , UCl_4 and hexavalent compounds in both 38 normal and accident conditions of transport. 39 ^dThese values apply to all compounds of uranium other than those 40 41 specified in notes b and c of this table. ^eThese values apply to unirradiated uranium only. 42 43 4731.0423 DETERMINATION OF A1 AND A2. 44 Subpart 1. **Generally.** Values of A_1 and A_2 for individual 45 radionuclides, which are the bases for many activity limits 46 elsewhere in this chapter, are given in part 4731.0422, subpart

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10/22/07 [REVISOR] SGS/CA AR3618 The curie (Ci) values specified are obtained by converting 1 la. 2 from the Terabecquerel (TBq) values. The Terabecquerel values 3 are the regulatory standard. The curie values are for information only and are not intended to be the regulatory 4 5 standard. Where values of A_1 and A_2 are unlimited, it is for 6 radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile 7 material. 8

9 Subp. 2. Individual radionuclides; not listed in part 10 4731.0422, subpart la. For individual radionuclides whose 11 identities are known, but which are not listed in part 12 4731.0422, subpart 1a, the A_1 and A_2 values contained in subpart 13 6 may be used. Otherwise, the licensee shall obtain prior 14 commissioner, NRC, or agreement state approval of the 15 radionuclides not listed in part 4731.0422, subpart la, before 16 shipping the material.

17 Subp. 2a. Individual radionuclides; not listed in part 18 4731.0422, subpart 3. For individual radionuclides whose 19 identities are known, but which are not listed in part 20 4731.0422, subpart 3, the exempt material activity concentration and exempt consignment activity values contained in subpart 6 21 22 may be used. Otherwise, the licensee shall obtain prior 23 commissioner, NRC, or agreement state approval of the exempt 24 material activity concentration and exempt consignment activity 25 values for radionuclides not listed in part 4731.0422, subpart 26 3, before shipping the material.

27 Subp. 2b. Prior approval. The licensee must submit

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requests for prior approval, described under subparts 2 and 2a,
 to the commissioner, NRC, or agreement state, according to this
 chapter.

4 Subp. 3. Radioactive decay chain. In the calculations of A_1 and A_2 for a radionuclide not in part 4731.0422, subpart la, 5 a single radioactive decay chain, in which radionuclides are 6 present in their naturally occurring proportions and in which no 7 daughter nuclide has a half-life longer than ten days or longer 8 9 than that of the parent nuclide, shall be considered as a single radionuclide. The activity to be taken into account and the A_1 10 11 and A₂ value to be applied shall be those corresponding to the 12 parent nuclide of the chain. In the case of radioactive decay 13 chains in which any daughter nuclide has a half-life longer than 14 ten days or greater than that of the parent radionuclide, the 15 parent and those daughter radionuclides shall be considered as mixtures of different radionuclides. 16

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

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

 $\sum \frac{B(i)}{A(i)} \leq 1$

22

27 where B(i) is the activity of radionuclide i and $A_1(i)$ is the 28 A_1 value for radionuclide i.

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

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 $\sum \frac{B(i)}{A(i)} \leq 1$

6 where B(i) is the activity of radionuclide i and $A_2(i)$ is the 7 A_2 value for radionuclide i.

8 C. Alternatively, an A₁ value for mixtures of special 9 form material may be determined as follows:

 A_1 for mixture = $\frac{1}{\sum_{i} \frac{f(i)}{A_1(i)}}$

17 where f(i) is the fraction of activity of radionuclide i in the 18 mixture and A₁(i) is the appropriate A₁ value for radionuclide i. 19 D. Alternatively, the A₂ value for mixtures of normal 20 form material may be determined as follows:

$$A_2$$
 for mixture = $\frac{1}{\sum_{i} \frac{f(i)}{A_2(i)}}$

27 28 where f(i) is the fraction of activity of radionuclide i in the 29 mixture and A₂(i) is the appropriate A₂ value for radionuclide i. 30 E. The exempt activity concentration for mixtures of 31 radionuclides may be determined as follows:

66

34 35 Exempt activity concentration for mixture = $\frac{1}{\sum_{i} \frac{f(i)}{[A](i)}}$ 37 38 39 where f(i) is the fraction of activity concentration of 40 radionuclide i in the mixture, and [A] is the activity

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1	concentration fo	or exempt ma	terial contai	ning radion	uclide i.
2	F. T	ne activity	limit for an	exempt cons	ignment for
3	mixtures of radi	lonuclides m	ay be determi	ned as foll	ows:
4 5 7 8 9 10 11	Exempt consignme where f(i) is th	ent activity ne fraction o	limit for mi of activity o	xture = $\frac{1}{\sum_{i}}$	$\frac{1}{f(i)}$ $ide i in the$
12	mixture, and A i	s the activ	ity limit for	exempt con	signments for
13	radionuclide i.				
14	Subp. 5. A	Activities un	n <mark>known.</mark> When	the identi	ty of each
15	radionuclide is	known, but	the indi v idua	l activitie	s of some of
16	the radionuclide	es are not ki	nown, the rad	ionuclides n	nay be
17	grouped and the	lowest A _l or	r A ₂ value, a	s appropria	te, for the
18	radionuclides in	each group	may be used	in applying	the formulas
19	in subpart 4. G	roups may be	e based on th	e total alpl	na activity
20	and the total be	ta/gamma aci	ivity when t	hese are kno	own, using
21	the lowest A _l or	A2 values	for the alpha	emitters an	nd beta/gamma
22	emitters.				
23	Subp. 6. G	eneral value	es for A _l and	A ₂ .	
24 25		1	j	A	2
26 27	Contents	(TBq)	(Ci)	(TBq)	(Ci)
28 29 30 31	Only beta- or gamma-emitting radionuclides are known to				
32 33	be present	1×10^{-1}	2.7×10^{0}	2×10^{-2}	5.4 x 10^{-1}
34 35 36	Only alpha- emitting radionuclides				
37	be present	2×10^{-1}	5.4 x 10^{0}	9×10^{-5}	2.4 x 10^{-3}
			ca Ap	proved by Revisor	

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1					
2	No relevant				
3	data are	,	^		_
4	available	1×10^{-3}	2.7 x 10^{-2}	9×10^{-5}	2.4 x 10^{-3}
6		Activity	Activity	Activity	Activity
7		concentra-	concentra-	limits for	limits for
8	Contents	tion for	tion for	exempt	exempt
9		exempt	exempt	consign-	consign-
10		material	material	ments	ments
11		(Bq/g)	(Ci/g)	(Bq)	(Ci)
12					
13	Only beta- or				
14	gamma-emitting				
15	radionuclides				
16	are known to be	2.1	10	4	7
1/	present	1 x 10	2.7 x 10	T X T0	2.7 x 10
10					
19	onitting				
20	radionualidad				
21	are known to be				
22	are known to be	1×10^{-1}	27×10^{-12}	$1 - 10^{3}$	27×10^{-8}
24		T & T0	2.7 A 10	T V TO	2/ 7 10
25	No relevant				
26	data are				
27	available	1×10^{-1}	2.7×10^{-12}	1×10^{3}	2.7×10^{-8}
28			사용은 가격 것은 것이다. 또한 것 사용은 것은 것이다. 가격 것이다.		
20					DEL
29	4/31.0455 QUALITY	ASSURANCE FU	JR TRANSPORT	ATION PACKAG	3ĽD.
30	The licensee,	certificate	e holder, and	d applicant	for a
21	acutificate of com				
21	Certificate of com		г сошрту місі	i the requi	Lements IOI
32	quality assurance	for transpor	rtation packa	ages in Code	e of Federal
22	Desvietiese title	10 7	1		
33	Regulations, title	IU, part /.	L, SUDPART H		
34	4731.0610 AUTHORIZ	ED USE OF SI	PECIAL NUCLEA	AR MATERIAL	
			성 전 전 전 전 전 전 전 전 전 전 전 2019년 - 1919년 - 1919년 - 1919년 2019년 - 1919년 - 19		
35	Subpart 1. A	uthority und	der license.	A licensee	e must
26	confine the licens		tion and was	of special	
20	contine the ficens	ee s posses:	ston and use	or special	nuclear
37	material to the lo	cations and	purposes au	horized in	the
	· 이상				
38	license. Except a	s otherwise	provided in	the license	e, a license
39	issued under this	chapter car	ries with it	the right t	co receive
10	Atitle to own and			and use set	aial
ΨU	LILLE LO, OWN, acq	urre, recel	ve, possess,	and use spe	:ctat

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1 nuclear material. Preparation for shipment and transport of
2 special nuclear material must be according to parts 4731.0400 to
3 4731.0455.

[For text of subp 2, see M.R.]

5 4731.0780 FINANCIAL ASSURANCE AND RECORD KEEPING FOR6 DECOMMISSIONING.

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[For text of subps 1 and 2, see M.R.] Subp. 3. Between ten mCi and 100 mCi.

9 A. An applicant for a specific license authorizing 10 possession and use of quantities of source material greater than 11 ten millicuries (370 MBq) but less than or equal to 100 12 millicuries (3.7 GBq) in a readily dispersible form must:

13 (1) submit a decommissioning funding plan14 according to subpart 4; or

15 (2) submit a certification that financial
16 assurance for decommissioning has been provided in the amount of
17 \$225,000, using one of the methods described under subpart 5.
18 The certification may state that the appropriate assurance will
19 be obtained after the application has been approved and the
20 license issued but before the receipt of licensed material.

B. If an applicant defers execution of the financial instrument until after the license has been issued, a signed original of the financial instrument obtained to satisfy the requirements of subpart 5 must be submitted to the commissioner before receipt of licensed material.

26 C. If an applicant does not defer execution of the 27 financial instrument, the applicant must submit to the

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10/22/07 [REVISOR] SGS/CA AR3618 1 commissioner, as part of the certification, a signed original of 2 the financial instrument obtained to satisfy the requirements of 3 subpart 5.

D. A holder of a specific license:

5 (1) issued on or after July 27, 1990, which is
6 covered by subpart 1 or 2, shall provide financial assurance for
7 decommissioning according to this part; and

8 (2) issued before July 27, 1990, and of a type described in subpart 1 shall submit a decommissioning funding 9 10 plan as described in subpart 5 or a certification of financial 11 assurance for decommissioning in an amount at least equal to 12 \$1,125,000 according to this part. If the licensee submits the 13 certificate of financial assurance rather than a decommissioning 14 funding plan, the licensee shall include a decommissioning 15 funding plan in any application for license renewal. Licensees 16 required to submit the \$1,125,000 amount must do so by December 17 2, 2004.

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[For text of subps 4 to 6, see M.R.]

19 4731.1010 POSTING WORKER NOTICES.

20

[For text of subpart 1, see M.R.]

Subp. 2. Notice to employees. Each licensee and each applicant for a specific license must prominently post a MDH Form 3, "Notice to Employees," provided by the commissioner. A copy of any revision of the Notice to Employees must be posted within 30 days of receiving the revised notice from the commissioner. Copies of the Notice to Employees may be obtained by writing to the Radioactive Materials Unit, Minnesota

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1	Department of Health, 625 Robert Street N, P.O. Box 64975, St.	
2	Paul, MN 55164-0975.	
3	[For text of subps 3 and 4, see M.R.]	
	가 있는 것 같은 것은 것을 알려졌다. 것은 것을 가지 않는 것을 가지 않는 것이다. 가지 않는 것은 것은 것은 것은 것은 것은 것은 것은 것은 같은 것 같은 것은	
4	4731.2600 REPORTS; THEFT OR LOSS OF LICENSED MATERIAL.	
5	Subpart 1. Telephone reports.	
6	A. A licensee must report by telephone as follows:	
7	(1) immediately after its occurrence becomes	
8	known to the licensee, any lost, stolen, or missing licensed	
9	material in an aggregate quantity equal to or greater than 1,000	
10	times the quantity under part 4731.2800, under such	
11	circumstances that it appears to the licensee that an exposure	
12	could result to persons in unrestricted areas; or	
13	(2) within 30 days after an occurrence of any	
14	lost, stolen, or missing licensed material becomes known to the	
15	licensee, all licensed material in a quantity greater than ten	
16	times the quantity under part 4731.2800 that is still missing at	
17	the time of the report.	
18	[For text of item B, see M.R.]	
19	[For text of subps 2 to 5, see M.R.]	
20	4721 2000 OUNMENTED OF LIGENOED NAMEDIAL DEOUTDING LADELING	
20	4751.2800 QUANTITIES OF LICENSED MATERIAL REQUIRING LABELING.	
21	[For text of subps 1 and 2, see M.R.]	
22	Subp. 3. Quantities requiring labeling.	
23	The following quantities of licensed material require	
24	labeling:	
25 26	Radionuclide Abbreviation Quantity	
27		
28	Hydrogen-3 H-3 L,000	
	71 Approved by Revisor	

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1			
2	Beryllium-7	Be-7	1,000
3	Beryllium-10	Be-10	1
4			
5	Carbon-11	C-11	1,000
6	Carbon-14	C-14	100
7			지원 아님께서 이 관람들은
8	Fluorine-18	F-18	1,000
9			
10	Sodium-22 Codium-24	Na-22	10
10	5001uii-24	Na-24	του.
12	Magnagium-28	Ma-28	100
14	Maynesium 20	MY ZO	± UU
15	Aluminum-26	A1-26	10
16			문화가 있는 것은 것은 것을 가지 않는 것을 통하는 것을 가지 않는 것을 통하는 것을 가지 않는 것을 같은 것을 수 없는 것을 것을 것을 하는 것을 것을 갖고 있다. 것을
17	Silicon-31	Si-31	1,000
18	Silicon-32	Si-32	1
19			
20	Phosphorus-32	P-32	<u>.</u>
21	Phosphorus-33	P-33	100
22	· 동물 동물 방법 방법 : 이 문 방법 : 이 있는 이 문 가지 않는 것을 가지 않는 것을 하는 것을 하는 것을 하는 것을 하는 것을 하는 것을 하는 것을 가지 않는 것을 하는 것을 하는 것을 하는 것을 하는 것을 하는 것을 하는 것을 가지 않는 것을 하는 것을 하는 것을 수가 있다. 가지 않는 것을 가지 않는 것을 가지 않는 것을 수가 있다. 가지 않는 것을 수가 없다. 가지 않는 것을 수가 있다. 하는 것을 수가 있다. 가지 않는 것을 수가 있다. 가지 않는 것을 수가 있다. 하는 것을 수가 있다. 가지 않는 것 이야? 것을 것 같이 않는 것을 것을 수가 있다. 것을 것을 수가 있다. 것을 것을 것 같이 않는 것을 수가 있다. 것을 것 같이 않는 것을 수가 있다. 것을 것 같이 않는 것을 것 같이 않는 것을 것 같이 않는 것을 수가 있다. 것을 것 같이 않는 것 하는 것 같이 않는 것 않 것 같이 않는 것 않는 것 같이 않는 것 같이 않는 것 같이 않는 것 같이 않는 것 않는 것 않는 것 않 것 같이 않는 것 않는		
23	Sulfur-35	S-35	100
24		61 6	· 같은 가지 가지 않는 것은 것 이 가지 않는 것이다. 같은 것은 것 같은 것은 것은 것 같은 것 같은 것 같은 것 같은 것
25	Chlorine 28	CT-30	
20	Chlorine=30	C1-30	1,000
28		61-35	Τ,ΟΟΟ
29	Argon-39	Ar-39	1.000
30	Argon-41	Ar-41	1,000
31			
32	Potassium-40	K-40	100
33	Potassium-42	K-42	1,000
34	Potassium-43	K-43	1,000
35	Potassium-44	K-44	1,000
36	Potassium-45	K-45	1,000
37	일일 같은 같은 것은 것은 것을 것을 알았는 것을 것을 했다.		
38	Calcium-41	Ca-41	100
39		Ca-45	100
40		La-4/	
41	Scandium-43	50-13	1 000
43	Scandium-44m	Sc-44m	100
44	Scandium-44	Sc-44	100
45	Scandium-46	Sc-46	10
46	Scandium-47	Sc-47	100
47	Scandium-48	Sc-48	100
48	Scandium-49	Sc-49	1,000
49			
50	Titanium-44	Ti-44	1
51	Titanium-45	Ti-45	1,000
52		[]]] : : : : : : : : : : : : : : : : : :	고 있는 것 같은 말을 들었다.
53	Vanadium-47	V-47	1,000
54	vanadium-48	V-48	100

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91				
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1 2	Vanadium-49	V-49		1,000
3	Chromium-48	Cr-48		1,000
4	Chromium-49	Cr-49		1,000
5	Chromium-51	Cr-51		1.000
6				
7	Manganese-51	Mn-51		1,000
8	Manganese-52m	Mn-52m		1,000
9	Manganese-52	Mn-52		100
10	Manganese-53	Mn-53		1.000
11	Manganese-54	Mn-54		100
12	Manganese-56	Mn-56		1.000
13				
14	Tron-52	Fe-52		100
15	Tron-55	Fe-55		100
16	Tron-59	Fe-59		ĪŎ
17	Tron-60	Fe-60		· · · · · · · · · · · · · · · · · · ·
18	같은 것은 것은 것은 것은 것이 있는 것은 것은 것을 알려요. 것은			
19	Cobalt-55	Co-55		100
20	Cobalt-56	Co-56		10
21	Cobalt-57	Co-57		100
22	Cobalt-58m	Co-58m		1,000
23	Cobalt-58	Co-58		100
24	Cobalt-60m	Co-60m		1,000
25	Cobalt-60	Co-60		1
26	Cobalt-61	Co-61		1,000
27	Cobalt-62m	Co-62m		1,000
28	: 알려야 같은 것 같은			
29	Nickel-56	Ni-56		100
30	Nickel-57	Ni-57		100
31	Nickel-59	Ni-59		100
32	Nickel-63	Ni-63		100
33	Nickel-65	Ni-65		1,000
34	Nickel-66	Ni-66		10
35				
36	Copper-60	Cu-60		1,000
37	Copper-61	Cu-61		1,000
38	Copper-64	Cu-64		1,000
39	Copper-67	Cu-67		1,000
40	사람성 관계 수 있는 것이 이상을 통하는 것 같은 것이 가지 않는 것을 통하여 있다. 특별 기사의 관계 이상 이상을 통하는 것은 것을 통하는 것을 통 			한 2018 <u>- 2</u> 12 - 212 -
41	Zinc-62	Zn-62		
42	Zinc-63	Zn-63		1,000
43	Zinc-65	Zn-65		10
44	Zinc-69m	Zn-69m		
45	Zinc-69	Zn-69		1,000
46	Zinc-71m	2n-/1m		1,000
47	Z1nc-/2	2n-/2		τ00
48	Colling_CE			1 000
47	Gallium-66	Ga-05 Ca-66		100
50	Gallium-67	Ga-00 Ga-67		1 000
52	Gallium-68	Ga = 07 Ga = 68		1,000
53	Gallium-70	Ga-70		1.000
54	Gallium-72	Ga-72		100
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1	Gallium-73	Ga-73		1,000
3	Germanium-66	Ge-66		1,000
4	Germanium-67	Ge-67		1,000
5	Germanium-68	Ge-68		10
6	Germanium-69	Ge-69		1,000
7	Germanium-71	Ge-71		1,000
8	Germanium-75	Ge-75		1,000
9	Germanium-77	Ge-77		1,000
10	Germanium-78	Ge-78		1,000
11	에 관계 위험 전통 전통 전통 것이다. 그는 것이다. 것은 것이다. 가지 않는 것이다. 그 것은 것은 것은 것은 것은 것은 것은 것이다. 것은 것은 것은 것이다. 같은 것은 것이다.			
12	Arsenic-69	As-69		1,000
13	Arsenic-70	As-70		1,000
14	Arsenic-71	As-71		100
15	Arsenic-72	As-72		100
16	Arsenic-73	As-73		100
17	Arsenic-74	As-74		100
18	Arsenic-76	As-76		100
19	Arsenic-77	As-77		100
20	Arsenic-78	As-78		1,000
21				
22	Selenium-70	Se-70		1,000
23	Selenium-73m	Se-73m		1,000
24	Selenium-73	Se-73		100
25	Selenium-75	Se-75		100
26	Selenium-79	Se-79		100
27	Selenium-81m	Se-81m		1,000
28	Selenium-81	Se-81		1,000
29	Selenium-83	Se-83		1,000
30	2012년 2월 일상은 한 것을 위한다. 가지 않는 것은 것은 가지 않는 것이다. 가지 않는 것이다. 1912년 2월 2012년 2월 201			
31	Bromine-74m	Br-74m		1,000
32	Bromine-74	Br-74		1,000
33	Bromine-75	Br-75		1,000
34	Bromine-76	Br-76		100
35	Bromine-77	Br-77		1,000
36	Bromine-80m	Br-80m		1,000
37	Bromine-80	Br-80		1,000
38	Bromine-82	Br-82		100
39	Bromine-83	Br-83		1,000
40	Bromine-84	Br-84		1,000
41				
42	Krypton-74	Kr-74		1,000
43	Krypton-76	Kr-76		1,000
44	Krypton-77	Kr-77		1,000
45	Krypton-79	Kr-79		1,000
46	Krypton-81	Kr-81		1,000
47	Krypton-83m	Kr-83m		1,000
48	Krypton-85m	Kr-85m		1,000
49	Krypton-85	Kr-85		1,000
50	Krypton-87	Kr-87		1,000
51	Krypton-88	Kr-88		1,000
52				
53	Rubidium-79	Rb-79		1,000
54	Rubidium-81m	Rb-81m		1,000

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1	Rubidium-81	Rb-81		1,000
2	Rubidium-82m	Rb-82m		1,000
3	Rubidium-83	Rb-83		100
4	Rubidium-84	Rb-84		100
5	Rubidium-86	Rb-86		100
6	Rubidium-87	Rb-87		100
7	Rubidium-88	Rb-88		1,000
8 9	Rubidium-89	Rb-89		1,000
10	Strontium-80	Sr-80		100
11	Strontium-81	Sr-81		1,000
12	Strontium-83	Sr-83		100
13	Strontium-85m	Sr-85m		1,000
14	Strontium-85	Sr-85		100
15	Strontium-87m	Sr-87m		1,000
16	Strontium-89	Sr-89		10
17	Strontium-90	Sr-90		0.1
18	Strontium-91	Sr-91		100
19	Strontium-92	Sr-92		100
20	활동화 공격 등 여기는 것 같은 것 같은 것 같을 것 같			
21	Yttrium-86m	Y-86m		1,000
22	Yttrium-86	Y-86		100
23	Yttrium-87	Y-87		100
24	Yttrium-88	Y-88		
25	Yttrium-90m	Y-90m		1,000
26	Yttrium-90	Y-90		
27	Yttrium-91m	Y-91m		1,000
28	Yttrium-91	X 02		01 01
29	YCCT1UM-92 Ytt=ium-02	1-92 V-02		100
21	YLLIIUM-93 V++rium-04	1-95 V-04		1 000
33 2T	Vttrium-05	1 94 V-05		1 000
22				1/000
34	Zirconium-86	Zr-86		100
35	Zirconium-88	Zr-88		10
36	Zirconium-89	Zr-89		100
37	Zirconium-93	Zr-93		
38	Zirconium-95	Zr-95		10
39	Zirconium-97	Zr-97		100
40				
41	Niobium-88	Nb-88		1,000
42	Niobium-89m (66 min)	Nb-89m		1,000
43	Niobium-89 (122 min)	Nb-89		1,000
44	Niobium-89	Nb-89		1,000
45	Niobium-90	Nb-90		100
46	Niobium-93m	Nb-93m		10
47	N10D1UM-94	ND-94		
48	N10D1UM-95M	ND-95m		100 100
49	Nioblum-95	ND-95		100 100
50	N10D1UM-96	ND-96		1 000
5 T	NIODIUM-9/ Nichium-00	ND-9/		T ,000
コ <u>ノ</u> につ	NTODTIIII	0,66.0N		τ,000
54	Molvbdenum-90	Mo-90		100

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1	Molybdenum-93m	Mo-93m	100
2	Molybdenum-93	Mo-93	10
3	Molybdenum-99	Мо-99	100
4 5	Molybdenum-101	Mo-101	1,000
6	Technetium-93m	Tc-93 m	1,000
7	Technetium-93	Tc-93	1,000
8	Technetium-94m	Tc-94 m	1,000
9	Technetium-94	Tc-94	1,000
10	Technetium-96m	Tc-96m	1,000
11	Technetium-96	Tc-96	100
12	Technetium-97m	Tc-97 m	100
13	Technetium-97	Tc-97	1,000
14	Technetium-98	Tc−98	10
15	Technetium-99m	Tc-99m	1,000
16	Technetium-99	\Tc−99	100
17	Technetium-101	Tc−101	1,000
18 19	Technetium-104	Tc-104	1,000
20	Ruthenium-94	Ru-94	1,000
21	Ruthenium-97	Ru-97	1,000
22	Ruthenium-103	Ru-103	100
23	Ruthenium-105	Ru-105	1,000
24	Ruthenium-106	Ru-106	1
25	승규가 같은 것은 것을 하는 것을 수가 없다. 이렇게 하는 것을 수가 없는 것을 것을 것 같이 없는 것을 것 같이 없는 것을 것 같이 없다. 않는 것을 것 같이 없는 것을 것 같이 없는 것을 것 같이 없는 것 않는 것 같이 없는 것 같이 없는 것 않는 것 않는 것 않는 않는 것 않는 것 않는 것 않는 것 않		
26	Rhodium-99m	Rh-99m	1,000
27	Rhodium-99	Rh-99	100
28	Rhodium-100	Rh-100	100
29	Rhodium-101m	Rh-101m	1,000
30	Rhodium-101	Rn-101	
31	Rhodium-102m	Rn-102m	10
32	Rhodium-102	RN-LUZ	1 000
33	Rhodium-103m		L,000
34	Rhodium-105		1 000
35	Rhodium-106m	RD-TOOM	1,000
20	RHOUTUM-TOA	antan ang ang ang ang ang ang ang ang ang a	Τ, ΟΟΟ
20	Pollodium-100	−100	100
30	Palladium = 100	Pd-101	1.000
10	Palladium-103	Pd-103	100
40 /\1	Palladium = 107	Pd-107	10
41 Λ2	Palladium-109	Pd-109	100
43			
44	Silver-102	Ag-102	1,000
45	Silver-103	Ag-103	1,000
46	Silver-104m	Ag-104m	1,000
47	Silver-104	Ag-104	1,000
48	Silver-105	Ag-105	100
49	Silver-106m	Ag-106m	100
50	Silver-106	Ag-106	1,000
51	Silver-108m	Ag-108m	1
52	Silver-110m	Ag-110m	10
53	Silver-111	Ag-111	100
54	S11Ver-112	AG-LLZ	TOO

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3 Cadmium-104 Cd-104 1,000 4 Cadmium-107 Cd-107 1,000 5 Cadmium-113m Cd-109 1 6 Cadmium-113m Cd-113m 0.1 7 Cadmium-113m Cd-115m 100 8 Cadmium-115m Cd-117m 1,000 10 Cadmium-117m Cd-117m 1,000 11 Cadmium-117m Cd-117m 1,000 12 Cadmium-117 Cd-117m 1,000 13 Indium-100 1,000 1,000 14 Indium-110 1n-110 1,000 15 Indium-111 In-110 1,000 16 Indium-113m In/000 1,000 17 Indium-113m In/000 1,000 18 Indium-113m In/000 1,000 19 Indium-115m In/000 1,000 21 Indium-117m In-115m 1,000 21 Indium-117m In-116m 1,000 21 Indium-117m In-100 1,000 <	1 2	Silver-115	Ag-115	1,000
4 Cadmium-107 Cd-107 1,000 5 Cadmium-113m Cd-109 1 6 Cadmium-113m Cd-113m 0.1 7 Cadmium-115m Cd-115m 100 8 Cadmium-115m Cd-115m 100 10 Cadmium-117m Cd-117m 1,000 11 Cadmium-117 Cd-117m 1,000 12 Indium-109 In-109 1,000 12 Indium-110 1,000 1,000 13 Indium-109 In-109 1,000 14 Indium-110 In-09 1,000 15 Indium-111 In-111 100 16 Indium-112 In-112 1,000 17 Indium-113m In-113m 1,000 17 Indium-116m Indium 100 10 Indium-116m In-000 100 21 Indium-117m In-117m 1,000 21 Indium-117m In-117m 1,000 21 Indium-117m In-117m 1,000 <	3	Cadmium-104	Cd-104	1,000
5 Cadmium-109 Cd-109 1 6 Cadmium-113m Cd-113m 0.1 7 Cadmium-115m Cd-113 100 8 Cadmium-115m Cd-115m 100 9 Cadmium-115m Cd-117m 1,000 10 Cadmium-117m Cd-117m 1,000 11 Cadmium-117 Cd-117m 1,000 12 Inclum-109 In-109 1,000 13 Indium-110 (59.1 min) In-110 1,000 14 Indium-110 (59.1 min) In-110 1,000 15 Indium-112 In-112 1,000 16 Indium-113m In-112 1,000 17 Indium-114m 100 1,000 18 Indium-115m In00 1,000 21 Indium-115m In00 1,000 21 Indium-117m In-116m 1,000 21 Indium-117m In-116m 1,000 21 Indium-117m In-116m 1,000 21 Indium-117m In-110m 1,000	4	Cadmium-107	Cd-107	1,000
6 Cadmium-113m Cd-113m 0,1 7 Cadmium-113m Cd-113m 100 8 Cadmium-115m Cd-115m 10 9 Cadmium-115m Cd-115m 100 10 Cadmium-117m Cd-117m 1,000 11 Cadmium-117m Cd-117m 1,000 12 Indium-109 In-109 1,000 13 Indium-106 (9.1 min) In-110 1,000 14 Indium-110 (4.9h) In-111 100 16 Indium-113m In-113m 1,000 17 Indium-114m In0 1,000 18 Indium-113m In-113m 1,000 19 Indium-115m In-115m 1,000 20 Indium-116m In-115m 1,000 21 Indium-117m In-117m 1,000 22 Indium-117m In-117m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m Sn-112 1,000<	5	Cadmium-109	Cd-109	1
7 Cadmium-113 Cd-113 100 8 Cadmium-115 Cd-115 100 9 Cadmium-117 Cd-117m 1,000 10 Cadmium-117 Cd-117m 1,000 12 Indium-109 In-109 1,000 13 Indium-110 (69.1 min) In-110 1,000 14 Indium-110 (14.9h) In-110 1,000 15 Indium-112 In-112 1,000 16 Indium-112 In-112 1,000 17 Indium-112 In-112 1,000 18 Indium-113m In-110 1000 19 Indium-114m In-114m 10 20 Indium-115m In-115m 1,000 21 Indium-117m In-116m 1,000 21 Indium-117m In-117m 1,000 21 Indium-117m In-117m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m Sn-111 1,000	6	Cadmium-113m	Cd-113m	0.1
8 Cadmium-115m Cd-115m 100 9 Cadmium-117m Cd-117m 1,000 10 Cadmium-117m Cd-117m 1,000 11 Cadmium-117m Cd-117m 1,000 12 Indium-100 Cd-117m 1,000 13 Indium-100 (69.1 min) In-110 1,000 14 Indium-110 (69.1 min) In-110 1,000 15 Indium-110 (14.9h) In-111 100 16 Indium-112 In-113m 1,000 17 Indium-113m In-100 1,000 19 Indium-115m In-115m 1,000 21 Indium-115m In-116m 1,000 21 Indium-117m In-117m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m Sn-110 100 26 Int-111 Sn-113 100	7	Cadmium-113	Cd-113	100
9 Cadmium-115 Cd-115 100 10 Cadmium-117m Cd-117m 1,000 12	8	Cadmium-115m	Cd-115m	10
10 Cadnium-117m Cd-117m 1,000 11 Cadnium-117 Cd-117 1,000 12 Indium-110 (69.1 min) In-109 1,000 14 Indium-110 (69.1 min) In-110 1,000 15 Indium-110 (4.9h) In-110 1,000 16 Indium-112 In-111 100 17 Indium-113m In-112 1,000 18 Indium-113m In-113m 1,000 19 Indium-115m In-115m 1,000 21 Indium-115m In-115m 1,000 21 Indium-116m In-117m 1,000 21 Indium-117m In-117m 1,000 21 Indium-117m In-117m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m Sn-110 100 26 Tin-111 Sn-113 100 27 Tin-118m Sn-113 100 26 Tin-11	9	Cadmium-115	Cd-115	100
11 Cadmium-117 Cd-117 1,000 12 Indium-109 In-109 1,000 14 Indium-110 (69.1 min) In-110 1,000 15 Indium-110 (4.9h) In-110 1,000 16 Indium-113 In-111 100 17 Indium-113 In-113 1,000 18 Indium-113 In-113 1,000 19 Indium-114 In-115 1,000 10 Indium-115 In-115 100 20 Indium-115 In-115 100 21 Indium-117 In-117 1,000 23 Indium-117 In-117 1,000 24 Indium-117 In-117 1,000 25 Indium-118 Sn-110 100 26 7 Tin-110 Sn-111 1,000 27 Tin-117 Sn-113 100 30 Tin-128 Sn-121 1,000 31 Tin-128 Sn-123 10 32 Tin-123 Sn-123 10	10	Cadmium-117m	Cd-117m	1,000
12 Indium-109 In-109 1,000 14 Indium-110 (69.1 min) In-110 1,000 15 Indium-110 (4.9h) In-110 1,000 16 Indium-111 In-110 1,000 17 Indium-112 In-112 1,000 18 Indium-113m In-112 1,000 19 Indium-114m In-115m 1,000 20 Indium-115m In-115m 1,000 21 Indium-115m In-116m 1,000 21 Indium-117m In-117m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m In-117m 1,000 26 m-111 100 27 Tin-110 Sn-111 1,000 28 Tin-128 Sn-113 100 30 Tin-128 Sn-128 100 31 Tin-128 Sn-123 10 33 Tin-125 Sn-125 10 3	11	Cadmium-117	Cd-117	1,000
13 Indium-109 In-109 1,000 14 Indium-110 (4.9h) In-110 1,000 15 Indium-111 In-110 1,000 16 Indium-112 In-111 100 17 Indium-113m In-112 1,000 18 Indium-113m In-115m 1,000 19 Indium-114m In-115m 1,000 10 Indium-115m In-115m 1,000 21 Indium-115m In-115m 1,000 21 Indium-117m In-117m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m In-119m 1,000 26 Tin-110 Sn-110 100 27 Tin-110 Sn-111 1,000 26 Tin-117m 100 100 27 Tin-113 Sn-113 100 30 Tin-117m Sn-117 1,000 31 Tin-123 Sn-123 10 35	12			
14 Indium-110 (69.1 min) In-110 1,000 15 Indium-110 (4.9h) In-110 (1.000 16 Indium-111 In-111 (100 17 Indium-112 In-112 (1,000 18 Indium-113m In-113m (1,000 19 Indium-114m In-114m (10 20 Indium-115m In-115m (1,000 21 Indium-116m In-116m (1,000 21 Indium-117m In-117m (1,000 23 Indium-117m In-117m (1,000 24 Indium-117m In-117m (1,000 25 Indium-119m In-117m (1,000 26 7 27 Tin-110 Sn-111 (1,000 28 Tin-111 Sn-111 (1,000 29 Tin-113 Sn-113 (100 30 Tin-117m Sn-117m (100 31 Tin-120 Sn-121 (1,000 32 Tin-121 Sn-121 (1,000 33 Tin-123 Sn-123 (10 34 Tin-123 Sn-123 (10 35 Tin-126 Sn-125 (10 36 Tin-127 Sn-128 (1,000 37 Tin-128 Sn-125 (10 37 Tin-128 Sn-128 (1,000 30 Tin-126 Sn-126 (10 31 T	13	Indium-109	In-109	1,000
15 Indium-110 (4.9h) In-110 1,000 16 Indium-111 In-111 100 17 Indium-112 In-112 1,000 18 Indium-113m In-113m 1,000 19 Indium-114m In-115m 1,000 10 Indium-115m In-115m 1,000 21 Indium-115m In-115m 1,000 21 Indium-117m In-117m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m In-117m 1,000 26 7 Tin-110 Sn-110 100 27 Tin-110 Sn-111 1,000 26 7 Tin-117m 100 100 27 Tin-117m Sn-113 100 100 30 Tin-117m Sn-113 100 100 31 Tin-12m Sn-12m 100 1,000 32 Tin-12m Sn-12m 1,000 31 Tin-12	14	Indium-110 (69.1 min)	In-110	1,000
16 Indium-111 In-111 1000 17 Indium-112 In-112 1,000 18 Indium-113m In-113m 1,000 19 Indium-114m In-113m 1,000 10 Indium-115m In-115 100 21 Indium-116m In-115 100 22 Indium-117m In-117m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m In-117m 1,000 26 7 Tin-110 Sn-110 100 27 Tin-110 Sn-110 100 100 28 Tin-113 Sn-117m 100 30 Tin-117m Sn-121 1,000 31 Tin-123 Sn-123 100 32 Tin-123 Sn-123 10 100 33 Tin-123 Sn-125 10 100 34 Tin-126 Sn-126 100 1000 35 Tin-127 S	15	Indium-110 (4.9h)	In-110	1,000
17 Indium-112 In-112 1,000 18 Indium-113m In-113m 1,000 19 Indium-114m In 10 20 Indium-115m In-115m 1,000 21 Indium-115m In-115m 1,000 21 Indium-116m In-116m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m In-117m 1,000 26 Tin-110 Sn-110 100 27 Tin-110 Sn-110 100 26 Tin-111 Sn-113 100 27 Tin-113 Sn-113 100 20 Tin-117m Sn-113 100 20 Tin-117m Sn-113 100 21 Tin-12m Sn-12m 100 21 Tin-12m Sn-123 100 21 Tin-123 Sn-123 10 23 Tin-126 Sn-126 10 24 Antimony-116 <	16	Indium-111	In-111	100
18 Indium-113m In-113m 1,000 19 Indium-114m In-115m 1,000 21 Indium-115m In-115m 1,000 21 Indium-115m In-115m 1,000 22 Indium-117m In-117m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m In-117m 1,000 26	17	Indium-112	In-112	1,000
19 Indium-114m In-114m 10 20 Indium-115m In-115m 1,000 21 Indium-115m In-115m 100 22 Indium-116m In-116m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-119m In-117m 1,000 26	18	Indium-113m	In-113m	1,000
20 Indium-115m In-115m 1,000 21 Indium-115m In-115m 1,000 21 Indium-116m In00 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-117m In-117m 1,000 26 In-110 Sn-110 100 27 Tin-110 Sn-111 1,000 28 Tin-111 Sn-113 100 20 Tin-117m Sn-113 100 30 Tin-117m Sn-113 100 31 Tin-12m Sn-12m 100 32 Tin-12m Sn-12m 100 33 Tin-12m Sn-12m 1000 34 Tin-123m Sn-123m 1,000 35 Tin-123 Sn-125 10 36 Tin-126 Sn-125 100 37 Tin-128 Sh-115 1,000 34 Tin-0y-115 Sb-116 1,000 34 Antimony-117 <	19	Indium-114m	In-114 m	10
21 Indium-115 In-115 100 22 Indium-116m In-116m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-119m In-117m 1,000 26	20	Indium-115m	In-115m	1,000
22 Indium-116m In-116m 1,000 23 Indium-117m In-117m 1,000 24 Indium-117m In-117m 1,000 25 Indium-119m In-117m 1,000 26 Indium-119m In-119m 1,000 27 Tin-110 Sn-110 100 28 Tin-111 Sn-111 1,000 29 Tin-111 Sn-113 100 30 Tin-117m Sn-113 100 30 Tin-117m Sn-113 100 31 Tin-117m Sn-113 100 32 Tin-117m Sn-113 100 33 Tin-121m Sn-121m 1000 34 Tin-123m Sn-123 10 35 Tin-126 Sn-123 10 36 Tin-127 Sn-128 1,000 37 Tin-128 Sn-128 1,000 41 Antimony-116m Sb-116m 1,000 42 Antimony-117 Sb-117 1,000 43 Antimony-120 <td>21</td> <td>Indium-115</td> <td>In-115</td> <td>100</td>	21	Indium-115	In-115	100
23 Indium-117m In000 24 Indium-117 In-117m 1,000 24 Indium-119m In-117 1,000 25 Indium-119m In-119m 1,000 26 In-110 Sn-110 100 27 Tin-110 Sn-113 100 28 Tin-111 Sn-113 100 30 Tin-117m Sn-113 100 30 Tin-117m Sn-113 100 31 Tin-119m Sn-113 100 32 Tin-121m Sn-121 1,000 34 Tin-123m Sn-123 10 35 Tin-123 Sn-123 10 36 Tin-125 Sn-126 10 37 Tin-126 Sn-127 1,000 39 Tin-128 Sn-127 1,000 40 Antimony-116 Sb-116 1,000 41 Antimony-116m Sb-116 1,000 42 Antimony-117 Sb-118m 1,000 43 Antimony-119 Sb-120	22	Indium-116m	In-116m	1,000
24 Indium-117 In-117 1,000 25 Indium-119m In-119m 1,000 26 In-110 Sn-110 100 27 Tin-110 Sn-110 100 28 Tin-111 Sn-111 1,000 29 Tin-111 Sn-113 100 30 Tin-117m Sn-113 100 31 Tin-119m Sn-117m 100 32 Tin-121m Sn-121m 100 33 Tin-121 Sn-123 100 34 Tin-123 Sn-123 10 35 Tin-126 Sn-125 10 36 Tin-125 Sn-126 10 37 Tin-126 Sn-126 10 38 Tin-127 Sn-127 1,000 39 Tin-128 Sb-115 1,000 40 Antimony-116 Sb-116 1,000 41 Antimony-116 Sb-117 1,000 43 Antimony-118m Sb-119 1,000 45 Antimony-120 (5.76d) <td>23</td> <td>Indium-117m</td> <td>In-117m</td> <td>1,000</td>	23	Indium-117m	In-117m	1,000
25 Indium-119m In-119m 1,000 26	24	Indium-117	In-117	1,000
26 Sn-110 100 27 Tin-111 Sn-111 1,000 28 Tin-111 Sn-113 100 30 Tin-117m Sn-113 100 30 Tin-117m Sn-117m 100 31 Tin-117m Sn-117m 100 32 Tin-121m Sn-121m 100 33 Tin-121 Sn-123 100 34 Tin-123m Sn-123m 1,000 35 Tin-123 Sn-123 10 36 Tin-126 Sn-126 10 37 Tin-126 Sn-126 10 37 Tin-126 Sn-127 1,000 37 Tin-128 Sn-128 1,000 40 1,000 41 Antimony-115 Sb-115 1,000 42 Antimony-116 Sb-116 1,000 43 Antimony-117 Sb-117 1,000 44 Antimony-118m Sb-119 1,000 45 Antimony-120 (5.76d) Sb	25	Indium-119m	In-119m	1,000
27 Tin-110 Sn-110 100 28 Tin-111 Sn-110 1,000 29 Tin-113 Sn-113 100 30 Tin-117m Sn-117m 100 31 Tin-119m Sn-119m 100 32 Tin-121m Sn-121m 1,000 33 Tin-121 Sn-123m 1,000 34 Tin-123m Sn-123m 100 35 Tin-123 Sn-123 10 36 Tin-125 Sn-125 10 37 Tin-126 Sn-127 1,000 38 Tin-127 Sn-127 1,000 36 Tin-128 Sh-115 1,000 40 1,000 41 Antimony-115 Sb-115 1,000 42 Antimony-116 Sb-116 1,000 43 Antimony-117 Sb-117 1,000 44 Antimony-118 Sb-119 1,000 45 Antimony-120 (5.76d) Sb-120 100 46 Antimony-120 </td <td>26</td> <td>방향 · · · · · · · · · · · · · · · · · · ·</td> <td>전문 말을 물건이 다.</td> <td>- 클루토 등 1 · 포 가 등 : 관련당</td>	26	방향 · · · · · · · · · · · · · · · · · · ·	전문 말을 물건이 다.	- 클루토 등 1 · 포 가 등 : 관련당
28 Tin-111 Sn-111 1,000 29 Tin-113 Sn-113 100 30 Tin-117m Sn-117m 100 31 Tin-119m Sn-119m 100 32 Tin-121m Sn-121m 100 33 Tin-121 Sn-121m 100 34 Tin-123m Sn-123m 1,000 35 Tin-123 Sn-123 10 36 Tin-125 Sn-125 10 37 Tin-126 Sn-126 10 38 Tin-127 Sn-127 1,000 39 Tin-128 Sn-127 1,000 40	27	Tin-110	Sn-110	100
29 Tin-113 Sn-113 100 30 Tin-117m Sn-117m 100 31 Tin-117m Sn-117m 100 31 Tin-117m Sn-117m 100 31 Tin-117m Sn-117m 100 32 Tin-121m Sn-121m 100 33 Tin-121m Sn-121m 1,000 34 Tin-123m Sn-123m 1,000 35 Tin-123 Sn-123m 1,000 36 Tin-125 Sn-123m 10 37 Tin-126 Sn-126 10 38 Tin-127 Sn-127 1,000 39 Tin-128 Sn-128 1,000 40 Antimony-116m Sb-115 1,000 41 Antimony-116m Sb-116m 1,000 42 Antimony-117 Sb-117 1,000 43 Antimony-120 (16 min) Sb-120 100 44 Antimony-120 (5.76d) Sb-120 100 45 Antimony-122 Sb-124 100 100 </td <td>28</td> <td><u>Tin-111</u></td> <td>Sn-111</td> <td>1,000</td>	28	<u>Tin-111</u>	Sn-111	1,000
30 Tin-11/m Sn-11/m 100 31 Tin-119m Sn-119m 100 32 Tin-121m Sn-121m 100 33 Tin-121m Sn-121m 100 34 Tin-123m Sn-123m 1,000 35 Tin-123m Sn-123m 10 36 Tin-125 Sn-125 10 37 Tin-126 Sn-126 10 38 Tin-127 Sn-126 10 39 Tin-128 Sn-127 1,000 40 Antimony-116 Sb-115 1,000 42 Antimony-116m Sb-116m 1,000 43 Antimony-116m Sb-116 1,000 44 Antimony-117 Sb-117 1,000 45 Antimony-118m Sb-118m 1,000 46 Antimony-120 (16 min) Sb-120 100 48 Antimony-120 (5.76d) Sb-120 100 50 Antimony-124m Sb-124m 100 51 Antimony-124m Sb-124m 100	29	Tin-113	Sn-113	100
31 Tin-119m Sn-119m 100 32 Tin-121m Sn-121m 100 33 Tin-121m Sn-121m 1,000 34 Tin-123m Sn-123m 1,000 35 Tin-123m Sn-123m 100 36 Tin-123 Sn-123 10 36 Tin-125 Sn-125 10 37 Tin-126 Sn-126 10 38 Tin-127 Sn-127 1,000 39 Tin-128 Sn-127 1,000 40 1,000 40 1,000 41 Antimony-115 Sb-115 1,000 42 Antimony-116m Sb-116m 1,000 43 Antimony-117 Sb-117 1,000 44 Antimony-118m Sb-118m 1,000 45 Antimony-119 Sb-120 100 46 Antimony-120 (16 min) Sb-120 100 47 Antimony-120 (5.76d) Sb-122 100 50 Antimony-124	30	Tin-11/m	Sn-11/m	100
32 Tin-121m Sn-121m 1000 33 Tin-121 Sn-121 1,000 34 Tin-123m Sn-123m 1,000 35 Tin-123m Sn-123m 1,000 36 Tin-125 Sn-125 10 37 Tin-126 Sn-126 10 38 Tin-127 Sn-128 1,000 39 Tin-128 Sn-128 1,000 40 41 Antimony-115 Sb-115 1,000 42 Antimony-116m Sb-116m 1,000 43 Antimony-116m Sb-116 1,000 44 Antimony-117 Sb-117 1,000 45 Antimony-118m Sb-118m 1,000 46 Antimony-120 (16 min) Sb-120 1,000 47 Antimony-120 (5.76d) Sb-120 100 48 Antimony-122 Sb-124 100 50 Antimony-124 Sb-124 100 51 Antimony-124 Sb-125 100 </td <td>31</td> <td>11n-119m</td> <td>Sn-119m</td> <td>100</td>	31	11n-119m	Sn-119m	100
33 Tin-121 Sn-121 1,000 34 Tin-123m Sn-123m 1,000 35 Tin-123 Sn-123 10 36 Tin-125 Sn-125 10 37 Tin-126 Sn-126 10 38 Tin-126 Sn-127 1,000 39 Tin-126 Sn-128 1,000 40 Sn-128 1,000 40 41 Antimony-115 Sb-115 1,000 42 Antimony-116 Sb-116 1,000 43 Antimony-116 Sb-116 1,000 44 Antimony-117 Sb-117 1,000 45 Antimony-118m Sb-118m 1,000 46 Antimony-120 (16 min) Sb-120 100 47 Antimony-120 (5.76d) Sb-120 100 48 Antimony-121 Sb-120 100 49 Antimony-122 Sb-122 100 50 Antimony-124 Sb-124 10 51 Antimony-125 Sb-125 100 53	32	1/1n-121m	Sn-121m	100
34 Tin-123m Sn-123m 1,000 35 Tin-123 10 36 Tin-123 10 37 Tin-125 10 37 Tin-126 Sn-125 10 38 Tin-127 Sn-127 1,000 39 Tin-128 Sn-128 1,000 40 Sb-115 1,000 41 Antimony-116m Sb-116 1,000 42 Antimony-116m Sb-116 1,000 43 Antimony-117 Sb-116 1,000 44 Antimony-117 Sb-117 1,000 45 Antimony-118m Sb-118m 1,000 46 Antimony-120 (16 min) Sb-120 100 47 Antimony-120 (5.76d) Sb-120 100 48 Antimony-124 Sb-122 100 50 Antimony-124m Sb-124 10 51 Antimony-124 Sb-125 100 53 Antimony-126m Sb-126m 1,000 54 Antimony-126 Sb-126 100	33	110-121	Sn = 121	1,000 1,000
35 TIN-123 Sn-123 10 36 Tin-125 Sn-125 10 37 Tin-126 Sn-126 10 38 Tin-127 Sn-127 1,000 39 Tin-128 Sn-128 1,000 40 Sb-115 1,000 41 Antimony-116m Sb-116m 1,000 42 Antimony-116m Sb-116 1,000 43 Antimony-116 Sb-116 1,000 44 Antimony-117 Sb-116 1,000 45 Antimony-117 Sb-118m 1,000 46 Antimony-120 (16 min) Sb-120 100 47 Antimony-120 (5.76d) Sb-120 100 48 Antimony-120 (5.76d) Sb-120 100 49 Antimony-124 Sb-124 10 100 50 Antimony-124m Sb-125 100 100 51 Antimony-125 Sb-125 100 100 53 Antimony-126m Sb-126m 1,000 1,000	34	T1n-123m	Sn = 123m	1 ,000
36 TIN-125 Sn-125 10 37 Tin-126 Sn-126 10 38 Tin-127 1,000 39 Tin-128 Sn-127 1,000 40 Sn-128 1,000 41 Antimony-115 Sb-115 1,000 42 Antimony-116m Sb-116m 1,000 43 Antimony-116 Sb-116 1,000 44 Antimony-117 Sb-116 1,000 45 Antimony-117 Sb-118m 1,000 46 Antimony-129 Sb-119 1,000 47 Antimony-120 (16 min) Sb-120 100 48 Antimony-120 (5.76d) Sb-120 100 49 Antimony-122 Sb-122 100 50 Antimony-124m Sb-124m 1,000 51 Antimony-124 Sb-125 100 52 Antimony-125 Sb-125 100 53 Antimony-126m Sb-126m 1,000 54 Antimony-126 Sb-126 100	35	π^{1}	511-125 Cm-125	τ. ΤΟ
37 111-120 31-120 100 38 Tin-127 1,000 39 Tin-128 Sn-128 1,000 40	27	T111-125	511-125 Cn-126	10 70
39 Tin-128 Sn-128 1,000 40	20	$\pi_{1} \rightarrow -1.07$	S_{n-120}	1 000
40 30 1,000 41 Antimony-115 Sb-115 1,000 42 Antimony-116m Sb-116m 1,000 43 Antimony-116 Sb-116 1,000 44 Antimony-117 Sb-116 1,000 45 Antimony-117 Sb-117 1,000 46 Antimony-119 Sb-118m 1,000 47 Antimony-120 (16 min) Sb-120 1,000 48 Antimony-120 (5.76d) Sb-120 100 49 Antimony-124 Sb-122 100 50 Antimony-124m Sb-124m 1,000 51 Antimony-125 Sb-125 100 52 Antimony-126m Sb-126m 1,000 54 Antimony-126 Sb-126 100	30	$\pi_{1}\pi_{1}\pi_{2}$	Sn = 127 Sn = 128	1,000
41 Antimony-115 Sb-115 1,000 42 Antimony-116m Sb-116m 1,000 43 Antimony-116 Sb-116 1,000 44 Antimony-117 Sb-116 1,000 45 Antimony-117 Sb-117 1,000 45 Antimony-118m Sb-118m 1,000 46 Antimony-120 (16 min) Sb-120 1,000 47 Antimony-120 (5.76d) Sb-120 100 48 Antimony-120 (5.76d) Sb-120 100 50 Antimony-124m Sb-124m 1,000 51 Antimony-124m Sb-124m 1,000 51 Antimony-125 Sb-125 100 53 Antimony-126m Sb-126m 1,000 54 Antimony-126 Sb-126 100	40		DII 120	±,
42 Antimony-116 Sb-116 1,000 43 Antimony-116 Sb-116 1,000 44 Antimony-117 Sb-116 1,000 45 Antimony-117 Sb-117 1,000 46 Antimony-118m Sb-118m 1,000 47 Antimony-120 (16 min) Sb-120 1,000 48 Antimony-120 (5.76d) Sb-120 100 49 Antimony-122 Sb-122 100 50 Antimony-124m Sb-124m 1,000 51 Antimony-125 Sb-125 100 53 Antimony-126m Sb-126m 1,000 54 Antimony-126 Sb-126 100	41	Antimony-115	Sb-115	1-000
43Antimony-116Sb-1161,00044Antimony-117Sb-1161,00045Antimony-118mSb-1171,00046Antimony-119Sb-1191,00047Antimony-120 (16 min)Sb-1201,00048Antimony-120 (5.76d)Sb-12010049Antimony-122Sb-12210050Antimony-124mSb-12410051Antimony-124Sb-1241052Antimony-125Sb-12510053Antimony-126mSb-126m1,00054Antimony-126Sb-126100	42	Antimony 115	Sb-116m	1,000
44Antimony-117Sb-1171,00045Antimony-118mSb-118m1,00046Antimony-119Sb-1191,00047Antimony-120 (16 min)Sb-1201,00048Antimony-120 (5.76d)Sb-12010049Antimony-122Sb-12210050Antimony-124mSb-124m1,00051Antimony-124mSb-124m1,00051Antimony-125Sb-12510053Antimony-126mSb-126m1,00054Antimony-126Sb-126100	43	Antimony 110m	Sb-116	1,000
45 Antimony-118m Sb-118m 1,000 46 Antimony-119 Sb-119 1,000 47 Antimony-120 (16 min) Sb-120 1,000 48 Antimony-120 (5.76d) Sb-120 100 49 Antimony-122 Sb-122 100 50 Antimony-124m Sb-124m 1,000 51 Antimony-124 Sb-124 10 52 Antimony-125 Sb-125 100 53 Antimony-126m Sb-126m 1,000 54 Antimony-126 Sb-126 100	44	Antimony-117	Sb-117	1,000
46 Antimony-119 Sb-119 1,000 47 Antimony-120 (16 min) Sb-120 1,000 48 Antimony-120 (5.76d) Sb-120 100 49 Antimony-122 Sb-122 100 50 Antimony-124m Sb-124 100 51 Antimony-124 Sb-124 10 52 Antimony-125 Sb-125 100 53 Antimony-126m Sb-126m 1,000 54 Antimony-126 Sb-126 100	45	Antimony-118m	Sb-118m	ī,000
47Antimony-120 (16 min)Sb-1201,00048Antimony-120 (5.76d)Sb-12010049Antimony-122Sb-12210050Antimony-124mSb-124m1,00051Antimony-124Sb-1241052Antimony-125Sb-12510053Antimony-126mSb-126m1,00054Antimony-126Sb-126100	46	Antimony-119	Sb-119	1,000
48 Antimony-120 (5.76d) Sb-120 100 49 Antimony-122 Sb-122 100 50 Antimony-124m Sb-124m 1,000 51 Antimony-124 Sb-124 10 52 Antimony-125 Sb-125 100 53 Antimony-126m Sb-126m 1,000 54 Antimony-126 Sb-126 100	47	Antimony -120 (16 min)	Sb-120	1,000
49 Antimony-122 Sb-122 100 50 Antimony-124m Sb-124m 1,000 51 Antimony-124 Sb-124 10 52 Antimony-125 Sb-125 100 53 Antimony-126m Sb-126m 1,000 54 Antimony-126 Sb-126 100	48	Antimony-120 (5.76d)	Sb-120	100
50Antimony-124mSb-124m1,00051Antimony-124Sb-1241052Antimony-125Sb-12510053Antimony-126mSb-126m1,00054Antimony-126Sb-126100	49	Antimony-122	Sb-122	100
51Antimony-124Sb-1241052Antimony-125Sb-12510053Antimony-126mSb-126m1,00054Antimony-126Sb-126100	50	Antimony-124m	Sb-124m	1,000
52Antimony-125Sb-12510053Antimony-126mSb-126m1,00054Antimony-126Sb-126100	51	Antimony-124	Sb-124	10
53Antimony-126mSb-126m1,00054Antimony-126Sb-126100	52	Antimony-125	Sb-125	100
54 Antimony-126 Sb-126 100	53	Antimony-126m	Sb-126m	1,000
	54	Antimony-126	Sb-126	100

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İ.	Antimony-127	Sb-127		100
2	Antimony 128 (10.4 min)	Sb = 127		1,000
3	Antimony -128 (9.01b)	Sb-128		100
4	Antimony-129	Sb-129		100
5	Antimony -130	Sb = 130		1 - 000
6	Antimony-131	Sb-131		1,000
7				1,000
8	Tellurium-116	Te-116		1,000
9	Tellurium-121m	Te-121m		10
10	Tellurium-121	Te-121		100
11	Tellurium-123m	Te-123m		10
12	Tellurium-123	Te-123		100
13	Tellurium-125m	Te-125m		10
14	Tellurium-12/m	Te-127m		10
15	Tellurium-12/	Te-127		1,000
	Tellurium-129m	Te-129m		
10	Tellurium-129 Mellurium 121-	Te-129		1,000
10	Tellurium-131m Mollurium-121	TG-131M		10
20	mollurium-122	Te-131		100
20	$\frac{1011}{10} = 132$	Te-132		100
22	Terrurrer = 133			1 000
22	Terrur rum = 133	Te = 133		1,000
24		TC T74		т, ооо
25	Iodine-120m	I-120m		1,000
26	Iodine-120	I-120		100
27	Iodine-121	I-121		1,000
28	Iodine-123	I-123		100
29	Iodine-124	I-124		10
30	Iodine-125	I-125		1
31	Iodine-126	I-126		1
32	Iodine-128	I-128		1,000
33	Iodine-129	I-129		1
34	Iodine-130	I-130		10
35	lodine-131	I-131		1
30	lodine-132m	1-132m		100
3/	Iodine-I32	L-132 T 122		100
20	Todine-133	1-133 T 124		
29	Todine-134	1-134 T 12F		1,000
40		T-T32		тоо
42	Xenon-120	Xe-120		1.000
43	Xenon-121	Xe 120 Xe-121		1,000
44	Xenon-122	Xe-122		1,000
45	Xenon-123	Xe-123		1,000
46	Xenon-125	Xe-125		1,000
47	Xenon-127	Xe-127		1,000
48	Xenon-129m	Xe-129m		1,000
49	Xenon-131m	Xe-131m		1,000
50	Xenon-133m	Xe-133m		1,000
51	Xenon-133	Xe-133		1,000
52	Xenon-135m	Xe-135m		1,000
53	Xenon-135	Xe-135		1,000
54	Xenon-138	Xe-138		1,000

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1 3 4 5 6 7 8 9 10 11 12 13 4	Cesium-125 Cesium-127 Cesium-129 Cesium-130 Cesium-131 Cesium-132 Cesium-134 Cesium-134 Cesium-135 Cesium-135 Cesium-136 Cesium-137 Cesium-138		Cs-125 Cs-127 Cs-129 Cs-130 Cs-131 Cs-132 Cs-134m Cs-134m Cs-135m Cs-135m Cs-135 Cs-136 Cs-137 Cs-138		1,000 1,000 1,000 1,000 1,000 1,000 1,000 100 1
15 16 17 18 19 20 21 22 23 24 25 26 27	Barium-126 Barium-128 Barium-131 Barium-131 Barium-133 Barium-133 Barium-135 Barium-139 Barium-140 Barium-141 Barium-142		Ba-126 Ba-128 Ba-131m Ba-131 Ba-133m Ba-133 Ba-135m Ba-139 Ba-140 Ba-141 Ba-142		1,000 100 1,000 100 100 100 1,000 1,000 1,000
27 28 29 30 31 32 33 34 35 36	Lanthanum-131 Lanthanum-132 Lanthanum-135 Lanthanum-137 Lanthanum-138 Lanthanum-140 Lanthanum-141 Lanthanum-142 Lanthanum-143		La-131 La-132 La-135 La-137 La-138 La-140 La-141 La-142 La-143		1,000 100 1,000 10 100 100 1,000 1,000
37 38 39 40 41 42 43 44 45 46	Cerium-134 Cerium-135 Cerium-137m Cerium-137 Cerium-139 Cerium-141 Cerium-143 Cerium-144		Ce-134 Ce-135 Ce-137m Ce-137 Ce-139 Ce-141 Ce-143 Ce-144		100 100 1,000 1,000 100 100 100
47 48 49 50 51 52 53 54	Praseodymium-136 Praseodymium-137 Praseodymium-138m Praseodymium-139 Praseodymium-142m Praseodymium-142 Praseodymium-143 Praseodymium-144		Pr-136 Pr-137 Pr-138m Pr-139 Pr-142m Pr-142 Pr-143 Pr-144		1,000 1,000 1,000 1,000 1,000 100 1,000
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1	Praseodymium-145	Pr-145		100
2	Praseodymium-147	PI-14/		Τ,000
4	Neodymium-136	Nd-136		1.000
5	Neodymium-138	Nd-138		100
6	Neodymium-139m	Nd-139m		1.000
7	Neodymium-139	Nd-139		1,000
8	Neodymium-141	Nd-141		1,000
9	Neodymium-147	Nd-147		100
10	Neodymium-149	Nd-149		1,000
11	Neodymium-151	Nd-151		1,000
12	2011년 2월 2011년 1월 2011년 1월 2011년 1월 2011년 1월 2011년 1월 2011년 1월 2011년 2월 2011년 1월 201			
13	Promethium-141	Pm-141		1,000
14	Promethium-143	Pm-143		100
15	Promethium-144	Pm-144		10
16	Promethium-145	Pm-145		10
17	Promethium-146	Pm-146		요. 말못 잘못된.
18	Promethium-147	Pm-147		10
19	Promethium-148m	Pm-148m		10
20	Promethium-148	Pm-148		10
21	Promethium-149	Pm-149		
22	Promethium-150	Pm-150		1,000
23 24	Promethium-151	Pm-191		T00
25	Samarium-141m	Sm-141m		1,000
26	Samarium-141	Sm-141		1,000
27	Samarium-142	Sm-142		1,000
28	Samarium-145	Sm-145		100
29	Samarium-146,	Sm-146		그는 것을 통해야다.
30	Samarium-147	Sm-147		100
31	Samarium-151	Sm-151		10
32	Samarium-153	Sm-153		100
33	Samarium-155	Sm-155		1,000
34	Samarıum-156	Sm-156		1,000
35				100
30	Europium-145			100
20	Europium-140 Turopium-147	些U=140 Fu=147		100
30	Furopium-149	Eu-14/ Eu-149		10
10	Europium-140 Furopium-140	Eu-140 Fu-140		100
40	Europium $=150$ (12 62b)	$E_{11} = 150$		100
41	Europium 150 (12.0211) Europium 150 $(34.2y)$	$E_{11} = 150$		100
13	Europium 150 $(54.2y)$ Europium-152m	Eu 150		100
44	Europium-152	$E_{11} = 152$		1
45	Europium-154	$E_{\rm U} = 154$		· · · · · · · · · · · · · · · · · · ·
46	Europium-155	$E_{\rm U} = 155$		1ō
47	Europium-156	Eu-156		100
48	Europium-157	Eu-157		100
49	Europium-158	Eu-158		1,000
50	4월 28일 등 전철의 전문에 가지 않는 것이라. 2013년 1월 20일 등 10일 1월 20일 등 명령은 전문을 통하는 것이다. 10일 등 10			
51	Gadolinium-145	Gd-145		1,000
52	Gadolinium-146	Gd-146		10
53	Gadolinium-147	Gd-147		100
54	Gadolinium-148	Gd-148		0.001

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1	Gadolinium-149	Gd-149		100
2	Gadolinium-151	Gd-151		10
3	Gadolinium-152	Gd-152		100
4	Gadolinium-153	Gd-153		10
5	Gadolinium-159	Gd-159		100
6				
7	Terbium-147	Tb-147		1,000
8	Terbium-149	Tb-149		100
9	Terbium-150	Tb-150		1,000
10	Terbium-151	Tb-151		100
11	Terbium-153	Tb-153		1,000
12	Terbium-154	Tb-154		100
13	Terbium-155	Tb-155		1,000
14	Terbium-156m (5.0h)	Tb-156m		1,000
15	Terbium-156m (24.4h)	Tb-156 m		1,000
16	Terbium-156	Tb-156		100
17	Terbium-157	Tb-157		10
18	Terbium-158	Tb-158		1
19	Terbium-160	Tb-160		10
20	Terbium-161	Tb-161		100
21				
22	Dysprosium-155	Dy-155		1,000
23	Dysprosium-157	Dy-157		1,000
24	Dysprosium-159	Dy-159		100
25	Dysprosium-165	Dy-165		1,000
26	Dysprosium-166	Dy-166		100
27	(1993년) 1월 2일 - 1993년 1993년 1993년 1993년 1993년 1993년 1993년 1993년 - 1997년 1			
28	Holmium-155	Ho-155		1,000
29	Holmium-157	Ho-157		1,000
30	Holmium-159	Ho-159		1,000
31	Holmium-161	Ho-161		1,000
32	Holmium-162m	Ho-162m		1,000
33	Holmium-162	Ho-162		1,000
34	Holmium-164m	Ho-164m		1,000
35	Holmium-164	Ho-164		1,000
36	Holmium-166m	H0-166m		1
37	Holmium-166	Ho-166		100
38	Holmium-167	HO-167		1,000
39				1 000
40	Erbium-161	ET-101		1,000
41	Erbium-165	Er-165		1,000
42	ErD1um-169	EI-109		100
43	Erblum-1/1	ビビーエノエ 田一 170		100
44		EI-1/2		TUU
45	π h 1 : 1	Mm_160		1 000
40	Thullum-162	$\frac{1111-102}{100}$		1,000
4/	111111111111111111111111111111111111	111-100 100-167		100
40	$\frac{11101100}{100}$	TIII-TO/		
49	$111UL \perp UIII = 1 / U$	1111-1/U mm_171		10
DU E 1	$\frac{111011011}{1100}$			100
с J J Т	TIIUIIUIII=1/2	111-1/2		100
52	IIIUIIUIII = 175	111-1/3 00m-175		1 000
55	ETHULLUMET / D ENGLAND	C \ 1 ⁻ 111		τ,000
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1 2 3 4 5 6 7	Ytterbium-162 Ytterbium-166 Ytterbium-167 Ytterbium-169 Ytterbium-175 Ytterbium-177 Ytterbium-178	Yb-162 Yb-166 Yb-167 Yb-169 Yb-175 Yb-177 Yb-177	1,000 100 1,000 100 1,000 1,000
8 9 10 11 12 13 14 15 16 17 18 19 20	Lutetium-169 Lutetium-170 Lutetium-171 Lutetium-172 Lutetium-173 Lutetium-174 Lutetium-174 Lutetium-176 Lutetium-176 Lutetium-177 Lutetium-177	Lu-169 Lu-170 Lu-171 Lu-172 Lu-173 Lu-174m Lu-174 Lu-176m Lu-176 Lu-177m Lu-177m	100 100 100 100 10 10 10 1,000 100 100 1
20 21 22 23 24 25 26	Lutetium-178 Lutetium-178 Hafnium-170 Hafnium-172 Hafnium-173	Lu-178 Lu-178 Lu-179 Hf-170 Hf-172 Hf-173	1,000 1,000 1,000 100 1,000
27 28 29 30 31 32	Hafnium-175 Hafnium-177m Hafnium-178m Hafnium-179m Hafnium-180m Hafnium-181	Hf-175 Hf-177m Hf-178m Hf-179m Hf-180m Hf-181	1,000 1,000 0.1 10 1,000 10
33 34 35 36 37 38	Hafnium-182m Hafnium-182 Hafnium-183 Hafnium-184 Tantalum-172	Hf-182m Hf-182 Hf-183 Hf-184 Ta-172	1,000 0.1 1,000 100
39 40 41 42 43 44	Tantalum-173 Tantalum-174 Tantalum-175 Tantalum-176 Tantalum-177 Tantalum-178	Ta-173 Ta-174 Ta-175 Ta-175 Ta-176 Ta-177 Ta-178	1,000 1,000 1,000 1,000 1,000 1,000
45 46 47 48 49 50	Tantalum-179 Tantalum-180m Tantalum-180 Tantalum-182m Tantalum-182 Tantalum-183	Ta-179 Ta-180m Ta-180 Ta-182m Ta-182 Ta-183	100 1,000 100 1,000 10 10
51 52 53 54	Tantalum-184 Tantalum-185 Tantalum-186	Ta-184 Ta-185 Ta-186	100 1,000 1,000

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1	Tungsten-176	W-176		1,000
2	Tungsten-177	W-177		1,000
3	Tungsten-178	W-178		1,000
4	Tungsten-179	W-179		1,000
5	Tungsten-181	W-181		1,000
6	Tungsten-185	W-185		100
7	Tungsten-187	W-187		100
8	Tungsten-188	W-188		10
9				
10	Rhenium-177	Re-177		1,000
11	Rhenium-178	Re-178		1,000
12	Rhenium-181	Re-181		1,000
13	Rhenium-182 (12.7h)	Re-182		1,000
14	Rhenium-182 (64.0h)	Re-182		100
15	Rhenium-184m	Re-184m		10
16	Rhenium-184	Re-184		T00
1/	Rhenium-186m	Re-186m		10 100
18	Rhenium-186	Re-186		1 000
19	Rnenium-18/	Re-18/		1,000
20	Rhenium-188m	Re-100m		1,000
21	Rhenium-190	Re-100		100
22	KIIGIITAIII-T02	RE-103		100
23	Oemium-180	0g-180		1-000
25	Osmium-181	0g-181		1,000
26	Osmium-182	05 ± 01		100
27	Osmium-185	05-185		100
28	Osmium-189m	Os-189m		1,000
29	Osmium-191m	Os-191m		1,000
30	Osmium-191	Os-191		100
31	Osmium-193	Os-193		100
32	Osmium-194	Os-194		1.
33				
34	Iridium-182	Ir-182		1,000
35	Iridium-184	Ir-184		1,000
36	Iridium-185	Ir-185		1,000
37	Iridium-186	Ir-186		100
38	Iridium-187	Ir-187		1,000
39	Iridium-188	1r-188		100
40	Iridium-189	1r-189		1 00
41	Iridium-190m	1r-190m		1,000
42	Iridium-190	TT-190		100
43	$1r_1a_1um - 192$ (/3.8a)	1r-192 Tr-102m		10
44	Tridium=192m (1.4 min)	$11 - 192$ m $T_{r} - 104$ m		01 0 T
40	111010m-194m Tridium-104	II-194m T∽-101		100
40	Tridium-195	11 - 199 Tr = 105m		1 000
48	Tridium-195	Tr-195		1_000
49		** <i>1//</i>		- ,
50	Platinum-186	P+-186		1.000
51	Platinum-188	Pt-188		100
52	Platinum-189	Pt-189		1.000
53	Platinum-191	Pt-191		100
54	Platinum-193m	Pt-193m		100
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1	Platinum-193	Pt-193		1,000
2	Platinum-195m	Pt-195m		100
3	Platinum-197m	Pt-197m		1,000
4	Platinum-197	Pt-197		100
5	Platinum-199	Pt-199		1,000
6	Platinum-200	Pt-200		100
8	Gold-193	Au-193		1,000
9	Gold-194	Au-194		100
10	Gold-195	Au-195		10
11	Gold-198m	Au-198m		100
12	Gold-198	Au-198		100
13	Gold-199	Au-199		100
14	Gold-200m	Au-200m		100
15	Gold-200	Au-200		1,000
16	Gold-201	Au-201		1,000
17				100
18	Mercury-193m	Hg-193m		1 000
19	Mercury-193	HG-193		1,000
20	Mercury-194	HG-105m		
21	Mercury-195m Morcury-195	Hg-195		1 000
22	Mercury-195 Mercury-107m	Hg-195 Hg-197m		100
23	Mercury 197m Mercury-197	$H_{\alpha} = 1.97$		1 - 000
25	Mercury-199m	$H_{a} = 1.99 m$		1,000
26	Mercury-203	Hg=203		100
27				
28	Thallium-194m	T1-194m		1,000
29	Thallium-194	T1-194		1,000
30	Thallium-195	T1-195		1,000
31	Thallium-197	T1-197		1,000
32	Thallium-198m	T1-198 m		1,000
33	Thallium-198	T1-198		1,000
34	Thallium-199	T1-199		1,000
35	Thallium-200	T1-200		1,000
36	Thallium-201	T1-201		1,000
37	Thallium-202	T1-202		100
38	Thallium-204	11-204		100
39		Pb-105m		1 000
40 //1		Pb-198		1,000
42	Lead 190 Lead-199	Pb-199		1,000
43	Lead-200	Pb-200		100
44	Lead-201	Pb-201		1,000
45	Lead-202m	Pb-202m		1,000
46	Lead-202	Pb-202		10
47	Lead-203	Pb-203		1,000
48	Lead-205	Pb-205		100
49	Lead-209	Pb-209		1,000
50	Lead-210	Pb-210		0.01
51	Lead-211	Pb-211		100
52	Lead-212	Pb-212		1
53	Lead-214	Pb-214		100
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1 2 3 4 5 6 7 8 9 10	Bismuth-200 Bismuth-201 Bismuth-202 Bismuth-203 Bismuth-205 Bismuth-206 Bismuth-207 Bismuth-210m Bismuth-210 Bismuth-212	Bi-200 Bi-201 Bi-202 Bi-203 Bi-205 Bi-206 Bi-207 Bi-210m Bi-210 Bi-212		1,000 1,000 1,000 100 100 100 10 0.1 1 10
11 12 13	Bismuth-213 Bismuth-214	B1-213 Bi-214		10 100
14 15 16 17 18	Polonium-203 Polonium-205 Polonium-207 Polonium-210	Po-203 Po-205 Po-207 Po-210		1,000 1,000 1,000 0.1
19 20	Astatine-207 Astatine-211	At-207 At-211		100 10
21 22 23	Radon-220 Radon-222	Rn-220 Rn-222		1
24 25 26 27	Francium-222 Francium-223	Fr-222 Fr-223		100 100
27 28 29 30 31 32 33	Radium-223 Radium-224 Radium-225 Radium-226 Radium-227 Radium-228	Ra-223 Ra-224 Ra-225 Ra-226 Ra-227 Ra-228		0.1 0.1 0.1 0.1 1,000 0.1
35 36 37 38 39	Actinium-224 Actinium-225 Actinium-226 Actinium-227 Actinium-228	Ac-224 Ac-225 Ac-226 Ac-227 Ac-228		1 0.01 0.1 0.001 1
40 41 42 43 44 45 46 47 48 49	Thorium-226 Thorium-227 Thorium-228 Thorium-229 Thorium-230 Thorium-231 Thorium-232 Thorium-234 Thorium-natural	Th-226 Th-227 Th-228 Th-229 Th-230 Th-231 Th-232 Th-234		10 0.01 0.001 0.001 100 100 100
50 51 52 53 54	Protactinium-227 Protactinium-228 Protactinium-230 Protactinium-231	Pa-227 Pa-228 Pa-230 Pa-231		10 1 0.01 0.001

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1	Protactinium-232		Pa-232		1
2	Protactinium-233		Pa-233		100
3	Protactinium-234		Pa-234		100
4					
5	Uranium-230		U-230		0.01
6	Uranium-231		U-231		100
7	Uranium-232		U-232		0.001
8	Uranium-233		U-233		0.001
9	Uranium-234		U-234		0.001
10	Uranium-235		Ū−235		0.001
11	Uranium-236		U-236		0.001
12	Uranium-237		U-237		100
13	Uranium-238		U-238		100
14	Uranium-239		U-239		1,000
15	Uranium-240		U-240		100
16	Uranium-natural				100
17					
18	Neptunium-232		Np-232		100
19	Neptunium-233		Np-233		1,000
20	Neptunium-234		Np-234		100
21	Neptunium-235		Np-235		100
22	Neptunium-236 (1.1	5x10 [°] y)	Np-236		0.001
23	Neptunium-236 (22.	5h)	Np-236		1
24	Neptunium-237		Np-237		0.001
25	Neptunium-238		Np-238		10
26	Neptunium-239		Np-239		100
27	Neptunium-240		Np-240		1,000
28					
29	Plutonium-234		Pu-234		10
30	Plutonium-235		Pu-235		1,000
31	Plutonium-236		Pu-236		0.001
32	Plutonium-237		Pu-237		100
33	Plutonium-238		Pu-238		0.001
34	Plutonium-239		Pu-239		0.001
35	Plutonium-240		Pu-240		0.001
36	Plutonium-241		Pu-241		0.01
37	Plutonium-242		Pu-242		0.001
38	Plutonium-243		Pu-243		1,000
39	Plutonium-244		Pu-244		0.001
40	Plutonium-245		Pu-245		100
41	이는 것은 것은 것은 것은 것은 것은 것은 것은 것을 가지 않는다. 같은 것은 것은 것은 것은 것은 것은 것은 것을 가지 않는다. 것은 것을 가지 않는다. 것은				
42	Americium-237		Am-237		1,000
43	Americium-238		Am-238		100
44	Americium-239		Am-239		1,000
45	Americium-240		Am-240		100
46	Americium-241		Am-241		0.001
47	Americium-242m		Am-242m		0.001
48	Americium-242		Am-242		10
49	Americium-243		Am-243		0.001
50	Americium-244m		Am-244m		100
51	Americium-244		Am-244		10
52	Americium-245		Am-245		1,000
53	Americium-246m		Am-246m		1,000
54	Americium-246		Am-246		1,000

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1				
2	Curium-238	Cm-238		100
3	Curium-240	Cm-240		0.1
4	Curium-241	Cm-241		
5	Curium-242	Cm-242		0.01
6	Curium-243	Cm-243		0.001
7	Curium-244	Cm-244		0.001
8	Curium-245	Cm-245		0.001
- 9	Curium-246	Cm-246		0.001
10	Curium-247	Cm-24/		0.001
ΤT		Cm-248		0.001
12	Curium-249	Cm-249		1,000
13				0.0
14	Berkellum-245	BK-245		100
10	Berkellum-240 Borkolium-247	BK-240 Di- 247		
17	Berkelium-247	DK = 24/ Dir = 240		
⊥/ 10	Berkellum-249 Borkolium-250	DK-249 Dk-250		
10	Beikeilum-200	BK-23U		τv
20	Californium-211	CE_211		100
20	Californium-244	CI-244 CF-246		100
21	Californium-240	Cf = 240		
22	Californium-249	Cf = 240		0 001
23	Californium-250	Cf-250		0.001
25	Californium-251	Cf = 250		0.001
26	Californium-252	Cf = 252		0.001
27	Californium-253	Cf-253		0.001
28	Californium-254	Cf-254		0.001
29				
30	Any alpha emitting radionuclid	e		
31	not listed above or mixtures			
32	or alpha emitters of			
33	unknown composition			0.001
34				
35	Einsteinium-250	Es-250		100
36	Einsteinium-251	Es-251		100
37	Einsteinium-253	Es-253		0.1
38	Einsteinium-254m	Es-254m		1
39	Einsteinium-254	Es-254		0.01
40	· · · · · · · · · · · · · · · · · · ·			
41	Fermium-252	Fm-252		1
42	Fermium-253	Fm-253		1
43	Fermium-254	Fm-254		10
44	Fermium-255	Fm-255		1
45	Fermium-257	Fm-257		0.01
46	같은 것은 것은 것은 것을 못했다. 것은 것은 것은 것을 가지 않는 것을 것을 했다.			
4/	Mendelevium-257	Md-257		0 L C
48	Menaelevium-258	Md-258		0.01
49				
50	Any radionuclide other than			
5T	aipha emitter radionuclides			
52	of both omitters of			
55	UL DELA EMITTELS OF			רח ח
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2 4731.3075 TERMS AND CONDITIONS OF LICENSES.

[For text of subps 1 and 2, see M.R.] 3 Scope of license. A person licensed by the 4 Subp. 3. commissioner under this chapter must confine the licensee's 5 possession and use of radioactive material to the locations and 6 7 purposes authorized in the license. Except as otherwise provided in the license, a license issued under parts 4731.3000 8 to 4731.7280 carries with it the right to receive, acquire, own, 9 and possess radioactive material. Preparation for shipment and 10 transport of radioactive material must be according to parts 11 12 4731.0400 to 4731.0455.

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Subp. 4. Bankruptcy.

A. A general licensee required to register under part 4731.3215, subpart 3a, and a specific licensee issued a license under this chapter must notify the commissioner, in writing, immediately following the filing of a voluntary or involuntary petition for bankruptcy under any chapter of United States Code, title 11, by or against:

20 [For text of subitems (1) to (3), see M.R.] 21 [For text of item B, see M.R.] 22 [For text of subps 5 to 7, see M.R.]

23 Subp. 8. Security requirements for portable gauges. A 24 portable gauge licensee must use a minimum of two independent 25 physical controls that form tangible barriers to secure portable 26 gauges from unauthorized removal, whenever portable gauges are 27 not under the control and constant surveillance of the licensee.

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4731.3080 FINANCIAL ASSURANCE AND RECORD KEEPING FOR
 DECOMMISSIONING.

Subpart 1. Decommissioning funding plan required.

A. An applicant for a specific license authorizing 4 the possession and use of unsealed radioactive material of 5 half-life greater than 120 days and in quantities exceeding 10⁵ 6 times the applicable quantities under part 4731.3160 must submit 7 a decommissioning funding plan according to subpart 5. A 8 decommissioning funding plan must also be submitted when a 9 combination of isotopes is involved, if R divided by 10⁵ is 10 greater than one (unity rule), where R is the sum of the ratios 11 of the quantity of each isotope to the applicable value under 12 part 4731.3160. 13

14 B. A holder of or an applicant for a specific license 15 authorizing possession and use of sealed sources or plated foils 16 of half-life greater than 120 days and in quantities exceeding 17 10^{12} times the applicable quantities set forth in part 4731.3160 18 or, when a combination of isotopes is involved, if R, as defined 19 in subpart 1, divided by 10^{12} is greater than 1, must submit a 20 decommissioning funding plan as described in subpart 5.

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Subp. 2. Plan or financial assurance required.

A. A holder of or an applicant for a specific license authorizing possession and use of radioactive material of half-life greater than 120 days and in quantities specified in subpart 4 must:

26[For text of subitems (1) and (2), see M.R.]27[For text of items B and C, see M.R.]

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[For text of subps 3 to 7, see M.R.]

2 4731.3215 GENERAL LICENSE; DETECTING, MEASURING, GAUGING,
3 CONTROLLING, AND OTHER DEVICES.

4 [For text of subps 1 and 2, see M.R.]
5 Subp. 3. Requirements. A person who acquires, receives,
6 possesses, uses, or transfers radioactive material in a device
7 according to the general license issued under subpart 1 must:

[For text of items A to P, see M.R.] Q. report changes to the mailing address for the

9 Q. report changes to the mailing address for the 10 location of use, including change in name of the general 11 licensee, to the commissioner within 30 days of the effective 12 date of the change. For a portable device, a report of address 13 change is required only for a change in the device's primary 14 place of storage; and

not hold devices that are not in use for more than 15 R. 16 two years. If a device with shutters is not being used, the shutters must be locked in the closed position. The testing 17 18 required under item B need not be performed during the period of 19 storage only. When a device is put back into service or 20 transferred to another person, and has not been tested within 21 the required test interval, the device must be tested for 22 leakage before use or transfer and the shutters must be tested 23 before use. Devices kept in standby for future use are excluded 24 from the two-year time limit if the general licensee performs quarterly physical inventories of these devices while they are 25 26 in standby.

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Subp. 3a. Registration of generally licensed devices.

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10/22/07 [REVISOR] SGS/CA AR3618 A. A person to whom subpart 3 applies shall register 1 2 generally licensed devices according to items B and C. These 3 devices contain: (1) at least ten millicuries (370 MBg) of 4 cesium-137; 5 (2) at least 0.1 millicurie (3.7 MBq) of 6 strontium-90; 7 (3) at least one millicurie (37 MBq) of 8 9 cobalt-60; or (4) at least one millicurie (37 MBq) of 10 11 americium-241 or any other transuranic (any other element with an atomic number greater than uranium-92) based on the activity 12 indicated on the label. 13 14 If in possession of a device meeting the criteria Β. of item A, a person to whom subpart 3 applies must register the 15 device annually with the commissioner and pay the fee required 16 under Minnesota Statutes, section 144.1205. 17 (1) Registration must be done by verifying, 18 19 correcting, or adding to the information provided in a request for registration received from the commissioner. Registration 20 information must be submitted to the commissioner within 30 days 21 of the date of the request for registration or as otherwise 22 23 indicated in the request. (2) A general licensee holding devices meeting 24 the criteria of item A is subject to the bankruptcy notification 25 requirement under part 4731.3075, subpart 4. Each address for a 26 location of use under item C, subitem (4), represents a separate 27

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10/22/07 [REVISOR] SGS/CA AR3618 general license and requires a separate registration and fee. 1 2 (3) Persons generally licensed by an agreement state with respect to devices meeting the criteria in item A are 3 not subject to registration under this item if the devices are 4 used in areas subject to the commissioner's jurisdiction for a 5 period of less than 180 days in any calendar year. 6 The commissioner shall not request registration information from 7 such licensees. 8 9 C. In registering devices under item B, a person to whom subpart 3 applies must furnish the following information 10 11 and any other information specifically requested by the 12 commissioner: 13 (1) name and mailing address of the general 14 licensee; (2) the following information about each device: 15 16 (a) the manufacturer or initial transferor; (b) the model number; 17 (c) the serial number; and 18 19 (d) the radioisotope and activity, as indicated on the label; 20 21 (3) name, title, and telephone number of the 22 responsible person designated as a representative of the general 23 licensee under subpart 3, item P; (4) address or location at which each device is 24 used or stored. For portable devices, the address of the 25 primary place of storage must be furnished; 26 27 (5) certification by the responsible

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[REVISOR] SGS/CA AR3618 10/22/07 representative of the general licensee that the information 1 concerning the device has been verified through a physical 2 inventory and checking of label information; and 3 (6) certification by the responsible 4 representative of the general licensee that the responsible 5 6 representative is aware of the requirements of the general license. 7 Subp. 4. Limitation. The general license issued under 8 subpart 1 does not authorize the manufacture or import of 9 devices containing radioactive material. 10 4731.3330 SPECIFIC LICENSE; CERTAIN DEVICES CONTAINING 11 RADIOACTIVE MATERIALS; MANUFACTURE OR INITIAL TRANSFER. 12 Subpart 1. Approval criteria. An application for a 13 specific license to manufacture or initially transfer devices 14 containing radioactive material to a person generally licensed 15 under part 4731.3215 or equivalent regulations of the NRC or an 16 agreement state shall be approved if: 17 [For text of items A to D, see M.R.] 18 each device meeting the criteria of part 19 Ε. 20 4731.3215, subpart 3a, bears a permanent embossed, etched, 21 stamped, or engraved label affixed to the source housing if separable, or the device if the source housing is not separable, 22 that includes the words "Caution-Radioactive Material" and, if 23 practicable, the radiation symbol described in part 4731.2300. 24 25 [For text of subps 2 and 3, see M.R.] 26 Subp. 4. Transfer for use under general license; requirements. If a device containing radioactive material is to 27 Approved by Revisor _ 93

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[REVISOR] SGS/CA AR3618 10/22/07 1 be transferred for use under a general license issued under part 2 4731.3215, a person that is licensed under this part must 3 provide the information specified in this subpart to each person to whom a device is to be transferred. The information must be 4 provided before the device may be transferred. In case of a 5 transfer through an intermediate person, the information must 6 also be provided to the intended user before the initial 7 transfer to the intermediate person. The required information 8 9 includes: 10 A. a copy of the general license issued under part 11 4731.3215. If part 4731.3215, subpart 3, items B to D, or 3a, do not apply to the particular device, those items may be 12 13 omitted; 14 [For text of items B to E, see M.R.] 15 [For text of subps 5 to 11, see M.R.] 16 4731.3395 SPECIFIC LICENSE; RADIOACTIVE DRUGS FOR MEDICAL USE; MANUFACTURE, PREPARATION, OR TRANSFER. 17 18 [For text of subpart 1, see M.R.] Pharmacy licensees. 19 Subp. 2. A. A licensee described in subpart 1, item B, subitem 20 21 (3) or (4) may: (1) prepare radioactive drugs for medical use, 22 provided that the radioactive drug is prepared by either an 23 authorized nuclear pharmacist, as specified in subitem (2) or 24 25 item C, or an individual under the supervision of an authorized 26 nuclear pharmacist, as specified in part 4731.4407; and (2) allow a pharmacist to work as an authorized 27

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1	nuclear pharmacist if:
2	(a) the individual qualifies as an
3	authorized nuclear pharmacist;
4	(b) the individual meets the requirements
5	under parts 4731.4413 and 4731.4415 and the licensee has
6	received an approved license amendment identifying the
7	individual as an authorized nuclear pharmacist; or
8	(c) the individual is designated as an
9	authorized nuclear pharmacist according to item C.
10	[For text of items B to D, see M.R.]
11	[For text of subps 3 and 4, see M.R.]
12	4731.3400 SPECIFIC LICENSE; SOURCES OR DEVICES FOR MEDICAL USE;
13	MANUFACTURE AND DISTRIBUTION.
14	Subpart 1. Approval criteria. An application for a
15	specific license to manufacture and distribute sources and
16	devices containing radioactive material to persons licensed
17	according to parts 4731.4400 to 4731.4527 for use as a
18	calibration, transmission, or reference source or for the uses
19	listed under parts 4731.4450, 4731.4460, and 4731.4463 shall be
20	approved if:
21	[For text of items A to C, see M.R.]
22	[For text of subps 2 and 3, see M.R.]
23	4731.4030 PERFORMANCE REQUIREMENTS; INDUSTRIAL RADIOGRAPHY
24	EQUIPMENT.
25	[For text of subpart 1, see M.R.]
26	Subp. 2. Additional requirements.

10/22/07 [REVISOR] SGS/CA AR3618 [For text of items A and B, see M.R.] 1 2 C. Radiographic exposure devices intended for use as Type B transport containers must meet the applicable 3 requirements under parts 4731.0400 to 4731.0455. 4 5 [For text of item D, see M.R.] 6 [For text of subps 3 and 4, see M.R.] 4731.4110 LABELING; PACKAGING; SECURITY. 7 [For text of subpart 1, see M.R.] 8 9 Subp. 2. Required packaging. A licensee may not transport licensed material unless the material is packaged, and the 10 package is labeled, marked, and accompanied with appropriate 11 12 shipping papers, according to parts 4731.0400 to 4731.0455. [For text of subps 3 and 4, see M.R.] 13 14 4731.4140 RADIOGRAPHER TRAINING. 15 Subpart 1. Requirements; radiographer. A licensee may not 16 permit an individual to act as a radiographer until the 17 individual: 18 [For text of items A to C, see M.R.] receives copies of and instruction in parts 19 D. 20 4731.0200, 4731.0280, and 4731.0290; the applicable DOT regulations under parts 4731.0400 to 4731.0455; the applicable 21 22 portions of parts 4731.1000 to 4731.2950; parts 4731.4000 to 23 4731.4360; the license under which the radiographer will perform 24 industrial radiography; and the licensee's operating and 25 emergency procedures; 26 [For text of items E to G, see M.R.]

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10/22/07 [REVISOR] SGS/CA AR3618 Subp. 2. Requirements; radiographer's assistant. A 1 2 licensee may not permit an individual to act as a radiographer's assistant until the individual: 3 A. receives copies of and instruction in parts 4 5 4731.0200, 4731.0280, and 4731.0290; the applicable DOT regulations under parts 4731.0400 to 4731.0455; the applicable 6 portions of parts 4731.1000 to 4731.2950; parts 4731.4000 to 7 4731.4360; the license under which the radiographer's assistant 8 will perform industrial radiography; and the licensee's 9 operating and emergency procedures; 10 [For text of items B and C, see M.R.] 11 12 [For text of subps 3 to 7, see M.R.] 13 4731.4403 SPECIFIC LICENSE; MEDICAL USE OF RADIOACTIVE MATERIALS. 14 [For text of subps 1 and 2, see M.R.] Subp. 3. License amendments. A licensee must apply for 15 and receive a license amendment: 16 [For text of item A, see M.R.] 17 18 before the licensee permits anyone to work as an Β. 19 authorized user, authorized nuclear pharmacist, or authorized 20 medical physicist under the license, except: 21 (1) for an authorized user, an individual who meets the requirements under parts 4731.4415 and 4731.4433, 22 subpart 1, item A; 4731.4436, subpart 1, item A; 4731.4443, 23 24 subpart 1, item A; 4731.4444, item A; 4731.4445, item A; 25 4731.4458, subpart 1, item A; 4731.4461, item A; or 4731.4479, 26 subpart 1, item A; 27 (2) for an authorized nuclear pharmacist, an

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1	individual who meets the requirements under parts 4731.4413,
2	subpart 1, item A, and 4731.4415;
3	(3) for an authorized medical physicist, an
4	individual who meets the requirements under parts 4731.4412,
5	subpart 1, item A, and 4731.4415; or
6	[For text of subitem (4), see M.R.]
7	[For text of items C to G, see M.R.]
8	Subp. 4. Notifications of changes.
9	A. A licensee must provide the commissioner a copy of
10	the board certification and written attestation signed by a
11	preceptor, the license issued by the NRC or an agreement state,
12	the permit issued by an NRC or agreement state master material
13	license broad scope permittee, or the permit issued by an NRC or
14	agreement state licensee of broad scope for each individual no
15	later than 30 days after the date that the licensee allows,
16	under subpart 3, item B, the individual to work as:
17	(1) an authorized user;
18	(2) an authorized nuclear pharmacist; or
19	(3) an authorized medical physicist.
20	B. A licensee must notify the commissioner by letter
21	no later than 30 days after:
22	(1) an authorized user, an authorized nuclear
23	pharmacist, a radiation safety officer, or an authorized medical
24	physicist permanently discontinues performance of duties under
25	the license or has a name change;
26	(2) the licensee's mailing address changes;
27	(3) the licensee's name changes, but the name

10/22/07 [REVISOR] SGS/CA AR3618 change does not constitute a transfer of control of the license 1 2 as described under part 4731.3075, subpart 2; 3 (4) the licensee has added to or changed the 4 areas of use identified in the application or license where radioactive material is used according to part 4731.4432 or 5 4731.4434; or 6 7 (5) the licensee permits an authorized user or an 8 individual qualified to be a radiation safety officer under 9 parts 4731.4411 and 4731.4415, to function as a temporary 10 radiation safety officer and to perform the functions of a 11 radiation safety officer as described under part 4731.4405, 12 subpart 1, item C. 13 C. A licensee must mail required documents to the 14 address under part 4731.0200, subpart 4. 15 [For text of subps 5 to 7, see M.R.] 16 4731.4410 SUPPLIERS OF MEDICAL USE SEALED SOURCES OR DEVICES. 17 For medical use, a licensee may use only: 18 sealed sources or devices manufactured, labeled, Α. 19 packaged, and distributed according to a license issued under 20 parts 4731.3000 to 4731.3175 and 4731.3400 or equivalent 21 requirements of the NRC or an agreement state; 22 sealed sources or devices noncommercially Β. 23 transferred from a licensee licensed under parts 4731.4400 to 24 4731.4527 or equivalent requirements of the NRC or an agreement 25 state; or 26 C. teletherapy sources manufactured and distributed 27 according to a license issued under parts 4731.3000 to 4731.3175

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10/22/07 [REVISOR] SGS/CA AR3618 1 or equivalent requirements of the NRC or an agreement state. 2 4731.4411 RADIATION SAFETY OFFICER TRAINING. Subpart 1. Training and education requirements. Except as 3 4 provided under part 4731.4414, a licensee must require an 5 individual fulfilling the responsibilities of a radiation safety officer as provided under part 4731.4405 to be an individual who: 6 7 is certified by a specialty board whose Α. certification process has been recognized by the NRC or an 8 agreement state and: 9 10 (1) has obtained written attestation, signed by a 11 preceptor radiation safety officer, that the individual has 12 satisfactorily completed the requirements in this item and subpart 2 and has achieved a level of radiation safety knowledge 13 14 sufficient to function independently as a radiation safety officer for a medical use licensee; and 15 16 (2) has training in the radiation safety, 17 regulatory issues, and emergency procedures for the types of use 18 for which a licensee seeks approval. This training requirement 19 may be satisfied by completing training that is supervised by a 20 radiation safety officer, authorized medical physicist, 21 authorized nuclear pharmacist, or authorized user, as 22 appropriate, who is authorized for the types of use for which 23 the licensee is seeking approval; 24 B. (1) has completed a structured educational program 25 consisting of both: 26 (a) 200 hours of classroom and laboratory 27 training in the following areas:

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1	i. radiation physics and		
2	instrumentation;		
3	ii. radiation protection;		
4	iii. mathematics pertaining to the use		
5	and measurement of radioactivity;		
6	iv. radiation biology; and		
7	v. radiation dosimetry;		
8	(b) one year of full-time radiation safety		
9	experience under the supervision of an individual identified as		
10	the radiation safety officer on an NRC or agreement state		
11	license or permit issued by an NRC master material licensee that		
12	authorizes similar types of uses of radioactive material		
13	involving:		
14	i. shipping, receiving, and performing		
15	related radiation surveys;		
16	ii. using and performing checks for		
17	proper operation of instruments used to determine the activity		
18	of dosages, survey meters, and instruments used to measure		
19	radionuclides;		
20	iii. securing and controlling		
2 1	radioactive material;		
22	iv. using administrative controls to		
23	avoid mistakes in the administration of radioactive material;		
24	v. using procedures to prevent or		
25	minimize radioactive contamination and using proper		
26	decontamination procedures;		
27	vi. using emergency procedures to		

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10/22/07[REVISOR] SGS/CA AR36181 control radioactive material; and

2 vii. disposing of radioactive
3 material;

4 (2) has obtained written attestation, signed by a 5 preceptor radiation safety officer, that the individual has 6 satisfactorily completed the requirements in this item and has 7 achieved a level of radiation safety knowledge sufficient to 8 function independently as a radiation safety officer for a 9 medical use licensee; and

10 (3) has training in the radiation safety, 11 regulatory issues, and emergency procedures for the types of use 12 for which a licensee seeks approval. This training requirement may be satisfied by completing training that is supervised by a 13 14 radiation safety officer, authorized medical physicist, 15 authorized nuclear pharmacist, or authorized user, as 16 appropriate, who is authorized for the types of use for which 17 the licensee is seeking approval;

18 C. is a medical physicist who has been certified by a 19 specialty board whose certification process has been recognized 20 by the NRC or an agreement state under part 4731.4412 and has 21 experience in radiation safety for similar types of use of 22 radioactive material for which the licensee is seeking approval 23 of the individual as radiation safety officer and:

(1) has obtained written attestation, signed by a
preceptor radiation safety officer, that the individual has
satisfactorily completed the requirements in this item and has
achieved a level of radiation safety knowledge sufficient to

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1 function independently as a radiation safety officer for a
2 medical use licensee; and

3 (2) has training in the radiation safety, regulatory issues, and emergency procedures for the types of use 4 for which a licensee seeks approval. This training requirement 5 6 may be satisfied by completing training that is supervised by a radiation safety officer, authorized medical physicist, 7 authorized nuclear pharmacist, or authorized user, as 8 appropriate, who is authorized for the types of use for which 9 10 the licensee is seeking approval; or

D. is an authorized user, authorized medical physicist, or authorized nuclear pharmacist identified on the licensee's license and has experience with the radiation safety aspects of similar types of use of radioactive material for which the individual has radiation safety officer

16 responsibilities and:

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17 (1) has obtained written attestation, signed by a
18 preceptor radiation safety officer, that the individual has
19 satisfactorily completed the requirements in this item and has
20 achieved a level of radiation safety knowledge sufficient to
21 function independently as a radiation safety officer for a
22 medical use licensee; and

(2) has training in the radiation safety,
regulatory issues, and emergency procedures for the types of use
for which a licensee seeks approval. This training requirement
may be satisfied by completing training that is supervised by a
radiation safety officer, authorized medical physicist,

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1 authorized nuclear pharmacist, or authorized user, as
2 appropriate, who is authorized for the types of use for which
3 the licensee is seeking approval.

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Subp. 2. Certification requirements. A specialty board
under subpart 1, item A, shall require all candidates for
certification to:

A. (1) hold a bachelor's or graduate degree from an
8 accredited college or university in physical science or
9 engineering or biological science with a minimum of 20 college
10 credits in physical science;

(2) have five or more years of professional
experience in health physics, including at least three years in
applied health physics. Graduate training may be substituted
for no more than two years of the required experience; and

(3) pass an examination administered by
diplomates of the specialty board, which evaluates knowledge and
competence in radiation physics and instrumentation, radiation
protection, mathematics pertaining to the use and measurement of
radioactivity, radiation biology, and radiation dosimetry; or

B. (1) hold a master's or doctor's degree in physics,
medical physics, other physical science, engineering, or applied
mathematics from an accredited college or university;

(2) have two years of full-time practical
training or supervised experience in medical physics:
(a) under the supervision of a medical
physicist who is certified in medical physics by a specialty
board recognized by the NRC or an agreement state; or

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(b) in clinical nuclear medicine facilities
 providing diagnostic or therapeutic services under the direction
 of physicians who meet the requirements for authorized users in
 part 4731.4436 or 4731.4443; and

5 (3) pass an examination, administered by 6 diplomates of the specialty board, that assesses knowledge and 7 competence in clinical diagnostic radiological or nuclear 8 medicine physics and in radiation safety.

9 4731.4412 AUTHORIZED MEDICAL PHYSICIST TRAINING.

Subpart 1. Training and education requirements. Except as provided in part 4731.4414, a licensee must require an authorized medical physicist to be an individual who:

A. is certified by a specialty board whose
14 certification process has been recognized by the NRC or an
15 agreement state and:

16 (1) has obtained written attestation that the 17 individual has satisfactorily completed the requirements in this 18 item and subpart 2 and has achieved a level of competency 19 sufficient to function independently as an authorized medical 20 physicist for each type of therapeutic medical unit for which 21 the individual is requesting authorized medical physicist 22 status. The written attestation must be signed by a preceptor 23 authorized medical physicist who meets the requirements in this 24 part or equivalent agreement state requirements for an 25 authorized medical physicist for each type of therapeutic 26 medical unit for which the individual is requesting authorized 27 medical physicist status; and

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1 (2) has training for the types of use for which 2 authorization is sought that includes hands-on device operation, safety procedures, clinical use, and the operation of a 3 treatment planning system. This training requirement may be 4 satisfied by satisfactorily completing either a training program 5 provided by the vendor or by training supervised by an 6 7 authorized medical physicist authorized for the types of use for which the individual is seeking authorization; or 8 B. (1) holds a master's or doctor's degree in physics, 9 10 medical physics, other physical science, engineering, or applied mathematics from an accredited college or university, and: 11 12 (a) has completed one year of full-time 13 training in medical physics; 14 (b) has completed an additional year of 15 full-time work experience under the supervision of an individual who meets the requirements for an authorized medical physicist 16 17 for the types of use for which the individual is seeking authorization. This training and work experience must be 18 19 conducted in clinical radiation facilities that provide high-energy, external beam therapy (photons and electrons with 20 21 energies greater than or equal to 1,000,000 electron volts) and brachytherapy services and must include: 22 23 i. performing sealed source leak tests 24 and inventories; 25 ii. performing decay corrections; 26 iii. performing full calibration and

27 periodic spot checks of external beam treatment units,

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1 stereotactic radiosurgery units, and remote afterloading units
2 as applicable; and

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iv. conducting radiation surveys
around external beam treatment units, stereotactic radiosurgery
units, and remote afterloading units as applicable;

6 (2) has obtained written attestation that the 7 individual has satisfactorily completed the requirements in this item and has achieved a level of competency sufficient to 8 9 function independently as an authorized medical physicist for 10 each type of therapeutic medical unit for which the individual is requesting authorized medical physicist status. The written 11 12 attestation must be signed by a preceptor authorized medical 13 physicist who meets the requirements in this part or equivalent 14 NRC or agreement state requirements for an authorized medical physicist for each type of therapeutic medical unit for which 15 16 the individual is requesting authorized medical physicist 17 status; and

18 (3) has training for the types of use for which 19 authorization is sought that includes hands-on device operation, 20 safety procedures, clinical use, and the operation of a 21 treatment planning system. This training requirement may be 22 satisfied by satisfactorily completing either a training program. 23 provided by the vendor or by training supervised by an 24 authorized medical physicist authorized for the types of use for which the individual is seeking authorization. 25

26 Subp. 2. Certification requirements. A specialty board 27 under subpart 1, item A, shall require all candidates for

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10/22/07 [REVISOR] SGS/CA AR3618 1 certification to: 2 A. hold a master's or doctor's degree in physics, 3 medical physics, or other physical science, engineering, or 4 applied mathematics from an accredited college or university; 5 and 6 в. have two years of full-time practical training or 7 supervised experience in medical physics: 8 (1) under the supervision of a medical physicist 9 who is certified in medical physics by a specialty board 10 recognized by the commissioner, the NRC, or an agreement state; 11 or 12 (2) in clinical radiation facilities providing 13 high-energy, external beam therapy (photons and electrons with 14 energies greater than or equal to 1,000,000 electron volts) and 15 brachytherapy services under the direction of physicians who 16 meet the requirements for authorized users in part 4731.4458 or 17 4731.4479; and 18 C. pass an examination, administered by diplomates of 19 the specialty board, that assesses knowledge and competence in 20 clinical radiation therapy, radiation safety, calibration, 21 quality assurance, and treatment planning for external beam 22 therapy, brachytherapy, and stereotactic radiosurgery. 23 4731.4413 AUTHORIZED NUCLEAR PHARMACIST TRAINING. 24 Subpart 1. Training and education requirements. Except as 25 provided in part 4731.4414, a licensee must require an authorized nuclear pharmacist to be a pharmacist who: 26 27 Α. is certified by a specialty board whose Approved by Revisor 108

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[REVISOR] SGS/CA AR3618 10/22/07 1 certification process has been recognized by the NRC or an 2 agreement state and has obtained written attestation signed by a 3 preceptor authorized nuclear pharmacist, that the individual has satisfactorily completed the requirements in subpart 2 and has 4 achieved a level of competency sufficient to function 5 independently as an authorized nuclear pharmacist; or 6 B. (1) has completed 700 hours in a structured 7 educational program consisting of both: 8 (a) 200 hours of classroom and laboratory 9 training in the following areas: 10 radiation physics and 11 i. instrumentation; 12 ii. radiation protection; 13 iii. mathematics pertaining to the use 14 and measurement of radioactivity; 15 chemistry of radioactive material 16 iv. for medical use; and 17 radiation biology; and 18 v. 19 (b) supervised practical experience in a nuclear pharmacy involving: 20 shipping, receiving, and performing 21 i. 22 related radiation surveys; 23 using and performing checks for ii. proper operation of instruments used to determine the activity 24 of dosages, survey meters, and, if appropriate, instruments used 25 to measure alpha- or beta-emitting radionuclides; 26 iii. calculating, assaying, and safely 27

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10/22/07 [REVISOR] SGS/CA AR3618 1 preparing dosages for patients or human research subjects; 2 iv. using administrative controls to avoid medical events in the administration of radioactive 3 4 material; and 5 v. using procedures to prevent or 6 minimize radioactive contamination and using proper decontamination procedures; and 7 8 (2) has obtained written attestation signed by a preceptor authorized nuclear pharmacist, that the individual has 9 10 satisfactorily completed the requirements in this item and has achieved a level of competency sufficient to function 11 12 independently as an authorized nuclear pharmacist. 13 Subp. 2. Certification requirements. A specialty board 14 under subpart 1, item A, shall require all candidates for certification to: 15 16 A. have graduated from a pharmacy program accredited 17 by the American Council on Pharmaceutical Education (ACPE) or 18 have passed the Foreign Pharmacy Graduate Examination Committee 19 (FPGEC) examination; 20 B. hold a current, active license to practice 21 pharmacy; 22 С. provide evidence of having acquired at least 4,000 23 hours of training or experience in nuclear pharmacy practice. 24 Academic training may be substituted for no more than 2,000 25 hours of the required training and experience; and 26 D. pass an examination in nuclear pharmacy, 27 administered by diplomates of the specialty board, that assesses

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knowledge and competency in procurement, compounding, quality
 assurance, dispensing, distribution, health and safety,
 radiation safety, provision of information and consultation,
 monitoring patient outcomes, research, and development.

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5 4731.4414 TRAINING; EXPERIENCED RADIATION SAFETY OFFICER,
6 TELETHERAPY OR MEDICAL PHYSICIST, AUTHORIZED USER, AND NUCLEAR
7 PHARMACIST.

[For text of item A, see M.R.]

9 An individual identified as a radiation safety в. 10 officer, an authorized medical physicist, or an authorized 11 nuclear pharmacist on an NRC or agreement state license; a 12 permit issued by an NRC or agreement state broad scope licensee; 13 an NRC or agreement state master material license permit; or a 14 permit issued by a master material license permittee of broad 15 scope between October 24, 2002, and April 29, 2005, need not 16 comply with the training requirements of part 4731.4411, 17 4731.4412, or 4731.4413.

Physicians, dentists, or podiatrists identified as 18 C. 19 authorized users for the medical use of radioactive material on 20 a license issued by the NRC or an agreement state; a permit 21 issued by an NRC master material licensee; a permit issued by an 22 NRC or agreement state broad scope licensee; or a permit issued 23 by an NRC master material license broad scope permittee before 24 October 24, 2002, who perform only those medical uses for which 25 they were authorized on that date, need not comply with the 26 training requirements of parts 4731.4432 to 4731.4479.

D. Physicians, dentists, or podiatrists identified as

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10/22/07 [REVISOR] SGS/CA AR3618 authorized users for the medical use of radioactive material on 1 2 a license issued by the commissioner, the NRC, or an agreement state; a permit issued by an NRC master material licensee; a 3 permit issued by an NRC or agreement state broad scope licensee; 4 or a permit issued by an NRC master material license broad scope 5 permittee who perform only those medical uses for which they 6 7 were authorized between October 24, 2002, and April 29, 2005, need not comply with the training requirements of parts 8 4731.4432 to 4731.4479. 9 10 4731.4423 AUTHORIZATION FOR CALIBRATION, TRANSMISSION, AND **REFERENCE USE.** 11 12 A person authorized under part 4731.4403, subpart 1, for 13 medical use of radioactive material may receive, possess, and 14 use the following radioactive material for check, calibration, 15 transmission, and reference use: 16 [For text of items A to C, see M.R.] any radioactive material with a half-life longer 17 D. than 120 days in individual amounts not to exceed the smaller of 18 19 200 microcuries (7.4 MBq) or 1,000 times the quantities in part 20 4731.3160; and 21 Ε. technetium-99m in amounts as needed. 22 4731.4427 RELEASE OF INDIVIDUALS CONTAINING UNSEALED RADIOACTIVE 23 MATERIAL OR IMPLANTS. 24 Α. A licensee may authorize release from licensee control of an individual who has been administered unsealed 25 26 radioactive material or implants containing radioactive material

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10/22/07 [REVISOR] SGS/CA AR3618 1 if the total effective dose equivalent to any other individual from exposure to the released individual is not likely to exceed 2 3 0.5 rem (5 mSv). 4 [For text of items B to D, see M.R.] 4731.4432 UNSEALED RADIOACTIVE MATERIAL; UPTAKE, DILUTION, AND 5 EXCRETION STUDIES; WRITTEN DIRECTIVE NOT REQUIRED. 6 7 Except for guantities that require a written directive 8 under part 4731.4408 or 4731.4409, a licensee may use any 9 unsealed radioactive material prepared for medical use for uptake, dilution, or excretion studies that is: 10 11 [For text of item A, see M.R.] 12 В. prepared by: 13 (1) an authorized nuclear pharmacist; 14 (2) a physician who is an authorized user and who 15 meets the requirements of part 4731.4436 or parts 4731.4436, subpart 1, item C, subitem (1), unit (b), subunit vii, and 16 17 4731.4443; or 18 (3) an individual under the supervision, 19 according to part 4731.4407, of the authorized nuclear 20 pharmacist in subitem (1) or the physician who is an authorized 21 user in subitem (2); 22 [For text of items C and D, see M.R.] 23 4731.4433 UPTAKE, DILUTION, AND EXCRETION STUDIES; TRAINING. 24 Subpart 1. Training and education requirements. Except as 25 provided under part 4731.4414, a licensee must require the 26 authorized user of unsealed radioactive material for the uses

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1	authorized under part 4731.4432 to be a physician who:
2	A. is certified by a medical specialty board whose
3	certification process has been recognized by the NRC or an
4	agreement state and has obtained written attestation, signed by
5	a preceptor authorized user who meets the requirements of this
6	part, part 4731.4436 or 4731.4443, or equivalent requirements of
7	the NRC or an agreement state, that the individual has
8	satisfactorily completed the requirements in subpart 2 and has
9	achieved a level of competency sufficient to function
10	independently as an authorized user for the medical uses
11	authorized under part 4731.4432;
12	B. is an authorized user under part 4731.4436 or
13	4731.4443 or under equivalent requirements of the NRC or an
14	agreement state; or
15	
16	(1) completed 60 hours of training and
17	experience, including a minimum of eight hours of classroom and
18	laboratory training, in basic radionuclide handling techniques
19	applicable to the medical use of unsealed radioactive material
20	for uptake, dilution, and excretion studies. The training and
21	experience must include:
22	[For text of unit (a), see M.R.]
23	(b) work experience, under the supervision
24	of an authorized user who meets the requirements under this
25	part, part 4731.4436 or 4731.4443, or equivalent requirements of
26	the NRC or an agreement state, involving:
27	i. ordering, receiving, and unpacking

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10/22/07 [REVISOR] SGS/CA AR3618 1 radioactive materials safely and performing the related 2 radiation surveys; ii. performing quality control 3 procedures on instruments used to determine the activity of 4 dosages and performing checks for proper operation of survey 5 meters; 6 7 iii. calculating, measuring, and safely preparing patient or human research subject dosages; 8 9 iv. using administrative controls to prevent a medical event involving the use of unsealed 10 11 radioactive material; 12 using procedures to safely contain V . spilled radioactive material and using proper decontamination 13 14 procedures; and administering dosages of 15 vi. 16 radioactive drugs to patients or human research subjects; and (2) obtained written attestation, signed by a 17 18 preceptor authorized user who meets the requirements of this 19 part, part 4731.4436 or 4731.4443, or equivalent requirements of the NRC or an agreement state, that the individual has 20 21 satisfactorily completed the requirements in this item and has 22 achieved a level of competency sufficient to function 23 independently as an authorized user for the medical uses 24 authorized under part 4731.4432. 25 Subp. 2. Certification requirements. A specialty board 26 under subpart 1, item A, shall require all candidates for 27 certification to:

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[REVISOR] SGS/CA AR3618 complete 60 hours of training and experience in Α. basic radionuclide handling techniques and radiation safety

applicable to the medical use of unsealed radioactive material 3 for uptake, dilution, and excretion studies that include the 4 topics listed in subpart 1, item C, subitem (1), units (a) and 5 (b); and 6

pass an examination, administered by diplomates of 7 в. the specialty board, that assesses knowledge and competence in 8 radiation safety, radionuclide handling, and quality control. 9

4731.4434 UNSEALED RADIOACTIVE MATERIAL; IMAGING AND 10 LOCALIZATION STUDIES; WRITTEN DIRECTIVE NOT REQUIRED. 11

Except for guantities that require a written directive 12 13 under part 4731.4408, a licensee may use any unsealed 14 radioactive material prepared for medical use for imaging and localization studies that is: 15

obtained from a manufacturer or preparer licensed 16 Α. under part 4731.3395 or equivalent requirements of the NRC or an 17 18 agreement state;

19 B. prepared by:

20

(1) an authorized nuclear pharmacist;

(2) a physician who is an authorized user and 21 meets the requirements specified in part 4731.4436; or parts 22 4731.4436, subpart 1, item C, subitem (1), unit (b), subunit 23 24 vii, and 4731.4443; or

(3) an individual under the supervision, 25 26 according to part 4731.4407, of the authorized nuclear pharmacist in subitem (1) or the physician who is an authorized 27

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user in subitem (2);

2 C. obtained from and prepared by an NRC or agreement 3 state licensee for use in research according to a radioactive 4 drug research committee-approved protocol or an investigational 5 new drug protocol accepted by the Food and Drug Administration; 6 or

[For text of item D, see M.R.]

8 4731.4436 IMAGING AND LOCALIZATION STUDIES; TRAINING.

9 Subpart 1. Training and education requirements. Except as 10 provided under part 4731.4414, a licensee must require an 11 authorized user of unsealed radioactive material for the uses 12 authorized under part 4731.4434 to be a physician who:

13 is certified by a medical specialty board whose Α. certification process has been recognized by the NRC or an 14 agreement state and has obtained written attestation, signed by 15 a preceptor authorized user who meets the requirements in this 16 part; or in item C, subitem (1), unit (b), subunit vii, and part 17 4731.4443; or equivalent requirements of the NRC or an agreement 18 state, that the individual has satisfactorily completed the 19 20 requirements in subpart 2 and has achieved a level of competency sufficient to function independently as an authorized user for 21 the medical uses authorized under parts 4731.4432 and 4731.4434; 22

B. is an authorized user under part 4731.4443 and meets the requirements in item C, subitem (1), unit (b), subunit vii, or equivalent requirements of the NRC or an agreement state; or

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(1) completed 700 hours of training and 1 2 experience, including a minimum of 80 hours of classroom and 3 laboratory training, in basic radionuclide handling techniques applicable to the medical use of unsealed radioactive material 4 for imaging and localization studies. The training and 5 experience must include, at a minimum: 6 [For text of unit (a), see M.R.] 7 8 (b) work experience, under the supervision of an authorized user who meets the requirements under this 9 part; or in subunit vii and part 4731.4443; or equivalent 10 11 requirements of the NRC or an agreement state, involving: 12 ordering, receiving, and unpacking i. 13 radioactive materials safely and performing the related 14 radiation surveys; ii. performing quality control 15 16 procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey 17 18 meters; 19 [For text of subunits iii to vii, see M.R.] (2) obtained written attestation, signed by a 20 21 preceptor authorized user who meets the requirements in this part; or in subitem (1), unit (b), subunit vii, and part 22 23 4731.4443; or equivalent requirements of the NRC or an agreement state, that the individual has satisfactorily completed the 24 requirements in this item and has achieved a level of competency 25 sufficient to function independently as an authorized user for 26 the medical uses authorized under parts 4731.4432 and 4731.4434. 27

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10/22/07 [REVISOR] SGS/CA AR3618 Subp. 2. Certification requirements. A specialty board 1 shall require all candidates for certification to: 2 3 complete 700 hours of training and experience in Α. basic radionuclide handling techniques and radiation safety 4 applicable to the medical use of unsealed radioactive material 5 6 for imaging and localization studies that include the topics listed in subpart 1, item C, subitem (1), units (a) and (b); and 7 B. pass an examination administered by diplomates of 8 the specialty board, which assesses knowledge and competence in 9 radiation safety, radionuclide handling, and quality control. 10 4731.4443 UNSEALED RADIOACTIVE MATERIAL; WRITTEN DIRECTIVE 11 12 REQUIRED; TRAINING. 13 Subpart 1. Training and education requirements. Except as provided under part 4731.4414, a licensee must require an 14 authorized user of unsealed radioactive material for the uses 15 16 authorized under part 4731.4440 to be a physician who: 17 is certified by a medical specialty board whose Α. certification process has been recognized by the NRC or an 18 19 agreement state, meets the requirements in item B, subitem (1), 20 unit (b), subunit vi, and has obtained written attestation that the individual has satisfactorily completed the requirements in 21 22 this item and subpart 2 and has achieved a level of competency sufficient to function independently as an authorized user for 23 the medical uses authorized under part 4731.4440. The written 24 attestation must be signed by a preceptor authorized user who 25 26 meets the requirements of this part or equivalent requirements 27 of the NRC or an agreement state. A preceptor authorized user

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who meets the requirements in item B must also have experience
 in administering dosages in the same dosage category or
 categories under item B, subitem (1), unit (b), subunit vi, as
 the individual requesting authorized user status;

B. has:

6 (1) completed 700 hours of training and 7 experience, including a minimum of 200 hours of classroom and 8 laboratory training, in basic radionuclide handling techniques 9 applicable to the medical use of unsealed radioactive material 10 requiring a written directive. The training and experience must 11 include:

[For text of unit (a), see M.R.]

13 (b) work experience, under the supervision 14 of an authorized user who meets the requirements in this part or 15 equivalent requirements of the NRC or an agreement state. A 16 supervising authorized user who meets the requirements in this 17 item must also have experience in administering dosages in the 18 same dosage category or categories under subunit vi as the 19 individual requesting authorized user status. The work 20 experience must involve:

i. ordering, receiving, and unpacking
radioactive materials safely and performing the related
radiation surveys;

ii. performing quality control
procedures on instruments used to determine the activity of
dosages and performing checks for proper operation of survey
meters;

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[REVISOR] SGS/CA AR3618 [For text of subunits iii to v, see M.R.] vi. administering dosages of

3 radioactive drugs to patients or human research subjects involving a minimum of three cases in each of the following 4 categories for which the individual is requesting authorized 5 user status: oral administration of less than or equal to 33 6 millicuries (1.22 GBq) of sodium iodide (I-131) for which a 7 8 written directive is required; oral administration of greater 9 than 33 millicuries (1.22 GBq) of sodium iodide (I-131) (experience with at least three cases also satisfies the 10 11 requirement of oral administration of less than or equal to 33 millicuries of I-131); parenteral administration of any beta 12 emitter, or a photon-emitting radionuclide with a photon energy 13 14 less than 150 kilo electron volts for which a written directive is required; or parenteral administration of any other 15 16 radionuclide for which a written directive is required; and

(2) obtained written attestation that the 17 individual has satisfactorily completed the requirements in this 18 19 item and has achieved a level of competency sufficient to function independently as an authorized user for the medical 20 21 uses authorized under part 4731.4440. The written attestation must be signed by a preceptor authorized user who meets the 22 23 requirements of this part or equivalent requirements of the NRC or an agreement state. A preceptor authorized user who meets 24 the requirements in this item must also have experience in 25 administering dosages in the same dosage category or categories 26 under subitem (1), unit (b), subunit vi, as the individual 27

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1 requesting authorized user status.

2 Subp. 2. Certification requirements. A specialty board 3 under subpart 1, item A, shall require all candidates for 4 certification to:

successfully complete residency training in a 5 Α. radiation therapy or nuclear medicine training program or a 6 program in a related medical specialty. These residency 7 training programs must include 700 hours of training and 8 experience as described in subpart 1, item B, subitem (1), units 9 (a) and (b), subunits i to v. Eligible training programs must 10 11 be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal 12 College of Physicians and Surgeons of Canada, or the Committee 13 on Postgraduate Training of the American Osteopathic 14 Association; and 15

B. pass an examination, administered by diplomates of the specialty board, that tests knowledge and competence in radiation safety, radionuclide handling, quality assurance, and clinical use of unsealed radioactive material for which a written directive is required.

21 4731.4444 ORAL ADMINISTRATION OF SODIUM IODIDE I-131; QUANTITIES
22 LESS THAN OR EQUAL TO 33 MILLICURIES (1.22 GBq); WRITTEN
23 DIRECTIVE REQUIRED; TRAINING.

Except as provided under part 4731.4414, a licensee must require an authorized user for the oral administration of sodium iodide (I-131) requiring a written directive in quantities less than or equal to 33 millicuries (1.22 GBq) to be a physician who:

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is certified by a medical specialty board whose 1 Α. certification process has been recognized by the NRC or an 2 agreement state and includes all of the requirements of item C, 3. subitems (1) and (2), and who has obtained written attestation 4 that the individual has satisfactorily completed the 5 requirements of item C, subitems (1) and (2), and has achieved a 6 level of competency sufficient to function independently as an 7 authorized user for medical uses authorized under part 8 The written attestation must be signed by a 9 4731.4440. preceptor authorized user who meets the requirements of this 10 part, part 4731.4443 or 4731.4445, or equivalent requirements of 11 the NRC or an agreement state. A preceptor authorized user who 12 meets the requirement in part 4731.4443, subpart 1, item B, must 13 also have experience in oral administration of less than or 14 equal to 33 millicuries (1.22 GBq) of sodium iodide (I-131) for 15 16 which a written directive is required or oral administration of greater than 33 millicuries (1.22 GBq) of sodium iodide (I-131) 17 as specified in part 4731.4443, subpart 1, item B, subitem (1), 18 unit (b), subunit vi; 19

B. is an authorized user under part 4731.4443, for
oral administration of less than or equal to 33 millicuries
(1.22 GBq) of sodium iodide (I-131) for which a written
directive is required or oral administration of greater than 33
millicuries (1.22 GBq) of sodium iodide (I-131) under part
4731.4443 or 4731.4445, or under equivalent requirements of the
NRC or an agreement state; or

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has:

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(1) successfully completed 80 hours of classroom 1 2 and laboratory training, applicable to the medical use of sodium iodide (I-131) for procedures requiring a written directive. 3 4 The training must include:

[For text of units (a) to (e), see M.R.]

(2) work experience under the supervision of an 6 authorized user who meets the requirements of this part, part 7 8 4731.4443 or 4731.4445, or equivalent requirements of the NRC or an agreement state. A supervising authorized user who meets the 9 requirements in part 4731.4443, subpart 1, item B, must also 10 11 have experience in oral administration of less than or equal to 33 millicuries (1.22 GBq) of sodium iodide (I-131) for which a 12 13 written directive is required or oral administration of greater than 33 millicuries (1.22 GBq) of sodium iodide (I-131) as 14 specified in part 4731.4443. The work experience must involve: 15 16 (a) ordering, receiving, and unpacking radioactive materials safely and performing the related 17 18 radiation surveys; 19 (b) performing quality control procedures on instruments used to determine the activity of dosages and 20 performing checks for the proper operation of survey meters; 21

[For text of units (c) to (f), see M.R.] 23 (3) obtained written attestation that the individual has satisfactorily completed the requirements of this 24 item and has achieved a level of competency sufficient to 25 function independently as an authorized user for medical uses 26 authorized under part 4731.4440. The written attestation must 27

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1 be signed by a preceptor authorized user who meets the requirements of this part, part 4731.4443 or 4731.4445, or 2 equivalent requirements of the NRC or an agreement state. A 3 preceptor authorized user who meets the requirement in part 4 4731.4443, subpart 1, item B, must also have experience in oral 5 administration of less than or equal to 33 millicuries (1.22 6 7 GBq) of sodium iodide (I-131) for which a written directive is required or oral administration of greater than 33 millicuries 8 9 (1.22 GBq) of sodium iodide (I-131) as specified in part 10 4731.4443.

4731.4445 ORAL ADMINISTRATION OF SODIUM IODIDE; QUANTITIES
 GREATER THAN 33 MILLICURIES (1.22 GBq); WRITTEN DIRECTIVE
 REQUIRED; TRAINING.

Except as provided under part 4731.4414, a licensee must require an authorized user for the oral administration of sodium iodide (I-131) requiring a written directive in quantities greater than 33 millicuries (1.22 GBq) to be a physician who:

18 Α. is certified by a medical specialty board whose 19 certification process has been recognized by the NRC or an 20 agreement state and includes all the requirements in item C, 21 subitems (1) and (2), and who has obtained written attestation 22 that the individual has satisfactorily completed the 23 requirements of this item and has achieved a level of competency 24 sufficient to function independently as an authorized user for 25 medical uses authorized under part 4731.4440. The written 26 attestation must be signed by a preceptor authorized user who 27 meets the requirements in this part, part 4731.4443, or

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10/22/07 [REVISOR] SGS/CA AR3618 1 equivalent requirements of the NRC or an agreement state. Α preceptor authorized user who meets the requirements in part 2 4731.4443, subpart 1, item B, must also have experience in the 3 oral administration of I-131 in quantities greater than 33 4 millicuries as specified in part 4731.4443, subpart 1, item B, 5 subitem (1), unit (b), subunit vi; 6 7 B. is an authorized user under part 4731.4443, subpart 1, item A; 4731.4443, subpart 1, item B, for the oral 8 administration of I-131 in quantities greater than 33 9 10 millicuries under part 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit vi; or equivalent requirements of the NRC 11 12 or an agreement state; or 13 C. has: 14 (1) successfully completed 80 hours of classroom 15 and laboratory training, applicable to the medical use of I-131 for procedures requiring a written directive. The training must 16 17 include: 18 [For text of units (a) to (e), see M.R.] 19 (2) has work experience, under the supervision of 20 an authorized user who meets the requirements under this part, part 4731.4443, subpart 1, item A or B, or equivalent 21 22 requirements of the NRC or an agreement state. A supervising authorized user who meets the requirements in part 4731.4443, 23 24 subpart 1, item B, must also have experience in the oral 25 administration of I-131 in quantities greater than 33 26 millicuries under part 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit vi. The work experience must involve: 27

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10/22/07 [REVISOR] SGS/CA AR3618 (a) ordering, receiving, and unpacking 1 2 radioactive materials safely and performing the related 3 radiation surveys; 4 (b) performing quality control procedures on instruments used to determine the activity of dosages and 5 performing checks for proper operation of survey meters; 6 7 [For text of units (c) to (f), see M.R.] 8 (3) obtained written attestation that the 9 individual has satisfactorily completed the requirements of this 10 item and has achieved a level of competency sufficient to 11 function independently as an authorized user for medical uses authorized under part 4731.4440. The written attestation must 12 be signed by a preceptor authorized user who meets the 13 14 requirements in this part, part 4731.4443, or equivalent requirements of the NRC or an agreement state. A preceptor 15 16 authorized user who meets the requirements in part 4731.4443, subpart 1, item B, must also have experience in the oral 17 administration of I-131 in quantities greater than 33 18 19 millicuries under part 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit vi. 20 21 4731.4446 PARENTERAL ADMINISTRATION OF UNSEALED RADIOACTIVE MATERIAL; WRITTEN DIRECTIVE REQUIRED; TRAINING. 22 23 Except as provided in part 4731.4414, the licensee Α. 24 must require an authorized user for the parenteral

25 administration requiring a written directive to be a physician 26 who is:

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(1) an authorized user under part 4731.4443 or

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10/22/07 [REVISOR] SGS/CA AR3618 1 equivalent requirements of the NRC or an agreement state; 2 (2) an authorized user under part 4731.4458 or 3 4731.4479 or equivalent requirements of the NRC or an agreement 4 state and meets the requirements in item B; or (3) certified by a medical specialty board whose 5 certification process has been recognized by the NRC or an 6 agreement state under part 4731.4458 or 4731.4479 and meets the 7 requirements in item B. 8 9 в. The physician under item A, subitems (2) and (3), 10 must have: 11 (1) successfully completed 80 hours of classroom and laboratory training, applicable to parenteral 12 13 administrations, for which a written directive is required, of 14 any beta emitter, or any photon-emitting radionuclide with a photon energy less than 150 keV or parenteral administration of 15 16 any other radionuclide for which a written directive is 17 required. The training must include: 18 (a) radiation physics and instrumentation; 19 (b) radiation protection; 20 (c) mathematics pertaining to the use and 21 measurement of radioactivity; 22 (d) chemistry of radioactive material for medical use; and 23 24 (e) radiation biology; 25 (2) work experience, under the supervision of an authorized user who meets the requirements in this part or part 26 27 4731.4443, or equivalent requirements of the NRC or agreement

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[REVISOR] SGS/CA AR3618 10/22/07 state, in the parenteral administration, for which a written 1 directive is required, of any beta emitter, or any 2 photon-emitting radionuclide with a photon energy less than 150 3 keV or parenteral administration of any other radionuclide for 4 which a written directive is required. A supervising authorized 5 user who meets the requirements in part 4731.4443 must have 6 experience in parenteral administration of any beta emitter, or 7 a photon-emitting radionuclide with a photon energy less than 8 150 kilo electron volts for which a written directive is 9 required or parenteral administration of any other radionuclide 10 for which a written directive is required as specified in part 11 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit 12 vi. The work experience must involve: 13 14 (a) ordering, receiving, and unpacking radioactive materials safely and performing the related 15 16 radiation surveys; 17 (b) performing quality control procedures on instruments used to determine the activity of dosages and 18 19 performing checks for proper operation of survey meters; 20 (c) calculating, measuring, and safely preparing patient or human research subject dosages; 21 22 (d) using administrative controls to prevent a medical event involving the use of unsealed radioactive 23 materials; 24 (e) using procedures to contain spilled 25 26 radioactive materials safely and using proper decontamination 27 procedures; and

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(f) administering dosages to patients or 1 2 human research subjects, that include at least three cases involving the parenteral administration, for which a written 3 4 directive is required, of any beta emitter, or any photon-emitting radionuclide with a photon energy less than 150 5 keV or at least three cases involving the parenteral 6 administration of any other radionuclide for which a written 7 8 directive is required; and

9 (3) obtained written attestation that the 10 individual has satisfactorily completed the requirements in this item and item A, subitem (2) or (3), and has achieved a level of 11 12 competency sufficient to function independently as an authorized user for the parenteral administration of unsealed radioactive 13 14 material requiring a written directive. The written attestation must be signed by a preceptor authorized user who meets the 15 16 requirements in this part, part 4731.4443, or equivalent 17 requirements of the NRC or agreement state. A preceptor authorized user who meets the requirements in part 4731.4443 18 19 must have experience in parenteral administration of any beta 20 emitter, or a photon-emitting radionuclide with a photon energy 21 less than 150 kilo electron volts for which a written directive is required or parenteral administration of any other 22 23 radionuclide for which a written directive is required as specified in part 4731.4443, subpart 1, item B, subitem (1), 24 25 unit (b), subunit vi.

26 4731.4458 MANUAL BRACHYTHERAPY TRAINING.

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Subpart 1. Training and education requirements. Except as

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1 provided under part 4731.4414, a licensee must require an
2 authorized user of a manual brachytherapy source for the uses
3 authorized under part 4731.4450 to be a physician who:

is certified by a medical specialty board whose 4 Α. certification has been recognized by the NRC or an agreement 5 state and has obtained written attestation, signed by a 6 preceptor authorized user who meets the requirements of this 7 part or equivalent requirements of the NRC or an agreement 8 9 state, that the individual has satisfactorily completed the 10 requirements of subpart 2 and has achieved a level of competency sufficient to function independently as an authorized user of 11 12 manual brachytherapy sources for the medical uses authorized 13 under part 4731.4450; or

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B. has:

(1) completed a structured educational program in basic radionuclide handling techniques applicable to the use of manual brachytherapy sources that includes:

18 [For text of units (a) and (b), see M.R.] 19 (2) completed three years of supervised clinical 20 experience in radiation oncology, under an authorized user who meets the requirements of this part or equivalent requirements 21 22 of the NRC or an agreement state, as part of a formal training program approved by the Residency Review Committee for Radiation 23 24 Oncology of the Accreditation Council for Graduate Medical 25 Education, the Royal College of Physicians and Surgeons of 26 Canada, or the Committee on Postgraduate Training of the American Osteopathic Association. This experience may be 27

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10/22/07 [REVISOR] SGS/CA AR3618 1 obtained concurrently with the supervised work experience 2 required under subitem (1), unit (b); and

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3 (3) obtained written attestation, signed by a preceptor authorized user who meets the requirements of this 4 part or equivalent requirements of the NRC or an agreement 5 state, that the individual has satisfactorily completed the 6 requirements of this item and has achieved a level of competency 7. 8 sufficient to function independently as an authorized user of 9 manual brachytherapy sources for the medical uses authorized 10 under part 4731.4450.

Subp. 2. Certification requirements. A specialty board under subpart 1, item A, shall require all candidates for certification to:

A. successfully complete a minimum of three years of residency training in a radiation oncology program approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Committee on Postgraduate Training of the American Osteopathic Association; and

B. pass an examination, administered by diplomates of
the specialty board, that tests knowledge and competence in
radiation safety, radionuclide handling, treatment planning,
quality assurance, and clinical use of manual brachytherapy.

24 4731.4459 OPHTHALMIC USE OF STRONTIUM-90; TRAINING.

25 Except as provided under part 4731.4414, a licensee must 26 require an authorized user of strontium-90 for ophthalmic 27 radiotherapy to be a physician who:

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10/22/07 [REVISOR] SGS/CA AR3618 is an authorized user under part 4731.4458 or 1 Α. 2 equivalent requirements of the NRC or an agreement state; or 3 в. has: 4 (1) completed 24 hours of classroom and laboratory training applicable to the medical use of 5 strontium-90 for ophthalmic radiotherapy. The training must 6 include: 7 8 [For text of units (a) to (d), see M.R.] 9 (2) had supervised clinical training in ophthalmic radiotherapy under the supervision of an authorized 10 11 user at a medical institution, clinic, or private practice that 12 includes the use of strontium-90 for the ophthalmic treatment of five individuals. The supervised clinical training must involve: 13 14 [For text of units (a) to (d), see M.R.] (3) obtained written attestation, signed by a 15 16 preceptor authorized user who meets the requirements of this 17 part, part 4731.4458, or equivalent requirements of the NRC or an agreement state, that the individual has satisfactorily 18 19 completed the requirements in this item and has achieved a level 20 of competency sufficient to function independently as an 21 authorized user of strontium-90 for ophthalmic use. 22 4731.4461 USE OF SEALED SOURCES FOR DIAGNOSIS; TRAINING. 23 Except as provided under part 4731.4414, a licensee must require an authorized user of a diagnostic sealed source for use 24 25 in a device authorized under part 4731.4460 to be a physician, 26 dentist, or podiatrist who: 27 [For text of item A, see M.R.]

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10/22/07 [REVISOR] SGS/CA AR3618 1 в. has: 2 (1) completed eight hours of classroom and 3 laboratory training in basic radionuclide handling techniques 4 specifically applicable to the use of the device. The training 5 must include: 6 (a) radiation physics and instrumentation; 7 (b) radiation protection; 8 (c) mathematics pertaining to the use and 9 measurement of radioactivity; and 10 (d) radiation biology; and 11 (2) completed training in the use of the device 12 for the uses requested. 13 4731.4479 REMOTE AFTERLOADER UNITS, TELETHERAPY UNITS, AND GAMMA 14 STEREOTACTIC RADIOSURGERY UNITS; TRAINING. 15 Subpart 1. Training and education requirements. Except as 16 provided under part 4731.4414, a licensee must require an 17 authorized user of a sealed source for a use authorized under 18 part 4731.4463 to be a physician who: 19 is certified by a medical specialty board whose Α. 20 certification process has been recognized by the NRC or an 21 agreement state, meets the requirements in item B, subitem (4), 22 and has obtained written attestation that the individual has 23 satisfactorily completed the requirements in this item and 24 subpart 2 and has achieved a level of competency sufficient to 25 function independently as an authorized user of each type of 26 therapeutic medical unit for which the individual is requesting 27 authorized user status. The written attestation must be signed

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10/22/07 [REVISOR] SGS/CA AR3618 1 by a preceptor authorized user who meets the requirements of 2 this part or equivalent requirements of the NRC or an agreement state for an authorized user for each type of therapeutic 3 medical unit for which the individual is requesting authorized 4 5 user status; or Β. 6 has: (1) completed a structured educational program in 7 8 basic radionuclide techniques applicable to the use of a sealed 9 source in a therapeutic medical unit that includes: 10 [For text of units (a) and (b), see M.R.] 11 (2) completed three years of supervised clinical experience in radiation therapy, under an authorized user who 12 meets the requirements of this part or equivalent requirements 13 14 of the NRC or an agreement state, as part of a formal training program approved by the Residency Review Committee for Radiation 15 Oncology of the Accreditation Council for Graduate Medical 16 17 Education, the Royal College of Physicians and Surgeons of 18 Canada, or the Committee on Postgraduate Training of the 19 American Osteopathic Association. The experience may be 20 obtained concurrently with the supervised work experience 21 required under subitem (1), unit (b); 22 (3) obtained written attestation that the

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individual has satisfactorily completed the requirements in this item and has achieved a level of competency sufficient to function independently as an authorized user of each type of therapeutic medical unit for which the individual is requesting authorized user status. The written attestation must be signed

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by a preceptor authorized user who meets the requirements of this part or equivalent requirements of the NRC or an agreement state for an authorized user for each type of therapeutic medical unit for which the individual is requesting authorized user status; and

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(4) received training in device operation, safety 6 procedures, and clinical use for the types of use for which 7 8 authorization is sought. This training requirement may be 9 satisfied by satisfactory completion of a training program provided by the vendor for new users or by receiving training 10 11 supervised by an authorized user or authorized medical physicist, as appropriate, who is authorized for the types of 12 13 use for which the individual is seeking authorization.

14 Subp. 2. Certification requirements. A specialty board 15 under subpart 1, item A, shall require all candidates for 16 certification to:

A. successfully complete a minimum of three years of residency training in a radiation therapy program approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Committee on Postgraduate Training of the American Osteopathic Association; and

B. pass an examination, administered by diplomates of
the specialty board, that tests knowledge and competence in
radiation safety, radionuclide handling, treatment planning,
quality assurance, and clinical use of stereotactic
radiosurgery, remote afterloaders, and external beam therapy.

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4731.7050 LABELS, SECURITY, AND TRANSPORTATION PRECAUTIONS.
 Subpart 1. Labeling.

[For text of items A and B, see M.R.]

C. A licensee may not transport licensed material unless the material is packaged, labeled, marked, and accompanied with appropriate shipping papers according to parts 7 4731.0400 to 4731.0455.

[For text of subp 2, see M.R.]

9 REPEALER. Minnesota Rules, parts 4731.0405; 4731.0410, subparts 10 5 and 6; and 4731.0422, subpart 1, are repealed.

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