UT - Radiation Safety Department

P.I. Application for Use of Radioactive Material

Section A

Name: _____ _____ _____
(Last) (First) (MI)

Department: _____

Office: _____
(Building & Room #)

Lab: _____
(Building & Room #)

Net ID _____ Sex: ☐M ☐F

Phone #: _____
(Office) (Lab)

Highest Degree Held: _____ _____ _____
(Degree) (Area) (Granting Institution)

Section B

Experience and Training with Radionuclides

Please describe below all your experience with radioactive materials. In the first table, please describe all work/research experiences. In the next table, list all training courses or seminars.

Code	Nuclides and Activity	Description	Dates
Experience -1			

Code	Nuclides and Activity	Description	Dates
Experience-2			
Experience-3			
Experience-4			

Code	Institution	Seminar/Course Title	Dates Attended
T-1			
T-2			
T-3			
T-4			
T-5			
T-6			

Section C

Laboratory Personnel Form

List the full name of each person who will working with radioactive materials in your lab. Please make a note if there will be individuals in the lab who will not be trained for radioactive material use. All persons working with radioactive materials must complete UT's Radiation Safety Training before they begin working around radiation. It is your responsibility to notify Radiation Safety of any staff changes or training needs.

1. _____ Date of Training: _____
2. _____ Date of Training: _____
3. _____ Date of Training: _____
4. _____ Date of Training: _____
5. _____ Date of Training: _____
6. _____ Date of Training: _____
7. _____ Date of Training: _____
8. _____ Date of Training: _____

Section D

Radionuclides Requested For Usage at The University of Tennessee

Please complete the following information for each radionuclide that you are requesting for use: total activity amount you are requesting in milliCuries or microCuries, chemical form, physical form, type of source (sealed or loose), physical half-life, list modes of decay and energy in keV. Attach additional sheets if necessary.

Isotope	Possession Limit	Chemical Forms	Physical Form	Source Type	Physical Half-life	Decay and Energy

Proposed Use and Method for Each Isotope Requested

Please provide a description of the intended use of both the chemical and physical forms of the isotope listed above. Include any established protocols and published information that applies. (If necessary, provide an attachment to describe the entire process).

Waste Disposal

For the isotope above, please provide a description of the types of radioactive wastes anticipated from usage and the associated anticipated annual waste volumes. Examples of types of waste would include: dry solids, aqueous liquids, non-aqueous or hazardous liquids, animal waste or carcasses, liquid scintillation, sharps, and metals.

To complete this next section, you will need to use Appendix A of this document.

Γ R/hr @ 1 meter per milliCurie[1]	**TVL in mm lead[2]**	**Shielding to be Used**	**Protective Devices or Clothing to be Used in the Lab.**

$ALI_{(ingestion)}$[3]	**$ALI_{(inhalation)}$[4]**	**Toxicity Level**	**Container Posting Level (µCi)**

Section D Notes

[1] The Γ, or the specific gamma ray constant is the exposure rate from the given gamma emitting isotope in Rads per hour from a 1 Curie amount of the isotope at 1 meter from the source. This information can be found in Appendix A of this application.

[2] The Tenth-Value Layer (TVL) describes the thickness of various materials required to reduce the intensity of common photon energy beams to 1/10th their intensity. This information can be found in Appendix A of this application. Be sure to list the type of material to be used and thickness in millimeters, e.g. 2 mm of Pb.

[3,4] ALI-ingestion/inhalation is the Annual Limit of Intake for occupational exposure as listed in the State of Tennessee Regulations for Protection Against Radioactive Material (SRPAR) 0400-20-05-.161, RHS 8-30, Table I, Column 1. A copy of this table can be found in Appendix A of this application.

Radionuclide 2:

Please complete the following information for each radionuclide that you are requesting for use: total activity amount you are requesting in milliCuries or microCuries, chemical form, physical form, type of source (sealed or loose), physical half-life of the isotope, and list modes of decay and energy in keV. Attach additional sheets if necessary.

Isotope	Possession Limit	Chemical Forms	Physical Form	Source Type	Physical Half-life	Decay and Energy

Proposed Use and Method for Each Isotope Requested

Please provide a description of the intended use of both the chemical and physical forms of the isotope listed above. Include any established protocols and published information that applies. (If necessary, provide an attachment to describe the entire process).

Waste Disposal

For the isotope above, please provide a description of the types of radioactive wastes anticipated from usage and the associated anticipated annual waste volumes. Examples of types of waste would include: dry solids, aqueous liquids, non-aqueous or hazardous liquids, animal waste or carcasses, liquid scintillation, sharps, and metals.

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Γ R/hr @ 1 meter per milliCurie[1]	**TVL in mm lead[2]**	**Shielding to be Used**	**Protective Devices or Clothing to be Used in the Lab.**

$ALI_{(ingestion)}$[3]	**$ALI_{(inhalation)}$[4]**	**Toxicity Level**	**Container Posting Level (µCi)**

Section D Notes

[1] The Γ, or the specific gamma ray constant is the exposure rate from the given gamma emitting isotope in Rads per hour from a 1 Curie amount of the isotope at 1 meter from the source. This information can be found in Appendix A of this application.

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Radionuclide 3:

Please complete the following information for each radioisotope that you are requesting for use: total activity amount you are requesting in milliCuries or microCuries, chemical form, physical form, type of source (sealed or loose), physical half-life of the isotope, and list modes of decay and energy in keV. Attach additional sheets if necessary.

Isotope	Possession Limit	Chemical Forms	Physical Form	Source Type	Physical Half-life	Decay and Energy

Proposed Use and Method for Each Isotope Requested

Please provide a description of the intended use of both the chemical and physical forms of the isotope listed above. Include any established protocols and published information that applies. (If necessary, provide an attachment to describe the entire process).

Waste Disposal

For the isotope above, please provide a description of the types of radioactive wastes anticipated from usage and the associated anticipated annual waste volumes. Examples of types of waste would include: dry solids, aqueous liquids, non-aqueous or hazardous liquids, animal waste or carcasses, liquid scintillation, sharps, and metals.

To complete this next section, you will need to use Appendix A of this document.

Γ R/hr @ 1 meter per milliCurie[1]	**TVL in mm lead[2]**	**Shielding to be Used**	**Protective Devices or Clothing to be Used in the Lab.**

$ALI_{(ingestion)}$[3]	**$ALI_{(inhalation)}$[4]**	**Toxicity Level**	**Container Posting Level (µCi)**

Section D Notes

[1] The Γ, or the specific gamma ray constant is the exposure rate from the given gamma emitting isotope in Rads per hour from a 1 Curie amount of the isotope at 1 meter from the source. This information can be found in Appendix A of this application.

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Radionuclide 4:

Please complete the following information for each radioisotope that you are requesting for use: total activity amount you are requesting in milliCuries or microCuries, chemical form, physical form, type of source (sealed or loose), physical half-life of the isotope, and list modes of decay and energy in keV. Attach additional sheets if necessary.

Isotope	Possession Limit	Chemical Forms	Physical Form	Source Type	Physical Half-life	Decay and Energy

Proposed Use and Method for Each Isotope Requested

Please provide a description of the intended use of both the chemical and physical forms of the isotope listed above. Include any established protocols and published information that applies. (If necessary, provide an attachment to describe the entire process).

Waste Disposal

For the isotope above, please provide a description of the types of radioactive wastes anticipated from usage and the associated anticipated annual waste volumes. Examples of types of waste would include: dry solids, aqueous liquids, non-aqueous or hazardous liquids, animal waste or carcasses, liquid scintillation, sharps, and metals.

To complete this next section, you will need to use Appendix A of this document.

Γ R/hr @ 1 meter per milliCurie[1]	**TVL in mm lead[2]**	**Shielding to be Used**	**Protective Devices or Clothing to be Used in the Lab.**

$ALI_{(ingestion)}$[3]	**$ALI_{(inhalation)}$[4]**	**Toxicity Level**	**Container Posting Level (µCi)**

Section D Notes

[1] The Γ, or the specific gamma ray constant is the exposure rate from the given gamma emitting isotope in Rads per hour from a 1 Curie amount of the isotope at 1 meter from the source. This information can be found in Appendix A of this application.

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Section E

Facilities and Equipment

E1. Experimental Laboratory Description

Building	Room	Fume Hood Yes/No	How will radioactive materials be used in this location?

E2. Radionuclide Storage and Shielding Descriptions

(Describe how the radionuclides will be stored, shielded, and secured against unauthorized access).

Material Form	How will it be stored?	Shielding Type	How will it be secured from unauthorized access?
Stock Solution			
Samples			
Waste			
Other			

E3. Iodination

Check here if not applicable. ☐

Location Bld./Rm.	Activity/ Iodination (mCi)	# Iodination/ Month	Method

E4. Equipment Description

Please verify that the following safety equipment will be available to lab workers (check all that apply)

Lab Coats ☐	**Gloves** ☐	**Absorbent Paper** ☐	**Radiation Decontamination Cleaner** ☐
Safety Glasses ☐	**L-blocks/shielding** ☐	**Booties** ☐	**Radioactive Labels** ☐

Other:

Survey Meter (s)

Type	Manufacturer	Model	S/N	Probe Type	Probe Model

Radioactive Check Sources ☐ List Nuclide and Activity

Liquid Scintillation Counter or Gamma Counter to be used

Location	Type of Unit

Section F

1- I have taken or am scheduled to take the Radiation Safety Department's Radioactive Materials Training Course or other trainings required for the type and intended use of the material. My application cannot be approved until my training is complete.

Print Signature Date

2- I will provide experiment specific training and discussion to my laboratory staff prior to their use of any radioactive materials and will ensure that all users have completed the required Radiation Safety Training Course prior to use.

Print Signature Date

3- I will ensure that all my laboratory staff involved in the use of radioactive materials will complete the required radiation safety refresher training on an annual frequency.

Print Signature Date

4- I will ensure that radioactive material and sealed sources are secured against unauthorized access. Only persons with radiation safety training will have access to the radioactive materials:

Print Signature Date

5- If my research involves the generation of animal carcass waste, hazardous, bio-hazardous, or anything that could be considered mixed hazardous waste, I will inform the Radiation Safety Officer prior to usage:

Print Signature Date

6- If radiation dosimetry is required for my lab, no workers will be allowed to work around the radioactive material until they have a dosimeter from the Radiation Safety Department.

Print Signature Date

7- I verify that the information contained in this application is correct and accurate to the best of my knowledge:

Print Signature Date

8- Department Head must sign below indicating his/her approval of the application:

Print Signature Date

I have reviewed this application and all supporting documents and am submitting it to the Chairman of the Radiation Safety Committee for further review:

_____ Date**:** _____

Radiation Safety Officer

Appendix A

Table of Radionuclides **(Revised May 2013)**

Radionuclide	Half Life	Decay Mode	Internal Toxicity Class	ALI Ingestion/ Inhalation (µCi)	Container Posting Level (µCi)	Γ R/h @ 1 cm per mCi	TVL mm Pb	Radiation Types KeV (% per decay)
^{3}H	12.35 Y	β	Low	80000/ 80000	1000	-	-	Betas: 19 (100%)
^{11}C	20.38 M	β+, EC	Low	40000/ 60000	1000	5.97	13.7	Positrons: 960 (99.7%) Gammas: 511 (199.5%)
^{13}N	9.97 M	β+	Low		0.01	5.97	13.7	Positrons: 1,199 (99.8%) Gammas: 511 (199.6%)
^{14}C	5,730 Y	β	Moderate	2000/ 2000	1000	-	-	Betas: 156 (100%)
^{15}O	122.24 S	β+	Low		0.01	5.97	13.7	Positrons: 1,732 (99.9%) Gammas: 511 (199.8%)
^{18}F	109.77 M	β+	Low	50000/ 90000	1000	5.8	13.7	Positrons: 634 (96.7%) Gammas: 511 (193.4%)
^{22}Na	2.6 Y	β+, EC	High	400/ 600	10	12	26.6	Positrons: 545 (89.8%) Gammas: 511 (180%) 1,275 (99.9%)
^{24}Na	15 H	β	Moderate	4000/ 5000	100	18.4	52	Betas: 1,390 (99.9%) Gammas: 1,386 (100%) 2,754 (100%)
^{32}P	14.29 D	β	High	600/900	10	-	-	Betas: 1,710 (100%)
^{33}P	25.4 D	β	Moderate	6000/8000	100	-	-	Betas: 250 (100%)
^{35}S	87.44 D	β	Moderate	8000/2000	100	-	-	Betas: 167 (100%)
^{36}Cl	301,000Y	β	High	2000/2000	10	-	-	Betas: 714 (98%)
^{40}K	1.3×10^{9}Y	β, EC	High	300/400	100	0.7	38.7	Betas: 1,312 (89.3%) Gammas: 1,460 (10.7%)
^{42}K	12.36 H	β	Moderate	5000/5000	1000	1.4	39.8	Betas: 1,996 (17.5%) 3,521 (82%) Gammas: 1,525 (18%)

DECAY MODES: α = Alpha Decay, β = Beta Decay, β+ = Positron Decay, EC = Electron Capture, IT = Isomeric Transition (gamma) Decay, SF = Spontaneous Fission, ALI = Annual Limit on Intake, Γ = Specific Gamma Ray Constant, TVL = Tenth Value Layer

Appendix B
Table of Radionuclides

Radionuclide	Half Life	Decay Mode	Internal Toxicity Class	ALI Ingestion/ Inhalation (µCi)	Container Posting Level (mCi)	Γ R/h @ 1 cm per mCi	TVL mm Pb	Radiation Types KeV (% per decay)
^{45}Ca	163 D	β	Moderate	2000/800	100	-	-	Betas: 257 (100%)
^{46}Sc	83.83 D	β	High	900/ 200	10	10.9	29.1	Betas: 357 (100%) Electrons: 140 (38%) Gammas: 889 (100%) 1,121 (100%) 143 (62%)
^{47}Ca	4.53 D	β	Moderate	800/ 900	100	5.7	34.4	Betas: 691 (81.7%) 1,988 (18%) Gammas: 489(7.0%) 808(6.9%) 1297(74.9%)
^{48}V	16.24 D	β+	Moderate	600/ 1000	100	15.6	30.1	Positrons: 698 (50%) Gammas: 983 (100%) 1,312 (97.5%) 2,240 (2.4%) 511 (100%) 944 (7.7%)
^{51}Cr	27.7 D	EC	Low	40000/ 50000	1000	0.2	6.3	Gammas: 320 (9.8%)
^{54}Mn	312.5 D	EC	Moderate	2000/900	100	4.7	24.6	Gammas: 835 (100%)
^{55}Fe	2.7 Y	EC	Moderate	9000/2000	100	-	-	X-rays: 6 (28%)
^{57}Co	270.9 D	EC	Moderate	8000/3000	100	0.9	0.7	Gammas: 122 (85.5%) 136 (10.6%)
^{59}Fe	44.53 D	β	High	800/ 300	10	6.4	33.6	Betas: 273 (45.2%) 465 (53.1%) Gammas: 192 (3.0%) 1,099 (56.5%) 1,292 (43.2%)
^{60}Co	5.27 Y	β	High	500/ 200	1	13.2	34.8	Betas: 318 (100%) Gammas: 1,173 (100%) 1,332 (100%)
^{63}Ni	96 Y	β	Moderate	9000/2000	100	-	-	Betas: 66 (100%)
^{67}Ga	3.26 D	EC	Low	7000/ 10000	1000	1.1	4.7	Electrons: 84 (26.8%) Gammas: 93 (36%) 185 (19.7%) 300 (15.9%) 394 (4.5%)

DECAY MODES: α = Alpha Decay, β = Beta Decay, β+ = Positron Decay, EC = Electron Capture, IT = Isomeric Transition (gamma) Decay, SF = Spontaneous Fission, ALI = Annual Limit on Intake, Γ = Specific Gamma Ray Constant, TVL = Tenth Value Layer

Appendix B
Table of Radionuclides

Radionuclide	Half Life	Decay Mode	Internal Toxicity Class	ALI Ingestion/ Inhalation (µCi)	Container Posting Level (mCi)	Γ R/h @ 1 cm per mCi	TVL mm Pb	Radiation Types KeV (% per decay)
^{68}Ge	288 D	EC	High	5000/ 4000	10	5.51	14.4	Positrons: 836 (84%) Gammas: 511 (178%) 1,077 (3.3%) 1,883 (0.1%) X-rays: 9 (39%) 10 (5.5%)
^{74}As	17.76 D	β+	Moderate	1000/ 800	100	4.4	16.8	Betas: 718 (16%) 1,353 (19%) Positrons: 944 (27%) 945 (27%) Gammas: 10 (5.1%) 511 (59%) 596 (60%) 608 (5.5%)
^{75}Se	119.8 D	EC	Moderate	500/ 700	100	2.1	4.6	Gammas: 121 (16.7%) 136 (59.2%) 265 (59.8%) 280 (25.2%) 401 (11.4%)
^{85}Kr	10.72 Y	β			1000	0.4	2.8	Betas: 687 (99.6%) Gammas: 51.4 (43.4%)
^{85}Sr	64.84 D	EC	Moderate	3000/3000	100	3.0	13.9	Gammas: 514 (99.2%) 15 (8.7%)
^{86}Rb	18.66 D	β	Moderate	500/ 800	100	0.5	31.3	Betas: 698 (8.8%) 1,774 (94%) Gammas: 1,076 (8.8%)
^{89}Sr	50.5 D	β	High	600/800	10	-	26.8	Betas: 1,491 (100%)
^{90}Sr/Y	29.12 Y	β	Very High	0/4	0.1	-	-	Betas: 546 (100%) 2,284 (100%)
^{90}Y	64.0 H	β	High	400/700	10	-	-	Betas: 2,284 (100%)
^{95}Nb	35.15 D	β	Moderate	2000/1000	100	4.3	22.5	Betas: 160 (100%) Gammas: 766 (100%)
^{99}Mo	2.75 D	β	Moderate	2000/ 3000	100	1.8	20.5	Betas: 436 (17.3%) 1,214 (82.7%) Gammas: 181 (6.2%) 740 (12.8%)
^{99m}Tc	6.02 H	IT	Low	80000/ 200000	1000	0.6	0.9	Electrons: 119 (8.8%) 137 (1.1%) Gammas: 140 (89%)

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Appendix B
Table of Radionuclides

Radionuclide	Half Life	Decay Mode	Internal Toxicity Class	ALI Ingestion/ Inhalation (µCi)	Container Posting Level (mCi)	Γ R/h @ 1 cm per mCi	TVL mm Pb	Radiation Types KeV (% per decay)
^{103}Pd	16.96 D	EC	Low	6000/ 6000	100	1.48	0.02	X-Rays: 20.1 (28.7%) 20.2 (54.4%) 22.7 (16.9%)
^{109}Cd	464 D	EC	High	300/ 4000	1	1.8	-	Electrons: 63 (42%) 84 (44%) 88 (10%) X-rays: 22 (84%) 25 (18%)
^{110m}Ag	249.9 D	IT, β	High	500/ 100	10	-	-	Betas: 22 (67.3%) 531 (30.5%) Gammas: 658 (94.4%) 678 (10.7%) 687 (6.5%) 707 (16.7%) 764 (22.4%) 818 (7.3%) 885 (72.6%) 938 (34.3%) 1,384 (24.3%) 1,505 (13.1%)
^{111}In	2.83 D	EC	Moderate	4000/ 6000	100	3.4	2.2	Electrons: 145 (8.4%) 219 (4.9%) Gammas: 171 (90.2%) 245 (94%) X-rays: 23 (68%) 26 (15%)
^{113}Sn	115.1 D	IT	Moderate	2000/ 1000	100	1.7	0.05	Electrons: 20 (13%) X-rays: 24 (60%) 27 (13%)
^{115m}Cd	44.6 D	β	High	300/50	10	0.2	30.1	Betas: 616 (98%) 1,621 (98%)
^{123}I	13.2 H	EC	Moderate	3000/ 6000	100	1.3	1	Electrons: 127 (13.6%) Gammas: 159 (83%) X-rays: 27 (70.6%) 31 (16%)
^{125}I	60.14 D	EC	High	40/60	1	0.7	0.06	Electrons: 23 (19.7%) 31 (12.3%) Gammas: 35 (6.5%) X-rays: 27 (112%) 31 (25.4%)
^{129}I	1.6×10^7 Y	β	High	5/9	1	0.6	0.08	Betas: 152 (100%) Electrons: 34 (11%) Gammas: 40 (7.5%) X-rays: 30 (57%) 34 (13%)

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Radionuclide	Half Life	Decay Mode	Internal Toxicity Class	ALI Ingestion/ Inhalation (µCi)	Container Posting Level (mCi)	Γ R/h @ 1 cm per mCi	TVL mm Pb	Radiation Types KeV (% per decay)
^{131}I	8.04 D	β	High	30/ 50	1	2.1	9.6	Betas: 334 (7.4%) 606 (89.3%) Gammas: 284 (6.2%) 364 (81.2%) 637 (7.3%)
^{133}Ba	10.74 Y	EC	Moderate	2000/ 700	100	2.4	5.8	Electrons: 45 (48%) 75 (7.4%) Gammas: 81 (33%) 276 (6.9%) 303 (17.8%) 356 (60%) 383 (8.7%) X-rays: 31 (97%) 35 (22.8%)
^{133}Xe	5.25 D	β	-	-	1000	0.1	0.4	Betas: 346 (99.3%) Electrons: 45 (53.3%) Gammas: 81 (36.5%) X-rays: 31 (38.9%)
^{137}Cs	30.0 Y	β	High	100/ 200	10	3.5	18.9	Betas: 512 (94.6%) 1,173 (5.4%) Electrons: 624 (8.1%) Gammas: 662 (90%)
^{141}Ce	32.5 D	β	Moderate	2000/ 700	100	0.4	0.9	Betas: 435 (71%) 580 (29.5%) Electrons: 103 (18.8%) Gammas: 145 (48.4%) X-rays: 36 (13.8%)
^{150}Eu	34.2 Y	EC	High	800/ 20	1	-	-	Electrons: 5 (45.9%) 5 (45.9%) 6 (27.1%) 1(150%) Gammas: 334 (94%) 584 (51.5%) 737 (9.4%) 748 (5.1%) 1,049 (5.2%) X-rays: 40 (65.4%) 45 (8.3%)
^{152}Eu	13.33 Y	β, EC	High	800/ 20	1	-	-	Betas: 696 (13.6%) 1,475 (8.4%) Electrons: 5 (73.4%) 33 (5.7%) 75 (19.5%) 114 (10.6%)

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^{153}Gd	242 D	EC	High	5000/ 100	10	0.8	0.2	Electrons: 55 (32.2%) 49 (8.1%) 95 (5.1%) Gammas: 70 (2.6%) 97 (32%) 103 (22.2%) X-rays: 41 (100.5%) 47 (25.3%)
^{154}Eu	8.8 Y	β, EC	High	500/ 20	1	6.3	29.1	Betas: 247 (27.9%) 569 (36.5%) 839 (17.4%) 1,844 (11.4%) Gammas: 723 (19.7%) 873 (11.5%) 1,005 (17.9%) 127 (35.5%)
^{169}Yb	32.01 D	EC	Moderate	2000/ 800	100	1.8	1.6	Electrons: 50 (34.9%) 100 (5.6%) 118 (10.3%) 120 (51.6%) 139 (12.4%) Gammas: 63 (42%) 110 (17%) 131 (12%) 177 (22%) 197 (36%) 307 (10%) X-rays: 50 (147%) 58 (39%)
^{186}Re	3.78 D	β	Moderate	2000/ 3000	100	0.2	0.8	Betas: 1,070 (94%) 1,076 (71%) Gammas: 137 (9.5%)
^{188}Re	16.98 H	β	Moderate	2000/ 3000	100	0.3	16.8	Betas: 2,120 (71.4%) Gammas: 155 (15%)
^{192}Ir	74.02 D	β, EC	High	900/ 300	1	4.8	20	Betas: 536 (41.4%) 672 (48.3%) Gammas: 296 (29%) 308 (29.7%) 317 (82.8%) 468 (48%) 604 (8.2%) 612 (5.3%)
^{198}Au	2.7 D	β	Moderate	1000/ 4000	100	2.4	10.1	Betas: 961 (98.6%) Gammas: 412 (95.5%)
^{201}Tl	3.04 D	EC	Low	20000/ 20000	1000	0.4	0.9	Electrons: 84 (15.4%) Gammas: 167 (10%) X-rays: 69 (27.4%) 71 (46.5%) 80 (20.5%)

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Appendix B
Table of Radionuclides

Radionuclide	Half Life	Decay Mode	Internal Toxicity Class	ALI Ingestion/ Inhalation (µCi)	Container Posting Level (mCi)	Γ R/h @ 1 cm per mCi	TVL mm Pb	Radiation Types KeV (% per decay)
^{203}Hg	46.6 D	β	Moderate	500/ 800	100	1.3	4.7	Betas: 212 (100%) Electrons: 194 (16.9%) 264 (4.4%) Gammas: 279 (77.3%) X-rays: 71 (4.7%) 73 (8.0%)
^{206}Bi	6.24 D	EC	Moderate	600/ 1000	100	17.2	26	Electrons: 96 (22.2%) 256 (5.6%) Gammas: 516 (40%) 803 (98.9%) 881 (66.2%) 1,719 (32%)
^{207}Bi	38 Y	EC	High	1000/ 2000	10	8.3	25.8	Electrons: 976 (7.0%) Gammas: 570 (97.7%) 1,064 (75%) 1,770 (6.8%)
^{208}Po	2.93 Y	α	High	.0004	0.01	-	-	Alphas: 5,110 (100%)
^{210}Pb	22.3 Y	β	Very High	0.6/ 0.2	0.01	0.0	0.2	Betas: 17 (80.2%) 63 (19.8%) Electrons: 8 (33.6%) 30 (57.9%) 43 (18.1%) Gammas: 11 (24%)
^{210}Po	138.38 D	α	Very High	3/ 0.6	0.1	-	-	Alphas: 5,305 (100%)
^{222}Rn	3.82 D	α	High	0/10000	1	-	-	Alphas: 5,490 (99.9%)
^{226}Ra	1,600 Y	α	Very High	2/ 0.6	0.1	-	-	Alphas: 4,602 (5.6%) 4,785 (94.6%)
^{228}Th	1.91 Y	α	Very High	6/ 0.01	0.001	-	-	Alphas: 5,341 (26.7%) 5,423 (72.7%) Electrons: 9 (9.6%) 65 (19.1%) 80 (5.2%) X-rays: 12 (9.6%)

DECAY MODES: α = Alpha Decay, β = Beta Decay, β+ = Positron Decay, EC = Electron Capture, IT = Isomeric Transition (gamma) Decay, SF = Spontaneous Fission, ALI = Annual Limit on Intake, Γ = Specific Gamma Ray Constant, TVL = Tenth Value Layer

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^{238}Pu	87.74 Y	α, SF	Very High	0.9/ 0.007	0.001	-	-	Alphas: 5,457 (28.3%) 5,499 (71.6%) Electrons: 10 (9.1%) 22 (20.7%) 38 (7.6%) X-rays: 14 (11.6%)
^{238}U	4.5 x 10^9 Y	α, SF	Very High	10/ 1	100	-	-	Alphas: 4,147 (23%) 4,196 (77%) Electrons: 10 (8.2%) 29 (16.8%) 44 (6.1%) X-rays: 13 (9%)
^{239}Pu	24,065 Y	α	Very High	0.8/ 0.006	0.001	-	-	Alphas: 5,105 (11.5%) 5,143 (15.1%) 5,155 (73.3%) Electrons: 7 (19%)
^{241}Am	432.2 Y	α	Very High	0.8/ 0.006	0.001	0.1	0.4	Alphas: 5,443 (12.8%) 5,486 (85.2%) Gammas: 60 (35.9%)
^{244}Cm	18.11 Y	α, SF	Very High	1/ 0.01	0.001	-	-	Alphas: 5,763 (23.6%) 5,805 (76.4%) Electrons: 10 (6.9%) 20 (17.2%) 37 (6.3%) X-rays: 14 (10.3%)
^{250}Cf	13.08 Y	α	Very High	1/ 0.009	0.001	-	-	Alphas: 5,989 (16.2%) 6,031 (83.4%) Electrons: 18 (12%) X-rays: 15 (7.8%)
^{252}Cf	2.638 Y	α, SF	Very High	2/ 0.02	0.001	-	-	Alphas: 6,076 (15.2%) 6,118 (81.6%) Electrons: 19 (11.2%) X-rays: 15 (7.3%)

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