

Radiation Safety Department

P.I. Authorization Amendment Request

1) This amendment is to be used for (check all that apply):

- increasing possession limits for a currently approved nuclide
- adding a new nuclide to be used in established procedures

2) Principal Investigator: _____

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 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 (μ Ci)

- 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.

I will provide experiment specific training and discussion to my laboratory staff regarding the new or changed use of radioactive materials in my lab. New or different shielding and/or radiation monitoring techniques may be required with this change.

Signature: _____ Date: _____

Once reviewed, your completed request will be forwarded to the Chair of the Radiation Safety Committee for approval. If your request involves a major change to the university's radiation safety program, full committee review may be required.

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 x10 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%)

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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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^{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%)
$^{110\text{m}}\text{Ag}$	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%)
$^{115\text{m}}\text{Cd}$	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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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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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%)

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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	4.5×10^9 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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