

TITLE 180 - CONTROL OF RADIATION

APPENDIX 4-C

QUANTITIES¹ MATERIAL REQUIRING LABELING

*To convert mCi to kBq, multiply the mCi value by 37.

Quantity		Quantity	
Radionuclide	(μCi)*	Radionuclide	(μCi)*
Hydrogen-3	1,000	Manganese-56	1,000
Beryllium-7	1,000	Iron-52	100
Beryllium-10	1	Iron-55	100
Carbon-11	1,000	Iron-59	10
Carbon-14	100	Iron-60	1
Fluorine-18	1,000	Cobalt-55	100
Sodium-22	10	Cobalt-56	10
Sodium-24	100	Cobalt-57	100
Magnesium-28	100	Cobalt-58m	1,000
Aluminum-26	10	Cobalt-58	100
Silicon-31	1,000	Cobalt-60m	1,000
Silicon-32	1	Cobalt-60	1
Phosphorus-32	10	Cobalt-61	1,000
Phosphorus-33	100	Cobalt-62m	1,000
Sulfur-35	100	Nickel-56	100
Chlorine-36	10	Nickel-57	100
Chlorine-38	1,000	Nickel-59	100
Chlorine-39	1,000	Nickel-63	100
Argon-39	1,000	Nickel-65	1,000
Argon-41	1,000	Nickel-66	10
Potassium-40	100	Copper-60	1,000
Potassium-42	1,000	Copper-61	1,000
Potassium-43	1,000	Copper-64	1,000
Potassium-44	1,000	Copper-67	1,000
Potassium-45	1,000	Zinc-62	100
Calcium-41	100	Zinc-63	1,000
Calcium-45	100	Zinc-65	10
Calcium-47	100	Zinc-69m	100
Scandium-43	1,000	Zinc-69	1,000
Scandium-44m	100	Zinc-71m	1,000
Scandium-44	100	Zinc-72	100
Scandium-46	10	Gallium-65	1,000
Scandium-47	100	Gallium-66	100
Scandium-48	100	Gallium-67	1,000
Scandium-49	1,000	Gallium-68	1,000
Titanium-44	1	Gallium-70	1,000
Titanium-45	1,000	Gallium-72	100
Vanadium-47	1,000	Gallium-73	1,000
Vanadium-48	100	Germanium-66	1,000
Vanadium-49	1,000	Germanium-67	1,000
Chromium-48	1,000	Germanium-68	10
Chromium-49	1,000	Germanium-69	1,000
Chromium-51	1,000	Germanium-71	1,000
Manganese-51	1,000	Germanium-75	1,000
Manganese-52m	1,000	Germanium-77	1,000
Manganese-52	100	Germanium-78	1,000
Manganese-53	1,000	Arsenic-69	1,000

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Quantity		Quantity	
Radionuclide	(μ Ci)*	Radionuclide	(μ Ci)*
Arsenic-71	100	Strontium-85m	1,000
Arsenic-73	100	Strontium-85	100
Arsenic-74	100	Strontium-87m	1,000
Arsenic-76	100	Strontium-89	10
Arsenic-77	100	Strontium-90	0.1
Arsenic-78	1,000	Strontium-91	100
Selenium-70	1,000	Strontium-92	100
Selenium-73m	1,000	Yttrium-86m	1,000
Selenium-73	100	Yttrium-86	100
Selenium-75	100	Yttrium-87	100
Selenium-79	100	Yttrium-88	10
Selenium-81m	1,000	Yttrium-90m	1,000
Selenium-81	1,000	Yttrium-90	10
Selenium-83	1,000	Yttrium-91m	1,000
Bromine-74m	1,000	Yttrium-91	10
Bromine-74	1,000	Yttrium-92	100
Bromine-75	1,000	Yttrium-93	100
Bromine-76	100	Yttrium-94	1,000
Bromine-77	1,000	Yttrium-95	1,000
Bromine-80m	1,000	Zirconium-86	100
Bromine-80	1,000	Zirconium-88	10
Bromine-82	100	Zirconium-89	10
Bromine-83	1,000	Zirconium-93	1
Bromine-84	1,000	Zirconium-95	10
Krypton-74	1,000	Zirconium-97	100
Krypton-76	1,000	Niobium-88	1,000
Krypton-77	1,000	Niobium-89 (66 min)	1,000
Krypton-79	1,000	Niobium-89 (122 min)	1,000
Krypton-81	1,000	Niobium-90	100
Krypton-83m	1,000	Niobium-93m	10
Krypton-85m	1,000	Niobium-94	1
Krypton-85	1,000	Niobium-95m	100
Krypton-87	1,000	Niobium-95	100
Krypton-88	1,000	Niobium-96	100
Rubidium-79	1,000	Niobium-97	1,000
Rubidium-81m	1,000	Niobium-98	1,000
Rubidium-81	1,000	Molybdenum-90	100
Rubidium-82m	1,000	Molybdenum-93m	100
Rubidium-83	100	Molybdenum-93	10
Rubidium-84	100	Molybdenum-99	100
Rubidium-86	100	Molybdenum-101	1,000
Rubidium-87	100	Technetium-93m	1,000
Rubidium-88	1,000	Technetium-93	1,000
Rubidium-89	1,000	Technetium-94m	1,000
Strontium-80	100	Technetium-94	1,000
Strontium-81	1,000	Technetium-96m	1,000

Strontium-83	100	Technetium-96	100
Strontium-83	100	Technetium-97m	100

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Quantity		Quantity	
Radionuclide	(μ Ci)*	Radionuclide	(μ Ci)*
Technetium-97	1,000	Indium-109	1,000
Technetium-98	10	Indium-110 (69.1m)	1,000
Technetium-99m	1,000	Indium-110 (4.9h)	1,000
Technetium-99	100	Indium-111	100
Technetium-101	1,000	Indium-112	1,000
Technetium-104	1,000	Indium-113m	1,000
Ruthenium-94	1,000	Indium-114m	10
Ruthenium-97	1,000	Indium-115m	1,000
Ruthenium-103	100	Indium-115	100
Ruthenium-105	1,000	Indium-116m	1,000
Ruthenium-106	1	Indium-117m	1,000
Rhodium-99m	1,000	Indium-117	1,000
Rhodium-99	100	Indium-119m	1,000
Rhodium-100	100	Tin-110	100
Rhodium-101m	1,000	Tin-111	1,000
Rhodium-101	10	Tin-113	100
Rhodium-102m	10	Tin-117m	100
Rhodium-102	10	Tin-119m	100
Rhodium-103m	1,000	Tin-121m	100
Rhodium-105	100	Tin-121	1,000
Rhodium-106m	1,000	Tin-123m	1,000
Rhodium-107	1,000	Tin-123 10	
Palladium-100	100	Tin-125 10	
Palladium-101	1,000	Tin-126 10	
Palladium-103	100	Tin-127	1,000
Palladium-107	10	Tin-128	1,000
Palladium-109	100	Antimony-115	1,000
Silver-102	1,000	Antimony-116m	1,000
Silver-103	1,000	Antimony-116	1,000
Silver-104m	1,000	Antimony-117	1,000
Silver-104	1,000	Antimony-118m	1,000
Silver-105	100	Antimony-119	1,000
Silver-106m	100	Antimony-120 (16min.)	1,000
Silver-106	1,000	Antimony-120 (5.76d)	100
Silver-108m	1	Antimony-122	100
Silver-110m	10	Antimony-124m	1,000
Silver-111	100	Antimony-124	10
Silver-112	100	Antimony-125	100
Silver-115	1,000	Antimony-126m	1,000
Cadmium-104	1,000	Antimony-126	100
Cadmium-107	1,000	Antimony-127	100
Cadmium-109	1	Antimony-128 (10.4min.)	1,000
Cadmium-113m	0.1	Antimony-128 (9.01h)	100
Cadmium-113	100	Antimony-129	100

Cadmium-115m	10	Antimony-130	1,000
Cadmium-115	100	Antimony-131	1,000
Cadmium-117m	1,000	Tellurium-116	1,000
Cadmium-117	1,000	Tellurium-121m	10

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Quantity		Quantity	
Radionuclide	(μ Ci)*	Radionuclide	(μ Ci)*
Tellurium-121	100	Cesium-132	100
Tellurium-123m	10	Cesium-134m	1,000
Tellurium-123	100	Cesium-134	10
Tellurium-125m	10	Cesium-135m	1,000
Tellurium-127m	10	Cesium-135	100
Tellurium-127	1,000	Cesium-136	10
Tellurium-129m	10	Cesium-137	10
Tellurium-129	1,000	Cesium-138	1,000
Tellurium-131m	10	Barium-126	1,000
Tellurium-131	100	Barium-128	100
Tellurium-132	10	Barium-131m	1,000
Tellurium-133m	100	Barium-131	100
Tellurium-133	1,000	Barium-133m	100
Tellurium-134	1,000	Barium-133	100
Iodine-120m	1,000	Barium-135m	100
Iodine-120	100	Barium-139	1,000
Iodine-121	1,000	Barium-140	100
Iodine-123	100	Barium-141	1,000
Iodine-124	10	Barium-142	1,000
Iodine-125	1	Lanthanum-131	1,000
Iodine-126	1	Lanthanum-132	100
Iodine-128	1,000	Lanthanum-135	1,000
Iodine-129	1	Lanthanum-137	10
Iodine-130	10	Lanthanum-138	100
Iodine-131	1	Lanthanum-140	100
Iodine-132m	100	Lanthanum-141	100
Iodine-132	100	Lanthanum-142	1,000
Iodine-133	10	Lanthanum-143	1,000
Iodine-134	1,000	Cerium-134	100
Iodine-135	100	Cerium-135	100
Xenon-120	1,000	Cerium-137m	100
Xenon-121	1,000	Cerium-137	1,000
Xenon-122	1,000	Cerium-139	100
Xenon-123	1,000	Cerium-141	100
Xenon-125	1,000	Cerium-143	100
Xenon-127	1,000	Cerium-144	1
Xenon-129m	1,000	Praseodymium-136	1,000
Xenon-131m	1,000	Praseodymium-137	1,000
Xenon-133m	1,000	Praseodymium-138m	1,000
Xenon-133	1,000	Praseodymium-139	1,000
Xenon-135m	1,000	Praseodymium-142m	1,000
Xenon-135	1,000	Praseodymium-142	100

Xenon-138	1,000	Praseodymium-143	100
Cesium-125	1,000	Praseodymium-144	1,000
Cesium-127	1,000	Praseodymium-145	100
Cesium-129	1,000	Praseodymium-147	1,000
Cesium-130	1,000	Neodymium-136	1,000
Cesium-131	1,000	Neodymium-138	100

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Quantity		Quantity	
Radionuclide	(μ Ci)*	Radionuclide	(μ Ci)*
Neodymium-139m	1,000	Gadolinium-153	10
Neodymium-139	1,000	Gadolinium-159	100
Neodymium-141	1,000	Terbium-147	1,000
Neodymium-147	100	Terbium-149	100
Neodymium-149	1,000	Terbium-150	1,000
Neodymium-151	1,000	Terbium-151	100
Promethium-141	1,000	Terbium-153	1,000
Promethium-143	100	Terbium-154	100
Promethium-144	10	Terbium-155	1,000
Promethium-145	10	Terbium-156m (5.0h)	1,000
Promethium-146	1	Terbium-156m (24.4h)	1,000
Promethium-147	10	Terbium-156	100
Promethium-148m	10	Terbium-157	10
Promethium-148	10	Terbium-158	1
Promethium-149	100	Terbium-160	10
Promethium-150	1,000	Terbium-161	100
Promethium-151	100	Dysprosium-155	1,000
Samarium-141m	1,000	Dysprosium-157	1,000
Samarium-141	1,000	Dysprosium-159	100
Samarium-142	1,000	Dysprosium-165	1,000
Samarium-145	100	Dysprosium-166	100
Samarium-146	1	Holmium-155	1,000
Samarium-147	100	Holmium-157	1,000
Samarium-151	10	Holmium-159	1,000
Samarium-153	100	Holmium-161	1,000
Samarium-155	1,000	Holmium-162m	1,000
Samarium-156	1,000	Holmium-162	1,000
Europium-145	100	Holmium-164m	1,000
Europium-146	100	Holmium-164	1,000
Europium-147	100	Holmium-166m	1
Europium-148	10	Holmium-166	100
Europium-149	100	Holmium-167	1,000
Europium-150 (12.62h)	100	Erbium-161	1,000
Europium-150 (34.2y)	1	Erbium-165	1,000
Europium-152m	100	Erbium-169	100
Europium-152	1	Erbium-171	100
Europium-154	1	Erbium-172	100
Europium-155	10	Thulium-162	1,000
Europium-156	100	Thulium-166	100
Europium-157	100	Thulium-167	100

Europium-158	1,000	Thulium-170	10
Gadolinium-145	1,000	Thulium-171	10
Gadolinium-146	10	Thulium-172	100
Gadolinium-147	100	Thulium-173	100
Gadolinium-148	0.001	Thulium-175	1,000
Gadolinium-149	100	Ytterbium-162	1,000
Gadolinium-151	10	Ytterbium-166	100
Gadolinium-152	100	Ytterbium-167	1,000

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Quantity		Quantity	
Radionuclide	(μ Ci)*	Radionuclide	(μ Ci)*
Ytterbium-169	100	Tungsten-177	1,000
Ytterbium-175	100	Tungsten-178	1,000
Ytterbium-177	1,000	Tungsten-179	1,000
Ytterbium-178	1,000	Tungsten-181	1,000
Lutetium-169	100	Tungsten-185	100
Lutetium-170	100	Tungsten-187	100
Lutetium-171	100	Tungsten-188	10
Lutetium-172	100	Rhenium-177	1,000
Lutetium-173	10	Rhenium-178	1,000
Lutetium-174m	10	Rhenium-181	1,000
Lutetium-174	10	Rhenium-182 (12.7h)	1,000
Lutetium-176m	1,000	Rhenium-182 (64.0h)	100
Lutetium-176	100	Rhenium-184m	10
Lutetium-177m	10	Rhenium-184	100
Lutetium-177	100	Rhenium-186m	10
Lutetium-178m	1,000	Rhenium-186	100
Lutetium-178	1,000	Rhenium-187	1,000
Lutetium-179	1,000	Rhenium-188m	1,000
Hafnium-170	100	Rhenium-188	100
Hafnium-172	1	Rhenium-189	100
Hafnium-173	1,000	Osmium-180	1,000
Hafnium-175	100	Osmium-181	1,000
Hafnium-177m	1,000	Osmium-182	100
Hafnium-178m	0.1	Osmium-185	100
Hafnium-179m	10	Osmium-189m	1,000
Hafnium-180m	1,000	Osmium-191m	1,000
Hafnium-181	10	Osmium-191	100
Hafnium-182m	1,000	Osmium-193	100
Hafnium-182	0.1	Osmium-194	1
Hafnium-183	1,000	Iridium-182	1,000
Hafnium-184	100	Iridium-184	1,000
Tantalum-172	1,000	Iridium-185	1,000
Tantalum-173	1,000	Iridium-186	100
Tantalum-174	1,000	Iridium-187	1,000
Tantalum-175	1,000	Iridium-188	100
Tantalum-176	100	Iridium-189	100
Tantalum-177	1,000	Iridium-190m	1,000
Tantalum-178	1,000	Iridium-190	100

Tantalum-179	100	Iridium-192 (73.8d)	1
Tantalum-180m	1,000	Iridium-192m (1.4min.)	10
Tantalum-180	100	Iridium-194m	10
Tantalum-182m	1,000	Iridium-194	100
Tantalum-182	10	Iridium-195m	1,000
Tantalum-183	100	Iridium-195	1,000
Tantalum-184	100	Platinum-186	1,000
Tantalum-185	1,000	Platinum-188	100
Tantalum-186	1,000	Platinum-189	1,000
Tungsten-176	1,000	Platinum-191	100

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*To convert mCi to kBq, multiply the mCi value by 37.

Quantity		Quantity	
Radionuclide	(μ Ci)*	Radionuclide	(μ Ci)*
Platinum-193m	100	Lead-212	1
Platinum-193	1,000	Lead-214	100
Platinum-195m	100	Bismuth-200	1,000
Platinum-197m	1,000	Bismuth-201	1,000
Platinum-197	100	Bismuth-202	1,000
Platinum-199	1,000	Bismuth-203	100
Platinum-200	100	Bismuth-205	100
Gold-193	1,000	Bismuth-206	100
Gold-194	100	Bismuth-207	10
Gold-195	10	Bismuth-210m	0.1
Gold-198m	100	Bismuth-210	1
Gold-198	100	Bismuth-212	10
Gold-199	100	Bismuth-213	10
Gold-200m	100	Bismuth-214	100
Gold-200	1,000	Polonium-203	1,000
Gold-201	1,000	Polonium-205	1,000
Mercury-193m	100	Polonium-207	1,000
Mercury-193	1,000	Polonium-210	0.1
Mercury-194	1	Astatine-207	100
Mercury-195m	100	Astatine-211	10
Mercury-195	1,000	Radon-220	1
Mercury-197m	100	Radon-222	1
Mercury-197	1,000	Francium-222	100
Mercury-199m	1,000	Francium-223	100
Mercury-203	100	Radium-223	0.1
Thallium-194m	1,000	Radium-224	0.1
Thallium-194	1,000	Radium-225	0.1
Thallium-195	1,000	Radium-226	0.1
Thallium-197	1,000	Radium-227	1,000
Thallium-198m	1,000	Radium-228	0.1
Thallium-198	1,000	Actinium-224	1
Thallium-199	1,000	Actinium-225	0.01
Thallium-200	1,000	Actinium-226	0.1
Thallium-201	1,000	Actinium-227	0.001
Thallium-202	100	Actinium-228	1
Thallium-204	100	Thorium-226	10

Lead-195m	1,000	Thorium-227	0.01
Lead-198	1,000	Thorium-228	0.001
Lead-199	1,000	Thorium-229	0.001
Lead-200	100	Thorium-230	0.001
Lead-201	1,000	Thorium-231	100
Lead-202m	1,000	Thorium-232	100
Lead-202	10	Thorium-234	10
Lead-203	1,000	Thorium-natural	100
Lead-205	100	Protactinium-227	10
Lead-209	1,000	Protactinium-228	1
Lead-210	0.01	Protactinium-230	0.1
Lead-211	100	Protactinium-231	0.001

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Quantity		Quantity	
Radionuclide	(μ Ci)*	Radionuclide	(μ Ci)*
Protactinium-232	1	Americium-246m	1,000
Protactinium-233	100	Americium-246	1,000
Protactinium-234	100	Curium-238	100
Uranium-230	0.01	Curium-240	0.1
Uranium-231	100	Curium-241	1
Uranium-232	0.001	Curium-242	0.01
Uranium-233	0.001	Curium-243	0.001
Uranium-234	0.001	Curium-244	0.001
Uranium-235	0.001	Curium-245	0.001
Uranium-236	0.001	Curium-246	0.001
Uranium-237	100	Curium-247	0.001
Uranium-238	100	Curium-248	0.001
Uranium-239	1,000	Curium-249	1,000
Uranium-240	100	Berkelium-245	100
Uranium-natural	100	Berkelium-246	100
Neptunium-232	100	Berkelium-247	0.001
Neptunium-233	1,000	Berkelium-249	0.1
Neptunium-234	100	Berkelium-250	10
Neptunium-235	100	Californium-244	100
Neptunium-236 (1.15×10^5 y)	0.001	Californium-246	1
Neptunium-236 (22.5h)	1	Californium-248	0.01
Neptunium-237	0.001	Californium-249	0.001
Neptunium-238	10	Californium-250	0.001
Neptunium-239	100	Californium-251	0.001
Neptunium-240	1,000	Californium-252	0.001
Plutonium-234	10	Californium-253	0.1
Plutonium-235	1,000	Californium-254	0.001
Plutonium-236	0.001	Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.001
Plutonium-237	100		
Plutonium-238	0.001		
Plutonium-239	0.001		
Plutonium-240	0.001	Einsteinium-250	100
Plutonium-241	0.01	Einsteinium-251	100

Plutonium-242	0.001	Einsteinium-253	0.1
Plutonium-243	1,000	Einsteinium-254m	1
Plutonium-244	0.001	Einsteinium-254	0.01
Plutonium-245	100	Fermium-252	1
Americium-237	1,000	Fermium-253	1
Americium-238	100	Fermium-254	10
Americium-239	1,000	Fermium-255	1
Americium-240	100	Fermium-257	0.01
Americium-241	0.001	Mendelevium-257	10
Americium-242m	0.001	Mendelevium-258	0.01
Americium-242	10	Any radionuclide other than alpha-emitting radionuclides not listed above, or mixtures of beta- emitters of unknown composition	0.01
Americium-243	0.001		
Americium-244m	100		
Americium-244	10		
Americium-245	1,000		

QUANTITIES¹ MATERIAL REQUIRING LABELING

*To convert mCi to kBq, multiply the mCi value by 37.

Quantity	Quantity
Radionuclide (μCi)*	Radionuclide (μCi)*
¹ The quantities listed above were derived by taking 1/10th of the most restrictive annual limit on intake (ALI) listed in Table I, Columns 1 and 2, of Appendix 004-B to Section 004, rounding to the nearest factor of 10, and constraining the values listed between 37 Bq and 37 MBq (0.001 and 1,000 μCi). Values of 3.7 MBq (100 μCi) have been assigned for radionuclides having a radioactive half-life in excess of 109 years, except rhenium, 37 MBq (1,000 μCi), to take into account their low specific activity.	NOTE: For purposes of 180 NAC 4-34.05, 4-037.01 and 4-057.01 where there is involved a combination of radionuclides in known amounts, the limit for the combination should be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" or unity.

APPENDIX 4-D

REQUIREMENTS FOR TRANSFERS OF LOW-LEVEL RADIOACTIVE WASTE INTENDED FOR DISPOSAL AT LICENSED DISPOSAL FACILITIES AND MANIFESTS

SECTION I - MANIFEST

A waste generator, collector, or processor who transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste disposal facility must prepare a Manifest reflecting information requested on the following forms, U.S. Nuclear

Regulatory Commission (U.S. NRC) U.S. NRC 540, (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper) and U.S. Form NRC 541 (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description) and if necessary, on Agency Form NRC 542 (Uniform Low-Level Radioactive Waste Manifest (Manifest Index and Regional Compact Tabulation). U.S. NRC 540 and U.S. NRC 540A must be completed and must physically accompany the pertinent low-level radioactive waste shipment. Upon agreement between shipper and consignee, U.S. Forms U.S. NRC 541 and U.S. NRC 541A and U.S. NRC 542 and U.S. NRC 542A may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate, and complete records on the respective forms. Licensees are not required by the Agency to comply with the manifesting requirements of this section when they ship:

- (a) Low-Level Waste for processing and expect its return (that is, for storage under their license) prior to disposal at a licensed land disposal facility;
- (b) Low-Level Waste that is being returned to the licensee who is the "waste generator" or "generator," as defined in this section; or
- (c) Radioactively contaminated material to a "waste processor" that becomes the processor's "residual waste".

For guidance in completing these forms, refer to the instructions that accompany the forms. Copies of manifests required by this appendix may be legible carbon copies, photocopies, or computer printouts that reproduce the data in the format of the uniform manifest.

Forms U.S. NRC 540, U.S. NRC 541, U.S. NRC 541A and U.S. NRC 542 and U.S. NRC 542A and the accompanying instructions, in hard copy, may be obtained from:

Department of Health and Human Services
Division of Public Health, Radiological Health
301 Centennial Mall South
P.O. Box 95026
Lincoln, Nebraska 68509-5026

This appendix includes information requirements of the Department of Transportation, as codified in 49 CFR part 172. Information on hazardous, medical, or other waste, required to meet Environmental Protection Agency regulations, as codified in 40 CFR parts 259, 261 or elsewhere, is not addressed in this section, and must be provided on the required EPA forms. However, the required EPA forms must accompany the Uniform Low-Level Radioactive Waste Manifest required by this section.

As used in this appendix, the following definitions apply:

CHELATING AGENT. Chelating agent has the same meaning as that given in 180 NAC 1-002.

CHEMICAL DESCRIPTION. Chemical description is a description of the principal chemical characteristics of a low-level radioactive waste.

COMPUTER-READABLE MEDIUM. The Department's computer can transfer the information from the medium into its memory is computer-readable medium.

CONSIGNEE. Consignee is the designated receiver of the shipment of low-level radioactive waste.

DECONTAMINATION FACILITY. A decontamination facility is a facility operating under an Agency, U.S. Nuclear Regulatory Commission or Agreement State or license whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and, for purposes of this section, is not considered to be a consignee for low-level waste shipments.

DISPOSAL CONTAINER. A disposal container is a container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility. See "high integrity container". For some shipments the disposal container may be the transport package.

EPA IDENTIFICATION NUMBER. An EPA identification number is the number received by a transporter following application to the Administrator of the Environmental Protection Agency (EPA) as required by 40 CFR part 263.

GENERATOR. A generator is a licensee operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license who (1) is a waste generator as defined in this part, or (2) is the licensee to whom waste can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985, waste generated as a result of decontamination or recycle activities.

HIGH INTEGRITY CONTAINER (HIC). A high integrity container (HIC) is a container commonly designed to meet the structural stability requirements of Appendix 4-E, section II 180 NAC 4, and to meet Department of Transportation requirements for a Type A package.

U.S. NRC FORMS 540, 540A, 541, 541A, 542, AND 542A. U. S. Nuclear Regulatory Commission (NRC) forms 540, 540A, 541, 542 and 542A are forms referenced in this appendix. Licensees need not use originals of these U.S. Nuclear Regulatory Commission (NRC) forms as long as any substitute forms are equivalent to the original document in respect to content, clarity, size, and location of information. Upon agreement between the shipper and consignee, U.S. Nuclear Regulatory Commission (NRC) forms 541, 541A, 542 and 542A may be completed, transmitted, and stored in electronic media. The electronic media must have the capability for

producing legible, accurate, and complete records in the format of the uniform manifest.

PACKAGE. A package is an assembly of components necessary to ensure compliance with the packaging requirements of Department of Transportation (DOT) regulations, together with its radioactive contents, as presented for transport.

PHYSICAL DESCRIPTION. A physical description is the items called for on Form U.S. Nuclear Regulatory Commission (NRC) 541 to describe a low-level radioactive waste.

RESIDUAL WASTE. Residual waste is low-level radioactive waste resulting from processing or decontamination activities that cannot be easily separated into distinct batches attributable to specific waste generators. This waste is attributable to the processor or decontamination facility, as applicable.

SHIPPER. A shipper is a licensed entity, the waste generator, waste collector, or waste processor, who offers low-level radioactive waste for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator.

SHIPPING PAPER. U.S. Nuclear Regulatory Commission (NRC) 540 and, if required form U.S. Nuclear Regulatory Commission (NRC) 540A, which includes the information required by DOT in 49 CFR part 172.

SOURCE MATERIAL. Source material has the same meaning as that given in 180 NAC 1-002.

SPECIAL NUCLEAR MATERIAL. Special nuclear material has the same meaning as that given in 180 NAC 1-002.

UNIFORM LOW-LEVEL RADIOACTIVE WASTE MANIFEST OR UNIFORM MANIFEST. Uniform low-level radioactive waste manifest or uniform manifest means the combination of U.S. Nuclear Regulatory Commission (NRC) Forms 540, 541, and if necessary, 542, and their respective continuation sheets as needed, or equivalent.

WASTE COLLECTOR. A waste collector is an entity, operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license, whose principal purpose is to collect and consolidate waste generated by others, and to transfer this waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed disposal facility.

WASTE DESCRIPTION. A waste description is the physical, chemical and radiological description of a low-level radioactive waste as called for on Form U.S. Nuclear Regulatory Commission (NRC) 541.

WASTE GENERATOR. A waste generator is an entity, operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State

license, who (1) possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use, and (2) transfers this material or component to a licensed disposal facility or to a licensed waste collector or processor for handling or treatment prior to disposal. A licensee performing processing or decontamination services may be a "waste generator" if the transfer of low-level radioactive waste from its facility is defined as "residual waste."

WASTE PROCESSOR. A waste processor is an entity, operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license, whose principal purpose is to process, repackage, or otherwise treat low-level radioactive material or waste generated by others prior to eventual transfer of waste to a licensed low-level radioactive waste disposal facility.

WASTE TYPE. Waste type is a waste within a disposal container having a unique physical description that is, a specific waste descriptor code or description; or a waste absorbed on or solidified in a specifically defined media.

INFORMATION REQUIREMENTS

A. General Information

The shipper of the low-level radioactive waste must provide the following information on the uniform manifest:

1. The name, facility address, and telephone number of the licensee shipping the waste;
2. An explicit declaration indicting whether the shipper is acting as a waste generator, collector, processor, or a combination of these identifiers for purposes of the manifested shipment; and
3. The name, address, and telephone number, or the name and Environmental Protection Agency (EPA) identification number for the carrier transporting the waste.

B. Shipment Information

The shipper of the radioactive waste must provide the following information regarding the waste shipment on the uniform manifest:

1. The date of the waste shipment;
2. The total number of packages/disposal containers;
3. The total disposal volume and disposal weight in the shipment;
4. The total radionuclide activity in the shipment.
5. The activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the shipment; and
6. The total masses of U-233, U-235, and plutonium in the form of

special nuclear material, and the total mass of uranium and thorium in the form of source material.

C. Disposal Container and Waste Information

The shipper of the radioactive waste must provide the following information on the uniform manifest regarding the waste and each disposal container of waste in the shipment:

1. An alphabetic or numeric identification that uniquely identifies each disposal container in the shipment;
2. A physical description of the disposal container, including the manufacturer and model of any high integrity container;
3. The volume displaced by the disposal container;
4. The gross weight of the disposal container, including the waste;
5. For waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;
6. A physical and chemical description of the waste;
7. The total weight percentage of chelating agent for any waste containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;
8. The approximate volume of waste within a container;
9. The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name;
10. The identities and activities of individual radionuclides contained in each container, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material. For discrete waste types, activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification or stabilization media, the identities and activities of individual radionuclides associated with a disposal container must be reported;
11. The total radioactivity within each container; and
12. For wastes consigned to a disposal facility, the classification of the waste pursuant to Appendix 4-E, Section I. Waste not meeting the structural stability requirements of Appendix 4-E, Section II(b) must be identified.

D. Uncontainerized Waste Information

The shipper of the radioactive waste must provide the following information on the uniform manifest regarding a waste shipment delivered without a disposal container:

1. The approximate volume and weight of the waste;
2. A physical and chemical description of the waste;
3. The total weight percentage of chelating agent if the chelating agent exceeds 0.1% by weight, plus the identity of the principal chelating agent;
4. For waste consigned to a disposal facility, the classification of the waste pursuant to Appendix 4-E, Section I of 180 NAC 4. Waste not meeting the structural stability requirements of Appendix 4-E, Section

II(b) of 180 NAC 4 must be identified.

5. The identities and activities of individual radionuclides contained in the waste, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material; and
6. For wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

E. Multi-Generator Disposal Container Information

This section applies to disposal containers enclosing mixtures of waste originating from different generators. Licensees note that the origin of the low-level waste resulting from a processor's activities may be attributable to one or more "generators", including "waste generators", as defined in this section. It also applies to mixtures of wastes shipped in an uncontainerized form, for which portions of the mixture within the shipment originate from different generators:

1. For homogeneous mixtures of waste, such as incinerator ash, provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.
2. For heterogeneous mixtures of waste, such as the combined products from a large compactor, identify each generator contributing waste to the disposal container, and, for discrete waste types, activated materials, contaminated equipment, mechanical filters, sealed source or devices, and wastes in solidification or stabilization media, the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, provide the following:
 - (a) The volume of waste within the disposal container;
 - (b) A physical and chemical description of the waste, including the solidification agent, if any;
 - (c) The total weight percentage of chelating agents for any disposal container containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;
 - (d) The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements in Appendix 4-E, Section II(b) of 180 NAC 4; and
 - (e) Radionuclide identities and activities contained in the waste, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material if contained in the waste.

SECTION II - CERTIFICATION

An authorized representative of the waste generator, processor, or collector must certify by signing and dating the shipment manifest that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the Department. A collector in signing the certification is certifying that nothing

has been done to the collected waste which would invalidate the waste generator's certification.

SECTION III - CONTROL AND TRACKING

A. Any licensee who transfers radioactive waste to a land disposal facility or a licensed waste collector must comply with the requirements in A.1 through 9 of this section. Any licensee who transfers waste to a licensed waste processor for waste treatment or repackaging of A.4 through 9 of this section. A licensee must:

1. Prepare all wastes so that the waste is classified according to Appendix 4-E, Section I of 180 NAC 4 and meets waste characteristics requirements in Appendix 4-E, Section II of 180 NAC 4.
2. Label each disposal container, or transport package if potential radiation hazards preclude labeling of the individual disposal container, of waste to identify whether it is Class A waste, Class B waste, Class C waste, or greater than Class C waste, as required by Appendix 4-E, Section I of 180 NAC 4.
3. Conduct a quality assurance program to assure compliance with Appendix 4-E, Section I and Section II of 180 NAC 4. The program must include management evaluation of audits;
4. Prepare the Department Uniform Low-Level Radioactive Waste Manifest as required by this appendix;
5. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either (i) receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
6. Include forms U.S. Nuclear Regulatory Commission (NRC) 540 and U.S. Nuclear Regulatory Commission (NRC) 540A, if required, with the shipment regardless of the option in Paragraph A.5 of this section;
7. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3. This includes those manifests and documents required under the standards for protection against radiation in effect prior to May 30, 1994; and
8. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Appendix 4-D of 180 NAC 4.
9. For any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times specified in this appendix, conduct an investigation in accordance with Paragraph E of this appendix.

B. Any waste collector licensee who handles only prepackaged waste must:

1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of form U.S. Nuclear

Regulatory Commission (NRC) 540.

2. Prepare a new manifest to reflect consolidated shipments that meet the requirements of this appendix. The waste collector must ensure that, for each container of waste in the shipment, the manifest identifies the generator of that container of waste;
3. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) Receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
4. Include forms U.S. Nuclear Regulatory Commission (NRC) 540 and U.S. Nuclear Regulatory Commission (NRC) 540A, if required, with the shipment regardless of the option chosen in Paragraph B.3 of this section;
5. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3, and retain information from generator manifest until the license is terminated. This includes those manifests and documents of acknowledgment of receipt required under the standards for protection against radiation in effect prior to May 30, 1994;
6. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt;
7. For any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times specified in this appendix, conduct an investigation in accordance with Paragraph E of this appendix; and
8. Notify the shipper and the Department when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

C. Any licensed waste processor who treats or repackages waste must:

1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of Form U.S. Nuclear Regulatory Commission (NRC) 540;
2. Prepare a new manifest that meets the requirements of this appendix. Preparation of the new manifest reflects that the processor is responsible for meeting these requirements. For each container of waste in the shipment, the manifest must identify the waste generators, the preprocessed waste volume, and other information as required in Section I.E. of this appendix;
3. Prepare all wastes so that the waste is classified according to Appendix 4-D, Section I., paragraph E of 180 NAC 4 and meets the waste characteristics requirements in Appendix 4-E, Section II of 180 NAC 4;
4. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with Appendix 4-E, Section I and Section III of 180 NAC 4;
5. Conduct a quality assurance program to assure compliance with

Appendix 4-E, Sections I and II, the program must include management evaluation of audits of 180 NAC 4;

6. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
7. Include forms U.S. Nuclear Regulatory Commission (NRC) 540 and U.S. Nuclear Regulatory Commission (NRC) 540A, if required, with the shipment regardless of the option chosen in Paragraph C.6 of this section;
8. Retain copies of the original manifests and new manifests and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3. This includes those manifests and documents of acknowledgment of receipt required under the standards for protection against radiation in effect prior to May 30, 1994; and
9. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3;
10. For any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times specified in this appendix, conduct an investigation in accordance with Paragraph E of this appendix; and
11. Notify the shipper and the Department when any shipment, or any part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

D. The land disposal facility operator must:

1. Acknowledge receipt of the waste within one week of receipt by returning, as a minimum, a signed copy of Form U.S. NRC 540 to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the Uniform Low-Level Radioactive Waste Manifest and materials received, copies or electronic transfer of the affected forms must be returned indicating that discrepancy.
2. Maintain copies of all completed manifests or equivalent documentation until the license is terminated. This includes those manifests or equivalent documents required under the standards for protection against radiation in effect prior to May 30, 1994.
3. Notify the shipper and the Department when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

E. Any shipments or part of a shipment for which acknowledgment is not received within the times specified in this section must:

1. Be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and
2. Be traced and reported. The investigation must include tracing the shipment and filing a report with the Department. Each licensee who conducts a trace investigation must file a written report with the Department within two weeks of completion of the investigation.

APPENDIX 4-E

CLASSIFICATION AND CHARACTERISTICS OF LOW-LEVEL RADIOACTIVE WASTE

I. Classification of Radioactive Waste for Land Disposal

- a) Considerations. Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides, and their shorter-lived precursors, whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.
- b) Classes of waste.

- 1) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements specified in Section II. (a). If Class A waste also meets the stability requirements specified in Section II. (b), it is not necessary to segregate the waste for disposal.

- 2) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements specified in Section II.

- 3) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements specified in Section II.

- c) Classification determined by long-lived radionuclides. If the radioactive waste contains only radionuclides listed in Table I, classification must be determined as follows:

- 1) If the concentration does not exceed 0.1 times the value in Table I, the waste is Class A.
- 2) If the concentration exceeds 0.1 times the value in Table I, but does not exceed the value in Table I, the waste is Class C.
- 3) If the concentration exceeds the value in Table I, the waste is not generally acceptable for near surface disposal.
- 4) For wastes containing mixtures of radionuclides listed in Table I, the total concentration must be determined by the sum of fractions rule described in Section I. (g).

Table I		
Radionuclide	Concentration	
	curie/cubic meter ^a	nanocurie/gram ^b
C-14	8	
C-14 in activated metal	80	
Ni-59 in activated metal	220	
Nb-94 in activated metal	0.2	
Tc-99	3	
I-129	0.08	
Alpha emitting transuranic radionuclides with half-life greater than five years		100
Pu-241		3,500
Cm-242		20,000
Ra-226		100
^a To convert the Ci/m ³ values to gigabecquerel (Gbg) per cubic meter, multiply the Ci/m ³ value by 37.		
^b To convert the nCi/g values to becquerel (Bg) per gram, multiply the nCi/g value by 37.		

d) Classification determined by short-lived radionuclides. If the waste does not contain any of the radionuclides listed in Table I classification must be determined based on the concentrations shown in Table II. However, as

specified in Section I. (f), if radioactive waste does not contain any nuclides listed in either Table I or II, it is Class A.

- 1) If the concentration does not exceed the value in Column 1, the waste is Class A.
- 2) If the concentration exceeds the value in Column 1 but does not exceed the value in Column 2, the waste is Class B.
- 3) If the concentration exceeds the value in Column 2 but does not exceed the value in Column 3, the waste is Class C.
- 4) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.
- 5) For wastes containing mixtures of the radionuclides listed in Table II, the total concentration must be determined by the sum of fractions rule described in Section I. (g).

Table II			
	Concentration, curie/cubic meter*		
Radionuclide	Column 1	Column 2	Column 3
Total of all radionuclides with less than 5-year half-life	700	-----	-----
H-3	40	-----	-----
Co-60	700	-----	-----
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600
*To convert the Ci/m³ value to gigabecquerel (G bq) per cubic meter, multiply the curies (Ci)/m³ value by 37. There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table II determine the waste to be Class C independent of these radionuclides.			

e) Classification determined by both long- and short-lived radionuclides. If the radioactive waste contains a mixture of radionuclides, some of which are listed in Table I and some of which are listed in Table II, classification must be determined as follows:

- 1) If the concentration of a radionuclide listed in Table I is less than 0.1 times the value listed in Table I, the class must be that determined by the concentration of radionuclides listed in Table II.
 - 2) If the concentration of a radionuclide listed in Table I exceeds 0.1 times the value listed in Table I, but does not exceed the value in Table I, the waste must be Class C, provided the concentration of radionuclides listed in Table II does not exceed the value shown in Column 3 of Table II.
- f) Classification of wastes with radionuclides other than those listed in Tables I and II. If the waste does not contain any radionuclides listed in either Table I or II, it is Class A.
- g) The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column.
 Example: A waste contains Sr-90 in a concentration of 1.85 TBq/m³ (50 Ci/m³) and Cs-137 in a concentration of 814 GBq/m³ (22 Ci/m³). Since the concentrations both exceed the values in Column 1, Table II, they must be compared to Column 2 values. For Sr-90 fraction, $50/150 = 0.33$., for Cs-137 fraction, $22/44 = 0.5$; the sum of the fractions = 0.83. Since the sum is less than 1.0, the waste is Class B.
- h) Determination of concentrations in wastes. The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as becquerel (nanocurie) per gram.

II. Radioactive Waste Characteristics

- a) The following are minimum requirements for all classes of waste and are intended to facilitate handling and provide protection of health and safety of personnel at the disposal site.
- 1) Wastes must be packaged in conformance with the conditions of the license issued to the site operator to which the waste will be shipped. Where the conditions of the site license are more restrictive than the provisions of 180 NAC 4, the site license conditions shall govern.
 - 2) Wastes must not be packaged for disposal in cardboard or fiberboard boxes.
 - 3) Liquid waste must be packaged in sufficient absorbent material to absorb twice the volume of the liquid.
 - 4) Solid waste containing liquid must contain as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case

shall the liquid exceed 1% of the volume.

5) Waste must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

6) Waste must not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste. This does not apply to radioactive gaseous waste packaged in accordance with Section II. (a)(8).

7) Waste must not be pyrophoric. Pyrophoric materials contained in wastes must be treated, prepared, and packaged to be nonflammable.

8) Wastes in a gaseous form shall be packaged at an absolute pressure that does not exceed 1.5 atmospheres at 20°C. Total activity must not exceed 3.7 TBq (100 Ci) per container.

9) Wastes containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the maximum extent practicable the potential hazard from the non-radiological materials.

b) The following requirements are intended to provide stability of the waste. Stability is intended to ensure that the waste does not degrade and affect overall stability of the site through slumping, collapse, or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and nondispersible waste.

1) Waste must have structural stability. A structurally stable waste form will generally maintain its physical dimensions and its form, under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, and microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.

2) Notwithstanding the provisions in Section II. (a)(3) and (4), liquid wastes, or wastes containing liquid, must be converted into a form that contains as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5% of the volume of the waste for waste processed to a stable form.

3) Void spaces within the waste and between the waste and its package must be reduced to the extent practicable.

III. Labeling

Each package of waste must be clearly labeled to identify whether it is Class A, Class B, or Class C waste, in accordance with Section I.

APPENDIX 4-F

QUANTITIES FOR USE WITH
DECOMMISSIONING
(To convert μCi to kBq , multiply the
 μCi value by 37.)

Material	Microcurie
Americium-241	0.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
Barium-133	10
Barium-140	10
Bismuth-210	1
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-115	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Cesium-131	1,000
Cesium-134m	100
Cesium-134	1
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-58	10
Cobalt-60	1
Copper-64	100
Dysprosium-165	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 (9.2 h)	100
Europium-152 (13 yr)	1
Europium-154	1
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10

QUANTITIES FOR USE WITH
DECOMMISSIONING

(To convert μCi to kBq , multiply the μCi value by 37.)

Material	Microcurie
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100

QUANTITIES FOR USE WITH
DECOMMISSIONING

(To convert μCi to kBq , multiply the μCi value by 37.)

Material	Microcurie
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10
Osmium-191m	100
Osmium-191	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	0.01
Polonium-210	0.1
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10
Osmium-191m	100
Osmium-191	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	0.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100

QUANTITIES FOR USE WITH
DECOMMISSIONING

(To convert μCi to kBq , multiply the
 μCi value by 37.)

Material	Microcurie
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	0.01
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10
Rubidium-87	10
Ruthenium-97	100
Ruthenium-103	10
Ruthenium-105	10
Ruthenium-106	1
Samarium-151	10
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Selenium-75	10
Silicon-31	100
Silver-105	10
Silver-110m	1
Silver-111	100
Sodium-22	1
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1
Strontium-91	10
Strontium-92	10
Sulfur-35	100
Tantalum-182	10
Technetium-96	10
Technetium-97m	100
Technetium-97	100
Technetium-99m	100
Technetium-99	10
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	100
Tellurium-129m	10
Tellurium-129	100
Tellurium-131m	10
Tellurium-132	10
Terbium-160	10
Thallium-200	100
Thallium-201	100
Thallium-202	100

QUANTITIES FOR USE WITH
DECOMMISSIONING
(To convert μCi to kBq , multiply the
 μCi value by 37.)

Material	Microcurie
Thallium-204	10
Thorium (natural) ¹	100
Thulium-170	10
Thulium-171	
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	10
Tungsten-187	100
Uranium (natural) ²	100
Uranium-233	0.01
Uranium-234	0.01
Uranium-235	0.01
Vanadium-48	10
Xenon-131m	1,000
Xenon-133	100
Xenon-135	100
Ytterbium-175	100
Yttrium-90	10
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.01
Any radionuclide other than alpha emitting	
Radionuclides, not listed above or mixtures of Beta emitters of unknown composition	0.1

Where there is involved a combination of isotopes in known amounts, the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" is unity.

¹Based on alpha disintegration rate of Th-232, Th-230 and their daughter products.

²Based on alpha disintegration rate of U-238, U-234 and U-235.

APPENDIX 4-G

CONCENTRATION AND ACTIVITY LIMITS OF NUCLIDES FOR DISPOSAL IN A CITY OR COUNTY LANDFILL DISPOSAL FACILITY

(For use in 180 NAC 4-038)

Nuclides	Concentration Limits (Ci/m ³)	Annual Generator Disposal Limit (Ci/yr)
F-18	3E-1	8
Si-31	1E-2	3E +3
Na-24	9E-4	2E-2
P-32	2	5E +1
P-33	10	3E +2
S-35	9	2E +2
Ar-41	3E-1	8
K-42	2E-2	5E-1
Ca-45	4	1E +2
Ca-47	2E-2	5E-1
Sc-46	2E-3	5E-2
Cr-51	6E-1	2E +1
Fe-59	5E-3	1E-1
Co-57	6E-2	2
Co-58	1E-2	3E-1
Zn-65	7E-3	2E-1
Ga-67	3E-1	8
Se-75	5E-2	1
Br-82	2E-3	5E-2
Rb-86	4E-2	1
Sr-85	2E-2	5E-1
Sr-89	8	2E +2
Y-90	4	1E +2
Y-91	4E-1	10
Zr-95	8E-3	2E-1
Nb-95	8E-3	2E-1
Mo-99	5E-2	1

Tc-99m	1	3E +1
Rh-106	1	3E +1
Ag-110m	2E-3	5E-2
Cd-115m	2E-1	5
In-111	9E-2	2
In-113m	9	2E +2
Sn-113	6E-2	2
Sn-119	2E +1	5E +2
Sb-124	2E-3	5E-2

**CONCENTRATION AND ACTIVITY LIMITS OF
NUCLIDES FOR DISPOSAL IN A CITY OR COUNTY
LANDFILL DISPOSAL FACILITY**

(For use in 180 NAC 4-038)

Nuclides	Concentration Limits (Ci/m ³)	Annual Generator Disposal Limit (Ci/yr)
Te-129	2E-1	5
I-123	4E-1	1E +1
I-125	7E-1	2E +1
I-131	4E-2	1
I-133	2E-2	5E-1
Xe-127	8E-2	2
Xe-133	1	3E +1
Ba-140	2E-3	5E-2
La-140	2E-3	5E-2
Ce-141	4E-1	1E +1
Ce-144	1E-3	3E-2
Pr-143	6	2E +2
Nd-147	7E-2	2
Yb-169	6E-2	2
Ir-192	1E-2	3E-1
Au-198	3E-2	8E-1
Hg-197	8E-1	2E +1

TI-201	4E-1	1E +1
Hg-203	1E-1	3

In any case where there is a mixture in waste of more than one radionuclide, the limiting values for purposes of this Appendix must be determined as follows:

For each radionuclide in the mixture, calculate the ratio between the quantity present in the mixture and the limit established in Appendix 004-G for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" or "unity".

Examples: If radionuclides a, b, and c are present in concentrations Ca, Cb, and Cc, and if the applicable concentrations are CLa, CLb, and CLc respectively, then the concentrations shall be limited so that the following relationship exists:

$$(C_a/CL_a) + (C_b/CL_b) + (C_c/CL_c) < 1$$

If the total curies for radionuclides a, b, and c are represented Aa, Ab, and Ac, and the annual curie limit for each radionuclide is ALa, ALb, and ALc, then the generator is limited to the following:

$$(A_a/AL_a) + (A_b/AL_b) + (A_c/AL_c) < 1$$

APPENDIX 4-H

NATIONALLY TRACKED SOURCE THRESHOLDS

The Terabecquerel (TBq) values are the regulatory standard. The curie (Ci) values specified are obtained by converting from the TBq value. The curie values are provided for practical usefulness only and are rounded after conversion.

Radioactive material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Actinium-227	20	540	0.2	5.4
Americium-241	60	1,600	0.6	16
Americium-241/Be	60	1,600	0.6	16
Californium-252	20	540	0.2	5.4
Cobalt-60	30	810	0.3	8.1
Curium-244	50	1,400	0.5	14
Cesium-137	100	2,700	1.0	27
Gadolinium-153	1,000	27,000	10	270
Iridium-192	80	2,200	0.8	22
Plutonium-238	60	1,600	0.6	16
Plutonium-239/Be	60	1,600	0.6	16
Polonium-210	60	1,600	0.6	16
Promethium-147	40,000	1,100,000	400	11,000

Radium-226	40	1,100	0.4	11
Selenium-75	200	5,400	2	54
Strontium-90	1,000	27,000	10	270
Thorium-228	20	540	0.2	5.4
Thorium-229	20	540	0.2	5.4
Thulium-170	20,000	540,000	200	5,400
Ytterbium-169	300	8,100	3	81

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Nebraska Department of Health and Human Services, Radiological Health CUMULATIVE OCCUPATIONAL EXPOSURE HISTORY										NRH-1 EFFECTIVE DATE November 28, 2016					
1. NAME (LAST, FIRST, MIDDLE INITIAL)				2. IDENTIFICATION NUMBER				3. ID TYPE		4. SEX MALE ☐ FEMALE ☐		5. DATE OF BIRTH			
6. MONITORING PERIOD				7. LICENSEE OR REGISTRANT NAME				8. LICENSE OR REGISTRATION NUMBER		9. RECORD RECORD ☐ ESTIMATE ☐ NO RECORD ☐		10. ROUTINE ☐ PSE ☐			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD				7. LICENSEE OR REGISTRANT NAME				8. LICENSE OR REGISTRATION NUMBER		9. RECORD RECORD ☐ ESTIMATE ☐ NO RECORD ☐		10. ROUTINE ☐ PSE ☐			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD				7. LICENSEE OR REGISTRANT NAME				8. LICENSE OR REGISTRATION NUMBER		9. RECORD RECORD ☐ ESTIMATE ☐ NO RECORD ☐		10. ROUTINE ☐ PSE ☐			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD				7. LICENSEE OR REGISTRANT NAME				8. LICENSE OR REGISTRATION NUMBER		9. RECORD RECORD ☐ ESTIMATE ☐ NO RECORD ☐		10. ROUTINE ☐ PSE ☐			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD				7. LICENSEE OR REGISTRANT NAME				8. LICENSE OR REGISTRATION NUMBER		9. RECORD RECORD ☐ ESTIMATE ☐ NO RECORD ☐		10. ROUTINE ☐ PSE ☐			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
6. MONITORING PERIOD				7. LICENSEE OR REGISTRANT NAME				8. LICENSE OR REGISTRATION NUMBER		9. RECORD RECORD ☐ ESTIMATE ☐ NO RECORD ☐		10. ROUTINE ☐ PSE ☐			
11. DDE		12. LDE		13. SDE, WB		14. SDE, ME		15. CEDE		16. CDE		17. TEDE		18. TODE	
19. SIGNATURE OF MONITORED INDIVIDUAL				20. DATE SIGNED		21. CERTIFYING ORGANIZATION				22. SIGNATURE OF DESIGNEE				23. DATE SIGNED	

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF NRH-1 (All doses should be stated in rems)		
1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc.), first name, middle initial (if applicable). 2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit. 3. Enter the code for the type of identification used as shown below: CODE ID TYPE SSN U.S. Social Security Number PPN Passport Number CSI Canadian Social Insurance Number WPN Work Permit Number IND INDEX Identification Number OTH Other 4. Check the box that denotes the sex of the individual being monitored. 5. Enter the date of birth of the individual being monitored in the format MM/DD/YY. 6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY. 7. Enter the name of the licensee, registrant, or facility not licensed by the Department that provided monitoring. 8. Enter the Department license or registration number or numbers. 9. Place an "X" in Record, Estimate, or No Record. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee or registrant intends to assign the record dose on the basis of TLD results that are not yet available.	10. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee should sum them and report the total of all PSEs. 11. Enter the deep dose equivalent (DDE) to the whole body. 12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye. 13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE, WB). 14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE, ME). 15. Enter the committed effective dose equivalent (CEDE). 16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ. 17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15. 18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16. 19. Signature of the monitored individual. The signature of the monitored individual on this form indicates that the information contained on the form is complete and correct to the best of his or her knowledge. 20. Enter the date this form was signed by the monitored individual. 21. [OPTIONAL] Enter the name of the licensee, registrant or facility not licensed by the Department, providing monitoring for exposure to radiation (such as a DOE facility) or the employer if the individual is not employed by the licensee or registrant and the employer chooses to maintain exposure records for its employees.	22. [OPTIONAL] Signature of the person designated to represent the licensee, registrant or employer entered in item 21. The licensee, registrant or employer who chooses to countersign the form should have on file documentation of all the information on the Department Form Y being signed. 23. [OPTIONAL] Enter the date this form was signed by the designated representative.

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Nebraska Department of Health and Human Services, Radiological Health				NRH-2 EFFECTIVE DATE November 28, 2016	
OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD					
1. NAME (LAST, FIRST, MIDDLE INITIAL)		2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX MALE _____ FEMALE _____	5. DATE OF BIRTH
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER(S)	9A. _____ RECORD ESTIMATE
					9B. _____ ROUTINE PSE
INTAKES				DOSES (in rem)	
10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN μCi		
				DEEP DOSE EQUIVALENT (DDE)	11.
				EYE DOSE EQUIVALENT TO THE LENS OF THE EYE (LDE)	12.
				SHALLOW DOSE EQUIVALENT, WHOLE BODY (SDE, WB)	13.
				SHALLOW DOSE EQUIVALENT, MAX EXTREMITY (SDE, ME)	14.
				COMMITTED EFFECTIVE DOSE EQUIVALENT (CEDE)	15.
				COMMITTED DOSE EQUIVALENT, MAXIMALLY EXPOSED ORGAN (CDE)	16.
				TOTAL EFFECTIVE DOSE EQUIVALENT (BLOCKS 11+15) (TEDE)	17.
				TOTAL ORGAN DOSE EQUIVALENT, MAX ORGAN (BLOCKS 11+16) (TODE)	18.
				19. COMMENTS	
20. SIGNATURE -- LICENSEE OR REGISTRANT					21. DATE PREPARED

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INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF NRH-2 (All doses should be stated in rems)																
1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc.), first name, middle initial (if applicable). 2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit. 3. Enter the code for the type of identification used as shown below: <table border="0"><tr><td>CODE</td><td>ID TYPE</td></tr><tr><td>SSN</td><td>U.S. Social Security Number</td></tr><tr><td>PPN</td><td>Passport Number</td></tr><tr><td>CSI</td><td>Canadian Social Insurance Number</td></tr><tr><td>WPN</td><td>Work Permit Number</td></tr><tr><td>IND</td><td>INDEX Identification Number</td></tr><tr><td>OTH</td><td>Other</td></tr></table> 4. Check the box that denotes the sex of the individual being monitored. 5. Enter the date of birth of the individual being monitored in the format MM/DD/YY. 6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY. 7. Enter the name of the licensee or registrant. 8. Enter the Department license or registration number or numbers. 9A. Place an "X" in Record or Estimate. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of TLD results that are not yet available. 9B. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring	CODE	ID TYPE	SSN	U.S. Social Security Number	PPN	Passport Number	CSI	Canadian Social Insurance Number	WPN	Work Permit Number	IND	INDEX Identification Number	OTH	Other	period. If more than one PSE was received in a single year, the licensee or registrant should sum them and report the total of all PSEs. 10A. Enter the symbol for each radionuclide that resulted in an internal exposure recorded for the individual, using the format "Xx-###x," for instance, Cs-137 or Tc-99m. 10B. Enter the lung clearance class as listed in Appendix B to Part D (D, W, Y, V, or O for other) for all intakes by inhalation. 10C. Enter the mode of intake. For inhalation, enter "H." For absorption through the skin, enter "B." For oral ingestion, enter "G." For injection, enter "J." 10D. Enter the intake of each radionuclide in μCi. 11. Enter the deep dose equivalent (DDE) to the whole body. 12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye. 13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB). 14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME). 15. Enter the committed effective dose equivalent (CEDE) or "NR" for "Not Required" or "NC" for "Not Calculated". 16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for "Not Required" or "NC" for "Not Calculated". 17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15. 18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.	19. Signature of the person designated to represent the licensee or registrant. 20. Enter the date this form was prepared. 21. COMMENTS. In the space provided, enter additional information that might be needed to determine compliance with limits. An example might be to enter the note that the SDE,ME was the result of exposure from a discrete hot particle. Another possibility would be to indicate that an overexposed report has been sent to the Department in reference to the exposure report.
CODE	ID TYPE															
SSN	U.S. Social Security Number															
PPN	Passport Number															
CSI	Canadian Social Insurance Number															
WPN	Work Permit Number															
IND	INDEX Identification Number															
OTH	Other															

