DEC 05 1989

MEMORANDUM FOR: Michael J. Bell, Chief
Regulatory Branch
LLWM, NMSS

FROM: G.W. Roles, Project Manager
Regulatory Branch
LLWM, NMSS

SUBJECT: RADIONUCLIDE DISTRIBUTIONS IN LOW-LEVEL WASTE AS REPORTED IN 1988 SHIPMENT MANIFESTS

I have enclosed information about the radionuclide distributions within low-level waste disposed during 1988 at the three operating commercial low-level waste disposal facilities. This information was obtained from the disposal facility operators as part of our annual contracts to purchase microfiche copies of shipment manifests.

Tables 1 and 2 both present waste volumes and gross activities as a function of waste class. The emphasis, however, in the two tables is different. Table 1 emphasizes waste volume and activity distributions within each disposal facility. Table 2 emphasizes waste volume and activity distributions among the three disposal facilities. Tables 3 through 5 list the activities reported in shipment manifests for each disposal facility and waste class. Table 3 addresses the Richland, WA disposal facility, Table 4 the Beatty, NV disposal facility, and Table 5 the Barnwell, SC disposal facility. Tables 6 through 8 present radionuclide activities as summed over all three disposal facilities. Table 6 lists, as a function of waste class, the activity distribution for radionuclides having a total activity in low-level waste of at least 100 curies. (Table 6 encompasses 99.7% of the waste activity.) Table 7 lists, as a function of waste class, the activity distribution for radionuclides having half-lives exceeding 100 years. Finally, Table 8 presents the activity distribution as a function of waste class for each radionuclide listed in Section 61.55.

Table 7 shows that initially, most of the low-level waste activity is in Class C waste, followed by Class B waste and then Class A waste. But with the exception of Ni-63, a radionuclide mostly found in activated metals and having a 100-year half-life, 90% of the long-lived activity is found in Class A waste. This long-lived activity is principally C-14 and uranium and thorium isotopes. This means that eventually, Class A waste will contain more activity than either Class B waste or Class C waste. Some may find this result surprising.

I was impressed to find that 88% of the I-129 activity is reported in Class A waste, along with 30% of the Tc-99 activity and 71% of the C-14 activity. These radionuclides are reputed to be significant for performance assessments of disposal facilities.

This evidence is misleading. It suggests that impacts from potential releases into the environment may be dominated by Class A waste. If this were true, then NRC might consider imposing additional requirements for Class A waste

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SUBJECT ABSTRACT: RADIONUCLIDE DIST. IN LLW AS REPORTED IN 88 MANIFESTS

disposal. For example, NRC could require licensees to process Class A wastes into a form whereby these radionuclides would be released at lower rates. These additional requirements would impose monetary and radiological costs on licensees.

But the evidence is misleading. Iodine-129 and Tc-99 are generated principally by nuclear power licensees. These licensees estimate concentrations of these nuclides using scaling factors calculated from radiochemical analysis of waste samples. The sample results are usually given in terms of the lower limits of detection (LLD) for the radionuclides and analytical techniques. Because these licensees use these LLD values to determine scaling factors, the quantities of these radionuclides in shipment manifests are greatly overreported.

Carbon-14 seems to be generated principally by industrial and institutional licensees. These licensees normally determine C-14 quantities in waste using material accountability techniques. But this isotope is also reported by nuclear power licensees, who frequently determine radionuclide quantities using scaling factors calculated from waste sample analyses. These scaling factors are occasionally based on LLD values.

This situation illustrates the need for accurate information in shipment manifests. NRC's regulations for disposal of LLW are geared to the waste hazard. The higher the hazard, as determined by the concentrations of particular radionuclides, the more stringent the waste form and disposal requirements. The shipment manifests provide the most detailed information about the waste hazard. If the manifests are grossly overconservative, then NRC's regulatory and research programs could be misdirected. The wrong waste streams and generators could be emphasized and unneeded requirements imposed, with concomitant increases in licensee costs and radiation exposures.

Over the next few months, I will obtain additional information about the radiological characteristics of low-level waste disposed at the Richland and Beatty facilities. This additional information will come from the contract with the Utility Data Institute, and should help to confirm the industries producing the radionuclides of most concern, and to identify the waste streams containing these radionuclides.

Original signed by

G.W. Roles
Regulatory Branch
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Enclosure:
Tables 1 - 8

OFC	:LLRB	:LLRB	:
NAME	:GRoles/es	:RBoyle	:
DATE	:12/5/89	:12/5/89	:

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TABLES 1-8
DISTRIBUTION OF LOW-LEVEL WASTE
PER SHIPPING MANIFESTS

Table 1. Volume and Activity Distribution by Waste Class, 1988

Site and Class	Volume (ft^3)	Activity (Ci)
Barnwell		
Class A	8.889E+5 (95.4%)	2.124E+4 (9.7%)
Class B	3.350E+4 (3.6%)	3.361E+4 (15.4%)
Class C	9.570E+3 (1.0%)	1.640E+5 (74.9%)
Total	9.320E+5	2.189E+5
Richland		
Class A	3.969E+5 (98.4%)	4.575E+3 (14.3%)
Class B	4.146E+3 (1.0%)	2.286E+4 (71.3%)
Class C	2.403E+3 (0.6%)	4.628E+3 (14.4%)
Total	4.034E+5	3.207E+4
Beatty		
Class A	9.250E+4 (99.0%)	2.549E+3 (29.3%)
Class B	6.881E+2 (0.7%)	3.590E+3 (41.3%)
Class C	2.276E+2 (0.2%)	2.553E+3 (29.4%)
Total	9.341E+4	8.691E+3
Total		
Class A	1.378E+6 (96.4%)	2.837E+4 (10.9%)
Class B	3.834E+4 (2.7%)	6.007E+4 (23.1%)
Class C	1.220E+4 (0.9%)	1.712E+5 (65.9%)
Total	1.429E+6	2.597E+5

Table 2. Volume and Activity Distribution by Waste Class and Site, 1988

Class	Barnwell	Richland	Beatty	Total
Class A				
Vol. (ft^3)	888,903 (64.5%)	396,851 (28.8%)	92,496 (6.7%)	1,378,250
Act. (Ci)	21,244 (74.9%)	4,575 (16.1%)	2,549 (9.0%)	28,368
Class B				
Vol. (ft^3)	33,501 (87.4%)	4,146 (10.8%)	688 (1.8%)	38,335
Act. (Ci)	33,611 (56.0%)	22,865 (38.1%)	3,590 (6.0%)	60,066
Class C				
Vol. (ft^3)	9,570 (78.4%)	2,403 (19.7%)	228 (1.9%)	12,201
Act. (Ci)	164,048 (95.8%)	4,628 (2.7%)	2,553 (1.5%)	171,229
Total				
Vol. (ft^3)	931,974 (65.2%)	403,399 (28.2%)	93,412 (6.5%)	1,428,785
Act. (Ci)	218,902 (84.3%)	32,068 (12.3%)	8,692 (3.3%)	259,662

Table 3. Richland 1988 Radionuclide Distribution (Ci) by Waste Class

Radionuclide	Class A	Class B	Class C	Total
Ag-108	1.000E-6			1.000E-6
Ag-108m	1.012E-2			1.012E-2
Ag-110	3.080E-4			3.080E-4
Ag-110m	2.116E+1	4.892E+1	3.693E+1	1.070E+2
Am-241	1.709E-1	3.537E-3	9.833E-2	2.728E-1
Am-247	7.300E-5			7.300E-5
As-73	9.090E-4			9.090E-4
Au-195	1.425E-3			1.425E-3
Ba-133	3.561E-2			3.561E-2
Ba-140	4.005E-1	5.000E-6		4.005E-1
Be-7	1.415E-2		2.079E-1	2.220E-1
Bi-205	2.000E-6			2.000E-6
Bi-207	4.570E-4			4.570E-4
Bi-210	1.400E-5			1.400E-5
C-14	8.357E+1	1.420E+0	5.107E+0	9.009E+1
Ca-45	1.204E+0			1.204E+0
Ca-47	2.620E-4			2.620E-4
Cd-107	1.100E-5			1.100E-5
Cd-109	2.339E-1			2.339E-1
Cd-115	1.000E-6			1.000E-6
Ce-139	6.300E-5			6.300E-5
Ce-141	5.620E-1		2.666E-2	5.887E-1
Ce-144	2.192E+0	1.451E+0	4.618E+0	8.262E+0
Cf-252	8.460E-4			8.460E-4
Cl-36	3.254E-1			3.254E-1
Cm-242	2.314E-2	1.462E-3	4.556E-3	2.916E-2
Cm-243	3.850E-4	8.000E-6	6.000E-6	3.990E-4
Cm-244	1.897E-3	6.610E-4	1.542E-3	4.100E-3
Co-56	7.950E-4			7.950E-4
Co-57	2.016E+0	7.797E-1	4.280E-1	3.224E+0
Co-58	1.079E+2	1.425E+2	1.079E+2	3.583E+2
Co-60	4.214E+2	1.499E+2	1.973E+2	7.687E+2
Cr-51	1.290E+2	2.507E+0	8.064E+0	1.396E+2
Cs-134	3.254E+1	2.950E+2	7.748E+2	1.102E+3
Cs-136	3.532E-2	5.000E-6		3.533E-2
Cs-137	6.481E+1	5.423E+2	2.148E+3	2.755E+3
Cs-144	2.469E-3			2.469E-3
Cu-64	1.100E-5			1.100E-5
Cu-67	1.600E-5			1.600E-5
Dy-165	1.000E-4			1.000E-4
Eu-152	1.014E-1			1.014E-1
Eu-154	1.961E-2			1.961E-2
Eu-155	4.344E-2	4.510E-3	1.043E-1	1.522E-1

Table 3 (Continued)

Radionuclide	Class A	Class B	Class C	Total
Fe-55	3.600E+2	2.441E+2	2.254E+2	8.294E+2
Fe-59	7.912E+0	4.440E-2	4.019E-1	8.358E+0
Ga-67	6.698E-2			6.698E-2
Ga-68	1.013E-3			1.013E-3
Gd-153	1.510E-1			1.510E-1
Ge-68	2.493E-2			2.493E-2
H-3	2.396E+3	2.083E+4	2.215E+0	2.323E+4
Hf-181	5.997E-2	4.760E-3		6.473E-2
Hg-203	1.025E-2			1.025E-2
I-121	4.000E-6			4.000E-6
I-123	3.206E-2			3.206E-2
I-125	4.137E+1			4.137E+1
I-126	5.000E-6			5.000E-6
I-129	2.933E-2	3.043E-3	1.803E-2	5.040E-2
I-131	2.662E+0	6.657E+0	3.520E+0	1.284E+1
I-133	2.000E-3			2.000E-3
I-137	4.000E-4			4.000E-4
In-111	1.560E-1			1.560E-1
In-113	8.000E-6			8.000E-6
In-114	2.996E-3			2.996E-3
In-114m	1.679E-3			1.679E-3
Ir-192	9.779E-2			9.779E-2
K-40	8.500E-5			8.500E-5
K-42	1.000E-6			1.000E-6
Kr-85	5.292E+0			5.292E+0
La-140	5.002E-1	6.000E-6	5.920E-1	1.092E+0
Mn-54	9.123E+1	3.267E+1	4.954E+1	1.734E+2
Mn-57	1.000E-6			1.000E-6
Mo-99	7.773E-3			7.773E-3
Na-22	6.055E-1			6.055E-1
Na-24	3.413E-2			3.413E-2
Nb-88	1.000E-5			1.000E-5
Nb-93	4.000E-6			4.000E-6
Nb-94	3.960E-3			3.960E-3
Nb-95	1.944E+1	5.383E+0	5.413E+0	3.024E+1
Ni-59	5.679E-2	2.170E-1	3.485E-2	3.086E-1
Ni-63	3.150E+1	5.947E+1	1.650E+2	2.559E+2
P-32	7.304E+1			7.304E+1
P-33	4.681E-3			4.681E-3
Pa-233	7.000E-6			7.000E-6
Pa-234	1.000E-6			1.000E-6
Pb-203	2.000E-6			2.000E-6
Pb-210	1.898E-2			1.898E-2
Pb-212	2.000E-6			2.000E-6

Table 3 (Continued)

Radionuclide	Class A	Class B	Class C	Total
Pm-145	1.000E-6			1.000E-6
Pm-147	6.660E+0	1.561E-1	1.533E+2	1.601E+2
Po-208	1.000E-6			1.000E-6
Po-210	7.878E-1			7.878E-1
Pt-193	1.000E-6			1.000E-6
Pu-236	1.000E-5			1.000E-5
Pu-238	8.982E-3	1.306E-3	1.323E-2	2.352E-2
Pu-239	2.929E-2	4.510E-3	7.914E-2	1.129E-1
Pu-240	8.608E-3	9.760E-4	2.211E-2	3.169E-2
Pu-241	8.579E-1	2.108E-1	2.440E+0	3.508E+0
Pu-242	6.370E-4	1.900E-3	1.500E-5	2.552E-3
Ra-224	1.000E-5			1.000E-5
Ra-226	1.689E-1	1.600E-5	5.754E-1	7.443E-1
Ra-228	1.400E-5			1.400E-5
Rb-83	1.836E-2			1.836E-2
Rb-86	1.245E-1			1.245E-1
Re-187	1.000E-6			1.000E-6
Rh-106	1.300E-4			1.300E-4
Ru-103	4.965E-2	8.000E-6	8.230E-4	5.048E-2
Ru-106	1.286E+0	1.801E-2	7.861E+0	9.165E+0
S-35	1.009E+2			1.009E+2
Sb-122	4.570E-4			4.570E-4
Sb-124	1.393E+1	6.815E+1	1.130E+0	8.320E+1
Sb-125	1.759E+1	4.945E+0	5.725E+0	2.826E+1
Sc-46	1.416E-1			1.416E-1
Sc-47	5.000E-6			5.000E-6
Sc-50	1.000E-6			1.000E-6
Se-75	2.882E-2			2.882E-2
Sm-145	1.000E-6			1.000E-6
Sn-113	7.335E-1	6.708E-1	2.562E-2	1.430E+0
Sn-119	4.501E-3			4.501E-3
Sn-119m	1.859E-1			1.859E-1
Sr-81	1.000E-6			1.000E-6
Sr-85	6.044E-2			6.044E-2
Sr-89	1.186E-1	5.531E-1	2.381E+0	3.053E+0
Sr-90	6.560E+1	2.956E+2	7.146E+2	1.076E+3
Sr-92	5.420E-3			5.420E-3
Ta-182	1.567E-3			1.567E-3
Tc-99	6.228E-1	2.424E-2	4.251E-1	1.072E+0
Tc-99m	1.467E+0			1.467E+0
Te-123	1.602E-2			1.602E-2
Te-123m	4.000E-2			4.000E-2
Te-125	4.954E-3			4.954E-3
Te-125m	4.532E+0	7.136E-1	8.200E-1	6.065E+0

Table 3 (Continued)

Radionuclide	Class A	Class B	Class C	Total
Th-228	9.000E-4			9.000E-4
Th-229	1.000E-5			1.000E-5
Th-230	4.400E-5			4.400E-5
Th-232	5.014E-1			5.014E-1
Th-NAT	2.150E+1			2.150E+1
Tl-201	3.845E-1			3.845E-1
Tl-202	3.120E-3			3.120E-3
Tl-204	5.584E-3			5.584E-3
Tl-208	4.000E-6			4.000E-6
Tl-210	2.000E-6			2.000E-6
U-232	4.010E-4			4.010E-4
U-233	3.000E-6			3.000E-6
U-234	7.830E-4	2.200E-5	7.140E-4	1.519E-3
U-235	6.345E-2	1.000E-5	4.605E-3	6.807E-2
U-236	2.000E-6			2.000E-6
U-238	1.396E+1	1.400E-5	2.310E-4	1.396E+1
U-NAT	3.297E+0			3.297E+0
W-181	1.000E-6			1.000E-6
W-188	1.000E-6			1.000E-6
Xe-127	1.326E-2			1.326E-2
Xe-131	8.160E-2	3.900E-5		8.164E-2
Xe-131m	1.822E-2	1.520E-4	1.410E-2	3.248E-2
Xe-133	8.227E-1			8.227E-1
Y-88	3.367E-3			3.367E-3
Y-90	1.505E-2			1.505E-2
Yb-169	2.890E-4			2.890E-4
Zn-65	4.087E+2	1.286E+2	3.022E-2	5.374E+2
Zr-85	1.000E-6			1.000E-6
Zr-89	5.000E-3			5.000E-3
Zr-95	1.171E+1	2.653E+0	2.791E+0	1.715E+1
Zr-97	6.000E-5			6.000E-5
Total	4.575E+3	2.286E+4	4.628E+3	3.207E+4

Table 4. Beatty 1988 Radionuclide Distribution (Ci) by Waste Class

Radionuclide	Class A	Class B	Class C	Total
Ac-227	1.937E-3			1.937E-3
Ag-110	2.049E-2			2.049E-2
Ag-110m	7.448E-2			7.448E-2
Am-241	2.282E-1	2.600E-5	3.038E-2	2.586E-1
As-73	5.300E-5			5.300E-5
Au-195	6.800E-5	3.000E-6		7.100E-5
Ba-133	6.690E-3	9.660E-4	3.000E-6	7.659E-3
Ba-140	1.490E-4			1.490E-4
Be-7	1.710E-3			1.710E-3
Bi-205	9.000E-6			9.000E-6
Bi-207	2.710E-4			2.710E-4
Bi-210	1.030E-4			1.030E-4
C-14	5.975E+0	5.085E-2	1.650E+0	7.676E+0
Ca-45	1.265E-1			1.265E-1
Cd-109	3.690E-2	1.000E-6		3.690E-2
Ce-141	3.398E-2			3.398E-2
Ce-144	6.893E-1	1.000E-6		6.839E-1
Cf-252		4.200E-5		4.200E-5
Cl-36	1.333E-2			1.333E-2
Cm-241	7.700E-5			7.700E-5
Cm-242	9.081E-2			9.081E-2
Cm-243	8.200E-5			8.200E-5
Cm-244	5.300E-5		2.740E-2	2.745E-2
Co-57	7.731E+0	1.445E-3		7.732E+0
Co-58	3.383E+1	2.030E+1		5.413E+1
Co-60	5.821E+2	1.248E+2	1.970E+2	9.039E+2
Cr-51	2.193E+2			2.193E+2
Cs-134	7.728E+0	4.336E+1		5.109E+1
Cs-136	2.400E-2			2.400E-2
Cs-137	1.903E+1	1.583E+2	2.340E+3	2.518E+3
Dy-159	2.000E-6			2.000E-6
Eu-152	4.750E-4	1.000E-6		4.760E-4
Eu-154	2.240E-4			2.240E-4
Eu-155	2.200E-5			2.200E-5
Fe-55	1.237E+3	5.417E+0		1.242E+3
Fe-59	6.421E-1			6.421E-1
Ga-67	8.476E-3			8.476E-3
Gd-153	1.540E-1	3.000E-3		1.570E-1
Ge-68	3.867E-3			3.867E-3
H-3	9.237E+1	3.214E+3		3.307E+3
Hf-181	6.800E-5			6.800E-5
Hg-203	5.000E-6			5.000E-6

Table 4 (Continued)

Radionuclide	Class A	Class B	Class C	Total
I-121	1.478E-3			1.478E-3
I-123	4.089E-3			4.089E-3
I-124	1.000E-6			1.000E-6
I-125	2.836E+1	2.000E-6		2.836E+1
I-129	2.386E-2	2.000E-6		2.386E-2
I-131	1.119E+0			1.119E+0
In-111	1.632E-2			1.632E-2
In-113	1.250E-4			1.250E-4
In-114	7.790E-4			7.790E-4
Ir-192	9.064E-1			9.064E-1
K-40	4.400E-5			4.400E-5
Kr-85	6.696E+1	1.500E-2		6.697E+1
Mn-54	1.612E+2	5.647E+0		1.668E+2
Mo-93	1.000E-6			1.000E-6
Mo-99	1.710E-4			1.710E-4
Na-22	3.794E-2	1.000E-6		3.794E-2
Na-24	1.101E-3			1.101E-3
Nb-94	7.430E-4			7.430E-4
Nb-95	2.432E-1			2.432E-1
Nd-147	1.000E-6			1.000E-6
Ni-59	1.820E-4			1.820E-4
Ni-63	5.084E+0	1.084E+1		1.592E+1
P-32	2.380E+1			2.380E+1
Pa-234	2.000E-6			2.000E-6
Pb-210	8.330E-4	2.000E-6		8.350E-4
Pm-147	5.136E-1			5.136E-1
Po-210	1.404E-2			1.404E-2
Pr-147	1.000E-6			1.000E-6
Pt-195	5.000E-3			5.000E-3
Pu-238	1.774E-2		6.000E-2	7.774E-2
Pu-239	4.506E-2			4.506E-2
Pu-240	2.220E-2			2.220E-2
Pu-241	9.274E-1			9.274E-1
Pu-242	3.420E-4			3.420E-4
Ra-226	1.090E+1	6.719E-2	9.941E-1	1.196E+1
Ra-228	2.940E-4			2.940E-4
Rb-86	1.238E-2			1.238E-2
Ru-103	4.997E-3			4.997E-3
Ru-106	3.070E-4	1.000E-6		3.080E-4
S-35	5.371E+0			5.371E+0
Sb-122	1.900E-5			1.900E-5
Sb-124	7.203E+0			7.203E+0
Sb-125	2.828E-1			2.828E-1

Table 4 (Continued)

Radionuclide	Class A	Class B	Class C	Total
Sc-46	1.088E-2			1.088E-2
Sc-47	3.000E-3			3.000E-3
Se-75	8.065E-3			8.065E-3
Sm-151	4.000E-6			4.000E-6
Sn-111	1.460E-4			1.460E-4
Sn-113	1.097E-2	1.000E-6		1.097E-2
Sn-119m	1.000E-6			1.000E-6
Sr-85	1.034E-2			1.034E-2
Sr-89	2.834E-3			2.834E-3
Sr-90	3.440E-1	6.672E+0	1.280E+1	1.982E+1
Ta-179	2.000E-6			2.000E-6
Ta-182	4.446E-3			4.446E-3
Tb-157	1.000E-5			1.000E-5
Tb-158	1.000E-5			1.000E-5
Tc-99	1.332E-1	1.000E-6		1.332E-1
Tc-99m	6.108E-3			6.108E-3
Te-123	4.248E-3			4.248E-3
Te-125m	2.190E-4			2.190E-4
Te-129m	3.000E-6			3.000E-6
Th-228	1.690E-4	2.000E-5		1.890E-4
Th-230	1.147E-3			1.147E-3
Th-232	2.767E-2	1.078E-3		2.874E-2
Th-235	2.500E-5			2.500E-5
Th-NAT	7.540E-4			7.540E-4
Tl-201	3.435E-3			3.435E-3
Tl-204	1.895E-3	1.000E-5		1.905E-3
Tm-171	2.000E-5			2.000E-5
U-232	1.000E-6			1.000E-6
U-233	1.000E-6			1.000E-6
U-234	1.723E-2			1.723E-2
U-235	1.104E-3		1.000E-3	2.104E-3
U-236	2.600E-5			2.600E-5
U-238	1.358E+1		2.358E-3	1.359E+1
U-DEP	3.492E-3			3.492E-3
U-NAT	4.807E-2	1.606E-3		4.968E-2
W-178	6.792E-3			6.792E-3
Xe-127	2.700E-5			2.700E-5
Y-88	1.983E-2			1.983E-2
Y-90	9.481E-3	1.000E-6		9.482E-3
Zn-65	1.428E+1	1.100E-5		1.428E+1
Zr-95	9.050E-2			9.050E-2
Zr-97	2.100E-5			2.100E-5
Total	2.549E+3	3.590E+3	2.553E+3	8.691E+3

Table 5. Barnwell 1988 Radionuclide Distribution (Ci) by Waste Class

Radionuclide	Class A	Class B	Class C	Total
Am-241	2.613E-1	8.602E-2	4.220E-2	3.895E-1
Am-242	1.000E-5		1.110E-3	1.120E-3
Sb-122	4.779E-2	1.083E+1	1.468E+1	2.556E+1
Sb-124	5.497E+0	1.887E+1	3.428E+1	5.865E+1
Sb-125	1.393E+1	2.826E+2	7.640E+2	1.061E+3
As-76	7.949E-2			7.949E-2
Ba-131	2.561E+1			2.561E+1
Ba-133	3.400E-4	8.000E-5	5.645E+0	5.646E+0
Ba-140	2.639E+0	1.608E+1		1.872E+1
Ba-137m		1.125E-1	6.423E-1	7.548E-1
Be-7	8.149E-1			8.149E-1
Cd-109	3.094E+0			3.094E+0
Ca-45	7.180E-2			7.180E-2
C-14	4.430E+1	2.197E+1	2.491E+1	9.118E+1
Ce-141	1.316E+0	1.116E+2	4.080E-2	1.129E+2
Ce-144	3.086E+1	7.282E+2	1.352E+1	7.725E+2
Cs-134	1.792E+2	1.421E+3	1.860E+3	3.460E+3
Cs-136	1.366E-1	4.181E+0	3.104E+0	7.422E+0
Cs-137	5.198E+2	2.885E+3	4.332E+3	7.737E+3
Cs-144	1.000E-5			1.000E-5
Cl-36	1.286E-2	5.000E-5		1.291E-2
Cr-51	1.297E+3	6.147E+2	1.203E+2	2.032E+3
Co-57	9.566E+0	4.701E+1	7.703E+0	6.428E+1
Co-58	1.488E+3	2.758E+3	4.597E+3	8.843E+3
Co-59	1.400E-4			1.400E-4
Co-60	4.294E+3	5.133E+3	4.186E+4	5.129E+4
Cu-64	8.981E-1			8.981E-1
Cm-242	1.628E-1	1.445E-1	7.911E-1	1.098E+0
Cm-243	1.299E-1	3.164E-2	1.004E-2	1.716E-1
Cm-244	2.304E-2	3.026E-2	8.025E-2	1.336E-1
U-[illegible]	1.404E+2			1.404E+2
Eu-154	1.000E-5		4.816E-1	4.816E-1
Eu-155	3.402E-2	5.300E-3	5.300E-3	4.462E-2
Gd-153	2.568E-2			2.568E-2
Ga-67	2.000E-3			2.000E-3
Au-198	4.000E-5			4.000E-5
Hf-181	1.062E+0			1.062E+0
H-3	1.345E+2	9.073E+3	5.049E+2	9.713E+3
In-111	1.964E-2			1.964E-2
In-114	7.550E-3			7.550E-3
I-125	7.047E+0	5.600E-4	2.500E-2	7.073E+0
I-126	4.651E-2			4.651E-2
I-129	9.893E-1	5.905E-2	6.899E-2	1.117E+0
I-131	3.197E+1	4.808E+1	1.247E+1	9.252E+1

Table 5 (Continued)

Radionuclide	Class A	Class B	Class C	Total
I-132	1.400E-2			1.400E-2
I-133	1.940E+0		2.071E+0	4.012E+0
I-134	3.721E-1			3.721E-1
Ir-192	7.800E-4			7.800E-4
Fe-55	6.273E+3	4.009E+3	7.653E+4	8.681E+4
Fe-59	2.025E+2	5.291E+1	1.104E+1	2.664E+2
Kr-85	1.203E+1	6.807E-1	4.055E+0	1.677E+1
La-140	3.683E+0	4.316E+0	9.496E-2	8.095E+0
Mn-54	1.883E+3	1.006E+3	1.987E+4	2.271E+4
Mo-99	2.171E-1			2.171E-1
Np-237	4.000E-5	4.500E-4		4.900E-4
Ni-59	8.638E-1	4.526E+0	4.396E+1	4.937E+1
Ni-63	2.696E+2	1.463E+3	6.413E+3	8.145E+3
Ni-65	1.015E+0			1.015E+0
Nb-94	4.024E-2	4.590E-1	2.175E-1	7.167E-1
Nb-95	2.987E+1	8.694E+2	1.670E+1	9.160E+2
Nb-97		6.510E-1		6.510E-1
P-32	3.337E+0	7.400E-4		3.338E+0
Pu-238	6.583E-2	6.991E-2	1.347E-1	2.704E-1
Pu-239	4.355E-2	6.572E-2	1.040E-1	2.133E-1
Pu-240	7.380E-3	9.930E-3	4.061E-2	5.792E-2
Pu-241	1.518E+1	5.861E+0	1.428E+1	3.532E+1
Pu-242	1.165E-2	1.000E-5	1.547E-2	2.713E-2
Po-210	7.820E-3	5.[illegible]0E-4		8.320E-3
Po-218	6.000E-3			6.000E-3
K-40	2.870E-3			2.870E-3
Pr-147	5.825E+1	1.485E+2	3.174E+2	5.242E+2
Pa-233	1.800E-4			1.800E-4
Pa-234	1.350E-3			1.350E-3
Ra-226	1.921E-1	4.737E-2		2.394E-1
Rb-86	4.440E-3			4.440E-3
Ru-103	2.880E-1	7.434E+1		7.463E+1
Ru-105	9.464E-2	4.600E-1		5.546E-1
Ru-106	5.384E+0	4.453E+1	1.477E+1	6.468E+1
Sc-46	1.520E-2			1.520E-2
Se-75	5.800E-4			5.800E-4
Ag-108m	1.800E-4			1.800E-4
Ag-110	1.287E-2		9.740E-2	1.103E-1
Ag-110m	1.673E+1	2.620E+1	3.657E+3	3.700E+3
Na-22	2.397E-2	3.000E-5		2.400E-2
Na-24	3.000E-5			3.000E-5
Sr-85	9.610E-3			9.610E-3
Sr-89	4.502E+0	2.981E+2	3.149E+0	3.058E+2

Table 5 (Continued)

Radionuclide	Class A	Class B	Class C	Total
Sr-90	8.755E+0	5.717E+2	2.309E+3	2.890E+3
Sr-92		1.835E-1	2.870E-1	4.705E-1
S-35	1.856E+0			1.856E+0
Ta-182	4.500E-4			4.500E-4
Tc-99	2.329E+0	1.157E+0	5.684E+0	9.170E+0
Tc-99m	8.958E-2		1.586E-1	2.482E-1
Te-125m	5.864E-2	1.611E+0	5.997E+0	7.667E+0
Te-132	7.300E-4			7.300E-4
Tl-201	6.800E-4			6.800E-4
Th-232	4.237E+2			4.237E+2
Sn-113	7.644E-1	2.689E+1	4.011E-1	2.805E+1
TRU-NOS	4.330E-1	8.481E-2	5.312E-1	1.049E+0
U-234	2.073E+0	6.600E-4	1.800E-4	2.074E+0
U-235	3.342E-1	1.000E-5		3.342E-1
U-236	1.936E-2			1.936E-2
U-238	3.207E+2	3.000E-5	1.100E-4	3.207E+2
Xe-131	5.812E-2	7.186E-1		7.767E-1
Xe-131m	2.875E+0	5.807E+0	3.333E-2	8.715E+0
Xe-133	9.312E-1	9.961E-1		1.927E+0
Xe-133m	1.580E-3	1.424E+0		1.426E+0
Xe-135	7.980E-3			7.980E-3
Y-90			3.044E-2	3.044E-2
Y-91		4.619E+2		4.619E+2
Zn-65	3.681E+3	1.152E+3	1.996E+2	5.033E+3
Zr-95	1.959E+1	4.688E+2	1.139E+1	4.998E+2
Total	2.124E+4	3.361E+4	1.640E+5	2.189E+5

Table 6. Radionuclides Contained in Significant Quantities[a] in LLW, 1988

Nuclide	H-L (yrs)	Activity (Ci)			
		Class A	Class B	Class C	Total
Ag-110m	6.91E-1	3.796E+1	7.512E+1	3.694E+3	3.807E+3
C-14	5.73E+3	1.338E+2	2.344E+1	3.167E+1	1.889E+2
Ce-141	8.92E-2	1.912E+0	1.116E+2	6.746E-2	1.135E+2
Ce-144	7.80E-1	3.374E+1	7.297E+2	1.814E+1	7.814E+2
Co-58	1.94E-1	1.630E+3	2.921E+3	4.705E+3	9.255E+3
Co-60	5.27E+0	5.298E+3	5.408E+3	4.225E+4	5.296E+4
Cr-51	7.59E-2	1.645E+3	6.172E+2	1.284E+2	2.391E+3
Cs-134	2.06E+0	2.195E+2	1.759E+3	2.635E+3	4.613E+3
Cs-137	3.02E+1	6.036E+2	3.586E+3	8.820E+3	1.301E+4
Fe-55	2.69E+0	7.870E+3	4.259E+3	7.676E+4	8.888E+4
Fe-59	1.22E-1	2.111E+2	5.295E+1	1.144E+1	2.754E+2
H-3	1.24E+1	2.623E+3	3.312E+4	5.071E+2	3.625E+4
I-131	2.20E-2	3.575E+1	5.474E+1	1.599E+1	1.065E+2
Mn-54	8.55E-1	2.085E+3	1.044E+3	1.992E+4	2.305E+4
Nb-95	9.59E-2	4.955E+1	8.748E+2	2.211E+1	9.465E+2
Ni-63	1.00E+2	3.062E+2	1.533E+3	6.578E+3	8.417E+3
P-32	3.91E-2	1.002E+2	7.400E-4		1.002E+2
Pm-147	2.62E+0	7.174E+0	1.561E-1	1.533E+2	1.606E+2
Pr-147	2.59E-5	5.825E+1	1.485E+2	3.174E+2	5.242E+2
S-35	2.39E-1	1.081E+2			1.081E+1
Sb-124	1.65E-1	2.663E+1	8.702E+1	3.541E+1	1.491E+2
Sb-125	2.70E+0	3.180E+1	2.875E+2	7.697E+2	1.090E+3
Sr-89	1.39E-1	4.623E+0	2.987E+2	5.530E+0	3.089E+2
Sr-90	2.88E+1	7.470E+1	8.740E+2	3.036E+3	3.986E+3
Th-232	1.41E+10	4.242E+2	1.078E-3		4.242E+2
U-238	4.47E+9	3.482E+2	4.400E-5	2.699E-3	3.483E+2
U-DEP	-	1.404E+2			1.404E+2
Y-91	1.60E-1		4.619E+2		4.619E+2
Zn-65	6.69E-1	4.104E+3	1.281E+3	1.996E+2	5.585E+3
Zr-95	1.75E-1	3.139E+1	4.715E+2	1.418E+1	5.170E+2
Total		2.824E+4	6.008E+4	1.706E+5	2.590E+5
All LLW nuclides		2.837E+4	6.007E+4	1.712E+5	2.597E+5

a. Radionuclides in quantities equal to or exceeding 100 Ci.

Table 7. Distribution by Class of Radionuclides Having Half-Lives Exceeding 100 Years (Ci)

Nuclide	H-L (yr)	Class A	Class B	Class C	Total
Ag-108m	1.27E+2	1.030E-2			1.030E-2
Am-241	4.33E+2	6.604E-1	8.958E-2	1.709E-1	9.209E-1
C-14	5.73E+3	1.338E+2	2.344E+1	3.167E+1	1.889E+2
Cl-36	3.00E+5	3.516E-1	5.000E-5		3.516E-1
I-129	1.60E+7	1.042E+0	6.209E-2	8.702E-2	1.191E+0
K-40	1.28E+9	2.999E-3			2.999E-3
Mo-93	3.50E+3	1.000E-6			1.000E-6
Nb-94	2.03E+4	4.494E-2	4.590E-1	2.175E-1	7.214E-1
Ni-59	7.50E+4	9.408E-1	4.743E+0	4.399E+1	4.968E+1
Ni-63	1.00E+2	3.062E+2	1.533E+3	6.578E+3	8.417E+3
Np-237	2.14E+6	4.000E-5	4.500E-4		4.900E-4
Pu-239	2.41E+4	1.179E-1	7.023E-2	1.831E-1	3.713E-1
Pu-240	6.57E+3	3.819E-2	1.091E-3	6.272E-2	1.118E-1
Pu-242	3.76E+5	1.263E-2	1.910E-3	1.548E-2	3.002E-2
Ra-226	1.60E+3	1.126E+1	1.146E-1	1.570E+0	1.294E+1
Re-187	4.30E+10	1.000E-6			1.000E-6
Tb-157	1.50E+2	1.000E-5			1.000E-5
Tb-158	1.50E+2	1.000E-5			1.000E-5
Tc-99	2.14E+5	3.085E+0	1.181E+0	6.109E+0	1.038E+1
Te-123	5.00E+13	2.027E-2			2.027E-2
Th-229	7.34E+3	1.000E-5			1.000E-5
Th-230	8.00E+4	1.191E-3			1.191E-3
Th-232	1.41E+10	4.242E+2	1.078E-3		4.242E+2
Th-NAT[a]	1.41E+10	2.150E+1			2.150E+1
TRU-NOS[a]	-	4.330E-1	8.481E-2	5.312E-1	1.049E+0
U-233	1.59E+5	4.000E-6			4.000E-6
U-234	2.45E+5	2.091E+0	6.820E-4	8.940E-4	2.093E+0
U-235	7.04E+8	3.988E-1	2.000E-5	5.605E-3	4.044E-1
U-236	2.34E+7	1.939E-2			1.939E-2
U-238	4.47E+9	3.482E+2	4.400E-5	2.699E-3	3.483E+2
U-DEP[a]	-	1.404E+2			1.404E+2
U-NAT[a]	-	3.345E+0	1.606E-3		3.347E+0
Total		1.398E+3 (14.5%)	1.564E+3 (16.3%)	6.663E+3 (69.2%)	9.624E+3
Total Without Ni-63		1.092E+3 (90.5%)	3.026E+1 (2.5%)	8.462E+1 (7.0%)	1.207E+3

a. Th-NAT: natural thorium; TRU-NOS: unspecified transuranic isotopes; U-DEP: depleted uranium; U-NAT: natural uranium.

Table 8 Distribution by Class of Part 61 Radionuclides (Ci), 1988

Nuclide	Class A Activity	Class A (Percent)	Class B Activity	Class B (Percent)	Class C Activity	Class C (Percent)	Total Activity
Table 1 (a)							
C-14	1.338E+2	70.8	2.344E+1	12.4	3.167E+1	16.8	1.889E+2
Ni-59	9.408E-1	1.9	4.743E+0	9.5	4.399E+1	88.6	4.968E+1
Nb-94	4.494E-2	6.2	4.590E-1	63.6	2.175E-1	30.1	7.214E-1
Tc-99	3.085E+0	29.7	1.181E+0	11.4	6.109E+0	58.9	1.038E+1
I-129	1.042E+0	87.5	6.210E-2	5.2	8.702E-2	7.3	1.191E+0
TRU (b)	1.339E+0	45.9	3.881E-1	13.3	1.192E+0	40.8	2.920E+0
Pu-241	1.697E+1	42.7	6.072E+0	15.3	1.672E+1	42.1	3.976E+1
Cm-242	2.768E-1	22.7	1.460E-1	12.0	7.957E-1	65.3	1.218E+0
Table 2 (a)							
H-3	2.623E+3	7.2	3.312E+4	91.4	5.071E+2	1.5	3.625E+4
Co-60	5.298E+3	10.0	5.408E+3	10.2	4.225E+4	79.8	5.296E+4
Ni-63	3.062E+2	3.6	1.533E+3	18.2	6.578E+3	78.2	8.417E+3
Sr-90	7.470E+1	1.9	8.740E+2	21.9	3.036E+2	76.2	3.986E+3
Cs-137	6.036E+2	4.6	3.586E+3	27.6	8.820E+3	67.8	1.301E+4

a. Radionuclides listed Tables 1 and 2 of 10 CFR Section 61.55.
b. Sum of alpha-emitting transuranic radionuclides having half-lives exceeding five years.