Green, LindaE

From: Pruitt, Scott
Sent: Monday, March 06, 2017 8:51 AM
To: FOIA HQ; Gottesman, Larry
Subject: FW: Freedom of Information Act (FOIA) Request for Final DRL Values to be used in the 2017 PAG Manual (EP¬A-400/R-17/001)
Attachments: 233-DRLs.pdf; Po&Ra-DRLs.pdf; SOF-A_D.pdf

Forwarded by Brian Hope

From: Carmine Vasile [mailto:gfx-ch@msn.com]
Sent: Sunday, March 05, 2017 12:28 PM
To: Pruitt, Scott <Pruitt.Scott@epa.gov>
Cc: Hernandez-Quinones, Samuel <Hernandez.Samuel@epa.gov>; Laura Dumais <ldumais@peer.org>; dianed@nirs.org; info@peer.org; crborello@aol.com; joshua.tallent@ag.ny.gov
Subject: Freedom of Information Act (FOIA) Request for Final DRL Values to be used in the 2017 PAG Manual (EP¬A-400/R-17/001)

EPA Administrator Scott Pruitt & Samuel Hernandez (hernandez.samuel@epa.gov)
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue NW.
Washington, DC 20460
(202) 564-1735

Dear Administrator Pruitt: The "233-DRLs" & "Po&Ra-DRLs" attachments contain emails with inconsistent draft-DRLs corresponding to 233 manmade and naturally occurring radionuclides. They were obtained pursuant to the FOIA discussed at peer.org and have not been updated since the final version of the 2017 PAG Manual (EPA-400/R-17/001) was released pursuant to a notice filed in the Federal Register. See https://www.epa.gov/sites/production/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf & https://www.gpo.gov/fdsys/pkg/FR-2017-01-19/pdf/2017-01230.pdf.

Pursuant to the Freedom of Information Act (FOIA), please provide a complete set of DRLs corresponding to PAG values of **100 & 500 mrem/yr**, including DRLs for:

1. Radium-226, Radon-222 and their decay products including **Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210 & Po-210** in order to facilitate Sum of the Fractions calculations like those on page 65 of the 2017 PAG Manual -- Exhibit A in the "SOF-A_D" attachment;
2. Thorium 232, Radium-228 and their decay products including **Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Po-212, Tl-208** in order to facilitate Sum of the Fractions calculations like those on page 65 of the 2017 PAG Manual.
3. Non-Emergency DRLs for these radionuclides for use by water companies before and after FEMA declares and emergency in order to facilitate Sum of the Fractions calculations like those on page 65 of the 2017 PAG Manual and existing EPA Guidance manuals like those in Exhibits C & D of the "SOF-A_D" attachment.

Yours truly,
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Explanation of Spreadsheet and Chart Comparing 500 mrem/yr DRL Concentrations to MCL

There is an Excel Spreadsheet and Stacked Column Chart provided.

1. In general they are sorted by Radionuclide, in the order provided in the OW table for the 4 mrem/yr MCL concentrations with concentrations added for some of the gross alpha 15 pCi/l MCL, the 5 pCi/l Radium 226 and 228 MCL, and the some of the uranium isotopes converted to the 30 microgram per liter total uranium MCL
2. If no PAG DRL was provided in 2007 and 2015/2016 draft PAGs, the radionuclide is not included in the Chart (zero values will not work in a logarithmic Excel chart)
3. Y-90 was deleted from the Chart since it was the only DRL to decrease from 2007 to 2015/2016 (negative values will not work in a logarithmic Excel chart)
4. Since 3 of the 5 radionuclides listed in both the 2007 and 2015/2016 PAGs had a 22% increase in DRL concentrations (of the other two, one had a decrease and the other a 12% increase), an increase of 22% was assumed for the other 2007 radionuclides in the Chart to represent 2015/2016 concentrations (it is likely this is the result of reducing the water ingestion rates from 2 liters to 1.643 liters per day)

Rationale for Comparison to MCL:

The CERCLA policy most analogous to the drinking water PAG would be the "Regional Removal Management Levels (RMLs)" User Guide which discusses when short-term risks from chemically contaminated drinking water wells are high enough to warrant providing alternative (replacement) drinking water supplies. Although exceeding an MCL does not trigger a removal action, once the Agency has determined the need for a removal action under CERCLA, typically MCLs should be attained to the extent practicable during the removal action considering the exigencies of the situation.

Following are explanations of the information in the spreadsheet and chart.

DRLs info Source:

- 2007 PAG DRLs are provided in Table 4.1 of August 2007 internal review draft of Protective Action Guidance for Radiological Incidents. The DRLs without radioactive decay listed in 2007 that were most similar to those provided during the 2015 review and in the 2016 version of the PAGs

- 2015 PAG DRLs provided in spreadsheet attached to June 29, 2015 email from Samuel Hernandez-Quinones to Michael Scozzafava and Sara DeCair.

MCLs info Source:

- MCLs from OW webpage for 4 mrem/yr MCL, and OSWER directive "Use of Uranium Drinking Water Standards under 40 CFR 141 and 40 CFR 192 as Remediation Goals for Groundwater at CERCLA sites" which includes a list of radionuclides covered by 15 pCi/l gross alpha MCL (list provided by OW).

- Uranium MCLs are in terms of mass (micrograms per liter), not activity (picoCuries per liter). The 30 micrograms per liter MCL for the uranium element was converted to an activity for each isotope

Comparison of DRL to MCL

- Shows by a factor of #, how much DRL is greater than MCL concentration. The values in the bullets below are represented on the stacked column chart by horizontal lines

- What this means
  - if value is 70, then **1 year** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
  - if value is 840, then **1 month** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
  - if value is 3,650 then **1 week** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
  - if value is 25,550, then **1 day** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
    - For example, drinking less than one day at the daily rate of 2 liters of Ca-45 at the DRL concentration would result in an exposure that corresponds to drinking liters of water per day for 70 years at the MCL level.

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Radionuclide	MCL	500 mrem/yr 2007 PAG decay	500 mrem/yr 2007 PAG no decay	500 mrem/yr 2015 PAG	Multiple of MCL 2007 PAG decay	Multiple of MCL 2007 PAG no decay	Multiple of MCL 2015 PAG	Multiple of 2007 PAG no decay by 2015 PAG	Guessestimate for 2016 PAG (2015 or 22% increase to 2007 no decay)	Radionuclide	2007 PAG	Difference Between & 2007 PAG 2016 PAG	2016 PAG	
H-3	20,000	4,540,000	4,420,000		227	221	-		270	H-3	221	49	270	49
Be-7	6,000				-	-	-		-	Be-7	-	-	-	-
C-14	2,000	319,000	319,000		160	160	-		195	C-14	160	35	195	35
F-18	2,000				-	-	-		-	F-18	-	-	-	-
Na-22	400	66,100	58,000		165	145	-		177	Na-22	145	32	177	32
Na-24	600				-	-	-		-	Na-24	-	-	-	-
Si-31	3,000				-	-	-		-	Si-31	-	-	-	-
P-32	30	1,370,000	77,100		45,667	2,570	-		3,135	P-32	2,570	565	3,135	565
S-35 inorg	500	731,000	239,000		1,462	478	-		583	S-35 inorg	478	105	583	105
Cl-36	700	199,000	199,000		284	284	-		347	Cl-36	284	63	347	63
Cl-38	1,000				-	-	-		-	Cl-38	-	-	-	-
K-42	900				-	-	-		-	K-42	-	-	-	-
Ca-45	10	513,000	260,000		51,300	26,000	-		31,720	Ca-45	26,000	5,720	31,720	5,720
Ca-47	80				-	-	-		-	Ca-47	-	-	-	-
Sc-46	100	397,000	125,000		3,970	1,250	-		1,525	Sc-46	1,250	275	1,525	275
Sc-47	300				-	-	-		-	Sc-47	-	-	-	-
Sc-48	80				-	-	-		-	Sc-48	-	-	-	-
V-48	90	1,460,000	93,400		16,222	1,038	-		1,266	V-48	1,038	228	1,266	228
Cr-51	6,000	43,700,000	4,790,000		7,283	798	-		974	Cr-51	798	176	974	176
Mn-52	90				-	-	-		-	Mn-52	-	-	-	-
Mn-54	300	374,000	257,000		1,247	857	-		1,045	Mn-54	857	188	1,045	188
Mn-56	300				-	-	-		-	Mn-56	-	-	-	-
Fe-55	2,000	631,000	557,000		316	279	-		340	Fe-55	279	61	340	61
Fe-59	200	591,000	103,000		2,955	515	-		628	Fe-59	515	113	628	113
Co-57	1,000				-	-	-		-	Co-57	-	-	-	-
Co-58	300	909,000	247,000		3,030	823	-		1,004	Co-58	823	181	1,004	181
Co-58m	9,000				-	-	-		-	Co-58m	-	-	-	-
Co-60	100	57,600	53,900		576	539	-		658	Co-60	539	119	658	119
Ni-59	300				-	-	-		-	Ni-59	-	-	-	-
Ni-63	50	1,220,000	1,220,000		24,400	24,400	-		29,768	Ni-63	24,400	5,368	29,768	5,368
Ni-65	300				-	-	-		-	Ni-65	-	-	-	-
Cu-64	900				-	-	-		-	Cu-64	-	-	-	-
Zn-65	300	75,400	46,900		251	156	-		191	Zn-65	156	34	191	34
Zn-69	6,000				-	-	-		-	Zn-69	-	-	-	-
Zn-69m	200				-	-	-		-	Zn-69m	-	-	-	-
Ga-72	100				-	-	-		-	Ga-72	-	-	-	-
Ge-71	6,000				-	-	-		-	Ge-71	-	-	-	-
As-73	1,000				-	-	-		-	As-73	-	-	-	-
As-74	100				-	-	-		-	As-74	-	-	-	-
As-76	60				-	-	-		-	As-76	-	-	-	-
As-77	200				-	-	-		-	As-77	-	-	-	-
Se-75	900	170,000	70,900		189	79	-		96	Se-75	79	17	96	17
Br-82	100				-	-	-		-	Br-82	-	-	-	-
Rb-86	600	892,000	65,900		1,487	110	-		134	Rb-86	110	24	134	24
Rb-87	300				-	-	-		-	Rb-87	-	-	-	-
Sr-85 m	20,000				-	-	-		-	Sr-85 m	-	-	-	-
Sr-85	900				-	-	-		-	Sr-85	-	-	-	-
Sr-89	20	363,000	72,000		18,150	3,600	-		4,392	Sr-89	3,600	792	4,392	792

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Sr-90	8	6,730	6,650	7,415	841	831	927	1.12	927	Sr-90	831	96	927	96
Sr-91	200			346,676	-	-	1,733		1,733	Sr-91	-	1,733	1,733	1,733
Sr-92	200			528,966	-	-	2,645		2,645	Sr-92	-	2,645	2,645	2,645
Y-90	60	6,530,000	68,800	7,415	108,833	1,147	124		124	Y-90	1,147	(1,023)	124	(1,023)
Y-91	90	34,100	78,100	95,080	379	868	1,056	1.22	1,056	Y-91	868	188	1,056	188
Y-91m	9,000				-	-	-		-	Y-91m	-	-	-	-
Y-92	200			455,231	-	-	2,276		2,276	Y-92	-	2,276	2,276	2,276
Y-93	90			195,947	-	-	2,177		2,177	Y-93	-	2,177	2,177	2,177
Zr-93	2,000	167,000	167,000		84	84	-		102	Zr-93	84	18	102	18
Zr-95	200	773,000	192,000	234,484	3,865	960	1,172	1.22	1,172	Zr-95	960	212	1,172	212
Zr-97	60			108,860	-	-	1,814		1,814	Zr-97	-	1,814	1,814	1,814
Nb-93m	1,000				-	-	-		-	Nb-93m	-	-	-	-
Nb-95	300	2,260,000	314,000		7,533	1,047	-		1,277	Nb-95	1,047	230	1,277	230
Nb-97	3,000				-	-	-		-	Nb-97	-	-	-	-
Mo-99	600	28,100,000	306,000		46,833	510	-		622	Mo-99	510	112	622	112
Tc-96	300				-	-	-		-	Tc-96	-	-	-	-
Tc-96m	30,000				-	-	-		-	Tc-96m	-	-	-	-
Tc-97	6,000				-	-	-		-	Tc-97	-	-	-	-
Tc-97m	1,000				-	-	-		-	Tc-97m	-	-	-	-
Tc-99	900	288,000	288,000		320	320	-		390	Tc-99	320	70	390	70
Tc-99m	20,000				-	-	-		-	Tc-99m	-	-	-	-
Ru-97	1,000				-	-	-		-	Ru-97	-	-	-	-
Ru-103	200	1,620,000	252,000		8,100	1,260	-		1,537	Ru-103	1,260	277	1,537	277
Ru-105	200				-	-	-		-	Ru-105	-	-	-	-
Ru-106	30	36,500	26,400		1,217	880	-		1,074	Ru-106	880	194	1,074	194
Rh-103m	30,000				-	-	-		-	Rh-103m	-	-	-	-
Rh-105	300				-	-	-		-	Rh-105	-	-	-	-
Pd-103	900				-	-	-		-	Pd-103	-	-	-	-
Pd-109	300				-	-	-		-	Pd-109	-	-	-	-
Ag-105	300				-	-	-		-	Ag-105	-	-	-	-
Ag-110m	90	106,000	66,500		1,178	739	-		901	Ag-110m	739	163	901	163
Ag-111	100				-	-	-		-	Ag-111	-	-	-	-
Cd-109	600	120,000	92,600		200	154	-		188	Cd-109	154	34	188	34
Cd-115	90				-	-	-		-	Cd-115	-	-	-	-
Cd-115m	90				-	-	-		-	Cd-115m	-	-	-	-
In-113m	3,000				-	-	-		-	In-113m	-	-	-	-
In-114m	60	233,000	45,400		3,883	757	-		923	In-114m	757	166	923	166
In-115	300				-	-	-		-	In-115	-	-	-	-
In-115m	1,000				-	-	-		-	In-115m	-	-	-	-
Sn-113	300	620,000	251,000		2,067	837	-		1,021	Sn-113	837	184	1,021	184
Sn-125	60	1,580,000	60,100		26,333	1,002	-		1,222	Sn-125	1,002	220	1,222	220
Sb-122	90				-	-	-		-	Sb-122	-	-	-	-
Sb-124	60	311,000	72,900		5,183	1,215	-		1,482	Sb-124	1,215	267	1,482	267
Sb-125	300				-	-	-		-	Sb-125	-	-	-	-
Te-125m	600				-	-	-		-	Te-125m	-	-	-	-
Te-127	900	712,000,000	1,100,000		791,111	1,222	-		1,491	Te-127	1,222	269	1,491	269
Te-127m	200				-	-	-		-	Te-127m	-	-	-	-
Te-129	2,000	15,300,000,000	2,940,000		7,650,000	1,470	-		1,793	Te-129	1,470	323	1,793	323
Te-129m	90	468,000			5,200	-	-		-	Te-129m	-	-	-	-
Te-131m	200	19,200,000	94,900	115,559	96,000	475	578	1.22	578	Te-131m	475	104	578	104
Te-132	90	3,780,000	48,600	59,144	42,000	540	657	1.22	657	Te-132	540	117	657	117
I-126	3				-	-	-		-	I-126	-	-	-	-
I-129	1	1,750			1,750	-	-		-	I-129	-	-	-	-

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I-131	3	267,000	8,480	10,337	89,000	2,827	3,446	1.22	3,446	I-131	2,827	619	3,446	619
I-132	90				-	-	-		-	I-132	-	-	-	-
I-133	10				-	-	-		-	I-133	-	-	-	-
I-134	100				-	-	-		-	I-134	-	-	-	-
I-135	30				-	-	-		-	I-135	-	-	-	-
Cs-131	20,000				-	-	-		-	Cs-131	-	-	-	-
Cs-134	80	11,300			141	-	-		-	Cs-134	-	-	-	-
Cs-134m	20,000				-	-	-		-	Cs-134m	-	-	-	-
Cs-135	900				-	-	-		-	Cs-135	-	-	-	-
Cs-136	800	1,160,000			1,450	-	-		-	Cs-136	-	-	-	-
Cs-137	200	13,800	13,600	16,569	69	68	83	1.22	83	Cs-137	68	15	83	15
Ba-131	600				-	-	-		-	Ba-131	-	-	-	-
Ba-140	90	1,410,000	71,200		15,667	791	-		965	Ba-140	791	174	965	174
La-140	60	13,800,000	91,600		230,000	1,527	-		1,863	La-140	1,527	336	1,863	336
Ce-141	300	2,030,000	260,000		6,767	867	-		1,057	Ce-141	867	191	1,057	191
Ce-143	100	30,400,000	165,000		304,000	1,650	-		2,013	Ce-143	1,650	363	2,013	363
Ce-144	30	53,300	35,300		1,777	1,177	-		1,436	Ce-144	1,177	259	1,436	259
Pr-142	90				-	-	-		-	Pr-142	-	-	-	-
Pr-143	100				-	-	-		-	Pr-143	-	-	-	-
Nd-144	15				-	-	-		-	Nd-144	-	-	-	-
Nd-147	200	3,940,000	171,000		19,700	855	-		1,043	Nd-147	855	188	1,043	188
Nd-149	900				-	-	-		-	Nd-149	-	-	-	-
Pm-147	600	807,000	709,000		1,345	1,182	-		1,442	Pm-147	1,182	260	1,442	260
Pm-149	100	21,300,000	186,000		213,000	1,860	-		2,269	Pm-149	1,860	409	2,269	409
Sm-147	15				-	-	-		-	Sm-147	-	-	-	-
Sm-148	15				-	-	-		-	Sm-148	-	-	-	-
Sm-151	1,000	1,890,000	1,890,000		1,890	1,890	-		2,306	Sm-151	1,890	416	2,306	416
Sm-153	200				-	-	-		-	Sm-153	-	-	-	-
Eu-152	200	139,000	135,000		695	675	-		824	Eu-152	675	149	824	149
Eu-154	60	94,300	90,700		1,572	1,512	-		1,844	Eu-154	1,512	333	1,844	333
Eu-155	600	607,000	566,000		1,012	943	-		1,151	Eu-155	943	208	1,151	208
Gd-153	600	1,070,000	665,000		1,783	1,108	-		1,352	Gd-153	1,108	244	1,352	244
Gd-159	200				-	-	-		-	Gd-159	-	-	-	-
Tb-160	100	415,000	115,000		4,150	1,150	-		1,403	Tb-160	1,150	253	1,403	253
Dy-165	1,000				-	-	-		-	Dy-165	-	-	-	-
Dy-166	100				-	-	-		-	Dy-166	-	-	-	-
Ho-166	90	93,500	93,400		1,039	1,038	-		1,266	Ho-166	1,038	228	1,266	228
Er-169	300				-	-	-		-	Er-169	-	-	-	-
Er-171	300				-	-	-		-	Er-171	-	-	-	-
Tm-170	100	320,000	140,000		3,200	1,400	-		1,708	Tm-170	1,400	308	1,708	308
Tm-171	1,000				-	-	-		-	Tm-171	-	-	-	-
Yb-175	300				-	-	-		-	Yb-175	-	-	-	-
Lu-177	300				-	-	-		-	Lu-177	-	-	-	-
Hf-181	200	984,000	165,000		4,920	825	-		1,007	Hf-181	825	182	1,007	182
Ta-182	100				-	-	-		-	Ta-182	-	-	-	-
W-181	1,000				-	-	-		-	W-181	-	-	-	-
W-185	300				-	-	-		-	W-185	-	-	-	-
W-187	200	74,700,000	294,000		373,500	1,470	-		1,793	W-187	1,470	323	1,793	323
Re-186	300				-	-	-		-	Re-186	-	-	-	-
Re-187	9,000				-	-	-		-	Re-187	-	-	-	-
Re-188	200				-	-	-		-	Re-188	-	-	-	-
Os-185	200				-	-	-		-	Os-185	-	-	-	-
Os-191	600				-	-	-		-	Os-191	-	-	-	-

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Os-191m	9,000			-	-	-	-	Os-191m	-	-	-	-
Os-193	200			-	-	-	-	Os-193	-	-	-	-
Ir-190	600			-	-	-	-	Ir-190	-	-	-	-
Ir-192	100	477,000	135,000	4,770	1,350	-	1,647	Ir-192	1,350	297	1,647	297
Ir-194	90			-	-	-	-	Ir-194	-	-	-	-
Pt-191	300			-	-	-	-	Pt-191	-	-	-	-
Pt-193	3,000			-	-	-	-	Pt-193	-	-	-	-
Pt-193m	3,000			-	-	-	-	Pt-193m	-	-	-	-
Pt-197	300			-	-	-	-	Pt-197	-	-	-	-
Pt-197m	3,000			-	-	-	-	Pt-197m	-	-	-	-
Au-196	600			-	-	-	-	Au-196	-	-	-	-
Au-198	100	16,900,000	180,000	169,000	1,800	-	2,196	Au-198	1,800	396	2,196	396
Au-199	600			-	-	-	-	Au-199	-	-	-	-
Hg-197	900			-	-	-	-	Hg-197	-	-	-	-
Hg-197m	600			-	-	-	-	Hg-197m	-	-	-	-
Hg-203	60	529,000	96,900	8,817	1,615	-	1,970	Hg-203	1,615	355	1,970	355
Tl-200	1,000			-	-	-	-	Tl-200	-	-	-	-
Tl-201	900			-	-	-	-	Tl-201	-	-	-	-
Tl-202	300			-	-	-	-	Tl-202	-	-	-	-
Tl-204	300	170,000	156,000	567	520	-	634	Tl-204	520	114	634	114
Pb-203	1,000			-	-	-	-	Pb-203	-	-	-	-
Bi-206	100			-	-	-	-	Bi-206	-	-	-	-
Bi-207	200	147,000	146,000	735	730	-	891	Bi-207	730	161	891	161
Bi-210	15	7,110,000	141,000	474,000	9,400	-	11,468	Bi-210	9,400	2,068	11,468	2,068
Bi-211	15			-	-	-	-	Bi-211	-	-	-	-
Bi-212	15			-	-	-	-	Bi-212	-	-	-	-
Bi-213	15			-	-	-	-	Bi-213	-	-	-	-
Bi-214	15			-	-	-	-	Bi-214	-	-	-	-
Po-210	15	270	265	18	18		22	Po-210	18	4	22	4
Po-212	15			-	-		-	Po-212	-	-	-	-
Po-213	15			-	-		-	Po-213	-	-	-	-
Po-214	15			-	-		-	Po-214	-	-	-	-
Po-215	15			-	-		-	Po-215	-	-	-	-
Po-216	15			-	-		-	Po-216	-	-	-	-
Po-218	15			-	-		-	Po-218	-	-	-	-
At-217	15			-	-		-	At-217	-	-	-	-
At-218	15			-	-		-	At-218	-	-	-	-
Ra-219	15			-	-		-	Ra-219	-	-	-	-
Ra-223	15			-	-		-	Ra-223	-	-	-	-
Ra-224	15			-	-		-	Ra-224	-	-	-	-
Ra-226	5	659	659	132	132	-	161	Ra-226	132	29	161	29
Ra-228	5			-	-	-	-	Ra-228	-	-	-	-
Fr-221	15			-	-		-	Fr-221	-	-	-	-
Fr-223	15			-	-		-	Fr-223	-	-	-	-
Ac-225	15			-	-		-	Ac-225	-	-	-	-
Ac-227	15	585	576	39	38		47	Ac-227	38	8	47	8
Th-227	15	277,000	20,500	18,467	1,367		1,667	Th-227	1,367	301	1,667	301
Th-228	15			-	-		-	Th-228	-	-	-	-
Th-229	15			-	-		-	Th-229	-	-	-	-
Th-230	15			-	-		-	Th-230	-	-	-	-
Th-232	15			-	-		-	Th-232	-	-	-	-
Pa-230	600			-	-	-	-	Pa-230	-	-	-	-
Pa-231	15			-	-		-	Pa-231	-	-	-	-

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Pa-233	300			-	-	-	-	Pa-233	-	-	-	-
U-234	187,000			-	-	-	-	U-234	-	-	-	-
U-235	65	3,960	3,960	61	61	-	74	U-235	61	13	74	13
U-238	10	4,150	4,150	415	415		506	U-238	415	91	506	91
Np-239	300	24,900,000	232,000	83,000	773	-	943	Np-239	773	170	943	170
Pu-236	15	2,400	2,130	160	142		173	Pu-236	142	31	173	31
Pu-238	15	815	812	54	54		66	Pu-238	54	12	66	12
Pu-239	15	737	737	49	49		60	Pu-239	49	11	60	11
Pu-240	15	737	737	49	49		60	Pu-240	49	11	60	11
Pu-241	300	39,900	38,900	133	130	-	158	Pu-241	130	29	158	29
Pu-242	15	772	772	51	51		63	Pu-242	51	11	63	11
Am-241	15	908	907	61	60		74	Am-241	60	13	74	13
Cm-242	15	31,200	15,800	2,080	1,053		1,285	Cm-242	1,053	232	1,285	232
Cm-244	15	1,530	1,510	102	101		123	Cm-244	101	22	123	22
Cm-245	15	890	890	59	59		72	Cm-245	59	13	72	13
Cm-248	15			-	-		-	Cm-248	-	-	-	-
Bk-248	15			-	-		-	Bk-248	-	-	-	-
Bk-249	2,000			-	-	-	-	Bk-249	-	-	-	-
Cf-250	15			-	-		-	Cf-250	-	-	-	-

Radionuclide	2007 PAG	Difference Between & 2007 PAG 2016 PAG	1 year> MCL	1 month> MCL	1 week> M	1 day> MC
H-3	221	49	70	840	3,650	25,550
C-14	160	35	70	840	3,650	25,550
Na-22	145	32	70	840	3,650	25,550
P-32	2,570	565	70	840	3,650	25,550
S-35 inorg	478	105	70	840	3,650	25,550
Cl-36	284	63	70	840	3,650	25,550
Ca-45	26,000	5,720	70	840	3,650	25,550
Sc-46	1,250	275	70	840	3,650	25,550
V-48	1,038	228	70	840	3,650	25,550
Cr-51	798	176	70	840	3,650	25,550
Mn-54	857	188	70	840	3,650	25,550
Fe-55	279	61	70	840	3,650	25,550

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Fe-59	515	113	70	840	3,650	25,550
Co-58	823	181	70	840	3,650	25,550
Co-60	539	119	70	840	3,650	25,550
Ni-63	24,400	5,368	70	840	3,650	25,550
Zn-65	156	34	70	840	3,650	25,550
Se-75	79	17	70	840	3,650	25,550
Rb-86	110	24	70	840	3,650	25,550
Sr-89	3,600	792	70	840	3,650	25,550
Sr-90	831	96	70	840	3,650	25,550
Sr-91	1	1,732	70	840	3,650	25,550
Sr-92	1	2,644	70	840	3,650	25,550
Y-91	868	188	70	840	3,650	25,550
Y-92	1	2,275	70	840	3,650	25,550
Y-93	1	2,176	70	840	3,650	25,550
Zr-93	84	18	70	840	3,650	25,550
Zr-95	960	212	70	840	3,650	25,550
Zr-97	1	1,813	70	840	3,650	25,550
Nb-95	1,047	230	70	840	3,650	25,550
Mo-99	510	112	70	840	3,650	25,550
Tc-99	320	70	70	840	3,650	25,550
Ru-103	1,260	277	70	840	3,650	25,550
Ru-106	880	194	70	840	3,650	25,550
Ag-110m	739	163	70	840	3,650	25,550
Cd-109	154	34	70	840	3,650	25,550
In-114m	757	166	70	840	3,650	25,550
Sn-113	837	184	70	840	3,650	25,550
Sn-125	1,002	220	70	840	3,650	25,550
Sb-124	1,215	267	70	840	3,650	25,550
Te-127	1,222	269	70	840	3,650	25,550
Te-129	1,470	323	70	840	3,650	25,550
Te-131m	475	104	70	840	3,650	25,550
Te-132	540	117	70	840	3,650	25,550
I-131	2,827	619	70	840	3,650	25,550
Cs-137	68	15	70	840	3,650	25,550
Ba-140	791	174	70	840	3,650	25,550
La-140	1,527	336	70	840	3,650	25,550
Ce-141	867	191	70	840	3,650	25,550
Ce-143	1,650	363	70	840	3,650	25,550
Ce-144	1,177	259	70	840	3,650	25,550
Nd-147	855	188	70	840	3,650	25,550
Pm-147	1,182	260	70	840	3,650	25,550
Pm-149	1,860	409	70	840	3,650	25,550
Sm-151	1,890	416	70	840	3,650	25,550
Eu-152	675	149	70	840	3,650	25,550
Eu-154	1,512	333	70	840	3,650	25,550
Eu-155	943	208	70	840	3,650	25,550
Gd-153	1,108	244	70	840	3,650	25,550
Tb-160	1,150	253	70	840	3,650	25,550
Ho-166	1,038	228	70	840	3,650	25,550
Tm-170	1,400	308	70	840	3,650	25,550
Hf-181	825	182	70	840	3,650	25,550
W-187	1,470	323	70	840	3,650	25,550
Ir-192	1,350	297	70	840	3,650	25,550

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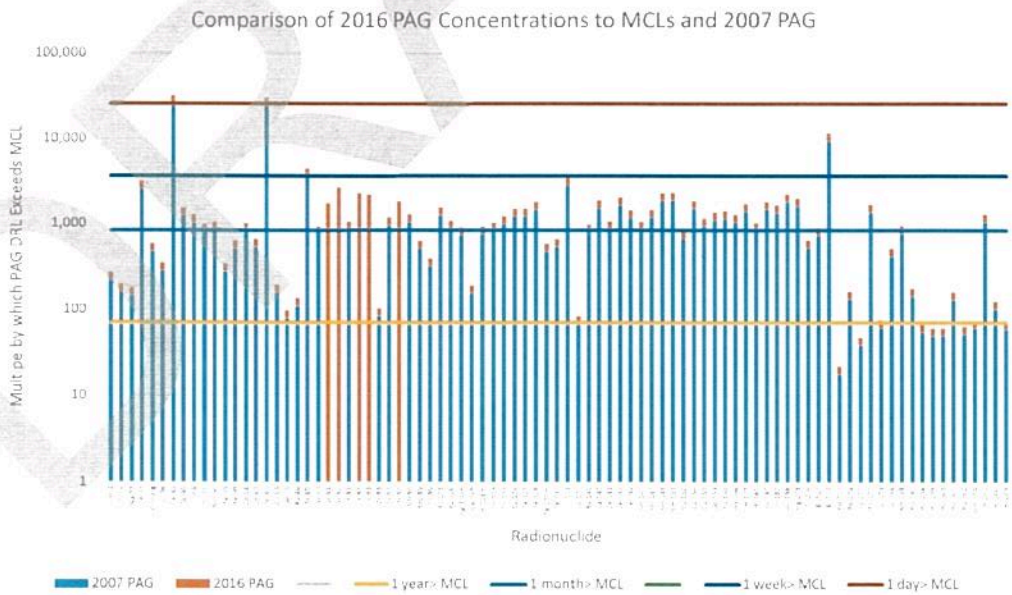
Au-198	1,800	396		70	840	3,650	25,550
Hg-203	1,615	355		70	840	3,650	25,550
Tl-204	520	114		70	840	3,650	25,550
Bi-207	730	161		70	840	3,650	25,550
Bi-210	9,400	2,068		70	840	3,650	25,550
Po-210	18	4		70	840	3,650	25,550
Ra-226	132	29		70	840	3,650	25,550
Ac-227	38	8		70	840	3,650	25,550
Th-227	1,367	301		70	840	3,650	25,550
U-235	61	13		70	840	3,650	25,550
U-238	415	91		70	840	3,650	25,550
Np-239	773	170		70	840	3,650	25,550
Pu-236	142	31		70	840	3,650	25,550
Pu-238	54	12		70	840	3,650	25,550
Pu-239	49	11		70	840	3,650	25,550
Pu-240	49	11		70	840	3,650	25,550
Pu-241	130	29		70	840	3,650	25,550
Pu-242	51	11		70	840	3,650	25,550
Am-241	60	13		70	840	3,650	25,550
Cm-242	1,053	232		70	840	3,650	25,550
Cm-244	101	22		70	840	3,650	25,550
Cm-245	59	13		70	840	3,650	25,550

		1 year> MCL	1 month> MCL		1 week> MCL	1 day> MCL
0	2	70	840	867	3,650	25,550
1	2	70	840	867	3,650	25,550



DRAFT

From:	DeCair, Sara
To:	Hernandez-Quinones, Samuel
Cc:	Ellis, Jerry
Subject:	A few more nuclides to consider, and briefing scheduling
Date:	Wednesday, January 08, 2014 3:57:25 PM
Attachments:	MCL DRL with Bar Graph.xls

Happy New Year Sam, Jerry,

I'm finally following up on our water discussion recently!

You asked if other nuclides would be of interest, and I'm attaching a highly sensitive, internal use only chart that Lowell created back when we were reacting to accusations that our pre-proposal water PAG would be really horrible. You'll see a couple nuclides that have a slightly higher risk for a DRL linked to 500 mrem. Use that however you like, but of course don't share the chart electronically if you can avoid it. Thanks for that!

We talked about potentially briefing our ODs on the thinking so far, so that the work doesn't get too far before we have a good feeling from leadership. Can I start that scheduling process with Ginny, Mike Flynn's scheduler, and use you as OW's points of contact in addition to your OD's scheduler? If you say that's good, then I'll confirm with Lee and Jon and get the ball rolling for briefing time about a month from now.

Thanks for letting me know what you think, and I'll review this draft report now,

Sara

Sara D. DeCair
http://www.epa.gov/radiation/rert/pags.html
202-343-9108

NOTE:

§ 141.66 Maximum contaminant levels for radionuclides @ https://www.law.cornell.edu/cfr/text/40/141.66 states:

(a) [Reserved]

(b) MCL for combined radium-226 and -228. The maximum contaminant level for combined radium-226 and radium-228 is 5 pCi/L. The combined radium-226 and radium-228 value is determined by the addition of the results of the analysis for radium-226 and the analysis for radium-228.

(c) MCL for gross alpha particle activity (excluding radon and uranium). The maximum contaminant level for gross alpha particle activity (including radium-226 but excluding radon and uranium) is 15 pCi/L.

(d) MCL for beta particle and photon radioactivity.

(1) The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water must not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year (mrem/year).

(2) Except for the radionuclides listed in table A, the concentration of man-made radionuclides causing **4 mrem total body or organ dose equivalents must be calculated on the basis of 2 liter per day drinking water** intake using the 168 hour data list in "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure," NBS (National Bureau of Standards) Handbook 69 as amended August 1963, U.S. Department of Commerce.

1976 RADIONUCLIDE MCLs AND CORRESPONDING DOSE AND RISK

Nuclide	Half-life	Decay mode	MCL (pCi/L)	DRL (pCi/L)	MCL Risk
Co-60	5.271 y	B-	100	53,900	8.04E-05
Sr-90/Y-90	29.12 y	B-	8	6,650	2.28E-05
Cs-137/Ba-137m	30 y	B-	200	13,600	3.11E-04
Ir-192	74.02 d	B-EC	100	135,000	3.76E-05
Po-210	138.38 d	A	15	153	1.36E-03
Ra-226	1600 y	A	5	659	9.83E-05
U-238	4.47E+09 y	SF A	20	4,150	6.54E-05
Am-241	432.2 y	A	15	907	7.97E-05

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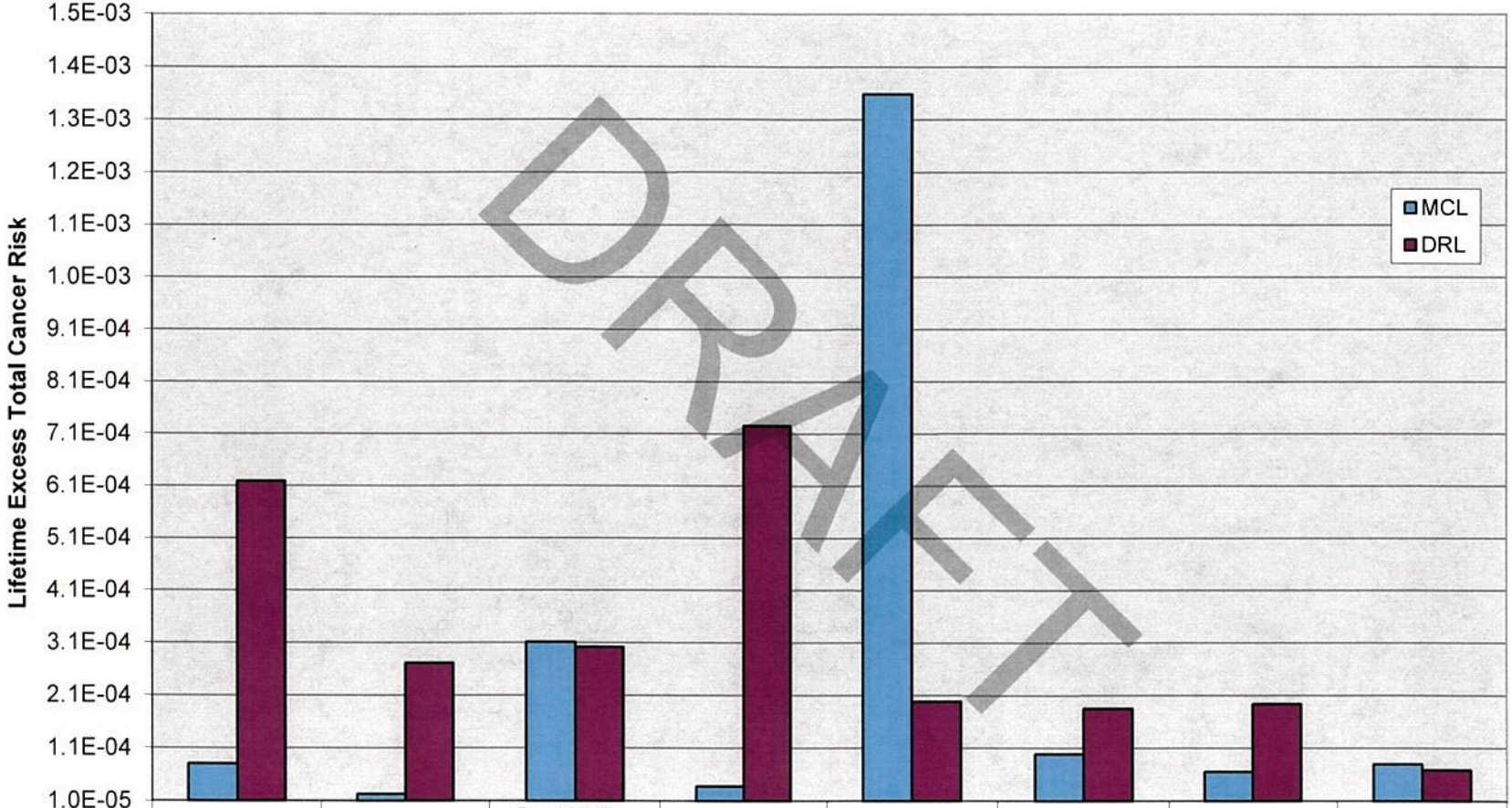
MCL vs. DRL: Cancer Risk for Selected Radionuclides



	Co-60	Sr-90/Y-90	Cs-137/Ba-137m	Ir-192	Po-210	Ra-226	U-238	Am-241
MCL	8.04E-05	2.28E-05	3.11E-04	3.76E-05	1.36E-03	9.83E-05	6.54E-05	7.97E-05
DRL	6.19E-04	2.71E-04	3.02E-04	7.26E-04	1.98E-04	1.85E-04	1.94E-04	6.88E-05

Table 4-3. Default Derived Response Levels (DRLs)[61] – Drinking Water Concentrations Corresponding to Specified Doses (mrem) of Select[62] Radionuclides, Assuming One Year of Exposure at Constant Levels[63]

Isotope	DRLs for pregnant women, nursing women and children age 15 and younger – 100 mrem dose	DRLs for the general population – 500 mrem dose
Sr-90/Y-90[64]	1,000 pCi/L	7,400 pCi/L
Cs-137	6,200 pCi/L	17,000 pCi/L
I-131	820 pCi/L	10,000 pCi/L

The DRLs provided in Table 4-3 were derived by calculating life stage-specific DRLs (as described below) for eight different ages (fetus, breastfed infant, infant, 1, 5, 10, 15, and adults). For the most sensitive life-stages, concentrations of individual radionuclides yielding a 100 mrem dose were calculated for each age group, then the most protective/lowest radioactivity concentration was selected as the DRL for the entire sensitive life-stage group, including pregnant and nursing women. The calculated values differ across individual life-stages because each age group has a different dose conversion factor and drinking water ingestion rates.

For example, the sensitive life-stage group DRL for I-131 was derived by calculating the concentration of I-131 which yields a 100 mrem dose for each age group. In this case the resulting concentrations were: fetus (2,500 pCi/L), breastfed infants (820 pCi/L), infants (2,100 pCi/L), 1 year (1,900 pCi/L), 5 years (1,300 pCi/L), 10 years (2,000 pCi/L), and 15 years (2,400 pCi/L). Since the lowest calculated concentration is that of the breastfed infant (820 pCi/L), this value is the DRL that will be applied to be the most protective for the entire sensitive life-stage group.

Calculation of Default DRLs

DRLs may be calculated with the help of the following equations.

The dose (mrem or Sv) due to the ingestion of radionuclide *i* to age group *a* over time period *T* is calculated as follows:

$$D_{iaT} = I_{iaT} \times DCF_{ia}$$

Where:

D_{iaT} = Dose (in mrem or Sv) due to the ingestion of radionuclide *i* to age group *a* over time period *T*.

[61] The DRLs in Table 1 indicate the concentration of each radionuclide which results in the corresponding radiation dose value if such radionuclide was the radiation emitter in drinking water. Values provided in this table have been rounded to two significant figures.

[62] Table 1 does not present DRLs for all radionuclides that may occur in drinking water following a contamination incident, however DRLs can be calculated for any isotope of interest by using the provided reference documents and calculation methodology.

[63] The calculated values provided in this table are intended to illustrate the methodology and conservative assumptions EPA believes are adequate to provide a reasonable level of protection to sensitive populations. Dose conversion factors, calculation methodologies as well as other comprehensive information regarding DRL development will be available and updated as needed in the FRMAC Assessment Manual.

[64] Y-90 is a radioactive decay product of Sr-90 and will normally be found alongside Sr-90 in the case of a Sr-90 release; therefore they are treated together. Solubility differences may cause less yttrium to be present, however it is a conservative assumption to include both in DRLs. When calculating the combined DRL, note that the dose coefficients (see Table 4-5) are additive.

EXHIBIT A

I_{iaT} = The total intake of radionuclide *i* for age group *a* (in pCi or Bq) over time period *T*.

DCF_{ia} = The dose conversion factor (also referred to as dose coefficient) for the ingestion of radionuclide *i* in drinking water and age group *a* (in mrem/pCi or Sv/pCi, or mrem/Bq or Sv/Bq). See below for guidance on dose conversion factors (DCFs).

The quantity of radionuclide *i* ingested by age group *a* over a given time period, *T*, is calculated as follows.

$$I_{iaT} = C_i \times Ing_a \times T$$

Where:

I_{iaT} = The total intake of radionuclide *i* for age group *a* (in pCi or Bq) over time period *T*.

C_i = The concentration of radionuclide *i* in drinking water (in pCi/L or Bq/L). A simplifying assumption is made that the concentration of the radionuclide is constant over the time period *T*.

Ing_a = The daily ingestion rate of water for age group *a*, in L/day. See below for guidance on daily water ingestion rates.

T = The time period that the population is drinking contaminated water (days). In this analysis, the time period of interest for fetus exposure is 280 days, for all other age groups the exposure timeframe is 365 days.

For each age group *a* and radionuclide *i*, substituting the applicable PAG for the dose D_{iaT} and then solving for C_i yields the applicable DRL.

For example, the DRL for iodine-131 for an adult is calculated as follows:

$$DRL = PAG / (Ing_a * T * DCF_{ia})$$

$$DRL = 500 \text{ mrem} / (1.643 \text{ L/day} * 365 \text{ days} * 8.05 \text{ E-05 mrem/pCi})$$

$$= 500/4.83 \text{ E-02}$$

$$= 10{,}352 \text{ pCi/L}$$

Which is rounded to 10,000 pCi/L (two significant figures) in consideration of the uncertainties involved.

Combining Default DRLs for Multiple Radionuclides

If multiple radionuclides are present in the water supply, the measured concentrations of each radionuclide should be divided by the provided DRL values and summed. Each quotient represents a fraction of the allowed concentration (the radionuclide-specific DRL) and the permissible dose (the PAG). If the sum of the fractions is less than 1, the total dose does not exceed the PAG value. Emergency response personnel may need to calculate the sum of fractions on an ongoing basis, as the concentrations of individual radionuclides may change over time.

The sum of the fractions is expressed as follows:

$$F = \sum (C_i / DRL_i)$$

Where:

F = sum of the fractions

C_i = the concentration of radionuclide *i* in the water supply (pCi/L or Bq/L)

$DRL_{i\ (100\ or\ 500\ mrem);}$ = derived response level for the ith radionuclide (pCi/L or Bq/L)

For example, if Sr-90/Y-90 and Cs-137 are the only radionuclides present in the drinking water, and Sr-90/Y-90 are present at 900 pCi/L and Cs-137 is present at 4,500 pCi/L, the combined dose exceeds the PAG of 100 mrem for fetuses, infants, and children:

$$F = \sum (C_i / DRL_i)$$

$$= (900\ pCi/L / 1{,}000\ pCi/L) + (4{,}500\ pCi/L / 6{,}200\ pCi/L)$$

$$= 0.90 + 0.73$$

$$= 1.63$$

$1.63 > 1$, so the PAG is exceeded.

The same concentrations do not exceed the PAG of 500 mrem for the general population:

$$F = \sum (C_i / DRL_i)$$

$$= (900\ pCi/L / 7{,}400\ pCi/L) + (4{,}500\ pCi/L / 17{,}000\ pCi/L)$$

$$= 0.12 + 0.26$$

$$= 0.38$$

$0.38 < 1$, so the PAG is not exceeded.

Water Ingestion Rates

Table 4-4 presents mean values for tap water consumption taken from the CD supplement to Federal Guidance Report #13 (EPA 1999).[65] Other sources of estimated drinking water ingestion rates are available (e.g., EPA's Exposure Factors Handbook[66]), but the ingestion rates presented in Federal Guidance Report #13 (EPA 1999) were specifically designed with corresponding age ranges to be used in conjunction with other data from Federal Guidance Report #13 (EPA 1999). Values are provided for males and females in various age groups. Since the ingestion rates for males are higher (and therefore more conservative) than those for females, EPA elected to use the intake values for males to represent

[65] EPA. Federal Guidance Report 13. Cancer Risk Coefficients for Environmental Exposure to Radionuclides: CD Supplement, EPA-402-C-99-001, Rev. 1 (2002).
[66] EPA. Exposure Factors Handbook: 2011 Edition. EPA 600-R-09-052F (2011). https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252.

Derived Concentrations (pCi/l) of Beta and Photon Emitters in Drinking Water

Yielding a Dose of 4 mrem/yr to the Total Body or to any Critical Organ as defined in NBS Handbook 69

Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l
H-3	20,000	Ni-65	300	Nb-95	300	Sb-124	60	Nd-147	200	Os-191	600
Be-7	6,000	Cu-64	900	Nb-97	3,000	Sb-125	300	Nd-149	900	Os-191m	9,000
C-14	2,000	Zn-65	300	Mo-99	600	Te-125m	600	Pm-147	600	Os-193	200
F-18	2,000	Zn-69	6,000	Tc-96	300	Te-127	900	Pm-149	100	Ir-190	600
Na-22	400	Zn-69m	200	Tc-96m	30,000	Te-127m	200	Sm-151	1,000	Ir-192	100
Na-24	600	Ga-72	100	Tc-97	6,000	Te-129	2,000	Sm-153	200	Ir-194	90
Si-31	3,000	Ge-71	6,000	Tc-97m	1,000	Te-129m	90	Eu-152	200	Pt-191	300
P-32	30	As-73	1,000	Tc-99	900	Te-131m	200	Eu-154	60	Pt-193	3,000
S-35 inorg	500	As-74	100	Tc-99m	20,000	Te-132	90	Eu-155	600	Pt-193m	3,000
Cl-36	700	As-76	60	Ru-97	1,000	I-126	3	Gd-153	600	Pt-197	300
Cl-38	1,000	As-77	200	Ru-103	200	I-129	1	Gd-159	200	Pt-197m	3,000
K-42	900	Se-75	900	Ru-105	200	I-131	3	Tb-160	100	Au-196	600
Ca-45	10	Br-82	100	Ru-106	30	I-132	90	Dy-165	1,000	Au-198	100
Ca-47	80	Rb-86	600	Rh-103m	30,000	I-133	10	Dy-166	100	Au-199	600
Sc-46	100	Rb-87	300	Rh-105	300	I-134	100	Ho-166	90	Hg-197	900
Sc-47	300	Sr-85 m	20,000	Pd-103	900	I-135	30	Er-169	300	Hg-197m	600
Sc-48	80	Sr-85	900	Pd-109	300	Cs-131	20,000	Er-171	300	Hg-203	60
V-48	90	Sr-89	20	Ag-105	300	Cs-134	80	Tm-170	100	Tl-200	1,000
Cr-51	6,000	Sr-90	8	Ag-110m	90	Cs-134m	20,000	Tm-171	1,000	Tl-201	900
Mn-52	90	Sr-91	200	Ag-111	100	Cs-135	900	Yb-175	300	Tl-202	300
Mn-54	300	Sr-92	200	Cd-109	600	Cs-136	800	Lu-177	300	Tl-204	300
Mn-56	300	Y-90	60	Cd-115	90	Cs-137	200	Hf-181	200	Pb-203	1,000
Fe-55	2,000	Y-91	90	Cd-115m	90	Ba-131	600	Ta-182	100	Bi-206	100
Fe-59	200	Y-91m	9,000	In-113m	3,000	Ba-140	90	W-181	1,000	Bi-207	200
Co-57	1,000	Y-92	200	In-114m	60	La-140	60	W-185	300	Pa-230	600
Co-58	300	Y-93	90	In-115	300	Ce-141	300	W-187	200	Pa-233	300
Co-58m	9000	Zr-93	2,000	In-115m	1,000	Ce-143	100	Re-186	300	Np-239	300
Co-60	100	Zr-95	200	Sn-113	300	Ce-144	30	Re-187	9,000	Pu-241	300
Ni-59	300	Zr-97	60	Sn-125	60	Pr-142	90	Re-188	200	Bk-249	2,000
Ni-63	50	Nb-93m	1,000	Sb-122	90	Pr-143	100	Os-185	200		

EXHIBIT B

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EXHIBIT C

State may determine compliance based on several factors including the quantity of water supplied by a source, the duration of service of the source, and contaminant concentration.

II-B.2 Violation/Compliance Determination for Gross Beta and Photon Emitters

The Radionuclides Rule uses a "sum-of-the-fractions" method to determine whether a system is in compliance with the MCL for beta particle and photon radioactivity (40 CFR 141.66(d)). This method is used because each photon emitter targets a different organ of the body, which results in a different magnitude of risk. The sum of the beta and photon emitters shall not exceed 4 millirems/year (40 CFR 141.66(d)(2)).

While the measure used in risk calculations is "millirems," contaminants are analyzed in "pCi/L." Therefore, to determine compliance, each beta and photon emitter must be converted from pCi/L to millirems using the conversion tables listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure" [National Bureau of Standards (NBS) Handbook 69 as amended August, 1963, U.S. Department of Commerce]. See Appendix I for the conversion tables.

The column titled "1976 limits based on critical organ at 4 mrem/yr" indicates what 4 mrem of exposure would be for that contaminant expressed as pCi/L. For each emitter that is detected by the laboratory, the system must divide the pCi/L found in the sample by the value in the conversion tables. This provides a fraction of how much the particular beta or photon emitter is providing towards the maximum of 4 mrem/year for all of the beta photon emitters.

$$\frac{\text{pCi/L found in sample (from laboratory results)}}{\text{pCi/L equivalent of 4 mrem of exposure (from conversion table)}} = \text{fraction of the maximum 4 mrem/year exposure limit}$$

Each fraction must then be converted to a dose equivalent of 4 mrem/year by multiplying the fraction by 4. The results for each emitter must be summed to determine compliance See Illustration II-1.

ILLUSTRATION II-1
Conversion of Beta Particle and Photon Emitters

A water system near a nuclear power facility collects a sample which the laboratory speciates by EPA method 902.0 (gamma spectrometry analysis). The laboratory also analyses for strontium-90 using EPA method 905.0. The analysis indicates the following:

Cesium-134 (Cs-134):	5,023 pCi/L
Cesium-137 (Cs-137):	30 pCi/L
Strontium-90 (Sr-90):	4 pCi/L
Iodine-131 (I-131):	2 pCi/L

To determine compliance the following calculations are completed:

Emitter	(X) Lab Analysis (pCi/L)	(Y) Conversion from table (pCi/4mrem)	(X/Y=A) Calculated Fraction[1]	(A*4) Calculated Total mrem[2]
Cs-134	5,023	20,000	0.25115	
I-131	2	3	0.7	
Cs-137	30	200	0.150	
Sr-90	4	8	0.5	
		Sum-of-the-fractions	1.60115	7

[1]To ensure accuracy, the results were rounded to the number of figures in the conversion table. See Appendix I.
[2]Since data reported to the State or EPA should be in a form containing the same number of significant digits as the MCL, the results were rounded to one significant digit. The last significant digit was increased by one unit if the digit dropped was a 5, 6, 7, 8, or 9; and was not altered if the preceding number was a 0, 1, 2, 3, or 4.

The system is in violation of the MCL because the "sum-of-the-fractions" is 7 mrem, which means that the sum of the annual dose equivalent to the total body, or to any internal organ, exceeds 4 mrems/year.

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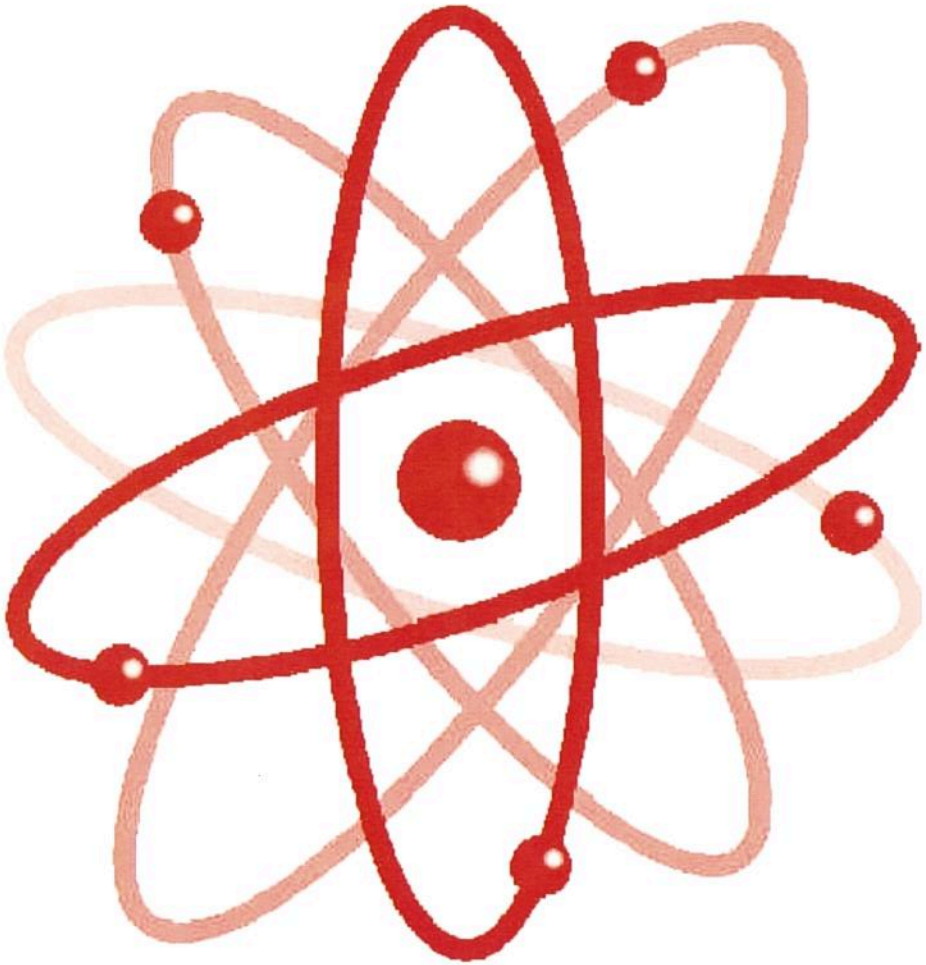

EXHIBIT D

7. What Are the Requirements for Man-Made Beta Particle and Photon Emitters?

Most systems will never need to monitor for beta particle and photon radioactivity. These emitters generally come from nuclear facilities; commercial nuclear power plants; institutional sources such as research facilities, hospitals, and universities; and from industrial sources such as laboratories and pharmaceutical companies. Unless your system is vulnerable to this type of contamination, or is already contaminated by beta and photon emitters, you do not have to monitor for these contaminants. Your State will determine whether your system is vulnerable to contamination or already contaminated.

In general, the regulations for beta particle and photon radioactivity are similar to those for other radionuclides, with some important exceptions, which are outlined below. Contact your State drinking water program if you are unsure if you need to monitor for beta particle and photon radioactivity.

What Is the MCL?

The MCL for beta particle and photon radioactivity did not change in the revised rule from the current level of 4 millirem per year (mrem/year). A millirem is a ***dose of energy*** to the body. EPA regulates 179 man-made nuclides, and each of them has a *concentration* of radiation (measured in picoCuries per liter [pCi/L]) which produces the 4 millirem (mrem) dose. These concentrations are listed on a conversion table that the State will use to determine if you are in compliance.

Each nuclide has a different concentration that produces a 4 mrem dose because different radionuclides have different energy levels. Some nuclides need to be in a higher concentration to give the same 4 mrem dose.

The laboratory will measure the nuclide concentration in the water, and the State will compare this result to the concentration allowed for that particular nuclide (see table on page 13). The comparison results in a *fraction*. This is shown in the calculation below.

$$\frac{\text{pCi/L found in sample (from laboratory results)}}{\text{pCi/L equivalent from 4 mrem of exposure (from conversion table)}} = \text{fraction of the maximum 4 mrem/yr exposure limit}$$

If your water contains several man-made radionuclides, the State will add all the fractions together. If the result is >1, your system exceeds the 4 mrem MCL. Your system must monitor monthly until a rolling average of 3 months is below the MCL.

What Are the Monitoring Requirements?

There are three types of systems when it comes to monitoring for beta particle and photon emitters:

- Those that are not vulnerable to man-made radionuclides (these systems are not required to monitor for beta and photon emitters).