

## 5.4 GAMMA

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### 5.4.1 SCOPE

Presented here is a tabulation of  $\gamma$  rays and nuclides that are common to environmental analyses. These data may be useful for interpreting either field or laboratory measurements.

As an aid in verifying nuclide identifications, two additional  $\gamma$ -ray lines are included when possible as E2 and E3.

The following special notations are used in the table:

Symbol	Meaning
%	ratio of $\gamma$ -rays to disintegrations.
X	indicates X-ray.
KX, LX	sum of K or L X-rays.
D	indicates a doublet.
T	indicates a triplet.
•	indicates annihilation radiation.
Long	in half-life column is used for all members of the primordial series, % refers to U or Th decays.

REFERENCE

Browne, E., R. B. Firestone and V. S. Shirley (Editors)  
*Table of Radioactive Isotopes*  
John Wiley and Sons, Inc., New York (1986)

TABLE OF  $\gamma$ -RAYS AND NUCLIDES COMMON TO ENVIRONMENTAL ANALYSES

Energy	Nuclide	%	T 1/2	E2	%	E3	%	Origin
14.4	<sup>57</sup> Co	9.5	272D	122.1	85.5	136.5	10.7	Activity
26.3	<sup>241</sup> Am	2.4	433Y	59.5	35.7	17.0LX	38.7	<sup>241</sup> Pu
30.0	<sup>140</sup> Ba	13.6	12.8D	162.7	6.2	304.9	4.3	Fallout
39.6	<sup>129</sup> I	7.5	1.6E7	30.0KX	70.8			Fission
39.9	<sup>212</sup> Bi	1.1	Long	727.3	6.7	1620.7	1.5	<sup>232</sup> Th
40.6	<sup>99</sup> Mo	1.1	65.9H	18.3X	3.2	140.5	3.5	Fallout
46.5	<sup>210</sup> Pb	4.1	22.3Y					<sup>238</sup> U
49.8	<sup>132</sup> Te	14.4	78.2H	30.0KX	70.9	111.9	1.9	Fallout
53.2	<sup>133</sup> Ba	2.2	10.5Y	81.0	34.2	31.0KX	101.3	Activity
59.5	<sup>237</sup> U	32.8	6.75D	101.1	26.0	208.0	22.0	Fallout
59.5	<sup>241</sup> Am	35.7	433Y	26.3	2.4	17.0LX	38.7	<sup>241</sup> Pu
60.0	<sup>155</sup> Eu	1.1	4.96Y	86.5	30.4	105.3	20.6	Fallout
61.5	<sup>239</sup> Np	1.0	2.36D	14.3LX	56.1	101.0KX	38.9	Fallout
63.3	<sup>234</sup> Th	3.8	Long	92.6D	5.4			<sup>238</sup> U
66.9	<sup>136</sup> Cs	12.5	13.2D	34.0KX	17.6	86.4	6.3	Fission
74.8X	<sup>214</sup> Pb	6.5	Long	77.1X	11.0	87.3X	3.9	<sup>238</sup> U
74.8X	<sup>212</sup> Pb	10.5	Long	77.1X	17.7	87.2X	6.3	<sup>232</sup> Th
75.0X	<sup>208</sup> Tl	3.6	Long	72.8X	2.1	84.8X	1.3	<sup>232</sup> Th
77.1X	<sup>214</sup> Pb	11.0	Long	74.8X	6.5	87.2X	3.9	<sup>238</sup> U
77.1X	<sup>212</sup> Pb	17.7	Long	74.8X	10.5	87.2X	6.3	<sup>232</sup> Th
79.6	<sup>133</sup> Ba	3.2	10.5Y	53.2	2.2			Activity
80.1	<sup>144</sup> Ce	1.1	285D	133.5	11.1	696.5	1.3	Fallout
80.2	<sup>131</sup> I	2.6	8.04D	364.5	81.2	284.3	6.1	Fission
81.0	<sup>133</sup> Ba	34.2	10.5Y	276.4	7.3	79.6	3.2	Activity
81.0	<sup>133</sup> Xe	37.0	5.25D	79.6	0.2	31.0KX	40.1	Fission
84.3X	<sup>228</sup> Th	1.2	1.91Y	12.3X	3.1			<sup>232</sup> Th
86.4	<sup>136</sup> Cs	6.3	13.2D	66.9	12.5	153.3	7.5	Fission
86.5	<sup>155</sup> Eu	34.0	4.96Y	105.3	20.6	60.0	1.1	Fallout
87.2X	<sup>214</sup> Pb	3.9	Long	77.1X	11.0	241.9	7.5	<sup>238</sup> U
87.2X	<sup>212</sup> Pb	6.3	Long	238.6	43.6	77.1X	17.7	<sup>232</sup> Th
88.0	<sup>109</sup> Cd	3.6	463D	23.0KX	99.8			Activity
90.0X	<sup>228</sup> Ac	3.4	Long	93.4X	5.6	99.6	1.3	<sup>232</sup> Th
91.1	<sup>147</sup> Nd	28.0	11.0D	38.5KX	37.4	319.4	2.0	Fallout
92.6D	<sup>234</sup> Th	5.4	Long	63.3	3.8			<sup>238</sup> U
93.4X	<sup>228</sup> Ac	5.6	Long	90.0X	3.4	99.6	1.3	<sup>232</sup> Th
97.1	<sup>237</sup> U	16.0	6.75D	101.0	26.0	208.0	22.0	Fallout
99.6	<sup>228</sup> Ac	1.3	Long	129.0	2.9	209.4	4.1	<sup>232</sup> Th
101.1	<sup>237</sup> U	26.0	6.75D	59.5	32.8	208.0	22.0	Fallout
105.3	<sup>155</sup> Eu	20.6	4.96Y	86.5	34.0	60.0	1.1	Fallout
105.4X	<sup>228</sup> Ac	2.0	Long	99.6	1.3	129.0	2.9	<sup>232</sup> Th
106.1	<sup>239</sup> Np	22.7	2.36D	61.5	1.0	117.0KX	11.6	Fallout
109.2	<sup>235</sup> U	1.5	70E7Y	93.4KX	5.5	143.8	10.5	Natural
111.9	<sup>132</sup> Te	1.9	78.2H	49.8	14.4	116.4	1.9	Fallout
113.9	<sup>237</sup> U	25.0	6.75D	101.1	26.0	208.0	22.0	Fallout
116.3	<sup>132</sup> Te	1.9	78.2H	111.9	1.9	228.3	88.2	Fallout

TABLE OF  $\gamma$ -RAYS AND NUCLIDES COMMON TO ENVIRONMENTAL ANALYSES (Cont'd)

Energy	Nuclide	%	T 1/2	E2	%	E3	%	Origin
121.8	<sup>152</sup> Eu	28.4	13.3Y	344.3	26.6	244.7	7.5	Fallout
122.1	<sup>57</sup> Co	85.5	273D	136.5	10.7	14.4	9.5	Activity
123.1	<sup>154</sup> Eu	40.5	8.8Y	248.0	6.6	591.8	4.8	Fallout
127.2	<sup>101</sup> Rh	73.0	3.3Y	198.0	70.8	325.2	13.4	Fallout
129.0	<sup>228</sup> Ac	2.9	Long	99.6	1.3	209.4	4.1	<sup>232</sup> Th
133.5	<sup>144</sup> Ce	11.1	285D	696.5	1.3	80.1	1.1	Fallout
136.5	<sup>57</sup> Co	10.7	272D	122.1	85.5	14.4	9.5	Activity
138.0	<sup>138</sup> Cs	1.5	32.2M	227.7	1.5	462.8	30.7	<sup>138</sup> Xe
140.5	<sup>99</sup> Mo	3.5	65.9H	40.6	1.1	181.1	6.1	Fallout
140.5	<sup>99m</sup> Tc	87.2	6.01H	18.4X	6.1	20.6X	1.2	<sup>99</sup> Mo
143.8	<sup>235</sup> U	10.5	70E7Y	109.2	1.5	163.4	4.7	Natural
145.4	<sup>141</sup> Ce	48.4	32.5D	37.0KX	17.4			Fission
151.2	<sup>85m</sup> Kr	75.2	4.48H	304.9	13.7			Fission
153.3	<sup>136</sup> Cs	7.5	13.2D	86.4	6.3	164.0	4.6	Fission
153.9	<sup>138</sup> Xe	6.0	14.1M	242.7	3.5	258.4	31.5	Fission
162.7	<sup>140</sup> Ba	6.2	12.8D	304.9	4.3	30.0	13.6	Fallout
163.4	<sup>235</sup> U	4.7	70E7Y	143.8	10.5	185.7	53.0	Natural
164.0	<sup>136</sup> Cs	4.6	13.2D	153.3	7.5	176.6	13.6	Fission
165.9	<sup>139</sup> Ce	79.9	138D	34.0KX	79.5			Activity
166.0	<sup>88</sup> Kr	3.1	2.84H	196.3	26.0	362.3	2.3	Fission
176.3	<sup>125</sup> Sb	6.8	2.73Y	427.9	29.4	380.4	1.5	Fallout
176.6	<sup>136</sup> Cs	13.6	13.2D	164.0	4.6	273.7	12.7	Fission
181.1	<sup>99</sup> Mo	6.1	65.9H	140.5	3.5	366.4	1.2	Fallout
185.7	<sup>235</sup> U	53.0	70E7Y	143.8	10.5	205.3	4.7	Natural
186.1	<sup>226</sup> Ra	3.3	1600Y					Natural
192.3	<sup>59</sup> Fe	3.1	44.5D	1099.3	56.5	1291.6	43.2	Activity
196.3	<sup>88</sup> Kr	26.0	2.84H	362.3	2.3	166.0	3.1	Fission
198.0	<sup>101</sup> Rh	70.8	3.3Y	127.2	73.0	325.2	13.4	Fallout
205.3	<sup>235</sup> U	4.7	70E7Y	185.7	53.0	143.8	10.5	Natural
208.0	<sup>237</sup> U	22.0	6.75D	59.5	32.8	101.1	26.0	Fallout
209.4	<sup>228</sup> Ac	4.1	Long	129.0	2.9	270.3	3.8	<sup>232</sup> Th
227.7	<sup>138</sup> Cs	1.5	32.2M	138.0	1.5	409.0	4.7	<sup>138</sup> Xe
228.2	<sup>239</sup> Np	10.7	2.36D	106.1	22.7	277.6	14.2	Fallout
228.3	<sup>132</sup> Te	88.2	78.2H	116.4	1.9	111.9	1.9	Fallout
233.2	<sup>133m</sup> Xe	10.3	2.19D	30.0KX	56.3			Fission
238.6	<sup>212</sup> Pb	43.6	Long	300.0	3.3			<sup>232</sup> Th
240.8	<sup>224</sup> Ra	3.9	Long					<sup>232</sup> Th
241.9	<sup>214</sup> Pb	7.5	Long	295.1	19.2	352.0	37.1	<sup>238</sup> U
242.7	<sup>138</sup> Xe	3.5	14.1M	153.9	6.0	258.4	31.5	Fission
244.7	<sup>152</sup> Eu	7.5	13.3Y	121.8	28.4	344.3	26.6	Fallout
248.0	<sup>154</sup> Eu	6.6	8.8Y	123.1	40.5	591.8	4.8	Fallout
249.8	<sup>135</sup> Xe	90.0	9.10H	608.2	2.9	31.0KX	5.2	Fission
258.4	<sup>138</sup> Xe	31.5	14.1M	242.7	3.5	396.6	6.3	Fission
262.8	<sup>132</sup> I	1.4	2.28H	505.9	5.0	522.7	16.1	<sup>132</sup> Te
270.3	<sup>228</sup> Ac	3.8	Long	209.4	4.1	328.0	3.5	<sup>232</sup> Th
273.7	<sup>136</sup> Cs	12.7	13.2D	176.6	13.6	340.6	48.6	Fission

TABLE OF  $\gamma$ -RAYS AND NUCLIDES COMMON TO ENVIRONMENTAL ANALYSES (Cont'd)

Energy	Nuclide	%	T 1/2	E2	%	E3	%	Origin
276.4	<sup>133</sup> Ba	7.1	10.5Y	302.9	18.4	81.0	34.2	Activity
277.3	<sup>208</sup> Tl	2.4	Long	510.6	7.8	583.0	30.9	<sup>232</sup> Th
277.6	<sup>239</sup> Np	14.2	2.36D	228.2	10.7	315.9	1.6	Fallout
279.2	<sup>203</sup> Hg	81.5	46.6D	74.6X	12.9			Fallout
284.3	<sup>131</sup> I	6.1	8.04D	364.5	81.2	80.2	2.6	Fission
295.1	<sup>214</sup> Pb	19.2	Long	351.9	37.1	241.9	7.5	<sup>238</sup> U
300.0	<sup>212</sup> Pb	3.3	Long	238.6	43.6			<sup>232</sup> Th
302.9	<sup>133</sup> Ba	18.4	10.5Y	276.4	7.1	356.0	62.2	Activity
304.9	<sup>140</sup> Ba	4.3	12.8D	162.7	6.2	423.7	3.1	Fallout
304.9	<sup>85m</sup> Kr	13.7	4.48H	151.2	75.1			Fission
315.9	<sup>239</sup> Np	1.6	2.36D	277.6	14.2	334.3	2.1	Fallout
319.4	<sup>147</sup> Nd	2.0	11.0D	439.9	1.2	91.1	28.0	Fallout
320.1	<sup>51</sup> Cr	9.8	27.7D					Activity
325.2	<sup>101</sup> Rh	13.4	3.3Y	127.2	73.0	198.0	70.8	Fallout
328.0	<sup>228</sup> Ac	3.5	Long	270.3	3.8	338.4	12.4	<sup>232</sup> Th
328.8	<sup>140</sup> La	20.7	40.3H	432.5	3.0	487.0	45.9	Fallout
334.3	<sup>239</sup> Np	2.1	2.36D	315.9	1.6	61.5	1.0	Fallout
338.4	<sup>228</sup> Ac	12.4	Long	328.0	3.5	409.6	2.2	<sup>232</sup> Th
340.6	<sup>136</sup> Cs	48.6	13.2D	273.7	12.7	818.6	99.8	Fission
344.3	<sup>152</sup> Eu	26.6	13.3Y	244.7	7.5	411.1	2.2	Fallout
352.0	<sup>214</sup> Pb	37.1	Long	241.9	7.5	295.1	19.2	<sup>238</sup> U
356.0	<sup>133</sup> Ba	62.2	10.5Y	302.9	18.4	383.8	8.9	Activity
362.3	<sup>88</sup> Kr	2.3	2.84H	196.3	26.0	834.9	13.0	Fission
364.5	<sup>131</sup> I	81.2	8.04D	637.0	7.3	284.3	6.1	Fission
366.4	<sup>99</sup> Mo	1.2	65.9H	181.1	6.1	739.5	12.1	Fallout
380.4	<sup>125</sup> Sb	1.5	2.73Y	176.3	6.8	427.9	29.4	Fallout
383.8	<sup>133</sup> Ba	8.9	10.5Y	356.0	62.2	302.9	18.4	Activity
396.6	<sup>138</sup> Xe	6.3	14.1M	258.4	31.5	401.5	2.2	Fission
401.5	<sup>138</sup> Xe	2.2	14.1M	434.6	20.3	396.6	6.3	Fission
402.6	<sup>87</sup> Kr	49.6	76.3M	845.5	7.3	673.9	1.9	Fission
409.0	<sup>138</sup> Cs	4.7	32.2M	227.7	1.5	462.8	30.7	<sup>138</sup> Xe
409.6	<sup>228</sup> Ac	2.2	Long	338.4	12.4	463.1	4.6	<sup>232</sup> Th
411.1	<sup>152</sup> Eu	2.2	13.3Y	344.3	26.6	444.0D	3.1	Fallout
415.3	<sup>102</sup> Rh	2.1	2.89Y	418.5	10.6	420.4	3.2	Fallout
418.5	<sup>102</sup> Rh	10.6	2.89Y	415.3	2.1	420.4	3.2	Fallout
420.4	<sup>102</sup> Rh	3.2	2.89Y	418.5	10.6	475.1	95.0	Fallout
423.7	<sup>140</sup> Ba	3.1	12.8D	437.6	1.9	304.9	4.3	Fallout
427.9	<sup>125</sup> Sb	29.4	2.73Y	380.4	1.5	463.4	10.5	Fallout
432.5	<sup>140</sup> La	3.0	40.3H	487.0	45.9	328.8	20.7	Fallout
434.6	<sup>138</sup> Xe	20.3	14.1M	401.5	2.2	1114.3	1.5	Fission
437.6	<sup>140</sup> Ba	1.9	12.8D	537.3	24.4	423.7	3.1	Fallout
439.9	<sup>147</sup> Nd	1.2	11.0D	319.4	2.0	531.0	13.1	Fallout
444.0D	<sup>152</sup> Eu	3.1	13.3Y	411.1	2.2	778.9	13.0	Fallout
446.8	<sup>110m</sup> Ag	3.8	250D	657.8	94.6	620.4	2.8	Activity

TABLE OF  $\gamma$ -RAYS AND NUCLIDES COMMON TO ENVIRONMENTAL ANALYSES (Cont'd)

Energy	Nuclide	%	T 1/2	E2	%	E3	%	Origin
462.8	<sup>138</sup> Cs	30.7	32.2M	547.0	10.8	409.0	4.7	<sup>138</sup> Xe
463.1	<sup>228</sup> Ac	4.6	Long	409.6	2.2	755.3	1.3	<sup>232</sup> Th
463.4	<sup>125</sup> Sb	10.5	2.73Y	427.9	29.4	600.5	17.8	Fallout
468.7	<sup>102m</sup> Rh	2.9	207D	475.1	46.0	556.6	1.9	Fallout
475.1	<sup>102m</sup> Rh	46.0	207D	468.7	2.9	556.6	1.9	Fallout
475.1	<sup>102</sup> Rh	95.0	2.89Y	628.1	8.5	420.5	3.2	Fallout
475.4	<sup>134</sup> Cs	1.5	2.06Y	563.2	8.4	569.3	15.4	Fission
477.6	<sup>7</sup> Be	10.3	53.2D					Cosmic
487.1	<sup>140</sup> La	45.5	40.2H	751.9	4.3	432.6	2.9	Fallout
497.1	<sup>103</sup> Ru	89.5	39.6D	610.3	5.6			Fallout
505.9	<sup>132</sup> I	5.0	2.28H	262.8	1.4	522.7	16.1	<sup>132</sup> Te
510.6	<sup>208</sup> Tl	7.8	Long	277.3	2.4	583.0	30.9	<sup>232</sup> Th
511.0*	<sup>65</sup> Zn	2.9	244D	1115.5	50.8			Activity
511.0*	<sup>58</sup> Co	30.0	70.9D	810.8	99.5			Activity
511.0*	<sup>22</sup> Na	180.8	2.60Y	1274.5	99.9			Cosmic
511.9	<sup>106</sup> Ru	20.7	372D	1050.4	1.5	621.9	9.8	Fallout
514.0	<sup>85</sup> Sr	99.3	64.8D	13.4KX	50.6	15.0KX	8.7	Activity
522.7	<sup>132</sup> I	16.1	2.28H	505.9	5.0	547.0	1.3	<sup>132</sup> Te
526.6	<sup>135m</sup> Xe	81.2	15.7M	30.0KX	14.0			Fission
531.0	<sup>147</sup> Nd	13.1	11.0D	439.9	1.2	319.4	2.0	Fallout
537.3	<sup>140</sup> Ba	24.4	12.8D	437.6	1.9	423.7	3.1	Fallout
547.0	<sup>138</sup> Cs	10.8	32.2M	462.8	30.7	871.7	5.1	<sup>138</sup> Xe
547.0	<sup>132</sup> I	1.3	2.28H	522.7	16.1	621.2	~2.0	<sup>132</sup> Te
556.6	<sup>102m</sup> Rh	1.9	207D	475.1	46.0	628.1	5.5	Fallout
563.2	<sup>134</sup> Cs	8.4	2.06Y	475.4	1.5	569.3	15.4	Fission
569.3	<sup>134</sup> Cs	15.4	2.06Y	563.2	8.4	604.7	97.6	Fission
569.2	<sup>207</sup> Bi	97.8	32.2Y	1063.1	74.9	1769.7	6.9	Fallout
583.0	<sup>208</sup> Tl	30.9	Long	510.6	7.8	860.3	4.3	<sup>232</sup> Th
591.8	<sup>154</sup> Eu	4.8	8.8Y	248.0	6.6	692.5	1.7	Fallout
600.5	<sup>125</sup> Sb	17.8	2.73Y	463.4	10.5	606.6	5.0	Fallout
602.7	<sup>124</sup> Sb	97.8	60.2D	645.9	7.4	709.3	1.4	Fallout
604.7	<sup>134</sup> Cs	97.6	2.06Y	795.9	85.4	569.3	15.4	Fission
606.6	<sup>125</sup> Sb	5.0	2.73Y	600.5	17.8	635.9	11.3	Fallout
608.2	<sup>135</sup> Xe	2.9	9.10H	249.8	90.0	31.6KX	5.2	Fission
609.3	<sup>214</sup> Bi	46.1	Long	665.4	1.6	768.4	4.9	<sup>238</sup> U
610.3	<sup>103</sup> Ru	5.6	39.3D	497.1	88.7			Fallout
620.4	<sup>110m</sup> Ag	2.8	250D	657.8	94.6	446.8	3.8	Activity
621.2	<sup>132</sup> I	~2.0	2.28H	547.1	1.3	630.3	13.8	<sup>132</sup> Te
621.9	<sup>106</sup> Ru	9.8	372D	511.9	20.7	1050.4	1.5	Fallout
628.1	<sup>102m</sup> Rh	5.5	207D	556.6	1.9	1103.2	2.9	Fallout
628.1	<sup>102</sup> Rh	8.5	~2.9Y	475.1	95.0	631.3	56.0	Fallout
630.3	<sup>132</sup> I	13.8	2.28H	621.2	~2.0	650.6	2.7	<sup>132</sup> Te
631.3	<sup>102</sup> Rh	56.0	~2.9Y	628.1	8.5	692.4	1.8	Fallout

TABLE OF  $\gamma$ -RAYS AND NUCLIDES COMMON TO ENVIRONMENTAL ANALYSES (Cont'd)

Energy	Nuclide	%	T 1/2	E2	%	E3	%	Origin
635.9	<sup>125</sup> Sb	11.3	2.73Y	606.6	5.0	671.4	1.8	Fallout
637.0	<sup>131</sup> I	7.3	8.04D	364.5	81.2	722.9	1.8	Fission
645.9	<sup>124</sup> Sb	7.4	60.2D	602.7	97.8	709.3	1.4	Fallout
650.6	<sup>132</sup> I	2.7	2.28H	630.3	13.8	667.7	98.7	<sup>132</sup> Te
657.8	<sup>110m</sup> Ag	94.6	250D	620.4	2.8	677.6	10.4	Activity
661.7	<sup>137</sup> Cs	85.2	30.0Y	33.0KX	7.1			Fallout
665.4	<sup>214</sup> Bi	1.6	Long	609.3	46.1	768.4	4.9	<sup>238</sup> U
667.7	<sup>132</sup> I	98.7	2.28H	650.6	2.7	669.9	4.9	<sup>132</sup> Te
669.9	<sup>132</sup> I	4.9	2.28H	667.7	98.7	671.6	5.2	<sup>132</sup> Te
671.4	<sup>125</sup> Sb	1.8	2.73Y	635.9	11.3	606.6	5.0	Fallout
671.6	<sup>132</sup> I	5.2	2.28H	669.9	4.9	727.D	5.4	<sup>132</sup> Te
673.9	<sup>87</sup> Kr	1.9	76.3M	845.5	7.3	402.6	49.6	Fission
677.6	<sup>110m</sup> Ag	10.4	250D	657.8	94.6	687.0	6.4	Activity
687.0	<sup>110m</sup> Ag	6.4	250D	677.6	10.4	706.7	16.4	Activity
692.4	<sup>102</sup> Rh	1.8	~2.9Y	631.3	56.0	695.6	2.7	Fallout
692.5	<sup>154</sup> Eu	1.7	8.8Y	591.8	4.8	723.4	19.7	Fallout
695.6	<sup>102</sup> Rh	2.7	~2.9Y	692.4	1.8	697.6	45.7	Fallout
696.5	<sup>144</sup> Ce	1.3	285D	133.5	11.1	80.1	1.1	Fallout
697.6	<sup>102</sup> Rh	45.7	~2.9Y	766.9	34.0	695.6	2.7	Fallout
706.7	<sup>110m</sup> Ag	16.4	250D	687.0	6.4	744.3	4.7	Activity
709.3	<sup>124</sup> Sb	1.4	60.2D	645.9	7.4	713.8	2.3	Fallout
713.8	<sup>124</sup> Sb	2.3	60.2D	709.3	1.4	722.8	10.9	Fallout
722.8	<sup>124</sup> Sb	10.9	60.2D	713.8	2.3	968.2	1.9	Fallout
722.9	<sup>131</sup> I	1.8	8.04D	364.5	81.2	637.0	7.3	Fission
723.4	<sup>154</sup> Eu	19.7	8.8Y	692.5	1.7	756.8	4.3	Fallout
724.2	<sup>95</sup> Zr	44.1	64.0D	756.7	54.5			Fallout
727.0D	<sup>132</sup> I	5.4	2.28H	671.6	5.2	728.7	1.1	<sup>132</sup> Te
727.3	<sup>212</sup> Bi	6.7	Long	39.9	1.1	1620.7	1.5	<sup>232</sup> Th
728.7	<sup>132</sup> I	1.1	2.28H	727.0D	5.4	772.7	76.2	<sup>132</sup> Te
739.5	<sup>99</sup> Mo	12.1	65.9H	366.4	1.2	777.9	4.4	Fallout
744.3	<sup>110m</sup> Ag	4.7	250D	706.7	16.4	763.9	22.3	Activity
751.7	<sup>140</sup> La	4.3	40.3H	487.0	45.9	815.8	23.6	Fallout
755.3	<sup>228</sup> Ac	1.3	Long	463.1	4.6	772.3	1.1	<sup>232</sup> Th
756.7	<sup>95</sup> Zr	54.5	64.0D	724.2	44.1			Fallout
756.8	<sup>154</sup> Eu	4.3	8.8Y	723.4	19.7	873.2	11.5	Fallout
763.1	<sup>208</sup> Tl	0.6	Long	583.0	30.9	860.3	4.3	<sup>232</sup> Th
763.9	<sup>110m</sup> Ag	22.3	250D	744.3	4.7	818.0	7.3	Activity
765.8	<sup>95</sup> Nb	99.8	35.0D					Fallout
766.9	<sup>102</sup> Rh	34.0	~2.9Y	697.6	45.7	1046.6	34.0	Fallout
768.4	<sup>214</sup> Bi	5.0	Long	665.6	1.6	786.4D	0.3	<sup>238</sup> U
772.3	<sup>228</sup> Ac	1.1	Long	755.3	1.3	794.8	4.6	<sup>232</sup> Th
772.7	<sup>132</sup> I	76.2	2.28H	728.7	1.1	780.1	1.2	<sup>132</sup> Te
777.9	<sup>99</sup> Mo	4.4	65.9H	739.5	12.1	366.4	1.2	Fallout

TABLE OF  $\gamma$ -RAYS AND NUCLIDES COMMON TO ENVIRONMENTAL ANALYSES (Cont'd)

Energy	Nuclide	%	T 1/2	E2	%	E3	%	Origin
778.9	<sup>152</sup> Eu	13.0	13.3Y	444.0D	3.1	867.4	4.2	Fallout
780.1	<sup>132</sup> I	1.2	2.28H	772.7	76.2	809.8	2.9	<sup>132</sup> Te
785.5	<sup>212</sup> Bi	1.1	Long	727.3	6.7	1620.7	1.5	<sup>232</sup> Th
786.4	<sup>214</sup> Bi	0.3	Long	768.4	4.9	806.2	1.2	<sup>238</sup> U
794.8	<sup>228</sup> Ac	4.6	Long	772.3	1.1	830.6	0.6	<sup>232</sup> Th
795.8	<sup>134</sup> Cs	85.4	2.06Y	604.7	97.8	801.9	8.7	Fission
802.0	<sup>134</sup> Cs	8.7	2.06Y	795.9	85.4	1038.6	1.0	Fission
806.2	<sup>214</sup> Bi	1.2	Long	786.4	0.3	934.0	3.2	<sup>238</sup> U
809.8	<sup>132</sup> I	2.9	2.28H	780.1	1.2	812.3	5.6	<sup>132</sup> Te
810.8	<sup>58</sup> Co	99.5	70.9D	511.0*	30.0			Activity
812.3	<sup>132</sup> I	5.6	2.28H	809.8	2.9	877.2	1.1	<sup>132</sup> Te
815.8	<sup>140</sup> La	23.6	40.3H	751.7	4.3	867.8	5.6	Fallout
818.0	<sup>110m</sup> Ag	7.3	250D	763.9	22.3	884.7	72.7	Activity
818.6	<sup>136</sup> Cs	99.8	13.2D	340.6	48.6	1048.1	79.7	Fission
830.6	<sup>228</sup> Ac	0.6	Long	794.8	4.6	835.6	1.7	<sup>232</sup> Th
834.8	<sup>54</sup> Mn	100.0	312.2D					Fallout
834.9	<sup>88</sup> Kr	13.0	2.84H	362.3	2.3	985.8D	1.3	Fission
835.6	<sup>228</sup> Ac	1.7	Long	830.6	0.6	840.4	0.9	<sup>232</sup> Th
840.4	<sup>228</sup> Ac	0.9	Long	835.6	1.7	904.3	0.9	<sup>232</sup> Th
845.5	<sup>87</sup> Kr	7.3	76.3M	673.9	1.9	1175.5	1.1	Fission
860.3	<sup>208</sup> Tl	4.3	Long	2614.4	35.8	583.0	30.9	<sup>232</sup> Th
867.4	<sup>152</sup> Eu	4.2	13.3Y	778.9	13.0	964.1	14.5	Fallout
867.8	<sup>140</sup> La	5.6	40.3H	815.8	23.6	919.6	2.7	Fallout
871.7	<sup>138</sup> Cs	5.1	32.2M	547.0	10.8	1009.8	29.8	<sup>138</sup> Xe
873.2	<sup>154</sup> Eu	11.5	8.8Y	756.8	4.3	996.3	10.3	Fallout
877.2	<sup>132</sup> I	1.1	2.28H	812.3	5.6	954.6	18.1	<sup>132</sup> Te
884.7	<sup>110m</sup> Ag	72.7	250D	818.0	7.3	937.5	34.4	Activity
898.1	<sup>88</sup> Y	92.7	107D	1836.1	99.4			Activity
898.0	<sup>88</sup> Rb	14.1	17.8M	1836.1	21.4	2677.9	2.0	<sup>88</sup> Kr
904.3	<sup>228</sup> Ac	0.9	Long	840.4	0.9	911.2	29.0	<sup>232</sup> Th
911.2	<sup>228</sup> Ac	29.0	Long	966.0D	23.2	840.4	0.9	<sup>232</sup> Th
919.6	<sup>140</sup> La	2.7	40.3H	867.8	5.6	925.2	7.0	Fallout
925.2	<sup>140</sup> La	7.1	40.3H	487.0	45.9	919.6	2.7	Fallout
934.0	<sup>214</sup> Bi	3.2	Long	1120.3	15.0	806.2	1.2	<sup>238</sup> U
937.5	<sup>110m</sup> Ag	34.4	250D	1384.3	24.3	884.7	72.7	Activity
954.6	<sup>132</sup> I	18.1	2.28H	877.2	1.1	1136.2	3.0	<sup>132</sup> Te
964.1	<sup>152</sup> Eu	14.5	13.3Y	1085.9	9.9	867.4	4.2	Fallout
964.6	<sup>228</sup> Ac	5.8	Long	969.0	17.4	911.2	29.0	<sup>232</sup> Th
968.2	<sup>124</sup> Sb	1.9	60.2D	1045.1	1.9	722.8	10.9	Fallout
969.0	<sup>228</sup> Ac	17.4	Long	911.2	29.0	1459.2	1.1	<sup>232</sup> Th
985.8	<sup>88</sup> Kr	1.3	2.84H	1141.4	1.3	834.9	13.0	Fission
996.3	<sup>154</sup> Eu	10.3	8.8Y	1004.8	17.9	873.2	11.5	Fallout



TABLE OF  $\gamma$ -RAYS AND NUCLIDES COMMON TO ENVIRONMENTAL ANALYSES (Cont'd)

Energy	Nuclide	%	T 1/2	E2	%	E3	%	Origin
1001.0	<sup>234m</sup> Pa	0.7	Long	766.4	0.2	742.8	0.1	<sup>238</sup> U
1004.8	<sup>154</sup> Eu	17.9	8.8Y	1274.5	35.5	996.3	10.3	Fallout
1009.8	<sup>138</sup> Cs	29.8	32.2M	1147.3	1.2	871.7	5.1	<sup>138</sup> Xe
1038.6	<sup>134</sup> Cs	1.0	2.06Y	1167.9	1.8	802.0	8.7	Fission
1045.1	<sup>124</sup> Sb	1.9	60.2D	1325.5	1.6	968.2	1.9	Fallout
1046.6	<sup>102</sup> Rh	33.0	2.9Y	1103.2	4.4	766.9	34.0	Fallout
1048.1	<sup>136</sup> Cs	79.7	13.2D	818.6	99.8	1235.4	19.8	Fission
1050.4	<sup>106</sup> Ru	1.5	372D	511.9	20.7	621.9	9.8	Fallout
1063.1	<sup>207</sup> Bi	74.9	32.2Y	569.2	97.8	1769.7	6.9	Fallout
1085.9	<sup>152</sup> Eu	9.9	13.3Y	1112.1	13.6	964.1	14.5	Fallout
1099.3	<sup>59</sup> Fe	56.5	44.5D	1291.6	43.2	192.3	3.1	Fallout
1103.2	<sup>102m</sup> Rh	2.9	207D	556.6	1.9	628.1	5.5	Fallout
1103.2	<sup>102</sup> Rh	4.4	2.9Y	1046.6	33.0	1112.9	18.9	Fallout
1112.1	<sup>152</sup> Eu	13.6	13.3Y	1085.9	9.9	1212.9	1.4	Fallout
1112.9	<sup>102</sup> Rh	18.9	2.9Y	1046.6	33.0	1103.2	4.4	Fallout
1114.3	<sup>138</sup> Xe	1.5	14.1M	1768.4	16.7	434.6	20.3	Fission
1115.5	<sup>65</sup> Zn	50.8	244D	511.0*	2.9			Activity
1120.3	<sup>214</sup> Bi	15.0	Long	1155.2	1.7	934.0	3.2	<sup>238</sup> U
1136.2	<sup>132</sup> I	3.0	2.28H	954.6	18.1	1143.6	1.4	<sup>132</sup> Te
1141.4	<sup>88</sup> Kr	1.3	2.84H	1369.4	1.5	985.8D	1.3	Fission
1143.6	<sup>132</sup> I	1.4	2.28H	1136.2	3.0	1173.3	1.1	<sup>132</sup> Te
1147.3	<sup>138</sup> Cs	1.2	32.2M	1009.8	29.8	1343.6	1.1	<sup>138</sup> Xe
1155.2	<sup>214</sup> Bi	1.7	Long	1238.1	5.9	1120.3	15.0	<sup>238</sup> U
1167.9	<sup>134</sup> Cs	1.8	2.06Y	1038.6	1.0	1365.2	3.0	Fission
1173.2	<sup>60</sup> Co	99.9	5.27Y	1332.5	100.0			Activity
1173.3	<sup>132</sup> I	1.1	2.28H	1143.6	1.4	1290.8	1.1	<sup>132</sup> Te
1175.5	<sup>87</sup> Kr	1.1	76.3M	1740.6	2.0	845.5	7.3	Fission
1212.9	<sup>152</sup> Eu	1.4	13.3Y	1112.1	13.6	1299.2	1.6	Fallout
1235.4	<sup>136</sup> Cs	19.8	13.2D	818.6	99.8	1048.1	79.7	Fission
1238.1	<sup>214</sup> Bi	5.9	Long	1155.2	1.7	1281.0	1.5	<sup>238</sup> U
1274.5	<sup>22</sup> Na	99.9	2.60Y	511.0*	181.0			Cosmic
1274.5	<sup>154</sup> Eu	35.5	8.8Y	1004.8	17.9	1596.6	1.8	Fallout
1281.0	<sup>214</sup> Bi	1.5	Long	1238.1	5.9	1377.7	4.0	<sup>238</sup> U
1290.8	<sup>132</sup> I	1.1	2.28H	1173.3	1.1	1295.4	2.0	<sup>132</sup> Te
1291.6	<sup>59</sup> Fe	43.2	44.5D	1099.3	56.5	192.3	3.1	Activity
1293.6	<sup>41</sup> Ar	99.2	1.83H					Activity
1295.4	<sup>132</sup> I	2.0	2.28H	1290.8	1.1	1372.1	2.5	<sup>132</sup> Te
1299.2	<sup>152</sup> Eu	1.6	13.3Y	1212.9	1.4	1408.0	20.8	Fallout
1325.5	<sup>124</sup> Sb	1.6	60.2D	1045.1	1.9	1368.2	2.7	Fallout
1332.5	<sup>60</sup> Co	100.0	5.27Y	1173.2	99.9			Activity
1343.6	<sup>138</sup> Cs	1.1	32.2M	1147.3	1.2	1435.8	76.3	<sup>138</sup> Xe
1365.2	<sup>134</sup> Cs	3.0	2.06Y	1167.9	1.8	1038.6	1.0	Fission
1368.2	<sup>124</sup> Sb	2.7	60.2D	1325.5	1.6	1436.7	1.3	Fallout

TABLE OF  $\gamma$ -RAYS AND NUCLIDES COMMON TO ENVIRONMENTAL ANALYSES (Cont'd)

Energy	Nuclide	%	T 1/2	E2	%	E3	%	Origin
1368.6	<sup>24</sup> Na	100.0	14.7H	2754.1	99.9			Activity
1369.4	<sup>88</sup> Kr	1.5	2.84H	1141.4	1.3	1518.4	2.2	Fission
1372.1	<sup>132</sup> I	2.5	2.28H	1295.4	2.0	1398.6	7.1	<sup>132</sup> Te
1377.7	<sup>214</sup> Bi	4.0	Long	1281.0	1.5	1401.5	1.4	<sup>238</sup> U
1384.3	<sup>110m</sup> Ag	24.3	250D	1475.8	4.0	937.5	34.4	Activity
1398.6	<sup>132</sup> I	7.1	2.28H	1372.1	2.5	1442.5	1.4	<sup>132</sup> Te
1401.5	<sup>214</sup> Bi	1.4	Long	1377.7	4.0	1408.0	2.5	<sup>238</sup> U
1408.0	<sup>214</sup> Bi	2.5	Long	1401.5	1.4	1509.2	2.2	<sup>238</sup> U
1408.0	<sup>152</sup> Eu	20.8	13.3Y	1299.2	1.6	1212.9	1.4	Fallout
1435.8	<sup>138</sup> Cs	76.3	32.2M	1343.6	1.1	2218.0	15.2	<sup>138</sup> Xe
1436.6	<sup>124</sup> Sb	1.3	60.2D	1368.2	2.7	1691.0	47.1	Fallout
1442.5	<sup>132</sup> I	1.4	2.28H	1398.6	7.1	1921.1	1.2	<sup>132</sup> Te
1459.2	<sup>228</sup> Ac	1.1	Long	1499.0D	1.6	969.0	17.4	<sup>232</sup> Th
1460.8	<sup>40</sup> K	10.7	1.3E9					Natural
1475.8	<sup>110m</sup> Ag	4.0	250D	1384.3	24.3	1505.0	13.0	Activity
1499.0D	<sup>228</sup> Ac	1.6	Long	1459.2	1.1	1588.2	3.6	<sup>232</sup> Th
1505.0	<sup>110m</sup> Ag	13.0	250D	1475.8	4.0	1562.3	1.0	Activity
1509.2	<sup>214</sup> Bi	2.2	Long	1408.0	2.5	1661.3	1.2	<sup>238</sup> U
1518.4	<sup>88</sup> Kr	2.2	2.84H	1369.4	1.5	1529.8	10.9	Fission
1529.8	<sup>88</sup> Kr	10.9	2.84H	1518.4	2.2	2029.9	4.5	Fission
1588.2	<sup>228</sup> Ac	3.6	Long	1499.0D	1.6	1630.5	2.0	<sup>232</sup> Th
1596.5	<sup>140</sup> La	95.4	40.3H	487.0	45.9	2521.7	3.4	Fallout
1596.6	<sup>154</sup> Eu	1.7	8.8Y	1274.5	35.5	1004.8	17.9	Fallout
1620.7	<sup>212</sup> Bi	1.5	Long	727.3	6.7	785.5	1.1	<sup>232</sup> Th
1630.5	<sup>228</sup> Ac	2.0	Long	1588.2	3.6	1499.0D	1.6	<sup>232</sup> Th
1661.3	<sup>214</sup> Bi	1.2	Long	1509.2	2.2	1729.6	3.1	<sup>238</sup> U
1691.0	<sup>124</sup> Sb	47.1	60.2D	2090.9	5.5	1436.7	1.3	Fallout
1729.6	<sup>214</sup> Bi	3.1	Long	1764.5	15.9	1661.3	1.2	<sup>238</sup> U
1740.6	<sup>87</sup> Kr	2.0	76.3M	1175.5	1.1	2011.9	2.9	Fission
1764.5	<sup>214</sup> Bi	15.9	Long	1729.6	3.1	1847.4	2.1	<sup>238</sup> U
1768.4	<sup>138</sup> Xe	16.7	14.1M	1114.3	1.5	1850.9	1.4	Fission
1769.7	<sup>207</sup> Bi	6.9	32.2Y	1063.1	74.9	569.2	97.8	Fallout
1836.1	<sup>88</sup> Rb	21.4	17.8M	2677.9	2.0	898.1	14.1	<sup>88</sup> Kr
1836.1	<sup>88</sup> Y	99.4	107D	898.1	92.7			Other
1847.4	<sup>214</sup> Bi	2.1	Long	1764.5	15.9	2118.5	1.2	<sup>238</sup> U
1850.9	<sup>138</sup> Xe	1.4	14.1M	1768.4	16.7	2004.8	5.4	Fission
1921.1	<sup>132</sup> I	1.2	2.28H	1442.5	1.4	2002.4	1.1	<sup>132</sup> Te
2002.4	<sup>132</sup> I	1.1	2.28H	1921.1	1.2	1442.5	1.4	<sup>132</sup> Te
2004.8	<sup>138</sup> Xe	5.4	14.1M	1850.9	1.4	2015.9	12.3	Fission
2011.9	<sup>87</sup> Kr	2.9	76.3M	1740.6	2.0	2556.0D	13.1	Fission

TABLE OF  $\gamma$ -RAYS AND NUCLIDES COMMON TO ENVIRONMENTAL ANALYSES (Cont'd)

Energy	Nuclide	%	T 1/2	E2	%	E3	%	Origin
2015.9	<sup>138</sup> Xe	12.3	14.1M	2004.8	5.4	2079.3	1.4	Fission
2029.9	<sup>88</sup> Kr	4.5	2.84H	1529.8	10.9	2035.5	3.7	Fission
2035.5	<sup>88</sup> Kr	3.7	2.84H	2029.9	4.5	2195.8	13.2	Fission
2079.3	<sup>138</sup> Xe	1.4	14.1M	2015.9	12.3	2252.3	2.3	Fission
2090.9	<sup>124</sup> Sb	5.5	60.2D	1436.6	1.3	1691.0	47.1	Fallout
2118.5	<sup>214</sup> Bi	1.2	Long	1847.4	2.1	2204.1	5.0	<sup>238</sup> U
2195.8	<sup>88</sup> Kr	13.2	2.84H	2035.5	3.7	2231.8	3.4	Fission
2204.1	<sup>214</sup> Bi	5.0	Long	2447.7	1.6	2118.5	1.2	<sup>238</sup> U
2217.8	<sup>138</sup> Cs	15.2	32.2M	1435.8	76.3	2639.4	7.6	<sup>138</sup> Xe
2231.8	<sup>88</sup> Kr	3.4	2.84H	2195.8	13.2	2392.1	34.6	Fission
2252.3	<sup>138</sup> Xe	2.3	14.1M	2079.3	1.4	2015.9	12.3	Fission
2392.1	<sup>88</sup> Kr	34.6	2.84H	2231.8	3.4	2195.8	13.2	Fission
2447.7	<sup>214</sup> Bi	1.6	Long	2204.1	5.0	2118.5	1.2	<sup>238</sup> U
2521.7	<sup>140</sup> La	3.4	40.3H	1596.5	96.4	487.0	45.9	Fallout
2556D	<sup>87</sup> Kr	13.1	76.3M	2011.9	2.9	1740.6	2.0	Fission
2614.4	<sup>208</sup> Tl	35.8	Long	860.3	4.3	583.0	30.9	<sup>232</sup> Th
2639.4	<sup>138</sup> Cs	7.6	32.2M	2217.8	15.2	1435.8	76.3	<sup>138</sup> Xe
2677.9	<sup>88</sup> Rb	2.0	17.8M	1836.1	21.4	898.1	14.1	<sup>88</sup> Kr
2754.0	<sup>24</sup> Na	99.9	14.7H	1368.6	100.0			Activity
6129.2	<sup>16</sup> N	68.8	7.13S	7115.2	4.7			Other
7115.2	<sup>16</sup> N	4.7	7.13S	6129.2	68.8			Other