

<sup>152</sup>Eu – Comments on evaluation of decay data

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We used the *Limitation of Relative Statistical Weights* (LWM) method (1985ZiZY, 1992Ra08) for averaging quantities throughout this evaluation. This method provides a uniform approach for the analysis for discrepant data.

**Decay Scheme**

<sup>152</sup>Eu decays by electron capture (EC) to <sup>152</sup>Sm, and by β<sup>-</sup> to <sup>152</sup>Gd. Only excited levels are populated in the daughter nuclei since decay to the respective ground states are highly hindered by spin selection rules. Therefore, we used the sum of the total γ-ray transition emission probabilities (photons + electrons) to the ground states of <sup>152</sup>Sm and <sup>152</sup>Gd to normalize the decay scheme of <sup>152</sup>Eu. We have deduced the following branchings: 72.1(3)% (EC), and 27.9(3)% (β<sup>-</sup>). This normalization is virtually the same as that based on the measurement of the absolute γ-ray emission probabilities (See **Gamma Rays**).

**Nuclear Data**

We have considered the following measured values of the half-life of <sup>152</sup>Eu for deducing a recommended value.

1.	4934.1 (23) d	2004Sc04	Duration of measurement: about 26 years
2.	4936.6 (20) d	1998Si12	Duration of measurement: 20 years
3.	4948 (7) d	1997Ma75	Duration of measurement: about 2 years
4.	4945.5 (23) d	1992Un01	Duration of measurement: 13.5 years
5.	4943 (4) d	1986Wo05	
6.	4792(37) d	1983Ba29	
7.	4939 (6) d	1983Wa26	
8.	4892.3 (82) d	1980RuZX	
9.	4785 (19) d	1978La21	
10.	4821 (110) d	1972Em01	

Our recommended value of 4939 (6) d (or 13.522 (16) a) is a weighted average (LWM) ( $\chi^2/\nu=12$ ) of the results from 2004Sc04, 1997Ma75, 1992Un01, 1986Wo05, and 1980RuZX. Values given by 1978La21, 1972Em01, and 1983Ba29 have not been included because they significantly disagree with most of the other results, suggesting that they may have been affected by systematic uncertainties. 1983Wa26 and 1998Si12 have been superseded by 2004Sc04 (same research groups, PTB).

### Electron Capture, Positrons ( $\beta^+$ ), and $\beta^-$ Transitions

EC and positron transition energies to levels in <sup>152</sup>Sm have been deduced from  $Q(\text{EC}) = 1874.3$  (7) keV (1995Au04) and the individual level energies. Transition probabilities ( $P_{\text{EC}}$ ) are from  $\gamma$ -ray transition probability balance at each level. They are given as branchings ( $P_{\text{EC}} \times 100$ ) in Sections 2.1 – 2.3. Fractional atomic sub-shell electron-capture probabilities (i.e.,  $P_{\text{K}}$ ,  $P_{\text{L}}$ ,  $P_{\text{M}}$ ,  $P_{\text{N}}$ ) are theoretical values (1998Sc28) calculated with the computer program EC-CAPTURE [1].

Positrons are energetically possible and allowed by spin selection rules to the 121- and 366-keV levels only. Their transition probabilities, presented here as branchings ( $P_{\beta^+} \times 100$ ), have been deduced from theoretical  $\beta^+/\text{EC}$  ratios (1957Zw01).

$\beta^-$  endpoint energies for the decay to levels in <sup>152</sup>Gd have been deduced from  $Q(\beta^-) = 1818.8$  (11) keV (1995Au04). Their transition probabilities, presented here as branchings ( $P_{\beta^-} \times 100$ ), have been deduced from  $\gamma$ -ray transition probability balance at each level.

### Gamma Rays

Energies. The precise energies of strong  $\gamma$  rays given here are from 2000He14. These values are based on a revised energy scale that uses the new fundamental constants and wave lengths deduced from an updated value of the lattice spacing in Si crystals (1987Co39). All other (less precise) energies are values adjusted to the new energy scale and recommended in 1996Ar09 evaluation.

Emission Probabilities. For a  $\gamma$ -ray transition, its absolute transition probability (photons + electrons) is given by  $P_{\gamma}(1 + \alpha) \times 100$ , where  $P_{\gamma}$  is the absolute  $\gamma$ -ray emission intensity, and  $\alpha$ , its theoretical (1978Ro22, [4]) conversion coefficient. We have deduced the  $P_{\gamma}$  values used here as follows:

1 By averaging (LWM) the experimental relative emission intensities reported by 1970No06, 1970Ri19, 1971Ba63, 1972Ba05, 1977Ge12, 1980Sh15, 1984Iw03, 1986Me10, 1989Da12, 1990Me15, 1990St02, 1992Ya12, 1993Ka30, 1998Hw07, and from the fourteen measurements (ICRM01, ICRM02, ICRM08, ICRM10, ICRM12, ICRM15, ICRM16, ICRM17, ICRM18, ICRM20, ICRM25, ICRM27, ICRM28, and ICRM29) of the study participants [5] from the International Committee on Radioactivity Measurements (ICRM), which 1991BaZS considered reliable. These data are presented in Table 1 and Table 2.

2. By normalizing the above mentioned relative emission intensities to absolute values. We normalized these scales by using  $P_{\gamma}(1408) = 0.2085$  (8), which was determined from an inter-comparison of measured absolute emission intensities produced by participants from various laboratories and coordinated by the ICRM [5]. This value agrees very well with  $P_{\gamma}(1408) = 0.2086$  (21), deduced by evaluators from the sum of the relative  $\gamma$ -ray transition probabilities (photons + electrons) to the respective ground states of <sup>152</sup>Sm and <sup>152</sup>Gd. The larger uncertainty in the latter value is due mostly to that in the conversion coefficient of the 121-keV  $\gamma$ -ray (taken as 3%). We used 47.46 (20) for the relative intensity of the 1086-keV  $\gamma$  ray that de-excites the 1086-keV level in <sup>152</sup>Sm. We deduced this value from our recommended relative emission intensity of 48.63 (20) for the 1086-“doublet” (See Table 2) and subtracting 1.17 (4) for the contribution of the 1084-keV  $\gamma$  ray (1990Me15). The excellent agreement between these two normalizations confirms the completeness and self-consistency of the <sup>152</sup>Eu decay scheme and the good quality of our recommended data. We have preferred not to statistically combine these normalizations because of the correlations that exist between them. Absolute  $\gamma$ -ray emission intensities ( $P_{\gamma}$ ) are given in Section 4.1.

Conversion Coefficients. Values given in Section 2.3 are the result of theoretical calculations (1978Ro22, [4]), interpolated for the recommended transition energies presented here, and for adopted multiplicities and mixing ratios from the 1996Ar09 evaluation, uncertainties have been taken being 3 %. For transitions with E0 multipolarity, the adopted values are derived from experiments.

### Atomic Data

X-Rays. X-ray energies and relative emission probabilities are from Schönfeld and Rodloff [6]. Absolute X-ray emission probabilities have been calculated with the computer program EMISSION [2] using absolute  $\gamma$ -ray emission probabilities from Section 4.1, theoretical conversion coefficients (1978Ro22) from Section 2.3, and fluorescence yields from 1996Sc06. These calculated X-ray emission probabilities agree well with the experimental results shown in Table 2, and thus support the correctness of our recommended  $\gamma$ -ray data and the self-consistency of the <sup>152</sup>Eu decay scheme.

### Electron Emission

Conversion-electron energies are from  $\gamma$ -ray energies given in Section 4.2 and the atomic binding energies reported by Larkins [7]. Absolute electron emission intensities are from  $\gamma$ -ray emission probabilities given in Section 4.1, and the theoretical (1978Ro22) conversion coefficients presented in Section 2.3.

Energies of K-Auger electrons are from Schönfeld and Rodloff [8]. Absolute emission intensities of Auger electrons are values calculated with the computer program EMISSION [2] using absolute  $\gamma$ -ray emission intensities from Section 4.2, theoretical conversion coefficients (1978Ro22) given in Section 2.3, and the electron-capture probabilities presented in Section 2.1. The same emission probabilities, but renormalized to a scale where  $P_{KLL} = 1.0$ , are given as relative emission probabilities in Section 3.2.

### Total Average Radiation Energy

We show below the total average radiation energy released (by  $\beta^-$ ,  $\beta^+$ , neutrinos,  $\gamma$  rays, atomic electrons, and nuclear recoil) in the electron-capture and  $\beta^-$  decay of <sup>152</sup>Eu, as well as the total decay energies from mass differences, Q-values, and decay branchings (1995Au04).

	Total Average Radiation Energy* (keV)	Total Decay Energy <sup>&amp;</sup> (Q x branching) (keV)
<sup>152</sup> Eu EC decay	1345 (18)	1351 (6)
<sup>152</sup> Eu $\beta^-$ decay	508 (2)	507 (5)

\* Calculated with the computer program RADLST [3], and using the recommended radiation data given in this evaluation.

<sup>&</sup> Q-values (Q(EC) and Q( $\beta^-$ )) are from 1995Au04. Branchings are from this evaluation.

The agreement between these values confirms the quality, completeness, and self-consistency of the <sup>152</sup>Eu decay scheme presented in this evaluation.

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**Table 1. Relative g-Ray Emission Probabilities Evaluated in this Revision (Uncertainty given below the value)**

E(keV)	1970NO06	1970RI19	1971BA63	1972BA05	1977GE12	1980SH15	1984IW03	1986ME10	1989DA12	1990ME15	1990ST02	1992YA12	1993KA30	1998HW07*
<b>121.8</b>	145.0	138.5	132.9	144.6	141.0	140.6	136.9	136.7	139.0	136.2	136.6		133.5	136.9
	4.1	6.4	4.0	4.7	4.0	2.8	1.3	0.7	1.0	1.6	1.8		1.8	3.9
<b>125.7</b>										0.057	0.115			
										0.009	0.013			
<b>148.0</b>			0.077			0.154				0.190	0.218		0.231	
			0.026			0.013				0.040	0.026		0.026	
<b>166.9</b>											0.051		0.010	
											0.013		0.004	
<b>173.1</b>										0.002	0.038		0.081	
										0.001	0.013		0.003	
<b>192.6</b>										0.033	0.023	0.031	0.029	
										0.001	0.006	0.008	0.005	
<b>202.6</b>										0.018	0.028			
										0.009	0.006			
<b>207.6</b>			0.064	0.035		0.038				0.021	0.031	0.022	0.035	
			0.038	0.012		0.013				0.006	0.006	0.003	0.003	
<b>209.4</b>			0.077	0.038		0.026				0.021	0.038	0.027	0.026	
			0.038	0.026		0.013				0.006	0.013	0.003	0.013	
<b>212.6</b>		0.086	0.103	0.097		0.103				0.094	0.115		0.077	
		0.037	0.026	0.029		0.026				0.003	0.026		0.026	
<b>237.3</b>			0.051							0.045	0.064		0.012	
			0.026							0.004	0.026		0.004	
<b>239.4</b>				0.321							0.051		0.019	
				0.154							0.013		0.004	
<b>244.7</b>	39.4	36.2	35.8	36.4	36.6	35.8	36.2	36.5	36.5	35.9	38.0			36.8
	1.3	1.8	1.0	1.2	1.1	0.6	0.3	0.4	0.3	0.6	0.5			0.9
<b>251.6</b>		0.333	0.372	0.359		0.359				0.300	0.321		0.308	
		0.051	0.064	0.051		0.013				0.010	0.026		0.026	
<b>269.9</b>				0.015						0.039				
				0.006						0.004				

Comments on evaluation

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Eg(keV)	1970NO06	1970RI19	1971BA63	1972BA05	1977GE12	1980SH15	1984IW03	1986ME10	1989DA12	1990ME15	1990ST02	1992YA12	1993KA30	1998HW07*
271.1#		0.359	0.359	0.374		0.410				0.389	0.372		0.436	
		0.051	0.064	0.038		0.026				0.011	0.026		0.013	
275.5		0.141	0.154	0.154		0.218				0.161	0.205		0.128	
		0.038	0.038	0.013		0.026				0.050	0.026		0.013	
286.0										0.053	0.064		0.044	
										0.005	0.026		0.004	
295.9	2.37	1.94	2.09	2.04		2.06	2.13	2.22	2.12	2.11	2.21		2.08	
	0.19	0.12	0.14	0.06		0.05	0.04	0.04	0.02	0.05	0.06		0.05	
315.2#		0.218	0.237	0.228		0.308				0.253	0.231		0.231	
		0.038	0.043	0.040		0.026				0.008	0.038		0.038	
316.2			0.045	0.023						0.010				
			0.019	0.012						0.006				
320.0										0.008				
										0.003				
324.8		0.333	0.385	0.346		0.359				0.360	0.346			
		0.038	0.064	0.051		0.026				0.010	0.013			
329.4		0.564	0.615	0.577		0.628	0.707			0.590	0.603		0.410	
		0.051	0.103	0.064		0.038	0.015			0.010	0.026		0.038	
330.5				0.029						0.360				
				0.008						0.050				
340.4			0.103	0.117						0.130	0.141		0.182	
			0.051	0.012						0.030	0.038		0.010	
344.3	128.2	128.2	128.2	128.2	127.2	128.2	127.1	126.9	128.2	127.5	128.2		128.2	128.2
	3.6	5.9	3.8	4.2	1.3	2.6	0.7	0.9	0.8	0.9	1.7		1.8	2.9
351.7			0.077	0.086		0.103				0.043	0.090		0.103	
			0.026	0.018		0.026				0.003	0.026		0.026	
357.3										0.023			0.013	
										0.003			0.004	
367.8	3.78	4.04	4.14	4.08	4.19	4.15	4.13	4.14	4.18	4.05	4.05		4.04	4.13
	0.32	0.23	0.15	0.14	0.04	0.09	0.04	0.07	0.04	0.08	0.06		0.08	0.10
379.4										0.004	0.051			
										0.001	0.013			

Comments on evaluation

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Eg(keV)	1970NO06	1970RI19	1971BA63	1972BA05	1977GE12	1980SH15	1984IW03	1986ME10	1989DA12	1990ME15	1990ST02	1992YA12	1993KA30	1998HW07*
385.7				0.109						0.024	0.269		0.167	
				0.049						0.003	0.026		0.026	
387.9										0.014	0.017		0.018	
										0.001	0.006		0.005	
391.3										0.006				
										0.001				
395.0											0.038		0.026	
											0.013		0.013	
406.7										0.004				
										0.001				
411.0	10.14	10.32	10.77	10.59	10.71	10.55	10.84	10.73	10.80	10.70	10.82		10.72	10.70
	0.54	0.51	0.38	0.27	0.11	0.22	0.07	0.10	0.10	0.10	0.15		0.23	0.29
416.0		0.487	0.513	0.500		0.513				0.530	0.526		0.500	
		0.051	0.064	0.051		0.026				0.010	0.026		0.026	
423.5										0.013	0.027	0.022	0.013	
										0.003	0.006	0.010	0.005	
440.9										0.052			0.069	
										0.009			0.006	
444.0		13.2	13.5	13.6										
		0.8	0.5	0.8										
444.0		1.15	1.67	1.28										
		0.38	0.26	0.26										
444.0@	15.47	14.36	15.13	14.87	15.00	14.95	15.01	14.81	14.90	14.80	15.06		15.18	13.78
	0.33	0.86	0.57	0.81	0.15	0.13	0.11	0.13	0.20	0.20	0.22		0.22	0.39
482.3		0.141	0.115	0.128		0.167				0.130	0.154			
		0.026	0.026	0.026		0.013				0.010	0.026			
488.7		1.90	1.95	1.91	1.98	1.95	2.03		1.95	1.95	2.01		1.95	1.97
		0.12	0.13	0.06	0.02	0.03	0.02		0.04	0.02	0.04		0.05	0.05
493.5		0.115	0.154	0.218		0.179				0.190	0.179		0.103	
		0.051	0.038	0.038		0.026				0.010	0.026		0.026	
496.3				0.038		0.051				0.044	0.064		0.040	
				0.015		0.013				0.003	0.026		0.009	

Comments on evaluation

<sup>152</sup>Eu

Eg(keV)	1970NO06	1970RI19	1971BA63	1972BA05	1977GE12	1980SH15	1984IW03	1986ME10	1989DA12	1990ME15	1990ST02	1992YA12	1993KA30	1998HW07*
503.5		0.705	0.718	0.705		0.718	0.768			0.730	0.782		0.474	
		0.038	0.077	0.038		0.026	0.018			0.010	0.051		0.256	
520.2		0.231	0.269	0.256		0.282				0.257	0.231			
		0.051	0.038	0.038		0.026				0.007	0.026			
523.1			0.051	0.031						0.071	0.103		0.096	
			0.026	0.010						0.004	0.038		0.123	
526.9			0.051	0.046		0.064				0.063	0.077		0.060	
			0.026	0.014		0.026				0.003	0.026		0.029	
534.4			0.179	0.179										
			0.051	0.051										
535.4#		0.205	0.218	0.205		0.231				0.206	0.192		0.167	
		0.051	0.053	0.052		0.026				0.005	0.038		0.026	
538.3										0.020				
										0.003				
556.6										0.091	0.077			
										0.005	0.013			
556.5#			0.115	0.090		0.051				0.110	0.128		0.090	
			0.026	0.026		0.026				0.006	0.018		0.013	
557.9										0.019	0.051			
										0.004	0.013			
561.2				0.013						0.005				
				0.006						0.001				
562.9				0.18										
				0.06										
564.0#		2.40	2.46	2.38		2.31	2.43		2.36	2.36	2.32			
		0.19	0.19	0.09		0.06	0.04		0.06	0.05	0.05			
566.4		0.526	0.564	0.577		0.679	0.640			0.620	0.551		0.697	
		0.128	0.128	0.051		0.038	0.060			0.010	0.026		0.022	
571.8										0.023			0.025	
										0.004			0.008	
586.3		2.08	2.28	2.22	2.24	2.27	2.19		2.22	2.20	2.24			2.14
		0.27	0.14	0.09	0.05	0.05	0.08		0.05	0.05	0.05			0.05



Comments on evaluation

<sup>152</sup>Eu

Eg(keV)	1970NO06	1970RI19	1971BA63	1972BA05	1977GE12	1980SH15	1984IW03	1986ME10	1989DA12	1990ME15	1990ST02	1992YA12	1993KA30	1998HW07*
728.0				0.044		0.051				0.054	0.064	0.051	0.064	
				0.009		0.013				0.050	0.026	0.013	0.013	
735.4										0.028				
										0.005				
756.1										0.026			0.301	
										0.004			0.013	
764.9		0.821	0.910	0.885			0.950			0.840	0.962		0.936	
		0.141	0.103	0.115			0.050			0.040	0.051		0.038	
768.9		0.372	0.397	0.346		0.410				0.430	0.500		0.449	
		0.103	0.064	0.038		0.038				0.040	0.038		0.038	
778.9		59.7	62.6	59.9	62.6	62.5	62.16	62.1	62.2	61.9	62.1		62.5	63.7
		2.9	1.4	0.7	0.6	1.2	0.22	0.5	0.4	0.8	0.9		1.3	1.4
794.8		0.192	0.141	0.141		0.192				0.118	0.192		0.136	
		0.051	0.064	0.090		0.026				0.006	0.038		0.014	
805.7				0.077						0.061	0.090		0.050	
				0.026						0.005	0.026		0.009	
810.5		1.38	1.56	1.50		1.55	1.56		1.51	1.52	1.55		1.50	
		0.12	0.10	0.06		0.05	0.04		0.02	0.02	0.04		0.03	
839.4			0.077	0.079						0.079	0.064		0.077	
			0.038	0.045						0.005	0.013		0.013	
841.6			0.769	0.769						0.780	0.769		0.859	
			0.090	0.115						0.010	0.038		0.051	
867.4		19.23	20.09	19.31	20.54	20.29	20.33	20.36	20.40	19.90	20.33		20.45	20.92
		0.90	0.49	0.35	0.21	0.51	0.10	0.17	0.30	0.40	0.27		0.42	0.48
896.6											0.269		0.323	
											0.051		0.010	
901.2		0.295	0.385	0.359		0.346	0.400			0.440	0.397		0.449	
		0.090	0.064	0.077		0.038	0.050			0.030	0.038		0.038	
906.0										0.072			0.087	
										0.006			0.008	
919.3		1.88	2.06	1.91		2.14	2.08		2.09	2.09	2.04		2.05	2.05
		0.14	0.24	0.07		0.06	0.06		0.04	0.05	0.05		0.06	0.12

Comments on evaluation

<sup>152</sup>Eu

Eg(keV)	1970NO06	1970RI19	1971BA63	1972BA05	1977GE12	1980SH15	1984IW03	1986ME10	1989DA12	1990ME15	1990ST02	1992YA12	1993KA30	1998HW07*
926.3		1.167	1.308	1.218		1.333	1.380		1.290	1.270	1.346		1.359	1.340
		0.103	0.128	0.115		0.051	0.060		0.040	0.040	0.641		0.051	0.058
930.6		0.308	0.333	0.346		0.359	0.370			0.350	0.385		0.308	
		0.077	0.064	0.051		0.038	0.060			0.010	0.038		0.038	
937.1				0.010						0.015	0.051			
				0.004						0.005	0.026			
958.6			0.064	0.077		0.064				0.110	0.103			
			0.038	0.038		0.026				0.010	0.038			
963.4			0.628	0.487										
			0.103	0.103										
964.1#		67.44	69.86	68.08	70.40	70.45	70.14	71.03	70.50	69.20	69.67		70.50	67.96
		3.33	1.79	1.79	0.70	1.41	0.23	0.40	0.60	0.90	0.95		1.49	1.93
974.1			0.045	0.051		0.064				0.069	0.090		0.065	
			0.019	0.013		0.013				0.005	0.026		0.009	
990.2		0.167	0.128	0.154		0.179				0.148	0.167		0.179	
		0.051	0.064	0.051		0.026				0.006	0.038		0.038	
1001.1										0.019			0.023	
										0.009			0.005	
1005.3		3.04	3.13	3.00	3.57	3.59	3.08		3.35	3.10	3.46		2.73	3.11
		0.31	0.32	0.21	0.07	0.13	0.02		0.04	0.07	0.13		0.12	0.13
1086.0		47.69	50.64	47.59	48.70	49.62	48.15	47.84	49.60	48.70	49.19		49.60	47.96
		2.82	1.54	0.86	0.50	1.28	0.16	0.31	0.40	0.80	0.67		0.94	1.06
1089.7		8.00	8.46	7.90	8.26	8.59	8.35	8.19		8.20	7.97		8.19	8.19
		0.64	0.77	0.37	0.09	0.26	0.04	0.10		0.10	0.51		0.17	0.19
1109.2			0.897	0.808			1.000			0.880				
			0.385	0.179			0.050			0.020				
1112.0#		63.59	65.77	63.99	65.00	65.64	65.67	65.45	65.90	65.80	65.23		62.47	
		3.21	1.85	0.87	0.70	1.28	0.22	0.78	0.50	0.90	0.99		1.12	
1112.0			64.87	63.18			64.67			64.90				
			1.79	0.86			0.21			0.90				
1139.0										0.006			0.006	
										0.002			0.002	



Comments on evaluation

<sup>152</sup>Eu

Eg(keV)	1970NO06	1970RI19	1971BA63	1972BA05	1977GE12	1980SH15	1984IW03	1986ME10	1989DA12	1990ME15	1990ST02	1992YA12	1993KA30	1998HW07*
1605.6		0.035	0.038	0.037		0.051				0.036	0.038	0.044	0.041	
		0.008	0.008	0.008		0.013				0.003	0.013	0.004	0.009	
1608.4		0.029	0.023	0.027						0.024	0.027	0.029		
		0.006	0.008	0.006						0.002	0.006	0.004		
1635.2										0.0007				
										0.0002				
1643.6		0.024				0.005								0.009
		0.005				0.003								0.003
1647.4		0.033	0.028	0.031		0.038					0.041	0.024	0.031	
		0.006	0.006	0.006		0.013					0.006	0.004	0.003	
1674.3										0.029				
										0.004				
1769.0		0.042	0.041	0.042		0.038				0.042	0.038	0.049	0.046	
		0.004	0.006	0.005		0.013				0.003	0.013	0.003	0.006	

\* Evaluators considered unwarranted the precision of the values given by 98Hw07. Their uncertainties have been doubled.

# Value includes the contribution from the weakest component of the doublet.

@ Value is the sum of the components of the doublet.

**Table 1. Relative g-Ray Emission Probabilities Evaluated in this Revision (Uncertainty given below the value), continuation**

Eg (keV)	ICRM01	ICRM02	ICRM08	ICRM10	ICRM12	ICRM15	ICRM16	ICRM17	ICRM18	ICRM20	ICRM25	ICRM27	ICRM28	ICRM29
<b>121.8</b>	135.0	135.7	136.4	131.5	135.8		133.4		139.2	137.0		136.4	132.5	134.8
	1.9	0.8	0.5	4.3	0.9		1.4		2.9	1.0		3.0	2.9	2.0
<b>244.7</b>	35.5	35.5	36.3	36.2	35.9		36.3	36.7		35.7	35.7		36.3	36.4
	0.5	0.3	0.2	1.0	0.5		0.3	1.1		0.4	0.4		0.7	0.4
<b>344.3</b>	128.9	127.2	127.4	123.9	127.6	130.6	130.4	127.1		127.2	126.7	126.2	128.9	128.8
	1.5	0.8	0.6	2.8	0.4	2.9	1.2	1.1		1.0	1.1	3.4	2.4	1.3
<b>411.0</b>	10.46	10.67	10.80	10.27	10.75	10.77	10.90	10.71	10.90	10.72	10.90	10.62	10.72	10.86
	0.16	0.07	0.06	0.22	0.04	0.12	0.12	0.11	0.23	0.10	0.33	0.67	0.26	0.12
<b>444.0@</b>	14.68	14.84	14.96	14.35	15.07	15.25	15.33	14.88	15.3	14.95	14.73	14.64	15.15	15.22
	0.21	0.09	0.07	0.4	0.06	0.12	0.18	0.15	0.26	0.13	0.43	0.89	0.32	0.15
<b>778.9</b>	62.4	62.6	62.25		62.12	62.6	62.4	62.6	61.8	61.9	61.1	61.0	62.0	62.4
	0.8	0.4	0.19		0.23	0.4	1.2	0.6	1.2	0.4	0.9	1.0	1.0	0.5
<b>964.1</b>	69.62	69.82	70.10		70.41	70.40	69.80	70.30	69.90	70.30	70.90	69.30	68.40	70.10
	0.84	0.42	0.23		0.22	0.60	0.90	0.70	1.00	0.40	1.00	1.00	1.10	0.50
<b>1086.0</b>	48.89	48.61	49.13	47.43	48.83	49.10	47.90	48.70	48.90	48.40		48.50		48.59
	0.59	0.29	0.19	0.60	0.14	0.40	0.60	0.50	0.50	0.30		0.90		0.30
<b>1112.0</b>	64.28	64.45	65.25	64.00	65.26	65.70	64.70	64.30	66.70	64.90	67.20	64.50	65.50	65.30
	0.77	0.32	0.27	0.80	0.20	0.70	0.40	0.60	0.80	0.50	0.90	1.10	1.00	0.50
<b>1408.0</b>	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	1.2	0.5	0.3	1.5	0.3	0.9	0.9	1.0	1.2	0.5	1.2	1.5	2.3	0.7

  

Eg (keV)	ICRM30	ICRM31	ICRM34	ICRM35
<b>121.8</b>	136.8	135.5	138.9	134.9
	4.1	2.0	4.3	1.2
<b>244.7</b>	37.9	35.6		36.4
	1.2	0.5		0.2
<b>344.3</b>	132.7	126.6	133.9	126.4
	4.0	1.3	5.5	0.9
<b>411.0</b>	11.21	10.52	11.18	10.57
	0.39	0.14	0.53	0.08
<b>444.0</b>		14.89	16.15	14.81
		0.19	0.73	0.16

  

Eg (keV)	ICRM30	ICRM31	ICRM34	ICRM35
<b>778.9</b>	61.2	61.3	64.2	62.0
	1.9	0.7	2.1	0.5
<b>964.1</b>	69.80	70.00	71.20	69.90
	2.20	0.80	2.30	0.50
<b>1086.0</b>	50.70	48.00	50.00	
	1.50	0.50	1.20	
<b>1112.0</b>	64.70	65.40	66.50	64.20
	2.00	0.80	1.50	0.70
<b>1408.0</b>	100.0	100.0	100.0	100.0
	3.0	1.0	2.9	1.2

**Table 2. Recommended Relative g-Ray Emission Probabilities (Uncertainty given below the value).**

<b>E<sub>g</sub>(keV)</b>	<b>Recommended</b>	<b>c2/n</b>	<b>Remarks</b>	<b>E<sub>g</sub>(keV)</b>	<b>Recommended</b>	<b>c2/n</b>	<b>Remarks</b>	<b>E<sub>g</sub>(keV)</b>	<b>Recommended</b>	<b>c2/n</b>	<b>Remarks</b>
121.8	136.35	1.3		271.1	0.374	1.9	[2]	379.4	0.004		[5]
	0.25				0.014				0.001		
125.7	0.09	9.9		275.5	0.155	2.3		385.7	0.024		[6]
	0.03				0.008				0.003		
148.0	0.166	5.8		286.0	0.048	1.2		387.9	0.0142		[5]
	0.024				0.003				0.0010		
166.9			[18]	295.9	2.123	1.6		391.3	0.006		[13]
					0.013				0.001		
173.1			[18]	315.2	0.238	1.1	[3]	395.0			[18]
					0.008						
192.6	0.0326	1.1		316.2	0.015		[3]	406.7	0.004		[13]
	0.0010				0.005				0.001		
202.6			[18]	320.0	0.008		[13]	411.0	10.735	0.95	
					0.003				0.020		
207.6	0.0285	2.1		324.8	0.354	0.27		416.0	0.523	0.4	
	0.0019				0.007				0.008		
209.4	0.0266	0.60		329.4	0.62	11		423.5	0.0155	1.7	
	0.0025				0.03				0.0023		
212.6	0.094	0.23		330.5	0.029		[4]	440.9	0.064	2.5	
	0.003				0.008				0.005		
237.3	0.012		[1]	340.4	0.151	4.6		444.0	13.46		[7]
	0.004				0.016				0.09		
239.4	0.036	3.2		344.3	127.53	0.66		444.0	1.53		[7]
	0.016				0.20				0.09		
244.7	36.23	1.5		351.7	0.067	2.2		444.0	14.99	1.2	[7]
	0.08				0.011				0.03		
251.6	0.322	2.4		357.3	0.0194	4.0		482.3	0.141	1.3	
	0.007				0.0024				0.008		
269.9	0.029	8.0		367.8	4.136	0.77		488.7	1.985	1.8	
	0.012				0.018				0.008		

Eg(keV)	Recommended	c2/n	Remarks	Eg(keV)	Recommended	c2/n	Remarks	Eg(keV)	Recommended	c2/n	Remarks
493.5	0.178	2.1		571.8	0.023	0.10		719.3	1.29	0.33	[12]
	0.016				0.004				0.06		
496.3	0.044	0.31		586.3	2.215	0.57		719.3	0.282	0.0	[12]
	0.004				0.019				0.035		
503.5	0.735	1.0		595.6	0.015		[11]	728.0	0.051	0.37	
	0.008				0.008				0.006		
520.2	0.257	0.46		616.1	0.044	0.32		735.4	0.028		[13]
	0.006				0.003				0.005		
523.1	0.054	2.7		644.4	0.030	0.65		756.1	0.026		[13]
	0.010				0.003				0.004		
526.9	0.062	0.39		656.5	0.689	0.63		764.9	0.912	0.94	
	0.003				0.008				0.021		
534.4	0.176	0.56	[8]	664.8	0.046	6.6		768.9	0.424	1.5	
	0.009				0.014				0.016		
535.4	0.029		[8]	671.3	0.093	1.3		778.9	62.17	0.8	
	0.010				0.006				0.09		
538.3	0.020			674.7			[18]	794.8	0.126	2.3	
	0.003								0.005		
556.6			[18]	675.0	0.897	1.3		805.7	0.060	1.0	
					0.021				0.004		
556.5	0.085	1.7	[9]	678.6	2.256	1.3		810.5	1.519	0.57	
	0.005				0.015				0.011		
557.9	0.021	5.5	[9]	686.6	0.096	2.1		839.4	0.077	0.29	
	0.003				0.008				0.004		
561.2	0.0052	1.7		688.7	4.037	0.60		841.6	0.782	0.62	
	0.0010				0.021				0.009		
562.9	0.18		[4]	696.9	0.014		[11]	867.4	20.35	1.3	
	0.06				0.005				0.07		
564.0	2.19		[10]	703.3	0.025	3.6		896.6	0.321	1.0	
	0.06				0.004				0.010		
566.4	0.628	3.2		712.8	0.461	0.48		901.2	0.404	1.0	
	0.018				0.009				0.016		



**REMARKS**

- Evaluator's recommended relative  $\gamma$ -ray emission probabilities deduced using the *Limitation of Relative Statistical Weights* method, unless otherwise specified.
- For absolute intensity per 100 disintegrations, multiply by 0.2085 (8).

- [1]. From 1993Ka30.
- [2].  $I_\gamma =$  weighted average (  $I_\gamma(271)$  doublet ) -  $I_\gamma(269) = 0.403$  (7) - 0.029 (12) = 0.374 (14).  $\chi^2/\nu = 1.9$ .
- [3].  $I_\gamma =$  weighted average (  $I_\gamma(315)$  doublet ) -  $I_\gamma(316) = 0.253$  (7) - 0.015 (5) = 0.238 (8).  $\chi^2/\nu = 1.1$ .
- [4]. From 72Ba05.
- [5]. From 1990Me15. Value agrees with <0.006 (1990St02).
- [6]. From 1990Me15. Author removed double-escape contribution from 1408-keV  $\gamma$  ray.
- [7].  $I_\gamma =$  weighted average (  $I_\gamma(444)$  doublet ) -  $I_\gamma(444, 810 \text{ level}) = 14.99$  (3) - 1.53 (9) = 13.46 (9).  
 $\chi^2/\nu = 1.2$ .  $I_\gamma(444, 810 \text{ level})$  is from <sup>152</sup>Eu(9.3h) EC decay branching.
- [8]  $I_\gamma =$  weighted average (  $I_\gamma(535)$  ) -  $I_\gamma(534) = 0.205$  (5) - 0.176(9)=0.029(10)
- [9].  $I_\gamma =$  weighted average (  $I_\gamma(556.5)$  doublet ) - weighted average  $I_\gamma(557.8) = 0.106$  (5) - 0.021 (4) = 0.085 (6)
- [10].  $I_\gamma =$  weighted average (  $I_\gamma(563.8)$  doublet ) -  $I_\gamma(562.9) = 2.37$  (2) - 0.18 (6) = 2.19 (6).  $\chi^2/\nu = 0.64$ .  
 $I_\gamma(562.9) = 2.37$  (2) from transition intensity balance.
- [11]. From 1993Ka30, close to upper limit of <sup>92</sup>Yb12.
- [12].  $I_\gamma =$  weighted average (  $I_\gamma(719)$  doublet,  $\chi^2/\nu = 3.4$  ) - weighted average  $I_\gamma(719.4) = 1.57$  (2) - 0.282 (35) = 1.29 (6).
- [13]. From 1990Me15.
- [14].  $I_\gamma =$  weighted average (  $I_\gamma(964)$  doublet ) -  $I_\gamma(963) = 70.19$  (10) - 0.644 (9) = 69.55 (10).  
 $I_\gamma(963) = 0.644$  (9) is from <sup>152</sup>Eu(9.3h) EC decay branching.
- [15].  $I_\gamma =$  weighted average (  $I_\gamma(1112)$  doublet,  $\chi^2/\nu = 1.5$  ) - weighted average  $I_\gamma(1109, \chi^2/\nu = 1.7) = 65.19$  (9) - 0.895 (18) = 64.30 (9)
- [16]. Weighted average of values from 1980Sh15 and 1993Ka30.
- [17]  $I_\gamma = I_\gamma(1084) + I_\gamma(1086) = 1.17$  (4) (1990Me15) + 47.46 (20) = 48.63 (20)
- [18]. Existence is uncertain.

**Table 3. Absolute Emission Probabilities of KX Rays**

<b>P<sub>KX</sub>*</b>	<b>70No06</b>	<b>Faerman<sup>†</sup></b>	<b>72Da23</b>	<b>Bylov<sup>‡</sup></b>	<b>79De36, 83De11</b>	<b>85Se18</b>	<b>86Me10</b>	<b>93Ka30</b>	<b>P<sub>KX</sub> (Avg.)<sup>&amp;</sup></b>	<b>P<sub>KX</sub>(Cal.)<sup>@</sup></b>
Sm KA	0.492(35)	0.592(21)	0.501(16)	0.595(9)	0.591(12)	0.595(9)	0.589(9)	0.595(90)	0.584(11)	0.585(7)
Sm KB	0.122(9)	0.173(9)	0.122(8)	0.143(8)	0.149(3)	0.143(8)	0.144(2)	0.137(5)	0.144(3)	0.1482(24)
Gd KA			0.0068(2)	0.00636(14)	0.00648(22)	0.00636(14)	0.00459(11) <sup>#</sup>		0.00645(8)	0.00680(18)
Gd KB			0.00167(50)	0.00163(4)	0.00176(18)	0.00163(4)	0.00171(3)		0.00167(2)	0.00174(5)

\* Absolute emission probabilities renormalized to Pg(121)=0.2841(13), Pg(344)=0.2658(12), or Pg(1408)=0.2084(9).

& Weighted average (LWM).

# Outlier, not used for calculating the average.

† Faermann S, Notea A., Segal Y., Trans. Am. Nuc. Soc. 14, 500 (1971).

‡ Bylov T., Osipenko B.D., Chudin V.G., EchA Ya no. 9, 1350 (1978) (quoted by 85Se18).

@ Calculated by evaluators using recommended  $\gamma$ -ray data and K-fluorescence yields.