^{57}Co - Comments on evaluation of decay data by V. P. Chechev and N. K. Kuzmenko

This evaluation was originally completed in October 2001 (2004BeZR) and then was updated in August 2014 to include new references on the ^{57}Co half-life and decay energy and new internal conversion coefficients and thus to re-evaluate the half-life and to correct nuclear transition energies and gamma ray transition and emission probabilities.

1. Decay Scheme

The 2nd forbidden electron capture (EC) transitions to the $3/2^-$ excited levels of 14.413 keV and 366.74 keV have not been observed, as well as the 2nd forbidden unique EC transition to the $1/2^-$ ground state of ^{57}Fe. From the log ft systematics the log ft of the 2nd forbidden transitions should be greater than 11.1 and 10.8, respectively, and for the 2nd forbidden unique transition, greater than 12.9. From these, the upper limits on the EC branch probabilities to the 14.413 keV level and ground state of ^{57}Fe are obtained as < 0.003% and < 0.00035%, and for the EC branch to the 366.74 keV level < 0.002%. The calculations of the level probability balance in the decay scheme of ^{57}Co were made not taking into account the first two unobserved transitions. The EC branch probabilities to the levels of 136.47 keV, 366.74 keV and 706.42 keV were obtained from the probability balance of the gamma transitions.

2. Nuclear Data

Q value is from 2012 mass evaluation by Wang *et al.* (2012Wa38).

The recommended half-life of ^{57}Co is based on the experimental results given in Table 1.

Table 1. Experimental values of the ^{57}Co half-life (in days).

N	Author(s) and year	Reference	$T_{1/2}$ (d)	Method and comments
1	Anspach *et al.* (1965)	1965An07	271.65 (13)	4πγ ionization chamber; *omitted* as superseded by 7
2	Emery *et al.* (1972)	1972Em01	269.84 (4)	NaI; *omitted* on the Chauvenet's criterion

3	Lagoutine *et al.* (1972)	1972La14	271.23 (21)	Ionization chamber; *omitted* on the Chauvenet's criterion
4	Houtermans *et al.* (1980)	1980Ho17	271.77 (5)	4πγ ionization chamber
5	Vaninbroukx *et al.* (1981)	1981Va11	271.90 (9)	NaI(Tl), Si(Li) detectors
6	Walz *et al.* (1983)	1983Wa26	271.84 (4)	4πγ pressurized ionization chamber
7	Unterweger *et al.* (1992)	1992Un01	272.11 (26)	4πγ ionization chamber; *omitted* as superseded by 9
8	Martin *et al.* (1997)	1997Ma75	271.68 (9)	4πγ ionization chamber
9	Fitzgerald (2012)	2012Fi12	271.65 (13)	4πγ ionization chamber; *omitted* as superseded by 11
10	Silva *et al.*(2012)	2012Da06	271.82 (17)	4πγ ionization chamber
11	Unterweger and Fitzgerald (2014)	2014Un01	271.87 (44)	4πγ ionization chamber
Recommended value			**271.81 (4)**	**LWM**

The value 2, 3 have been rejected by the LWEIGHT computer program based on the Chauvenet's criterion.

The values 1, 7, 9 were not used because they were replaced ultimately by later result of the same laboratory.

For remaining 6 values, the unweighted average is 271.813 d, the weighted average is 271.809 d, the reduced- $\chi^2 / (\chi^2)_{crit}$ value is 0.86/3.00, the internal uncertainty is 0.028 d, and the external uncertainty is 0.026 d. The largest contributions to the weighted average give the values 2 (48%) and 4 (30%), respectively. The LWEIGHT program using the limitation of relative statistical weight method (LWM) has chosen the weighted average and internal uncertainty. The smallest experimental uncertainty (0.04 d) is adopted as the recommended uncertainty.

The recommended value of the ^{57}Co half-life is **271.81 (4) days**.

2.1. Electron Capture Transitions

The energies of the electron capture, ε, transitions have been calculated from the Q value and the level energies which have been deduced from gamma transition energies.

Table 2. ^{57}Fe levels populated in the ^{57}Co ε – capture.

Level	Energy (keV)	Multipolarity	Half-life	Pε (%)
0	0	1/2−	Stable	< 0.00035
1	14.41295 (31)	3/2−	98.0 (4) ns	< 0.003
2	136.47374 (29)	5/2−	8.6 (4) ns	99.82 (20)
3	366.74 (3)	3/2−	10.5 (14) ps	< 0.002
4	706.42 (2)	5/2−	4.1 (11) ps	0.183 (7)

Table 3. The measured and adopted half-lives for two excited levels in ^{57}Fe (ns)

N	Reference	Half-life (14.413 keV level)	Half-life (136.474 keV level)
1	1960Fe06		8.6 (8)
2	1961Cl11	97.9 (2)	
3	1961Ho05		8.8 (4)
4	1965Ki03	98 (1)	
5	1966Ec05	97.7 (2)	
6	1969Ho28	99.3 (5)	
7	1969Ja18		8.5 (4)
8	1978AlZX	97.8 (14)	9.0 (7)
9	1995Ah04	99.2 (4)	
10	2006Mo26	98.1 (3)	8.0 (9)
Adopted (LWM)		**98.0 (4)**	**8.6 (4)**

The half-lives of the excited levels (136.474 and 14.413 keV) have been evaluated using the experimental data presented in Table 3.

For the 14.413 keV-level, the unweighted average is 98.29 ns, the weighted average is 98.05 ns, the reduced-$\chi^2 / (\chi^2)_{crit}$ value is 3.0/2.8, the internal uncertainty is 0.12 ns, and the external uncertainty is 0.20 ns. The largest contributions to the weighted average give the values 2 (34%) and 5 (34%), respectively. The LWEIGHT program using the limitation of relative statistical weight method (LWM) has chosen the weighted average and expanded the uncertainty (up to 0.35 ns) so to include the precise value 5 of 97.7 (2) ns. The recommended value of the 14.413 keV-level half-life is **98.0 (4) ns.**

For the 136.474 keV-level, the unweighted average is 8.58 ns, the weighted average is 8.64 ns, the reduced- χ^2 / $(\chi^2)_{crit}$ value is 0.26/3.30, the internal uncertainty is 0.24 ns, and the external uncertainty is 0.12 ns. The largest contributions to the weighted average give the values 3 (36%) and 7 (36%), respectively. The LWEIGHT program using the limitation of relative statistical weight method (LWM) has chosen the weighted average and internal uncertainty. The smallest experimental uncertainty (0.4 d) is adopted as the recommended uncertainty. The recommended value of the 136.474 keV-level half-life is **8.6 (4) ns.**

The J^π values and half-lives for the remaining excited levels ^{57}Fe are from Adopted Levels in Nuclear Data Sheets (1998Bh11).

The electron capture probabilities of $\varepsilon_{0,2}$, $\varepsilon_{0,3}$ and $\varepsilon_{0,4}$ have been deduced from the (γ+ce) - intensity balance at the 136.47 keV, 366.74 keV and 706.42 keV levels, respectively, using the evaluated Pγ+ce values and assuming negligible intensity of the EC transitions to the 14.413 keV level and the ground state of ^{57}Fe. The sum of Pγ+ce for the 4 gamma transitions to the ground state of ^{57}Fe is (99.986 ± 0.22) %.

The P_K, P_L, P_M values have been obtained from the tables of Schönfeld (1998Sc28). The experimental P_K values are available for $\varepsilon_{0,2}$ EC transition to the level of 136.47 keV: 0.885 (9) in 1968Ru04; 0.87 (2) in 1969Bo49; 0.922 (10) in 1973Mukerji and 0.89 (4) in 1990Si03.

The log ft values are from the LOGFT code.

2.2. Gamma Transitions and Internal Conversion Coefficients

The evaluated energies of gamma transitions are the energies of the gamma rays plus the recoil energy.

Gamma ray transition probabilities have been deduced from their gamma ray emission intensities and the total conversion coefficients ICC(s). The adopted ICC(s) are the theoretical values interpolated by the BrIcc computer program (2008Ki07) from the tables of Band et al. (2002Ba85), accepting the “frozen orbital (no hole)” approximation.

The probabilities of gamma ray transitions Pγ+ce have been computed using the evaluated absolute gamma ray emission intensities and the total internal conversion coefficients (ICC) except for Pγ+ce of $\gamma_{1,0}$ transition deduced from decay scheme probability balance at the 14.413-keV level.

The ICC(s) for gamma ray transitions with mixed multipolarities have been evaluated using the experimental information on the multipolarity admixture coefficients. The values of δ (E2/M1) have been adopted from the analysis of 1978Kr19 except for $\gamma_{2,1}$ which is obtained by weighting the 4 values of + 0.120 from 1972Fo05, + 0.116 (1) from 1973Sc15, + 0.1195 (10) from 1975Co22, and + 0.120 (4) from 1972Kr15 (see also the evaluation of 1998Bh11). The weighted average of δ (E2/M1) for $\gamma_{2,1}$ is + 0.1180 (12). The adopted values of δ (E2/M1) for other gamma transitions are 0,00223 (18) for $\gamma_{1,0}$; + 0.02 for $\gamma_{3,2}$; + 0.083 (5) for $\gamma_{4,3}$; + 0.025 (9) for $\gamma_{3,1}$; – 0,45 (5) for $\gamma_{3,0}$; + 0.097 (8) for $\gamma_{4,2}$; and – 0.465 (8) for $\gamma_{4,1}$.

There are many experimental values of ICC and the ratios of the fractional intensities of conversion electrons for $\gamma_{1,0}$, $\gamma_{2,1}$ and $\gamma_{3,0}$ which, with the exception of 1996Me11, support the adopted values of ICC:

$\gamma_{1,0}$ α_K = 7.76 (23), α_L = 0.804 (24) from 1976Ba63
α_K = 7.35 (19) from 1985HaZA
K:L:M+ = 100 : 9.59 (13) : 1.48 (15) from 1971Po05
$\gamma_{2,1}$ α_K = 0.0214 (12), K/L+ = 8,2 (6) from 1967Ha06
K:L:M+ = 100 : 9.0 : 1.5 from 1955Co31
$\gamma_{3,0}$ α_K = 0.122 (13), K/L+ = 8.6 (5), α_T/α_K = 1.118 (5) from 1967Ha06

There are 6 experimental values for the total ICC (α_T) of the low-energy gamma ray transition $\gamma_{1,0}$(14.413 keV): 9.0 (5) and 8.9 (6) from 1965Ki03; 8.26 (22) from 1965Mo22; 8.25 (46) from 1966Sp06; 8.26 (22) from 1968Ru04 and 8.19 (18) from 1970Jo30. They can be compared to the adopted value of α_T = 8.55 (12).

3. ATOMIC DATA

SAISINUC software has been used to determine the atomic data (fluorescence yields, X-ray energies and relative probabilities, and Auger electrons energies and relative probabilities).

The relative Kβ/Kα emission probability is taken from 1998Be and 1997Lepy. They have shown that taking into account double-electron transitions with a simultaneous emission of a photon and Auger electron (the radiative Auger effect, RAE) increases the value of Kβ /Kα = from 0.1368 (14) (1996Sc06) to 0.1419 (19) (1998Be) or 0.1423 (17) (1997Lepy). From these we have adopted Kβ/Kα = 0.142 (2). The ratio Kα_2/Kα_1 is from 1996Sc06.

4. PHOTON EMISSIONS

4.1. X-ray Emissions

The absolute emission intensities of the KX-ray components have been computed from the total P_{XK} using the relative probabilities from sect. 3. Below the measured values of Fe $P_{K\alpha}$ and P_{XK} are compared to our calculated (evaluated) values:

	Measured		*Calculated*
	1989Debertin	1994Ar22	(evaluated)
$P_{K\alpha}$ (%)	50.6 (9)	50.1 (5)	50.0 (6)

	Measured				*Calculated*
	1968Ru04	1973 Mukerji	1978 Vylov	1989 Debertin	(evaluated)
P_{XK} (%)	56.9 (8)	58.4 (17)	55.3 (15)	56.0 (11)	57.1 (9)

The total absolute emission intensity of LX-rays has been computed using the computed Pce_L, Pce_K, P_{XK}, P_{XL} and atomic data of section 3.

4.2. Gamma ray emissions

The energies of the gamma rays $\gamma_{2,1}$ and $\gamma_{2,0}$ have been adopted from 1976Bo16 and 2000He14. The energies of other gamma rays have been obtained as the weighted means of measurement results listed in Table 4 or calculated from the decay scheme of ^{57}Co. The corrections to the revised energetic scale in 2000He14 (lowering the values by 5.80 ppm) do not change these values.

The evaluators have assumed no EC feeding to the ground and first excited states and used the total gamma-ray transition probabilities to these two states (except that for the 14.413-keV transition) to normalize the decay scheme (using adopted relative photon intensities from Table 5 and the conversion coefficients). This procedure leads to a normalization factor of 0.8549 (15).

The absolute gamma ray emission intensity for $\gamma_{1,0}$ (14.413 keV) has been computed as follows: $P\gamma(\gamma_{1,0}) = P\gamma{+}ce(\gamma_{1,0}) / (1 + \alpha_T(\gamma_{1,0}))$, where $P\gamma{+}ce(\gamma_{1,0})$ = 87.67 (15) % comes from decay scheme probability balance at the 14.413-keV level, and $\alpha_T(\gamma_{1,0})$ = 8.55 (12). The deduced value of $P\gamma(\gamma_{1,0})$ = 9.18 (12) % can be compared with the experimental values, such as 9.5 (2) % (1978Vylov), 9.54 (12) % (1992ScZZ) and 9.16 (15) % (1989Debertin). It agrees very well with the CRP experimental result from 1989Debertin.

It should be noted also that the evaluated sum $P\gamma(\gamma_{2,0}) + P\gamma(\gamma_{1,0})$ = 19.89 (18) % agrees well with the measured value of 19.84 (17) % from 1971Ko19.

Table 4. - Measured and adopted energies of gamma-rays in the decays of $^{57}Co \rightarrow {}^{57}Fe$ and $^{57}Mn \rightarrow {}^{57}Fe$

γ	1965Ki03	1965Sp06	1970Gr13	1971Ko19	1972He42	1974Ti01[a]	1976Bo16	1980Ve05	LWM	Adopted
$\gamma_{1,0}$			14.408 (5)		14.41247 (29)	14.410 (6)				14.41295 (31)[b]
$\gamma_{2,1}$			122.07 (3)	122.06 (2)		122.063 (4)	122.06065 (12)			122.06065 (12)
$\gamma_{2,0}$			136.473 (4)	136.47 (3)		136.473 (4)	136.47356 (29)			136.47356 (29)
$\gamma_{3,2}$	229.8 (10)	230.6 (6)	230.4 (5)	230.4 (6)		230.25 (4)		230.29 (2)	230.27 (3)	230.27 (3)
$\gamma_{4,3}$	339.7 (4)	339.7 (5)	339.7 (3)	339.68 (28)		339.60 (6)		339.54 (18)	339.61 (9)	339.67 (3)[b]
$\gamma_{3,1}$	352.5 (4)	352.4 (5)	352.5 (3)	352.23 (27)		352.32 (3)		352.36 (1)	352.34 (2)	352.34 (2)
$\gamma_{3,0}$	366.8 (5)	366.7 (5)	336.8 (4)	367.0 (5)		366.73 (4)		366.75 (1)	366.74 (3)	366.74 (3)[b]
$\gamma_{4,2}$	570.0 (4)	570.3 (4)	570.1 (3)	570.04 (28)		569.93 (5)		569.92 (4)	569.94 (4)	569.94 (4)
$\gamma_{4,1}$	692.1 (3)	692.1 (3)	692.1 (2)	692.44 (6)		692.00 (3)		692.03 (2)	692.02 (2)	692.01 (2)[b]
$\gamma_{4,0}$	706.4 (4)	706.8 (4)	706.6 (3)	706.46 (34)		706.54 (22)		706.40 (20)	706.50 (20)	706.42 (2)[b]

[a] Experimental values from the decay of ^{57}Mn

[b] Calculated from decay scheme using the energies of $\gamma_{2,1}$, $\gamma_{2,0}$, $\gamma_{3,2}$, $\gamma_{3,2}$, $\gamma_{4,2}$

Table 5. - Relative emission probabilities of gamma rays in the decay of ^{57}Co

γ	Eγ	1965Ki03	1965Ma38	1971Ko19	1974HeYW	1980Sc07[a]	1982Gr10	LWM	Adopted
$\gamma_{1,0}$	14			1.14 (5) 10^4					10.74 (14)[b]
$\gamma_{2,1}$	122	10^5	10^5	10^5	10^5	10^5	10^5	10^5	100
$\gamma_{2,0}$	136	1.25 (8) 10^4	1.20 (1) 10^4	1.30 (4) 10^4	1.29 (7) 10^4	1.236 (9) 10^4	1.245 (30) 10^4	1.253 (18) 10^4 [c]	12.53 (18)
$\gamma_{3,2}$	230		0.2 (2)	0.5 (5)					0.0004 (4)[d]
$\gamma_{4,3}$	340		2.9 (3)	4.5 (4)					0.0045 (4)[d]
$\gamma_{3,1}$	352		2.0 (2)	3.7 (4)					0.0037 (4)[d]
$\gamma_{3,0}$	367		0.7 (1)	1.5 (4)					0.015 (4)
$\gamma_{4,2}$	570		16 (1)	19.4 (11)	10 (10)			18 (2)[e]	0.018 (2)
$\gamma_{4,1}$	692		188 (5)	183 (11)	190 (30)			186 (7)[f]	0.186 (7)
$\gamma_{4,0}$	706		5.5 (6)	6.2 (6)				5.8 (6)[g]	0.0058 (6)

[a] In 1980Sc07 the absolute gamma-ray emission probabilities are reported: $P\gamma_{2,0}$(136) = 10.58 (8) % and $P\gamma_{2,1}$(122) = 85.5%

[b] Calculated as described in the text.

[c] The LWEIGHT program has used an unweighted average and expanded the uncertainty so range include is reasonable choice because of disagreement of the experimental values some uncertainties of which are only statistical.

[e] Adopted from 1971Ko19.

[f] LWEIGHT has used a weighted average and expanded the uncertainty so range includes the most precise value of 1971Ko19

[g] The method of Limitation of Relative Statistical Weights (LRSW) increased the uncertainty of 1965Ma38 to 10.3.

[h] The experimental uncertainty is adopted as the uncertainty of the evaluated value.

5. ELECTRON EMISSIONS

The energies of the conversion electrons have been computed from the gamma ray transition energies and the electron binding energies.

The emission intensities of the conversion electrons have been calculated using the transition probabilities, the atomic data, and the internal conversion coefficients.

The low energy electron spectrum from the decay of ^{57}Co has been analyzed in 1997KoZJ using a combined electrostatic spectrometers. They obtained the following intensity ratios for the main spectrum components: (LMM+LXY) / KLL / KLX / KMX / K-14.413 / L-14.413 / (M+N)-14.413 = 49.3 (38) : 59.6 (23) : 15.2 (6) : 1.2 (2) : 49.9 (18) : 5.1 (3) : 0.80 (4). These values agree mainly with our evaluated data on electron emissions apart from the intensity of L Auger electrons. Perhaps, the latter is connected with difficulties of the electron spectrum measurement in the energy region of 0.6-0.7 keV. The discrepancy takes place also for the L/(M+N) and K/(M+N) ratios.

Also in 1997KoZJ, L_1/L_2 = 15.7 (5), L_1/L_3 = 39.3 (16), $M_{2,3}/M_1$ = 0.076 (4) have been measured for the gamma transition $\gamma_{1,0}$ (14.413 keV).

6. ENERGY CONSERVATION

The total average energy of 836.0 (17) keV, for one disintegration, calculated from the current evaluated data corresponds well to the available energy of 836.2 (5) keV (Q) from the mass tables (2012Wa38) confirming the consistency of the decay scheme and the reliability of this evaluation.

7. REFERENCES

1955Co31 J. M. Cork, M. K Brice, L. C Schmid, Phys. Rev. 99 (1955) 703.
(Relative conversion electron intensities)

1960Fe06 A.T.G. Ferguson, M.A. Grace, J.O. Newton, Nucl. Phys. 17 (1960) 9
(Half-life for 136 keV level)

1961Cl11 M.A. Clark, AECL-1337, (1961) 40.
(Half-life for 136 keV level)

1961Ho05 R.E. Holland, F.J. Lynch, Phys. Rev. 121 (1961) 1464
(Half-life for 136 keV level)

1965An07 S. C. Anspach, L. M. Cavallo, S. B. Garfinkel, J. M. R. Hutchinson, C. N. Smith, In: NP-15663, 1965.
(Half-life)

1965Ki03 O. C. Kistner, A.W. Sunyar, Phys. Rev. 139 (1965) B295.
(Experimental ICC, gamma ray energies and relative emission probabilities, Half-life for 136 keV level)

1965Ma38 J. M. Mathiesen, J. P. Hurley, Nucl. Phys. 72 (1965) 475.
(Relative gamma ray emission probabilities)

1965Mo22 G. Moreau, G. Ambrosino, Compt. Rend. 261 (1965) 5438.
(Experimental ICC)

1966Ec05 M. Eckhause, R.J. Harris, Jr., W.B. Shuler, R.E. Welsh, Proc. Phys. Soc. (London) 89 (1966) 187
(Half-life for 136 keV level)

1966Sp06 E. H. Spejewski, Nucl. Phys. 82 (1966) 481.
(Experimental ICC and gamma ray energies)

1967Ha06 D. C. Hall, R. G. Albridge, Nucl. Phys. A91 (1967) 495.
(Experimental ICC)

1968Ru04 W. Rubinson, K. P. Gopinathan, Phys. Rev. 170 (1968) 969.
(Experimental ICC, P_K and P_{XK} values)

1969Bo49 H. E. Bosch, M. A. Fariolli, N. Martin, M. C. Simon, Nuclear Instrum. Methods 73 (1969) 323.
(Experimental P_K values)

1969Ho28 C. Hohenemser, R. Reno, H.C. Benski, J. Lehr, Phys. Rev. 184 (1969) 298.
(Half-life for 136 keV level)

1969Ja18 E. Jaeschke, W. Reichardt, G. Ischenko, D. Frosch, B. Huber, E. Rinsdorf, Nucl. Instr. Methods 71 (1969) 29.
(Half-life for 136 keV level)

1970Gr13 R. C. Greenwood, R. G. Helmer, R. J. Gehrke, Nuclear Instrum. Methods 77 (1970) 141.
(Gamma ray energies)

1970Jo30 D.P. Johnson, Phys. Rev. B1 (1970) 3551.
(Experimental ICC)

1971Ko19 J. Konijn, E. W. A. Lingeman, Nuclear Instrum. Methods 94 (1971) 389.
(Gamma ray energies and emission probabilities)

1971Po05 F. T. Porter, M. S. Freedman, Phys. Rev. C3 (1971) 2285.
(Relative conversion electron intensities)

1972Em01 J.F. Emery, S.A. Reynolds, E.I. Wyatt, G.I. Gleason, Nucl. Sci. Eng. 48 (1972) 319.
(Half-life)

1972Fo05 R.A. Fox, W.D. Hamilton, M.J. Holmes, Phys. Rev. C5 (1972) 853.
(Mixing ratios E2/M1 for gamma transitions)

1972He42 U. Heim, O. W. B. Schult, Z. Naturforsch.27a (1972) 1861.
(14.413 keV gamma ray energy)

1972Kr15 K. S. Krane, W. A. Steyert, Phys. Rev. C6 (1972) 2268.
(Mixing ratios E2/M1 for gamma transitions)

1972La14 F. Lagoutine, J. Legrand, C. Perrot, J. P. Brethon, J. Morel, Intern. J. Appl. Radiat. Isotop. 23 (1972) 219.
(Half-life)

1973Mukerji A. Mukerji, Lee Chin, In: Proc. of the Intern. Conf. on Inner-Shell Ionization Phenomena and future Applications, April 17-22, 1972, Conf-720404, USAEC-Technical Information Center, Oak Ridge, Tenn. (1973).
(Experimental P_K and P_{XK} values)

1973Sc15 E. Schoeters, R. E. Silverans, L. Vanneste, Z. Phys. 260 (1973) 337.
(Mixing ratios E2/M1 for gamma transitions)

1974HeYW R. L. Heath, Gamma-Ray Spectrum Catalogue (1974), ANCR-1000-2.
(Relative gamma ray emission probabilities)

1974Ti01 K. G. Tirsell, L. G. Multhauf, S. Raman, Phys. Rev. C10 (1974) 785.
(Gamma ray energies)

1975Co22 E. J. Cohen, A. J. Becker, N. K. Cheung, H. E. Henrikson, Hyperfine Interact.1 (1975)193.
(Mixing ratios E2/M1 for gamma transitions)

1976Ba63 I. M. Band, M. B. Trzhaskovskaya, M. A. Listengarten, At. Data Nucl. Data Tables 18 (1976) 433.
(Theoretical ICC)

1976Bo16 G. I. Borchert, Z. Naturforsch. 31a (1976) 387.
(Gamma ray energies)

1978AlZX B.A. Alikov, Ya. Babryshchuk, G.I. Lizurei, K.M. Muminov, T.M. Muminov, Yu.S. Salikhbaev, R.R. Usmanov, JINR-P13-10911 (1978)
(Half-life for 136 keV level)

1978Kr19 K. S. Krane, At. Data Nucl. Data Tables 22 (1978) 269.
(Mixing ratios E2/M1 for gamma transitions)

1978Vylov C. Vylov, Preprint JINR R6-10416, Dubna, 1977.
(Experimental P_{XK} and Pγ(14,4 keV) values)

1980Ho17 H. Houtermans, O. Milosevic, F. Reichel, Intern. J. Appl. Radiat. Isotop. 31 (1980) 153.
(Half-life)

1980Sc07 U. Schötzig, K. Debertin, K. F. Walz, Nuclear Instrum. Methods 169 (1980) 43.
(Relative gamma ray emission probabilities)

1980Ve05 R. Vennink, J. Kopecky, P. M. Endt, P. W. M. Glaudemans, Nucl. Phys. A344 (1980) 421.
(Gamma ray energies)

1981Va11 R. Vaninbroukx, G. Grosse, W. Zehner, Intern. J. Appl. Radiat. Isotop. 32 (1981) 589.
(Half-life)

1982Gr10 A. Grutter, Intern. J. Appl. Radiat. Isotop. 33 (1982) 533.
(Relative gamma ray emission probabilities)

1983Wa26 K. F. Walz, K. Debertin, H. Schrader, Intern. J. Appl. Radiat. Isotop. 34 (1983) 1191.
(Half-life)

1985HaZA H. H. Hansen, In: European App. Res. Rept. Nucl. Sci. Technol. 6, No 4 (1985) 777.
(Compilation of experimental ICC)

1989Debertin K. Debertin, U. Schötzig, informal IAEA CRP paper GS/55 (1989), quoted in IAEA-TecDoc-619 (1991)
(Experimental KX and $\gamma_{1,0}$ (14,4 keV) absolute emission probabilities)

1990Si03 K. Singh, T. S. Gill, K. Singh, Appl. Radiat. Isot. 41 (1990) 333.
(Experimental P_K values)

1992ScZZ U. Schötzig, H. Schrader, K. Debertin. In: Proc. Inter. Conf. Nuclear Data for Science and Technology, Julich, Germany, 1992. P.562.
(Experimental Pγ (14,4 keV) value)

1992Un01 M.P. Unterweger, D.D. Hoppes, F.J. Schima, Nucl. Instr. Meth. A312 (1992) 349.
(Half-life)

1994Ar22 D. Arnold, G. Ulm, Nucl. Instr. Meth. Phys. Res. A339 (1994) 43.
(Experimental XKα absolute emission probability)

1995Ah04 I. Ahmad, K.E. Rehm, E.P. Kanter, W. Kutschera, W.R. Phillips, A.R. Barnett, Phys.Rev. C52 (1995) 2240
(Half-life for 136 keV level)

1996Me11 R.Ya. Metskhvarishvili, Z.N. Miminoshvili, M.A. Elizbarashvili, L.V. Nekrasova, I.R. Metskhvarishvili, N.G. Khazaradze, N.M. Marchilashvili, I.V. Zhorzholiani, Yad. Fiz. 59, No 5 (1996)773, Phys. Atomic Nuclei 59 (1996) 737.
(Relative conversion electron intensities and experimental ICC)

1996Sc06 E. Schönfeld, H. Janssen, Nucl. Instrum. Methods Phys. Res. A369 (1996) 527.
(Atomic data)

1997Lépy M.-C. Lépy, M.-M. Bé, J. Plagnard, In: CAARI'96 Conference proceedings AIP Press,1067 (1997).
(Experimental Kβ /Kα)

1997Ma75 R.H. Martin, K.I.W. Burns, J.G.V. Taylor, Nucl. Instrum. Meth. Phys. Res. A390 (1997) 267.
(Half-life)

1997KoZJ A. Kovalik, M. Rysavy, V. M. Gorozhankin, Ts. Vylov, D. V. Filosofov, M. A. Mahmoud, A. Minkova, N. Coursol, P. Casette, Ch. Briancon. Program and Thesis, Proc. 47th Ann. Conf. on Nucl. Spectrosc. Struct. At. Nuclei, Obninsk, 1997. P.277.
(Relative low energy electron emission probabilities)

1998Be** M.- M. Bé, M.- C. Lépy, J. Plagnard, B. Duchemin, Appl. Radiat. Isot. 49 (1998) 1367.
(Experimental Kβ /Kα)

1998Bh11 M. R. Bhat, Nucl. Data Sheets 85 (1998) 415.
(Mixing ratios E2/M1 for gamma transitions; half-lives for the excited levels)

1998Sc28 E. Schönfeld, Appl. Radiat. Isot. 49 (1998) 1353.
(Fractional electron capture probabilities P_K, P_L, P_M)

2000He14 R. G. Helmer, C. van der Leun, Nucl. Instrum. Meth. Phys. Res. A450 (2000) 35.
(Gamma ray energies)

2002Ba85 I.M. Band, M.B. Trzhaskovskaya, C.W. Nestor Jr., P.O. Tikkanen, S. Raman. At. Data Nucl. Data Tables 81 (2002) 1.
(Theoretical ICC)

2004BeZR M.-M. Bé, V. Chisté, C. Dulieu, E. Browne, V. Chechev, N. Kuzmenko, R. Helmer, A. Nichols, E. Shönfeld, and R. Dersch. *Table of Radionuclides (Vol. 1 – A = 1 to 150).* Bureau International des Poids et Mesures, 2004. ^{57}Co.
(Previous ^{57}Co decay data evaluation)

2006Mo26 V.A. Morozov, N.V. Morozova, T. Badica, Gh.Cata-Danil, D. Ghita, I.V. Popescu, Nucl.Instr. Meth. Phys.Res. A566 (2006) 448.
(Half-lives for the excited levels of ^{57}Fe)

2008Ki07 T. Kibédi, T.W. Burrows, M.B. Trzhaskovskaya, P.M. Davidson, C.W. Nestor Jr., Nucl. Instrum. Meth. Phys. Res. A589 (2008) 202.
(BrIcc computer program)

2012Da06 C.J.da Silva, A. Iwahara, D.S.Moreira, J.U. Delgado, R.S. Gomes, Appl. Radiat. Isot. 70 (2012) 1924.
(Half-life)

2012Wa38 M. Wang, G. Audi, A.H. Wapstra, F.G. Kondev, M. MacCormick, X. Xu, B. Pfeiffer. Chin. Phys. C36 (2012) 1603.
(Q value)

2012Fi12 R. Fitzgerald, J. Res. Natl. Inst. Stand. Technol. 117 (2012) 80.
(Half-life)

2014Un01 M.P. Unterweger, R. Fitzgerald. Appl. Radiat. Isot. 87 (2014) 92. (Half-life)