

Task on the comparison of half-life data in the Y2K k_0 -database

In response to the task from the 1st RCM of the CRP on a “Reference Database for Neutron Activation Analysis” a comparative exercise of the half-lives used in the Y2K k_0 -database¹ has been made. This analysis involved a comparison of the quoted half-life to those present in the recently released JEFF-3.1 Radioactive Decay Data Library². The sources of the data were investigated and uncertainties included as these were not originally quoted for the k_0 -database. Other sources were investigated as appropriate, particularly the recent NUBASE evaluation³ which uses the ENSDF database as a source for much of its data.

Three tables are shown which present the results of this action.

Table 1 contains 13 nuclei where the differences between the libraries exceeds 0.5%, in some cases more significantly. Some of these cases show that the values used in the JEFF-3.1 library may not be the latest (see comment at the bottom of this page), but others also highlight possible shortcomings in the k_0 -database value. The Comments column in the table gives the date of the JEFF-3.1 evaluation, normally followed by similar details for the k_0 -database (referred to as “De Corte”).

Below is an attempt to comment more closely on the findings shown in Table 1.

²⁰F, ³⁷S and ⁵¹Ti: all three probably highlight shortcomings in the JEFF-3.1 library.

^{105m}Rh: very approximate data (generally with no uncertainty), should be investigated experimentally and very careful use should be made of any value.

¹⁰⁹Pd: JEFF contains a recent and very accurate value, knowing the origin of the De Corte value would be useful and/or JEFF should be adopted.

¹⁰⁸Ag: although the JEFF evaluation is relatively old a 2005 evaluation supports this value.

^{114m}In: difference probably linked to age of JEFF evaluation.

^{113m}Sn: large uncertainties exist for all evaluations. How does this actually affect NAA?

¹²²Sb: perhaps the more recent JEFF value should be adopted?

^{133m}Ba: relatively large uncertainty on the quite old JEFF value, but not enough to justify the difference. Could a new measurement/evaluation of the half-life be made as the De Corte value is also quite old?

¹⁷⁷Lu: JEFF contains a very recent (2003) evaluation with reasonable uncertainty which matches NUBASE/ENSDF, hence knowing the origin of the De Corte value would be useful and/or JEFF should be adopted.

¹⁸⁷W: both are relatively old evaluations, but the difference is on the limit of relevance.

Would a new measurement/analysis be justified?

¹⁸⁶Re: JEFF contains an accurate value from LNHB, but their 2004 re-evaluation supports the De Corte value.

Short comment on the JEFF-3.1 half-life values

The JEFF-3.1 Library was assembled from a number of different sources, a small number of which date back as far as 20 years or more, but most of which are much more recent. Due to the criterion

¹ F. De Corte, “The updated NAA nuclear data library derived from the Y2K k_0 -database”, Journal of Radioanalytical and Nuclear Chemistry, 257, No. 3, 493-499 (2003)

² See the OECD/NEA Databank website which deals with the JEFF Project:
http://www.nea.fr/html/dbdata/projects/nds_jef.htm

³ G. Audi, O. Bersillon, J. Blachot and A.H. Wapstra, “The NUBASE evaluation of nuclear and decay properties”, Nuclear Physics A, 729, 3-128 (2003)

for complete and consistent files to be taken as a whole, no attempt was made to update individual values (such as half-life) within these sources. Changing the value of the half-life in a data file containing full decay scheme information can have serious implications on the other data included, e.g. the $\log ft$ values, which would have also required updating. Unfortunately it was not possible to undertake such adjustments within the constraints imposed for its construction. It should therefore be noted that there may be some shortcomings in the half-life values included. This exercise is thus also useful for the JEFF Project as well as this CRP.

Data accuracy: All data from JEFF-3.1 are given to a maximum of three decimal places. Any less means that they are not required.

Table 2 contains 21 nuclei where differences are in the range from ~0.1% to 0.5%. Although these differences are generally on the same level as the quoted uncertainties, there are some for which the differences are significantly higher and these should be noted and probably examined more closely, *i.e.* ^{103}Ru , $^{134\text{m}}\text{Cs}$, ^{153}Sm , $^{152\text{m}}\text{Eu}$ and ^{159}Gd .

For completeness Table 3 contains the details of the comparison of all the nuclei quoted in the De Corte paper (including those extracted in Tables 1 and 2).

I would welcome any comments from CRP participants on this analysis.

Mark A. Kellett
IAEA Nuclear Data Section
February 2006

Table 1: Nuclei with half-life differences > 0.5% (when compared to JEFF-3.1)

Nuclide	De Corte half-life	JEFF-3.1 half-life	JEFF-3.1 Source	%-diff	Comments
20F	11.163 s	11.03 s	UKPADD64	1.19	1982 Eval \pm 0.27% (De Corte = NUBASE from ENSDF 1998)
37S	5.05 min	4.99 m	UKPADD64	1.19	1982 Eval \pm 0.4% (De Corte = NUBASE from ENSDF 2001)
51Ti	5.76 min	5.8 m	UKPADD64	-0.69	1992 Eval \pm 0.51% (De Corte = NUBASE from ENSDF 1997)
105mRh	45 s	40 s	ENSDF	11.11	1993 Eval \pm not given (De Corte = NUBASE [which contains approximate value only]) Nuclear Wallet Cards = 42.9 \pm 3 s. Very inconsistent data.
109Pd	13.46 h	13.701 h	ENSDF	-1.79	1999 Eval \pm 0.02%
108Ag	2.37 min	2.4 m	UKPADD64	-1.27	1990 Eval \pm 0.83% (De Corte = NUBASE from ENSDF 2000) 2005 Eval from LNHB 2.395 min \pm 0.25% supports JEFF-3.1 value
114mIn	49.51 d	50 d	UKPADD64	-0.99	1992 Eval \pm 0.4% (De Corte = NUBASE from ENSDF 2003)
113mSn	21.4min	20.9 m	UKPADD64	2.34	1991 Eval \pm 2.4% (De Corte = NUBASE from ENSDF 2000 \pm 1.9%)
122Sb	2.7238 d	2.7 d	LNHB	0.87	1998 Eval \pm 0.37% [UK = 2.696 d 1991] (De Corte = NUBASE from ENSDF 1994)
133mBa	38.9 h	38.2 h	UKPADD64	1.78	1992 Eval \pm 0.8 % (De Corte = NUBASE from ENSDF 1995 [\pm 0.26%])
177Lu	6.73 d	6.647 d	LNHB	1.23	2003 Eval \pm 0.6% (= ENSDF 2003)
187W	23.72 h	23.85 h	UKPADD64	-0.55	1991 Eval \pm 0.34% (De Corte = NUBASE from ENSDF 1992)
186Re	3.7183 d	3.775 d	LNHB	-1.52	1998 Eval \pm 0.2% (De Corte = NUBASE from ENSDF 2003) 2004 Re-eval from LNHB 3.7186 d \pm 0.05% shows previous as incorrect

Table 2: Nuclei with half-life differences between ~0.1 % and 0.5% (when compared to JEFF-3.1)

Nuclide	De Corte half-life	JEFF-3.1 half-life	JEFF-3.1 Source	%-diff	Comments
41Ar	1.822 h	1.827 h	UKPADD64	-0.27	1983 Eval \pm 0.36% (BUT JEFF = NUBASE from ENSDF 2002)
52V	3.75 min	3.745 m	UKPADD64	0.13	1992 Eval \pm 0.13% (NUBASE = 3.743 m from ENSDF 2000)
56Mn	2.5789 h	2.582 h	LNHB	-0.12	2002 Eval \pm 0.2% (De Corte = NUBASE from ENSDF 1999)
65Ni	2.51719 h	2.52 h	UKPADD64	-0.11	1991 Eval \pm 0.04% (NUBASE = 2.5172 h from ENSDF 1997)
66Cu	5.120 min	5.1 m	UKPADD64	0.39	1992 Eval \pm 0.2% (De Corte = NUBASE)
75Se	119.79 d	119.64 d	UKPADD64	0.13	1990 Eval \pm 0.2% (NUBASE = 119.779 d from ENSDF 1999)
80mBr	4.4205 h	4.41 h	UKPADD64	0.24	1990 Eval (De Corte = NUBASE)
80Br	17.68 min	17.6 m	UKPADD64	0.45	1990 Eval (De Corte = NUBASE)
88Rb	17.78 min	17.8 m	LNHB	-0.11	De Corte = NUBASE
103Ru	39.35 d	39.26 d	ENSDF	0.23	2001 Eval \pm 0.05% (= UKPADD-6.5)
110Ag	24.6 s	24.56 s	LNHB	0.16	2002 Eval \pm 0.45% (De Corte = NUBASE from ENSDF 2000)
116mIn	54.41 min	54.6 m	UKPADD64	-0.35	1992 Eval \pm 0.55% (NUBASE = 54.29 min \pm 0.3% from ENSDF 2001)
134mCs	2.903 h	2.908 h	UKPADD64	-0.17	1992 Eval \pm 0.10% (De Corte = NUBASE from ENSDF 1994 \pm 0.07%)
131Ba	11.50 d	11.55 d	UKPADD64	-0.43	1994 Eval \pm 0.43% (De Corte = NUBASE from ENSDF 1994 [\pm 0.52%])
153Sm	46.50 h	46.284 h	LNHB	0.49	2001 Eval \pm 0.006% (~ ENSDF 1998 46.284 h \pm 0.009%) De Corte source unknown
152mEu	9.3116 h	9.275 h	UKPADD64	0.39	1992 Eval \pm 0.1% (De Corte = NUBASE from ENSDF 1997)
159Gd	18.56 h	18.479 h	ENSDF	0.44	2003 Eval \pm 0.02%
182Ta	114.43 d	114.7 d	UKPADD64	-0.24	1991 Eval \pm 0.35% (De Corte = NUBASE from ENSDF 1995)
188Re	17.005 h	16.98 h	LNHB	0.15	1998 Eval \pm 0.12% (De Corte ~ NUBASE from ENSDF 2002 [17.004 h])
185Os	93.6 d	93.8 d	UKPADD64	-0.21	1998 Eval \pm 0.96% (De Corte = NUBASE from ENSDF 1995)
197mHg	23.8 h	23.9 h	UKPADD64	-0.42	2000 Eval \pm 2.1% (De Corte = NUBASE from ENSDF 1996 \pm 0.42%)

Table 3: Complete list of all nuclei compared to JEFF-3.1
(includes those presented in Tables 1 and 2)
[Ordered as in De Corte's paper]

Nuclide	De Corte half-life	JEFF-3.1 half-life	JEFF-3.1 Source	%-diff	Comments
20F	11.163 s	11.03 s	UKPADD64	1.19	1982 Eval \pm 0.27% (De Corte = NUBASE from ENSDF 1998)
24Na	14.9590 h	14.957 h	LNHB	0.01	
27Mg	9.462 min	9.458 m	UKPADD64	0.04	
28Al	2.2414 min	2.241 m	UKPADD64	0.02	
31Si	2.622 h	2.62 h	UKPADD64	0.08	
37S	5.05 min	4.99 m	UKPADD64	1.19	1982 Eval \pm 0.4% (De Corte = NUBASE from ENSDF 2001)
38Cl	37.24 min	37.2 m	UKPADD64	0.11	
41Ar	1.822 h	1.827 h	UKPADD64	-0.27	1983 Eval \pm 0.36% (BUT JEFF = NUBASE from ENSDF 2002)
42K	12.360 h	12.359 h	LNHB	0.01	
47Ca	4.536 d	4.538 d	UKPADD64	-0.04	
47Sc	3.3492 d	3.351 d	LNHB	-0.05	
49Ca	8.718 min	8.72 m	UKPADD64	-0.02	
46Sc	83.83 d	83.788 d	LNHB	0.05	
51Ti	5.76 min	5.8 m	UKPADD64	-0.69	1992 Eval \pm 0.51% (De Corte = NUBASE from ENSDF 1997)
52V	3.75 min	3.745 m	UKPADD64	0.13	1992 Eval \pm 0.13% (NUBASE = 3.743 m from ENSDF 2000)
51Cr	27.7025 d	27.703 d	LNHB	-0.00	
56Mn	2.5789 h	2.582 h	LNHB	-0.12	2002 Eval \pm 0.2% (De Corte = NUBASE from ENSDF 1999)
59Fe	44.503 d	44.495 d	LNHB	0.02	
60mCo	10.467 min	10.47 m	LNHB	-0.03	
60Co	5.2714 y	5.271 y	LNHB	0.01	
65Ni	2.51719 h	2.52 h	UKPADD64	-0.11	1991 Eval \pm 0.04% (NUBASE = 2.5172 h from ENSDF 1997)
64Cu	12.700 h	12.701 h	LNHB	-0.01	
66Cu	5.120 min	5.1 m	UKPADD64	0.39	1992 Eval \pm 0.2% (De Corte = NUBASE)
65Zn	244.26 d	244.15 d	LNHB	0.05	
69mZn	13.76 h	13.76 h	ENSDF	0.00	
71Zn	2.45 min	2.45 m	ENSDF	0.00	
72Ga	14.10 h	14.1 h	ENSDF	0.00	
75mGe	47.7 s	47.7 s	NUBASE	0.00	
75Ge	82.78 min	1.38 h	ENSDF	-0.02	
77mGe	52.9 s	52.9 s	ENSDF	0.00	
77Ge	11.30 h	11.3 h	ENSDF	0.00	
76As	26.24 h	1.093 d	ENSDF	0.03	
75Se	119.79 d	119.64 d	UKPADD64	0.13	1990 Eval \pm 0.2% (NUBASE = 119.779 d from ENSDF 1999)
77mSe	17.36 s	17.36 s	NUBASE	0.00	
80mBr	4.4205 h	4.41 h	UKPADD64	0.24	1990 Eval (De Corte = NUBASE)
80Br	17.68 min	17.6 m	UKPADD64	0.45	1990 Eval (De Corte = NUBASE)
82Br	35.30 h	1.472 d	UKPADD64	-0.08	
86Rb	18.631 d	18.64 d	LNHB	-0.05	
88Rb	17.78 min	17.8 m	LNHB	-0.11	De Corte = NUBASE
85mSr	67.63 min	1.127 h	UKPADD64	0.01	
85Sr	64.84 d	64.849 d	LNHB	-0.01	
87mSr	2.803 h	2.803 h	ENSDF	0.00	
90mY	3.19 h	3.19 h	ENSDF	0.00	

95Zr	64.02 d	64.032 d	LNHB	-0.02	
97Zr	16.744 h	16.744 h	ENSDF	0.00	
97mNb	52.7 s	52.7 s	ENSDF	0.00	
94mNb	6.26 min	6.26 m	UKPADD64	0.00	
99Mo	65.94 h	2.748 d	ENSDF	-0.02	
99mTc	6.01 h	6.01 h	ENSDF	0.00	
101Mo	14.61 min	14.61 m	ENSDF	0.00	
101Tc	14.2 min	14.2 m	ENSDF	0.00	
97Ru	2.9 d	2.9 d	ENSDF	0.00	
103Ru	39.35 d	39.26 d	ENSDF	0.23	2001 Eval \pm 0.05% (= UKPADD-6.5)
105Ru	4.44 h	4.44 h	ENSDF	0.00	
105mRh	45 s	40 s	ENSDF	11.11	1993 Eval \pm not given (De Corte = NUBASE [which contains approximate value only]) Nuclear Wallet Cards = 42.9(3) s!! Very inconsistent data
105Rh	35.36 h	1.473 d	ENSDF	0.02	
104mRh	4.34 min	4.34 m	UKPADD64	0.00	
104Rh	42.3 s	42.3 s	UKPADD64	0.00	
109mPd	4.69 min	4.69 m	ENSDF	0.00	
109Pd	13.46 h	13.701 h	ENSDF	-1.79	1999 Eval \pm 0.02%
111mPd	5.5 h	5.5 h	NUBASE	0.00	
108Ag	2.37 min	2.4 m	UKPADD64	-1.27	1990 Eval \pm 0.83% (De Corte = NUBASE from ENSDF 2000) 2005 Eval from LNHB 2.395 min \pm 0.25% supports JEFF-3.1 value
110mAg	249.76 d	249.78 d	LNHB	-0.01	
110Ag	24.6 s	24.56 s	LNHB	0.16	2002 Eval \pm 0.45% (De Corte = NUBASE from ENSDF 2000)
115Cd	53.46 h	2.228 d	ENSDF	-0.02	
115mIn	4.486 h	4.486 h	ENSDF	0.00	
114mIn	49.51 d	50 d	UKPADD64	-0.99	1992 Eval \pm 0.4% (De Corte = NUBASE from ENSDF 2003)
116mIn	54.41 min	54.6 m	UKPADD64	-0.35	1992 Eval \pm 0.55% (NUBASE = 54.29 min \pm 0.3% from ENSDF 2001)
113mSn	21.4min	20.9 m	UKPADD64	2.34	1991 Eval \pm 2.4% (De Corte = NUBASE from ENSDF 2000 \pm 1.9%)
113Sn	115.09 d	115.09 d	UKPADD64	0.00	
113mIn	1.6582 h	1.658 h	LNHB	0.01	
117mSn	13.60 d	13.6 d	ENSDF	0.00	
123mSn	40.06 min	40.06 m	ENSDF	0.00	
125mSn	9.52 min	9.52 m	ENSDF	0.00	
125Sn	9.64 d	9.64 d	ENSDF	0.00	
122mSb	4.191 min	4.19 m	UKPADD64	0.02	
122Sb	2.7238 d	2.7 d	LNHB	0.87	1998 Eval \pm 0.37% [UK = 2.696 d 1991] (De Corte = NUBASE from ENSDF 1994)
124nSb	20.2 min	20.2 m	UKPADD64	0.00	
124mSb	93 s	1.55 m	UKPADD64	0.00	
124Sb	60.20 d	60.2 d	LNHB	0.00	
131mTe	30 h	1.25 d	LNHB	0.00	
131Te	25.0 min	25 m	LNHB	0.00	
131I	8.0207 d	8.023 d	LNHB	-0.03	
128I	24.99 min	24.99 m	LNHB	0.00	
134mCs	2.903 h	2.908 h	UKPADD64	-0.17	1992 Eval \pm 0.10% (De Corte = NUBASE from ENSDF 1994 \pm 0.07%)
134Cs	2.0648 y	2.065 y	LNHB	-0.01	

131Ba	11.50 d	11.55 d	UKPADD64	-0.43	1994 Eval \pm 0.43% (De Corte = NUBASE from ENSDF 1994 [\pm 0.52%])
133mBa	38.9 h	38.2 h	UKPADD64	1.78	1992 Eval \pm 0.8 % (De Corte = NUBASE from ENSDF 1995 [\pm 0.26%])
139Ba	83.06 min	1.384 h	ENSDF	0.02	
140La	1.6781 d	1.679 d	UKPADD64	-0.05	
141Ce	32.508 d	32.5 d	LNHB	0.02	
143Ce	33.10 h	1.379 d	ENSDF	0.01	
142Pr	19.12 h	19.12 h	ENSDF	0.00	
147Nd	10.98 d	10.98 d	LNHB	0.00	
149Nd	1.728 h	1.728 h	ENSDF	0.00	
149Pm	53.08 h	2.212 d	ENSDF	-0.02	
151Nd	12.44 min	12.44 m	ENSDF	0.00	
151Pm	28.40 h	1.183 d	ENSDF	0.03	
153Sm	46.50 h	46.284 h	LNHB	0.49	2001 Eval \pm 0.006% (~ ENSDF 1998 46.284 h \pm 0.009%) De Corte source unknown
155Sm	22.3 min	22.3 m	ENSDF	0.00	
152mEu	9.3116 h	9.275 h	UKPADD64	0.39	1992 Eval \pm 0.1% (De Corte = NUBASE from ENSDF 1997)
152Eu	13.537 y	13.525 y	LNHB	0.09	
154Eu	8.593 y	8.593 y	UKPADD64	0.00	
153Gd	240.4 d	240.4 d	LNHB	0.00	
159Gd	18.56 h	18.479 h	ENSDF	0.44	2003 Eval \pm 0.02%
161Gd	3.66 min	3.66 m	ENSDF	0.00	
160Tb	72.3 d	72.3 d	ENSDF	0.00	
165mDy	1.257 min	1.257 m	NUBASE	0.00	
165Dy	2.334 h	2.334 h	ENSDF	0.00	
166Ho	26.83 h	1.117 d	ENSDF	0.08	
171Er	7.516 h	7.516 h	ENSDF	0.00	
170Tm	128.6 d	128.6 d	ENSDF	0.00	
169Yb	32.026 d	32.018 d	LNHB	0.02	
175Yb	4.185 d	4.185 d	UKPADD64	0.00	
177Yb	1.911 h	1.911 h	ENSDF	0.00	
176mLu	3.635 h	3.635 h	LNHB	0.00	
177Lu	6.73 d	6.647 d	LNHB	1.23	2003 Eval \pm 0.6% (= ENSDF 2003)
175Hf	70 d	70 d	UKPADD64	0.00	
179mHf	18.67 s	18.67 s	NUBASE	0.00	
180mHf	5.5 h	5.5 h	UKPADD64	0.00	
181Hf	42.39 d	42.38 d	UKPADD64	0.02	
182Ta	114.43 d	114.7 d	UKPADD64	-0.24	1991 Eval \pm 0.35% (De Corte = NUBASE from ENSDF 1995)
187W	23.72 h	23.85 h	UKPADD64	-0.55	1991 Eval \pm 0.34% (De Corte = NUBASE from ENSDF 1992)
186Re	3.7183 d	3.775 d	LNHB	-1.52	1998 Eval \pm 0.2% (De Corte = NUBASE from ENSDF 2003) 2004 Re-eval from LNHB 3.7186 d \pm 0.05% shows previous as incorrect
188mRe	18.6 min	18.59 m	NUBASE	0.05	
188Re	17.005h	16.98 h	LNHB	0.15	1998 Eval \pm 0.12% (De Corte ~ NUBASE from ENSDF 2002 [17.004 h])
185Os	93.6 d	93.8 d	UKPADD64	-0.21	1998 Eval \pm 0.96% (De Corte = NUBASE from ENSDF 1995)
191mOs	13.10 h	13.1 h	UKPADD64	0.00	
191Os	15.4 d	15.4 d	NUBASE	0.00	

193Os	30.11 h	1.255 d	ENSDF	-0.03	
194Ir	19.28 h	19.3 h	LNHB	-0.10	
199Pt	30.80 min	30.8 m	ENSDF	0.00	
199Au	3.139 d	3.139 d	UKPADD64	0.00	
198Au	2.69517 d	2.694 d	LNHB	0.04	
197mHg	23.8 h	23.9 h	UKPADD64	-0.42	2000 Eval \pm 2.1% (De Corte = NUBASE from ENSDF 1996 \pm 0.42%)
203Hg	46.612 d	46.603 d	LNHB	0.02	
205Hg	5.2 min	5.2 m	UKPADD64	0.00	
233Th	22.3 min	22.3 m	UKHEDD24	0.00	
233Pa	26.967 d	27 d	LNHB	-0.12	
239U	23.45 min	23.47 m	UKHEDD24	-0.09	
239Np	2.3565 d	2.355 d	UKHEDD24	0.06	