SOURCES FOR RADIOACTIVE DECAY DATA

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Summary

The source of data for radioactivity half-life, decay route and radiation energy are given, together with samples from the relevant ADMS data files:

DECAY.DAT
HALIFIFE.DAT
GDATBASE.DAT

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1. Data sources

The original data base was provided by NRPB as a file, ORNLSPEC.DAT (dated 29/11/91). This contains tabulations of the isotopes, decay constants and gamma energies. The name suggests that it was derived from data complied by Oak Ridge National Laboratory. A section of the data base, together with a key, is shown in the Appendix.

As the radioactive module of ADMS must also contain decay route and decay route fractions, we then derived an additional main data base, MASTER.DAT, using:

- firstly, isotopes and half-lives from the NRPB/ORNL data base,
- secondly, additional half-life and the decay scheme and branching fractions for all isotopes from Lederer et al (1968), and
- finally, data to complete the data base from the American institute of Physics Handbook (1972), Nuffield Advanced Science Book of Data (1994), and Dzhelepov et al (1961).

We used the 6th edition of Lederer (1968) not the 7th (1979), which was not available to us but appears to have been used by NRPB/ORNL. Some minor discrepancies may be attributable to this. A selection of the derived data base, together with a key is shown in the Appendix.

The following minor changes were made:

1. Isotopes CM-250 and CF-254 were excluded on the grounds that their decay is dominated by spontaneous fission.

2. PB-195M was redesigned PB-195 since all references consulted regarded this as the only state of the isotope.

3. Argon was denoted by the chemical symbol AR rather than A given in the NRPB database.

2. Derived Data Bases

The ADMS radioactive decay module uses two data bases, one for half-lives and one for decay routes, whereas the gamma dose module uses a data base for gamma energies. These are stored in the following flies, derived from ORNLSPEC.DAT and MASTER.DAT:

DECAY.DAT for decay routes
HALIFLFE.DAT for half-lives
GDATBASE.DAT for gamma energies

A selection of data from these files, together with keys, is shown in the Appendix.

3. References

American Institute of Physics Handbook, 3rd Ed., 1972 McGraw-Hill

Lederer et al., 1968, Table of Isotopes, 6th Ed., Wiley

Nuffield Advanced Science Book of Data (first revised edition), 1984, Longman

Dzhelepov, B.S. and Peker, L.K., 1961, Decay Schemes of Radioactive Nuclei, Pergamon

4. Quality Assurance

It was agreed with the clients that the quality assurance plan would not include the radioactivity data. Data entered by hand was thoroughly (but not independently) checked, and that from NRPB was accepted as supplied.

APPENDIX

EXAMPLES FROM DATA BASES

A1. Master Data base, ORNLSPEC.DAT (29/11/91)

The decay constants and gamma energies data master data base from NRPB.

One element per block, entries per block:

> Line 1: Isotope name, decay mode (A, alpha; B, beta; G gamma)
> Line 2: Decay rate time constant (1 / day)
> Line 3 etc: Energy levels, probability per disintegration pairs, preceded by number of entries.

H-3 B
1.538E-04
10.1 5.68E-02
BE-7 BG
1.300E-02
2 0.1 8.92E-08 1.0 3.90E-08
2 0.200 7.69E-03 0.500 9.53E-02
BE-10 B
1.187E-09
1 1.0 2.52E-01
C-11BG
4.898E+01
2 0.1 4.45E-09 1.0 3.85E-01
2 0.500 1.96E+00 1.000 4.40E-02
……..

FM-225 ABG
8.289E-01
7.02E+00 1.0
1 0.1 9.86E-01
8 0.010 7.76E-03 0.015 3.67E-01 0.020 2.87E-01 0.030 1.94E-02 0.050 1.14E-02 0.100 9.37E-03 0.200 4.50E-04 0.500 3.13E-05
FM-257 ABG
6.897E-03
6.51E+00.1.0
2 0.1 1.08E+00 1.0 1.24E-02
8.0010 5.10E-03 0.15 2.31E-01 0.020 3.67E-01 0.030 3.92E-02 0.050 1.33E-02 0.100 4.92E-01 0.200 2.19E-01 0.500 1.03E-02
MD-257 ABG
3.199E+00
7.07E-01.1.0
2 0.1.1E-01 1.0 3.5IE-03
7 0.010 2.22E-03 0.015 1.15E-01 0.020 2.08E-01 0.030 4.87E-02 0.100 417E-01 0 200 1.57E-01 0.500 6.6IE-02

A2. Master Data base, MASTER.DAT

The decay route and fractions master data base.

One line per isotope, entries per line:

> Element symbol, atomic number, isotope mass number, parent state, decay mode, product state, decay fraction, half-life (s), half-life,

where:

1.parent state = designation of parent states other than ground state, where applicable (e.g. M, M1, M2, S, L)
2. decay mode = alpha; B-, B+ beta; IT isometric transition product
3 state = designation of product isotopic states where necessary to distinguish them from the ground state
4 fraction = fraction of parent decaying along route, where different from 0 or 1
5 half-life = half-life, given in seconds, then in the most convenient units (s, m, h, y)for checking purposes.

H	1	1				stable	
H	1	2				stable	
H	1	3		B-		.3894E+09	.1234E+02y
HE	2	3				stable	
HE	2	4				stable	
LI	3	6				stable	
LI	3	7				Stable	
BE	4	7		B+		.4607E07	.53332E+02d
……..							
FM	100	253		B+	0.89	.2593E+06	.3001E+01 d
+	100	253		A	0.11		
ES	99	254	M	B-		.1415E+06	.1637E+01d
ES	99	254		A		.2382E+08	.2757+03d
FM	100	254		A		.1166E+05	.3240E+01h
FM	100	257		A		.8683E+07	.1005E+03d
MD	101	257		B+	0.92	.1872E+05	.5200E+01h
+	101	257		A	0.08		

A3. ADMS Data Base, DECAY.DAT

The decay route used by ADMS.

One line per isotope, entries per line:

Isotope name, product name, decay fraction

H-3	HE-3	1.0000E+00
BE-7	LI-7	1.0000E+00
BE-10	B-10	1.0000E+00
C-11	B-11	1.0000E+00
N-13	C-13	1.0000E+00
C-14	N-14	1.0000E+00
O-15	N-15	1.0000E+00
F-18	O-18	1.0000E+00
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FM-253	ES-253	8.9000E-01
FM-253	CF-249	1.1000E-01
ES-254M	FM-254	1.0000E+00
ES-254	BK-250	1.0000E+00
FM-254	CF-250	1.0000E+00
FM-255	CF-251	1.0000E+00
FM-257	CF-253	1.0000E+00
MD-257	FM-257	9.2000E-01
MD-257	ES-253	8.0000E-02

A4. ADMS Data Base HALFLIFE.DAT

The half-life data base used by ADMS.

One line per isotope, entries per line:
Isotope, half-life (s)

H-3	3.8940E+08
BE-7	4.6070E+06
BE-10	5.0450E+13
C-11	1.2230E+03
N-13	5.9770E+02
C-14	1.8070E+11
O-15	1.2220E+02
F-18	6.5860E+03

FM-253	2.5930E+05
ES-254M	1.4150E+05
ES-254	2.3820E+07
FM-254	1.1660E+04
FM-255	7.2250E+04
FM-257	8.6830E+06
MD-257	1.8720E+04

A5. ADMS Data Base GDATBASE.DAT

The gamma energies data base used by ADMS.

One isotope per block, entries in block:

Line 1: isotope name
Line 2: decay rate constant (1/days)
Line 3 etc: Energy levels, probability per disintegration pairs, preceded by number of entries

```
BE-7
   1.300000E-02
        2    2.000000E-01    7.690000E-03    5.000000E-01    9.530000E-02
C-11
      48.980000
        2    5.000000E-01       1.960000       1.000000    4.400000E-02
N-13
     100.200000
        2    5.000000E-01       1.960000       1.000000    4.400000E-02
O-15
     489.900000
        2    5.000000E-01       1.960000       1.000000    4.400000E-02
F-18
       9.093000
        2    5.000000E-01       1.960000       1.000000    4.400000E-02

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FM-255
   8.289000E-01
        8    1.000000E-02    7.760000E-03    1.500000E-02    3.670000E-01
   2.000000E-02    2.870000E-01    3.000000E-02    1.940000E-02
   5.000000E-02    1.140000E-02    1.000000E-01    9.370000E-03
   2.000000E-01    4.500000E-04    5.000000E-01    3.130000E-05
FM-257
   6.897000E-03
        8    1.000000E-02    5.100000E-03    1.500000E-02    2.310000E-01
   2.000000E-02    3.670000E-01    3.000000E-02    3.920000E-02
   5.000000E-02    1.330000E-02    1.000000E-01    4.920000E-01
   2.000000E-01    2.190000E-01    5.000000E-01    1.030000E-02
MD-257
       3.199000
        7    1.000000E-02    2.220000E-03    1.500000E-02    1.150000E-01
   2.000000E-02    2.080000E-01    3.000000E-02    4.870000E-02
   1.000000E-01    4.170000E-01    2.000000E-01    1.570000E-01
   5.000000E-01    6.610000E-02
```