

Appendix E

Neutron activation and gamma-ray dose cross section for use with DS02

Table E1. Neutron activation cross sections: DABL-69 energy format VISTA files

DABL-69	Upper E	Mid E	N kerma	<sup>40</sup> Ca(n,γ)	<sup>35</sup> Cl(n,γ)	<sup>59</sup> Co(n,γ)	<sup>63</sup> Cu(n,p)	<sup>151</sup> Eu->gnd	<sup>151</sup> Eu(n,γ)	<sup>63</sup> Ni(n,γ)	S(nat)(n,p)	<sup>35</sup> S(n,p)	<sup>36</sup> K(n,α)
1	1.96E+01	1.82E+1	6.9E-11	5.2E-04	1.3E+05	3.8E-04	3.0E-02	2.7E-04	4.2E-04	1.9E-04	1.1E-01	1.2E-01	2.2E-01
2	1.69E+01	1.59E+1	6.73E-11	5.20E-04	1.31E+05	7.25E-04	3.79E-02	6.40E-04	8.60E-04	1.79E-02	2.25E-04	1.75E-01	2.45E-01
3	1.49E+01	1.45E+1	6.61E-11	5.20E-04	1.31E+05	8.74E-04	4.93E-02	9.12E-04	1.14E-03	2.41E-03	2.20E-01	2.29E-01	2.54E-01
4	1.42E+01	1.40E+1	6.57E-11	5.19E-04	1.31E+05	8.69E-04	4.61E-02	1.05E-03	1.27E-03	2.40E-04	2.45E-01	2.51E-01	2.57E-01
5	1.39E+01	1.32E+1	6.47E-11	4.62E-04	1.31E+05	8.48E-04	5.05E-02	1.33E-03	1.46E-03	2.33E-04	2.93E-01	2.92E-01	2.62E-01
6	1.25E+01	1.24E+1	6.38E-11	4.22E-04	1.31E+05	7.86E-04	5.45E-02	1.59E-03	1.60E-03	2.28E-04	3.39E-01	3.24E-01	2.62E-01
7	1.11E+01	1.16E+1	6.33E-11	3.76E-04	1.31E+05	7.12E-04	5.91E-02	1.99E-03	1.75E-03	2.22E-04	4.01E-01	3.63E-01	2.67E-01
8	1.11E+01	1.06E+1	6.04E-11	3.23E-04	1.31E+05	6.34E-04	6.22E-02	2.68E-03	1.95E-03	2.24E-04	4.08E-01	3.80E-01	2.87E-01
9	9.05E+00	8.61E+0	5.83E-11	2.75E-04	1.31E+05	6.28E-04	6.33E-02	3.85E-03	2.42E-03	3.42E-04	3.72E-01	3.72E-01	2.87E-01
10	9.05E+00	8.61E+0	5.54E-11	2.35E-04	1.31E+05	6.72E-04	6.21E-02	5.68E-03	3.16E-03	5.31E-04	3.45E-01	3.65E-01	3.03E-01
11	8.19E+00	7.79E+0	5.45E-11	2.02E-04	1.31E+05	7.41E-04	6.27E-02	8.15E-03	4.35E-03	7.01E-04	3.32E-01	3.55E-01	3.08E-01
12	7.41E+00	6.87E+0	5.12E-11	1.63E-04	1.31E+05	9.17E-04	6.46E-02	1.45E-02	8.14E-03	1.05E-03	3.25E-01	3.35E-01	3.24E-01
13	6.38E+00	5.63E+0	4.71E-11	1.18E-04	1.31E+05	1.17E-03	6.75E-02	2.81E-02	1.84E-02	1.51E-03	2.83E-01	2.75E-01	2.81E-01
14	4.97E+00	4.84E+0	4.58E-11	1.02E-04	1.31E+05	1.36E-03	6.69E-02	3.87E-02	2.78E-02	1.87E-03	2.90E-01	2.49E-01	2.40E-01
15	4.72E+00	4.38E+0	4.43E-11	1.08E-04	1.31E+05	1.51E-03	6.45E-02	4.73E-02	3.85E-02	2.29E-03	3.04E-01	2.79E-01	2.01E-01
16	4.07E+00	3.50E+0	4.18E-11	1.24E-04	1.31E+05	1.96E-03	5.18E-02	7.22E-02	6.42E-02	3.13E-03	1.90E-01	2.04E-01	9.48E-02
17	3.01E+00	2.68E+0	3.56E-11	1.46E-04	1.31E+05	2.51E-03	3.33E-02	1.00E-01	9.84E-02	3.77E-03	8.51E-02	8.16E-02	2.18E-02
18	2.39E+00	2.36E+0	3.33E-11	1.69E-04	1.31E+05	2.77E-03	2.60E-02	1.10E-01	1.11E-01	3.95E-03	8.66E-02	5.23E-02	1.27E-02
19	2.31E+00	2.06E+0	3.20E-11	1.69E-04	1.31E+05	3.11E-03	1.86E-02	1.22E-01	1.25E-01	4.17E-03	2.89E-02	2.47E-02	5.83E-03
20	1.83E+00	1.61E+0	2.89E-11	1.96E-04	1.36E+05	3.99E-03	8.29E-03	1.51E-01	1.55E-01	5.00E-03	8.63E-04	1.08E-03	1.62E-03
21	1.42E+00	1.26E+0	2.61E-11	2.27E-04	1.50E+05	5.71E-03	3.30E-03	1.93E-01	1.93E-01	6.64E-03	3.06E-04	1.00E+00	1.76E-04
22	1.11E+00	1.03E+0	2.50E-11	2.56E-04	1.35E+05	6.46E-03	1.38E-03	2.22E-01	2.18E-01	7.89E-03	1.57E-04	0.00E+00	1.03E-04
23	9.62E-01	8.88E-1	2.22E-11	3.28E-04	1.64E+05	6.46E-03	3.37E-04	2.49E-01	2.43E-01	8.31E-03	9.96E-05	0.00E+00	0.00E+00
24	8.21E-01	7.81E-1	2.06E-11	4.12E-04	2.58E+05	6.54E-03	0.00E+00	2.83E-01	2.77E-01	8.51E-03	5.29E-05	0.00E+00	0.00E+00
25	7.43E-01	6.89E-1	1.93E-11	5.22E-04	2.61E+05	6.69E-03	0.00E+00	3.24E-01	3.10E-01	8.73E-03	4.74E-05	0.00E+00	0.00E+00
26	6.39E-01	5.93E-1	1.79E-11	6.94E-04	2.68E+05	6.95E-03	0.00E+00	3.60E-01	3.51E-01	9.13E-03	4.28E-05	0.00E+00	0.00E+00
27	5.50E-01	4.50E-1	1.63E-11	1.14E-03	4.68E+05	7.64E-03	0.00E+00	4.10E-01	4.22E-01	9.71E-03	3.68E-05	0.00E+00	0.00E+00
28	3.69E-01	3.02E-1	1.29E-11	2.55E-03	1.27E-04	9.44E-03	0.00E+00	5.72E-01	5.54E-01	1.37E-02	2.92E-05	0.00E+00	0.00E+00
29	2.47E-01	1.97E-1	1.02E-11	4.95E-03	4.43E-04	1.24E-02	0.00E+00	7.45E-01	7.94E-01	1.69E-02	2.43E-05	0.00E+00	0.00E+00
30	1.59E-01	1.32E-1	8.06E-12	3.95E-03	1.31E-03	1.66E-02	0.00E+00	8.70E-01	1.13E+00	1.96E-02	2.12E-05	0.00E+00	0.00E+00
31	1.11E-01	7.64E-2	5.84E-12	2.90E-03	4.16E-03	1.78E-02	0.00E+00	1.12E+00	1.63E+00	3.36E-02	1.87E-05	0.00E+00	0.00E+00
32	5.29E-02	4.24E-2	3.57E-12	8.82E-03	1.01E-02	1.91E-02	0.00E+00	1.61E+00	1.61E+00	5.42E-02	1.70E-05	0.00E+00	0.00E+00
33	3.43E-02	2.92E-2	2.61E-12	9.04E-03	1.46E-02	4.09E-02	0.00E+00	2.16E+00	2.49E+00	5.99E-02	1.64E-05	0.00E+00	0.00E+00
34	2.48E-02	2.33E-2	2.14E-12	1.29E-02	1.71E-02	3.25E-02	0.00E+00	2.59E+00	2.79E+00	6.32E-02	1.61E-05	0.00E+00	0.00E+00
35	2.19E-02	1.50E-2	1.49E-12	1.43E-02	1.50E-02	5.20E-02	0.00E+00	3.61E+00	3.68E+00	6.83E-02	1.57E-05	0.00E+00	0.00E+00
36	1.03E-02	5.89E-3	3.39E-13	2.75E-03	2.16E-02	1.74E-01	0.00E+00	7.12E+00	6.59E+00	9.62E-02	1.53E-05	0.00E+00	0.00E+00
37	1.23E-03	2.03E-3	2.21E-13	2.58E-03	1.81E-02	6.49E-02	0.00E+00	1.50E+01	1.37E+01	5.53E-02	1.51E-05	0.00E+00	0.00E+00
38	1.53E-03	8.48E-4	9.25E-14	2.45E-03	5.44E-02	3.76E-02	0.00E+00	2.76E+01	2.45E+01	3.64E-02	1.50E-05	0.00E+00	0.00E+00
39	4.89E-04	4.01E-4	4.49E-14	3.44E-03	4.80E-01	1.27E-01	0.00E+00	4.36E+01	3.91E+01	4.42E-02	1.50E-05	0.00E+00	0.00E+00
40	2.75E-04	1.67E-4	2.09E-14	5.36E-03	1.78E-01	5.72E+01	0.00E+00	7.27E+01	6.64E+01	7.26E-02	1.50E-05	0.00E+00	0.00E+00
41	1.01E-04	5.42E-5	1.04E-14	9.47E-03	6.20E-01	2.85E+00	0.00E+00	1.17E+02	1.21E+02	1.47E-01	1.50E-05	0.00E+00	0.00E+00
42	2.90E-05	1.76E-5	9.37E-15	1.65E-02	1.41E+00	1.86E+00	0.00E+00	1.37E+02	2.11E+02	1.80E-01	1.50E-05	0.00E+00	0.00E+00
43	1.07E-05	5.71E-6	1.38E-14	2.92E-02	2.74E+00	2.70E+00	0.00E+00	3.65E+02	3.71E+02	8.91E-01	1.50E-05	0.00E+00	0.00E+00
44	3.06E-06	1.86E-6	1.28E-14	5.09E-02	5.15E+00	4.49E+00	0.00E+00	1.26E+02	5.00E+02	1.65E+00	1.50E-05	0.00E+00	0.00E+00
45	1.13E-06	6.83E-7	3.74E-14	8.40E-02	8.70E+00	7.32E+00	0.00E+00	3.60E+03	3.97E+01	2.78E+00	1.50E-05	0.00E+00	0.00E+00
46	4.14E-07	6.43E-8	1.50E-13	3.40E-01	3.43E+01	2.94E+01	0.00E+00	4.05E+03	2.32E+02	1.14E+01	1.53E-05	0.00E+00	0.00E+00

Table E2. Neutron activation cross sections: DLC-31 energy format VISTA files

DLC-58	Upper E	Mid E	N kerma	<sup>40</sup> Ca(n,p)	<sup>35</sup> Cl(n,γ)	<sup>59</sup> Co(n,γ)	<sup>83</sup> Cu(n,p)	<sup>151</sup> Eu→Grd	<sup>153</sup> Eu(n,γ)	<sup>63</sup> Ni(n,γ)	S(nat)(n,p)	<sup>32</sup> S(n,p)	<sup>36</sup> K(n,α)
1	1.98E+1	1.82E+1	6.9E-11	5.2E-04	1.3E-05	3.8E-04	3.0E-02	2.7E-04	4.2E-04	1.9E-04	1.1E-01	1.2E-01	2.2E-01
2	1.69E+1	1.59E+1	6.73E-11	5.20E-04	1.31E-05	7.25E-04	3.79E-02	6.40E-04	8.60E-04	2.25E-04	1.77E-01	1.75E-01	2.45E-01
3	1.49E+1	1.45E+1	6.61E-11	5.20E-04	1.31E-05	8.74E-04	4.33E-02	9.12E-04	1.14E-03	2.41E-04	2.20E-01	2.29E-01	2.54E-01
4	1.42E+1	1.40E+1	6.47E-11	5.14E-04	1.31E-05	8.96E-04	4.61E-02	1.05E-03	1.27E-03	2.40E-04	2.45E-01	2.51E-01	2.57E-01
5	1.38E+1	1.33E+1	6.47E-11	4.62E-04	1.31E-05	8.48E-04	5.05E-02	1.33E-03	1.46E-03	2.33E-04	2.83E-01	2.92E-01	2.62E-01
6	1.28E+1	1.25E+1	6.38E-11	4.22E-04	1.31E-05	7.86E-04	5.45E-02	1.59E-03	1.60E-03	2.28E-04	3.39E-01	3.24E-01	2.62E-01
7	1.22E+1	1.16E+1	6.33E-11	3.76E-04	1.31E-05	7.12E-04	5.91E-02	1.98E-03	1.75E-03	2.24E-04	4.01E-01	3.63E-01	2.67E-01
8	1.11E+1	1.05E+1	6.04E-11	3.23E-04	1.31E-05	6.34E-04	6.22E-02	2.68E-03	1.95E-03	2.22E-04	4.08E-01	3.80E-01	2.75E-01
9	1.00E+1	9.51E+0	5.83E-11	2.75E-04	1.31E-05	6.28E-04	6.33E-02	3.85E-03	2.42E-03	3.42E-04	3.72E-01	3.72E-01	2.87E-01
10	9.05E+0	8.61E+0	5.54E-11	2.35E-04	1.31E-05	6.72E-04	6.21E-02	5.58E-03	3.16E-03	5.31E-04	3.45E-01	3.65E-01	3.03E-01
11	8.19E+0	7.79E+0	5.45E-11	2.02E-04	1.31E-05	7.41E-04	6.27E-02	8.15E-03	4.35E-03	7.01E-04	3.32E-01	3.55E-01	3.09E-01
12	7.41E+0	6.87E+0	5.12E-11	1.62E-04	1.31E-05	9.17E-04	6.46E-02	1.45E-02	4.14E-03	1.05E-03	3.25E-01	3.35E-01	3.24E-01
13	6.38E+0	5.63E+0	4.71E-11	1.18E-04	1.31E-05	1.17E-03	6.75E-02	2.81E-02	1.84E-02	1.51E-03	2.83E-01	2.75E-01	2.81E-01
14	4.97E+0	4.84E+0	4.58E-11	1.02E-04	1.31E-05	1.36E-03	6.69E-02	3.87E-02	2.78E-02	1.87E-03	2.50E-01	2.49E-01	2.40E-01
15	4.72E+0	4.38E+0	4.43E-11	1.08E-04	1.31E-05	1.51E-03	6.45E-02	4.73E-02	3.65E-02	2.29E-03	3.04E-01	2.75E-01	2.01E-01
16	4.07E+0	3.50E+0	4.18E-11	1.24E-04	1.31E-05	1.96E-03	5.18E-02	7.22E-02	6.42E-02	3.13E-03	1.90E-01	2.04E-01	9.46E-02
17	3.01E+0	2.68E+0	3.55E-11	1.46E-04	1.31E-05	2.51E-03	3.33E-02	1.00E-01	9.84E-02	3.77E-03	8.51E-02	8.18E-02	2.18E-02
18	2.39E+0	2.35E+0	3.33E-11	1.56E-04	1.31E-05	2.77E-03	2.60E-02	1.10E-01	1.11E-01	3.95E-03	8.66E-02	5.25E-02	1.27E-02
19	2.31E+0	2.05E+0	3.20E-11	1.69E-04	1.31E-05	3.11E-03	1.86E-02	1.22E-01	1.25E-01	4.17E-03	2.89E-02	2.47E-02	5.83E-03
20	1.83E+0	1.42E+0	2.73E-11	2.14E-04	1.44E-05	4.98E-03	5.43E-03	1.75E-01	1.77E-01	5.94E-03	5.44E-04	4.68E-04	7.93E-04
21	1.11E+0	7.81E-1	2.02E-11	4.96E-04	2.32E-05	6.88E-03	1.93E-04	3.04E-01	2.96E-01	8.67E-03	6.66E-05	0.00E+00	9.30E-06
22	5.50E-1	2.95E-1	1.30E-11	3.01E-03	2.19E-04	9.99E-03	0.00E+00	5.86E-01	6.02E-01	1.37E-02	2.97E-05	0.00E+00	0.00E+00
23	1.98E-1	1.32E-1	8.06E-12	3.95E-03	1.31E-03	1.66E-02	0.00E+00	8.70E-01	1.13E+00	1.96E-02	2.12E-05	0.00E+00	0.00E+00
24	1.11E-1	7.84E-2	5.64E-12	2.90E-03	4.16E-03	1.78E-02	0.00E+00	1.12E+00	1.63E+00	3.38E-02	1.87E-05	0.00E+00	0.00E+00
25	5.25E-2	3.61E-2	3.17E-12	7.75E-03	1.20E-02	2.81E-02	0.00E+00	1.84E+00	2.27E+00	5.66E-02	1.67E-05	0.00E+00	0.00E+00
26	2.48E-2	2.33E-2	2.14E-12	1.29E-02	1.71E-02	3.25E-02	0.00E+00	2.59E+00	2.79E+00	6.32E-02	1.61E-05	0.00E+00	0.00E+00
27	2.19E-2	1.50E-2	1.49E-12	1.43E-02	1.50E-02	5.20E-02	0.00E+00	3.61E+00	3.58E+00	6.89E-02	1.57E-05	0.00E+00	0.00E+00
28	1.03E-2	5.89E-3	6.39E-13	2.75E-03	2.16E-02	1.74E-01	0.00E+00	7.12E+00	6.59E+00	9.62E-02	1.53E-05	0.00E+00	0.00E+00
29	3.35E-3	2.03E-3	2.21E-13	2.58E-03	1.81E-02	6.49E-02	0.00E+00	1.50E+01	1.37E+01	5.93E-02	1.51E-05	0.00E+00	0.00E+00
30	1.23E-3	8.48E-4	9.25E-14	2.45E-03	5.44E-02	3.76E-02	0.00E+00	2.76E+01	2.45E+01	3.64E-02	1.50E-05	0.00E+00	0.00E+00
31	5.83E-4	2.43E-4	3.09E-14	4.56E-03	3.04E-01	3.33E+01	0.00E+00	6.05E+01	5.50E+01	6.07E-02	1.50E-05	0.00E+00	0.00E+00
32	1.01E-4	5.42E-5	1.04E-14	9.47E-03	6.20E-01	2.65E+00	0.00E+00	1.17E+02	1.21E+02	1.80E-01	1.50E-05	0.00E+00	0.00E+00
33	2.90E-5	1.76E-5	9.37E-15	1.65E-02	1.41E+00	1.80E+00	0.00E+00	1.37E+02	2.11E+02	4.27E-01	1.50E-05	0.00E+00	0.00E+00
34	1.07E-5	5.71E-6	1.36E-14	2.92E-02	2.74E+00	7.40E+00	0.00E+00	3.65E+02	3.71E+02	8.91E-01	1.50E-05	0.00E+00	0.00E+00
35	3.06E-6	1.86E-6	2.28E-14	5.09E-02	5.15E+00	4.49E+00	0.00E+00	1.28E+02	5.00E+02	1.66E+00	1.50E-05	0.00E+00	0.00E+00
36	1.13E-6	6.83E-7	3.74E-14	8.40E-02	8.70E+00	7.32E+00	0.00E+00	3.60E+03	3.97E+01	2.78E+00	1.50E-05	0.00E+00	0.00E+00
37	4.14E-7	6.43E-8	1.50E-13	3.40E-01	3.43E+01	2.94E+01	0.00E+00	4.05E+03	2.32E+02	1.14E+01	1.53E-05	0.00E+00	0.00E+00

**Table E3. Gamma-ray dose cross sections: DABL-69 energy format VISTA files**

DABL-69	Upper E	Mid E	2nd G-kerma	Prompt G-kerma
47	2.00E+01	1.67E+1	3.8E-11	3.8E-11
48	1.40E+01	1.30E+1	3.0E-11	3.0E-11
49	1.20E+01	1.10E+1	2.66E-11	2.66E-11
50	1.00E+01	8.94E+0	2.28E-11	2.28E-11
51	8.00E+00	7.48E+0	1.98E-11	2.03E-11
52	7.00E+00	6.48E+0	1.78E-11	1.80E-11
53	6.00E+00	5.48E+0	1.61E-11	1.62E-11
54	5.00E+00	4.47E+0	1.43E-11	1.41E-11
55	4.00E+00	3.46E+0	1.21E-11	1.20E-11
56	3.00E+00	2.74E+0	1.03E-11	1.03E-11
57	2.50E+00	2.24E+0	8.96E-12	8.96E-12
58	2.00E+00	1.73E+0	7.53E-12	7.50E-12
59	1.50E+00	1.22E+0	5.84E-12	5.83E-12
60	1.00E+00	8.37E-1	4.25E-12	4.25E-12
61	7.00E-01	5.61E-1	2.86E-12	2.87E-12
62	4.50E-01	3.67E-1	1.92E-12	1.91E-12
63	3.00E-01	2.12E-1	1.03E-12	1.03E-12
64	1.50E-01	1.22E-1	5.30E-13	5.30E-13
65	1.00E-01	8.37E-2	3.49E-13	3.50E-13
66	7.00E-02	5.61E-2	3.16E-13	3.14E-13
67	4.50E-02	3.67E-2	4.64E-13	4.29E-13
68	3.00E-02	2.45E-2	1.07E-12	1.07E-12
69	2.00E-02	1.41E-2	3.51E-12	3.47E-12
	1.00E-02			

**Table E4. Gamma-ray dose cross sections: DLC-31 energy format VISTA files**

DLC-58	Upper E	Mid E	2nd G-kerma	Prompt G-kerma
38	1.40E+01	1.18E+1	2.66E-11	2.66E-11
39	1.00E+01	8.94E+0	2.28E-11	2.28E-11
40	8.00E+00	7.48E+0	1.98E-11	2.03E-11
41	7.00E+00	6.48E+0	1.78E-11	1.80E-11
42	6.00E+00	5.48E+0	1.61E-11	1.62E-11
43	5.00E+00	4.47E+0	1.43E-11	1.41E-11
44	4.00E+00	3.46E+0	1.21E-11	1.20E-11
45	3.00E+00	2.74E+0	1.03E-11	1.03E-11
46	2.50E+00	2.24E+0	8.96E-12	8.96E-12
47	2.00E+00	1.73E+0	7.53E-12	7.50E-12
48	1.50E+00	1.22E+0	5.84E-12	5.83E-12
49	1.00E+00	8.37E-1	4.25E-12	4.26E-12
50	7.00E-01	5.61E-1	2.86E-12	2.88E-12
51	4.50E-01	3.67E-1	1.92E-12	1.91E-12
52	3.00E-01	2.12E-1	1.03E-12	1.03E-12
53	1.50E-01	1.22E-1	5.30E-13	5.30E-13
54	1.00E-01	8.37E-2	3.49E-13	3.49E-13
55	7.00E-02	5.61E-2	3.16E-13	3.16E-13
56	4.50E-02	3.67E-2	4.64E-13	4.65E-13
57	3.00E-02	2.45E-2	1.07E-12	1.07E-12
58	2.00E-02	1.41E-2	3.51E-12	3.47E-12
	1.00E-02			