

## Appendix. Free-in-air kerma and neutron activation at 1 m above the ground based on DS02.

from Tables 11, 12, 13, 14 Chapter 3, Radiation Transport Calculations for Hiroshima and Nagasaki by Santoro, RT, Egbert, SD, Barnes, JM, Kerr, GD, Pace III, JV, Roberts, JA, Slater. In Report of the Joint US-Japan Dosimetry Working Group, Reassessment of the Atomic-Bomb Radiation Dosimetry for Hiroshima and Nagasaki – DS02. Robert W. Young and George D. Kerr editors, Radiation Effects Research Foundation, Hiroshima, Japan, 2005.

Table A-1. DS02 Hiroshima doses for 600 m height of burst above standard ground at 16 kT yield.

Ground Range meter	Slant Range meter	Neutron Dose			Secondary Gamma Dose			Primary Gamma Dose			Total Gamma Dose		
		Prompt gray	Delayed gray	Total gray	Prompt gray	Delayed gray	Total gray	Prompt gray	Delayed gray	Total gray	Prompt gray	Delayed gray	Total gray
0	599	3.16E+1	2.96E+0	3.45E+1	4.45E+1	1.51E+0	4.61E+1	6.18E-1	7.38E+1	7.44E+1	4.52E+1	7.53E+1	1.20E+2
100	607	2.93E+1	2.73E+0	3.20E+1	4.18E+1	1.42E+0	4.32E+1	7.22E-1	7.10E+1	7.17E+1	4.25E+1	7.24E+1	1.15E+2
200	632	2.29E+1	2.16E+0	2.51E+1	3.42E+1	1.18E+0	3.53E+1	6.86E-1	5.96E+1	6.02E+1	3.48E+1	6.07E+1	9.56E+1
300	670	1.60E+1	1.48E+0	1.75E+1	2.54E+1	8.84E-1	2.63E+1	5.90E-1	4.61E+1	4.67E+1	2.60E+1	4.70E+1	7.30E+1
400	720	1.02E+1	9.19E-1	1.11E+1	1.76E+1	6.13E-1	1.82E+1	5.02E-1	3.39E+1	3.44E+1	1.81E+1	3.46E+1	5.27E+1
500	780	5.98E+0	5.09E-1	6.48E+0	1.17E+1	4.00E-1	1.21E+1	3.91E-1	2.32E+1	2.36E+1	1.21E+1	2.36E+1	3.57E+1
600	848	3.33E+0	2.76E-1	3.61E+0	7.55E+0	2.53E-1	7.81E+0	2.90E-1	1.55E+1	1.58E+1	7.84E+0	1.58E+1	2.36E+1
700	921	1.80E+0	1.49E-1	1.95E+0	4.92E+0	1.60E-1	5.08E+0	2.07E-1	1.02E+1	1.04E+1	5.12E+0	1.04E+1	1.55E+1
800	999	9.24E-1	7.20E-2	9.96E-1	3.18E+0	9.95E-2	3.28E+0	1.50E-1	6.58E+0	6.73E+0	3.33E+0	6.68E+0	1.00E+1
900	1081	4.80E-1	3.62E-2	5.17E-1	2.08E+0	6.29E-2	2.15E+0	9.98E-2	4.22E+0	4.32E+0	2.18E+0	4.28E+0	6.47E+0
1000	1166	2.42E-1	1.77E-2	2.60E-1	1.38E+0	4.08E-2	1.42E+0	7.09E-2	2.73E+0	2.80E+0	1.45E+0	2.77E+0	4.22E+0
1100	1253	1.20E-1	8.29E-3	1.29E-1	9.21E-1	2.66E-2	9.48E-1	4.98E-2	1.75E+0	1.80E+0	9.71E-1	1.78E+0	2.75E+0
1200	1341	6.25E-2	3.99E-3	6.65E-2	6.26E-1	1.77E-2	6.44E-1	3.59E-2	1.13E+0	1.16E+0	6.62E-1	1.15E+0	1.81E+0
1300	1431	3.18E-2	1.92E-3	3.37E-2	4.27E-1	1.20E-2	4.39E-1	2.57E-2	7.21E-1	7.47E-1	4.53E-1	7.33E-1	1.19E+0
1400	1523	1.62E-2	9.05E-4	1.71E-2	2.92E-1	8.15E-3	3.01E-1	1.73E-2	4.71E-1	4.88E-1	3.10E-1	4.79E-1	7.89E-1
1500	1615	8.60E-3	4.41E-4	9.04E-3	2.03E-1	5.65E-3	2.08E-1	1.25E-2	3.06E-1	3.18E-1	2.15E-1	3.12E-1	5.27E-1
1600	1708	4.51E-3	2.11E-4	4.72E-3	1.40E-1	3.92E-3	1.44E-1	8.72E-3	2.00E-1	2.09E-1	1.49E-1	2.04E-1	3.53E-1
1700	1802	2.39E-3	1.02E-4	2.49E-3	9.80E-2	2.73E-3	1.01E-1	6.08E-3	1.31E-1	1.37E-1	1.04E-1	1.33E-1	2.37E-1
1800	1897	1.28E-3	5.06E-5	1.33E-3	6.88E-2	1.92E-3	7.07E-2	4.24E-3	8.99E-2	9.41E-2	7.30E-2	9.18E-2	1.65E-1
1900	1992	6.86E-4	2.47E-5	7.11E-4	4.85E-2	1.36E-3	4.99E-2	3.02E-3	5.75E-2	6.05E-2	5.16E-2	5.88E-2	1.10E-1
2000	2088	3.73E-4	1.24E-5	3.86E-4	3.45E-2	9.68E-4	3.54E-2	2.32E-3	3.87E-2	4.10E-2	3.68E-2	3.96E-2	7.64E-2
2100	2184	2.05E-4	6.28E-6	2.11E-4	2.46E-2	6.93E-4	2.53E-2	1.68E-3	2.54E-2	2.71E-2	2.63E-2	2.61E-2	5.24E-2
2200	2280	1.13E-4	3.19E-6	1.16E-4	1.76E-2	4.98E-4	1.81E-2	1.20E-3	1.66E-2	1.78E-2	1.88E-2	1.71E-2	3.59E-2
2300	2377	6.25E-5	1.64E-6	6.41E-5	1.26E-2	3.58E-4	1.30E-2	8.53E-4	1.15E-2	1.24E-2	1.35E-2	1.19E-2	2.53E-2
2400	2474	3.48E-5	8.46E-7	3.56E-5	9.05E-3	2.59E-4	9.31E-3	6.09E-4	7.94E-3	8.55E-3	9.66E-3	8.20E-3	1.79E-2
2500	2571	1.94E-5	4.38E-7	1.99E-5	6.53E-3	1.88E-4	6.72E-3	4.37E-4	5.38E-3	5.82E-3	6.97E-3	5.57E-3	1.25E-2

Table A-2. DS02 Hiroshima activation data for 600 m height of burst above standard ground at 16 kT yield.

Ground Range meter	Slant Range meter	Reaction									
		Ca40(n,g)	Cl35(n,g)	Co59(n,g)	Cu63(n,p)	Eu151->grd	Eu153(n,g)	Ni62(n,g)	S32(n,p)	K39(n,a)	
		Abundance	0.96941	0.7577	1	0.6917	0.4782	0.5218	0.03634	0.9502	0.93258
		MW	40.08	35.453	58.9332	63.54	151.96	151.96	58.71	32.064	39.102
		Half-Life	80000	301000	5.2714	100.1	13.542	8.593	100.1	14.262	301000
		Time units	years	years	years	years	years	years	years	days	years
		Branching ratio					0.641				
		Detector height								@ 6.5m	
		Units in atoms (unless otherwise indicated)	Ca41/grCa	Cl36/Cl	bq/mgr Co	Ni63/grCu	bq/mgr Eu	bq/mgr Eu	Ni63/grNi	dpm/gr S	Cl36/K
0	599	4.88E+10	2.54E-10	1.47E+1	1.14E+7	1.31E+2	2.01E+1	4.14E+10	2.38E+3	1.86E-15	
100	607	4.45E+10	2.31E-10	1.34E+1	1.14E+7	1.19E+2	1.83E+1	3.78E+10	2.42E+3	1.92E-15	
200	632	3.43E+10	1.78E-10	1.03E+1	9.49E+6	9.17E+1	1.40E+1	2.91E+10	2.04E+3	1.94E-15	
300	670	2.28E+10	1.19E-10	6.84E+0	7.12E+6	6.10E+1	9.32E+0	1.93E+10	1.56E+3	1.97E-15	
400	720	1.34E+10	6.98E-11	4.02E+0	5.27E+6	3.59E+1	5.47E+0	1.14E+10	1.19E+3	1.75E-15	
500	780	7.19E+09	3.74E-11	2.16E+0	3.58E+6	1.92E+1	2.93E+0	6.10E+09	8.23E+2	1.29E-15	
600	848	3.62E+09	1.88E-11	1.09E+0	2.28E+6	9.64E+0	1.47E+0	3.06E+09	5.44E+2	1.07E-15	
700	921	1.74E+09	9.05E-12	5.25E-1	1.44E+6	4.64E+0	7.10E-1	1.48E+09	3.46E+2	7.79E-16	
800	999	8.17E+08	4.24E-12	2.46E-1	8.43E+5	2.17E+0	3.33E-1	6.92E+08	2.07E+2	5.22E-16	
900	1081	3.78E+08	1.96E-12	1.14E-1	5.05E+5	1.01E+0	1.55E-1	3.20E+08	1.28E+2	3.68E-16	
1000	1166	1.74E+08	9.02E-13	5.26E-2	2.82E+5	4.62E-1	7.11E-2	1.47E+08	7.23E+1	2.34E-16	
1100	1253	8.00E+07	4.15E-13	2.43E-2	1.57E+5	2.13E-1	3.28E-2	6.78E+07	4.13E+1	1.35E-16	
1200	1341	3.73E+07	1.93E-13	1.13E-2	9.10E+4	9.91E-2	1.53E-2	3.15E+07	2.42E+1	7.96E-17	
1300	1431	1.74E+07	9.03E-14	5.29E-3	5.09E+4	4.63E-2	7.16E-3	1.47E+07	1.36E+1	4.64E-17	
1400	1523	8.21E+06	4.25E-14	2.49E-3	2.79E+4	2.18E-2	3.37E-3	6.95E+06	7.75E+0	2.73E-17	
1500	1615	3.96E+06	2.05E-14	1.20E-3	1.61E+4	1.05E-2	1.62E-3	3.35E+06	4.50E+0	1.55E-17	
1600	1708	1.93E+06	9.98E-15	5.86E-4	9.12E+3	5.11E-3	7.90E-4	1.63E+06	2.57E+0	8.91E-18	
1700	1802	9.49E+05	4.91E-15	2.89E-4	5.12E+3	2.51E-3	3.88E-4	8.02E+05	1.46E+0	5.22E-18	
1800	1897	4.73E+05	2.45E-15	1.44E-4	2.87E+3	1.25E-3	1.94E-4	4.00E+05	8.32E-1	2.99E-18	
1900	1992	2.39E+05	1.24E-15	7.27E-5	1.63E+3	6.32E-4	9.78E-5	2.02E+05	4.78E-1	1.74E-18	
2000	2088	1.22E+05	6.31E-16	3.71E-5	9.41E+2	3.23E-4	4.99E-5	1.03E+05	2.77E-1	9.88E-19	
2100	2184	6.31E+04	3.27E-16	1.92E-5	5.36E+2	1.67E-4	2.58E-5	5.33E+04	1.60E-1	5.74E-19	
2200	2280	3.30E+04	1.71E-16	1.01E-5	3.06E+2	8.74E-5	1.35E-5	2.79E+04	9.22E-2	3.33E-19	
2300	2377	1.75E+04	9.06E-17	5.33E-6	1.75E+2	4.63E-5	7.16E-6	1.48E+04	5.30E-2	1.94E-19	
2400	2474	9.38E+03	4.85E-17	2.85E-6	1.00E+2	2.48E-5	3.83E-6	7.92E+03	3.05E-2	1.12E-19	
2500	2571	5.06E+03	2.61E-17	1.54E-6	5.77E+1	1.34E-5	2.06E-6	4.27E+03	1.77E-2	6.48E-20	

Table A-3. DS02 Ngasaki doses for 503 m height of burst above standard ground at 21 kT yield.

Ground Range meter	Slant Range meter	Neutron Dose			Secondary Gamma Dose			Primary Gamma Dose			Total Gamma Dose		
		Prompt gray	Delayed gray	Total gray	Prompt gray	Delayed gray	Total gray	Prompt gray	Delayed gray	Total gray	Prompt gray	Delayed gray	Total gray
0	502	1.08E+1	7.97E+0	1.88E+1	7.17E+1	3.35E+0	7.50E+1	6.12E+1	1.92E+2	2.53E+2	1.33E+2	1.96E+2	3.28E+2
100	512	1.00E+1	7.18E+0	1.72E+1	6.88E+1	3.10E+0	7.19E+1	5.93E+1	1.81E+2	2.40E+2	1.28E+2	1.84E+2	3.12E+2
200	540	7.49E+0	5.38E+0	1.29E+1	5.34E+1	2.47E+0	5.58E+1	4.44E+1	1.48E+2	1.92E+2	9.78E+1	1.50E+2	2.48E+2
300	585	5.21E+0	3.45E+0	8.67E+0	3.97E+1	1.75E+0	4.14E+1	3.33E+1	1.10E+2	1.43E+2	7.30E+1	1.12E+2	1.85E+2
400	642	3.29E+0	1.97E+0	5.26E+0	2.80E+1	1.12E+0	2.91E+1	2.27E+1	7.55E+1	9.82E+1	5.06E+1	7.66E+1	1.27E+2
500	709	1.94E+0	1.03E+0	2.97E+0	1.85E+1	6.78E-1	1.92E+1	1.47E+1	4.92E+1	6.39E+1	3.31E+1	4.99E+1	8.30E+1
600	782	1.13E+0	5.22E-1	1.65E+0	1.21E+1	3.99E-1	1.25E+1	9.45E+0	3.12E+1	4.07E+1	2.16E+1	3.16E+1	5.32E+1
700	861	6.06E-1	2.49E-1	8.56E-1	8.21E+0	2.31E-1	8.44E+0	5.80E+0	1.93E+1	2.51E+1	1.40E+1	1.95E+1	3.35E+1
800	944	3.38E-1	1.20E-1	4.58E-1	5.58E+0	1.37E-1	5.72E+0	3.77E+0	1.20E+1	1.58E+1	9.36E+0	1.21E+1	2.15E+1
900	1031	1.81E-1	5.67E-2	2.37E-1	3.67E+0	8.23E-2	3.75E+0	2.30E+0	7.44E+0	9.74E+0	5.97E+0	7.52E+0	1.35E+1
1000	1119	9.82E-2	2.64E-2	1.25E-1	2.48E+0	5.06E-2	2.53E+0	1.52E+0	4.56E+0	6.08E+0	4.00E+0	4.61E+0	8.62E+0
1100	1209	5.20E-2	1.24E-2	6.45E-2	1.62E+0	3.23E-2	1.65E+0	9.35E-1	2.84E+0	3.78E+0	2.56E+0	2.87E+0	5.43E+0
1200	1301	2.83E-2	5.88E-3	3.41E-2	1.10E+0	2.10E-2	1.13E+0	6.07E-1	1.76E+0	2.37E+0	1.71E+0	1.78E+0	3.49E+0
1300	1394	1.53E-2	2.77E-3	1.81E-2	7.61E-1	1.39E-2	7.75E-1	4.03E-1	1.11E+0	1.51E+0	1.16E+0	1.12E+0	2.28E+0
1400	1487	8.26E-3	1.32E-3	9.58E-3	5.19E-1	9.37E-3	5.28E-1	2.61E-1	7.05E-1	9.66E-1	7.80E-1	7.15E-1	1.49E+0
1500	1582	4.47E-3	6.39E-4	5.11E-3	3.60E-1	6.41E-3	3.66E-1	1.71E-1	4.46E-1	6.17E-1	5.30E-1	4.53E-1	9.83E-1
1600	1677	2.44E-3	3.11E-4	2.75E-3	2.54E-1	4.43E-3	2.58E-1	1.14E-1	2.89E-1	4.04E-1	3.68E-1	2.94E-1	6.62E-1
1700	1773	1.34E-3	1.51E-4	1.49E-3	1.80E-1	3.07E-3	1.83E-1	7.75E-2	1.83E-1	2.60E-1	2.57E-1	1.86E-1	4.43E-1
1800	1869	7.38E-4	7.47E-5	8.13E-4	1.27E-1	2.15E-3	1.29E-1	5.21E-2	1.18E-1	1.70E-1	1.79E-1	1.20E-1	2.99E-1
1900	1965	4.05E-4	3.72E-5	4.43E-4	8.86E-2	1.52E-3	9.02E-2	3.50E-2	7.92E-2	1.14E-1	1.24E-1	8.07E-2	2.04E-1
2000	2062	2.25E-4	1.89E-5	2.44E-4	6.21E-2	1.08E-3	6.32E-2	2.37E-2	5.15E-2	7.52E-2	8.58E-2	5.26E-2	1.38E-1
2100	2159	1.25E-4	9.69E-6	1.35E-4	4.39E-2	7.68E-4	4.46E-2	1.62E-2	3.39E-2	5.01E-2	6.01E-2	3.47E-2	9.47E-2
2200	2257	7.05E-5	4.97E-6	7.55E-5	3.15E-2	5.51E-4	3.20E-2	1.13E-2	2.19E-2	3.32E-2	4.28E-2	2.25E-2	6.52E-2
2300	2354	3.98E-5	2.60E-6	4.24E-5	2.29E-2	3.96E-4	2.32E-2	7.96E-3	1.53E-2	2.33E-2	3.08E-2	1.57E-2	4.65E-2
2400	2452	2.24E-5	1.36E-6	2.38E-5	1.66E-2	2.87E-4	1.69E-2	5.60E-3	1.02E-2	1.58E-2	2.22E-2	1.04E-2	3.27E-2
2500	2550	1.28E-5	7.13E-7	1.35E-5	1.21E-2	2.08E-4	1.23E-2	3.93E-3	6.58E-3	1.05E-2	1.60E-2	6.79E-3	2.28E-2

Table A-4. DS02 Nagasaki activation data for 503 m height of burst above standard ground at 21 kT yield.

Ground Range meter	Slant Range meter	Reaction	Ca40(n,g)	Cl35(n,g)	Co59(n,g)	Cu63(n,p)	Eu151->grd	Eu153(n,g)	Ni62(n,g)	S32(n,p)	K39(n,a)
		Abundance	0.96941	0.7577	1.00E+0	6.92E-1	4.78E-1	5.22E-1	0.03634	9.50E-1	0.93258
		MW	40.08	35.453	5.89E+1	6.35E+1	1.52E+2	1.52E+2	58.71	3.21E+1	39.102
		Half-Life	80000	301000	5.27E+0	1.00E+2	1.35E+1	8.59E+0	100.1	1.43E+1	301000
		Time units	years	years	years	years	years	years	years	days	years
		Branching ratio					6.41E-1				
		Detector height							@ 6.5m		
Units in atoms (unless otherwise indicated)	Ca41/grCa	Cl36/Cl	bq/mgr Co	Ni63/grCu	bq/mgr Eu	bq/mgr Eu	Ni63/grNi	dpm/gr S	Cl36/K		
0	502	2.08E+10	1.09E-10	5.67E+0	2.51E+7	5.51E+1	6.75E+0	1.77E+10	6.93E+3	6.30E-15	
100	512	1.75E+10	9.13E-11	4.80E+0	2.39E+7	4.63E+1	5.74E+0	1.49E+10	6.61E+3	6.10E-15	
200	540	1.12E+10	5.85E-11	3.13E+0	1.73E+7	2.97E+1	3.82E+0	9.55E+09	4.73E+3	4.35E-15	
300	585	6.04E+09	3.14E-11	1.73E+0	1.23E+7	1.60E+1	2.17E+0	5.13E+09	3.39E+3	3.15E-15	
400	642	2.99E+09	1.55E-11	8.77E-1	7.83E+6	7.97E+0	1.14E+0	2.53E+09	2.14E+3	2.04E-15	
500	709	1.47E+09	7.63E-12	4.40E-1	4.64E+6	3.94E+0	5.83E-1	1.25E+09	1.29E+3	1.21E-15	
600	782	7.40E+08	3.84E-12	2.23E-1	2.74E+6	1.98E+0	3.00E-1	6.26E+08	7.69E+2	7.34E-16	
700	861	3.67E+08	1.90E-12	1.11E-1	1.47E+6	9.84E-1	1.50E-1	3.10E+08	4.19E+2	3.99E-16	
800	944	1.85E+08	9.61E-13	5.62E-2	8.48E+5	4.97E-1	7.60E-2	1.57E+08	2.40E+2	2.36E-16	
900	1031	9.21E+07	4.77E-13	2.79E-2	4.49E+5	2.47E-1	3.77E-2	7.79E+07	1.31E+2	1.26E-16	
1000	1119	4.57E+07	2.37E-13	1.39E-2	2.56E+5	1.22E-1	1.87E-2	3.87E+07	7.36E+1	7.38E-17	
1100	1209	2.29E+07	1.19E-13	6.95E-3	1.35E+5	6.12E-2	9.36E-3	1.94E+07	3.96E+1	3.95E-17	
1200	1301	1.15E+07	5.95E-14	3.49E-3	7.58E+4	3.07E-2	4.69E-3	9.72E+06	2.24E+1	2.25E-17	
1300	1394	5.80E+06	3.00E-14	1.76E-3	4.24E+4	1.54E-2	2.36E-3	4.90E+06	1.26E+1	1.28E-17	
1400	1487	2.95E+06	1.53E-14	8.97E-4	2.33E+4	7.85E-3	1.20E-3	2.49E+06	6.93E+0	7.16E-18	
1500	1582	1.51E+06	7.84E-15	4.60E-4	1.29E+4	4.03E-3	6.18E-4	1.28E+06	3.87E+0	4.01E-18	
1600	1677	7.84E+05	4.05E-15	2.38E-4	7.23E+3	2.08E-3	3.19E-4	6.62E+05	2.20E+0	2.29E-18	
1700	1773	4.09E+05	2.11E-15	1.24E-4	4.07E+3	1.08E-3	1.66E-4	3.45E+05	1.24E+0	1.31E-18	
1800	1869	2.15E+05	1.11E-15	6.54E-5	2.29E+3	5.70E-4	8.76E-5	1.82E+05	7.03E-1	7.44E-19	
1900	1965	1.14E+05	5.91E-16	3.47E-5	1.28E+3	3.03E-4	4.65E-5	9.66E+04	3.96E-1	4.19E-19	
2000	2062	6.11E+04	3.16E-16	1.86E-5	7.21E+2	1.62E-4	2.49E-5	5.17E+04	2.25E-1	2.38E-19	
2100	2159	3.29E+04	1.70E-16	1.00E-5	4.09E+2	8.72E-5	1.34E-5	2.78E+04	1.29E-1	1.36E-19	
2200	2257	1.79E+04	9.27E-17	5.45E-6	2.34E+2	4.74E-5	7.28E-6	1.51E+04	7.42E-2	7.87E-20	
2300	2354	9.80E+03	5.07E-17	2.98E-6	1.35E+2	2.59E-5	3.98E-6	8.28E+03	4.29E-2	4.56E-20	
2400	2452	5.39E+03	2.79E-17	1.64E-6	7.69E+1	1.42E-5	2.19E-6	4.55E+03	2.48E-2	2.63E-20	
2500	2550	2.98E+03	1.54E-17	9.06E-7	4.45E+1	7.87E-6	1.21E-6	2.52E+03	1.43E-2	1.53E-20	