

Table 1. UV Doses for Multiple Log Reductions for Various Spores

Spore	Lamp Type	UV Dose (Fluence) (mJ/cm ²) for a given Log Reduction without photo-reactivation							Reference
		1	2	3	4	5	6	7	
<i>Bacillus subtilis</i> ATCC6633	N/A	36	48.6	61	78				Chang et al. 1985
<i>Bacillus subtilis</i> ATCC6633	LP	24	35	47	79				Mamane-Gravetz and Linden 2004
<i>Bacillus subtilis</i> ATCC6633	LP	22	38	>50					Sommer et al. 1998
<i>Bacillus subtilis</i> ATCC6633	LP	20	39	60	81				Sommer et al. 1999
<i>Bacillus subtilis</i> WN626	LP	0.4	0.9	1.3	2				Marshall et al., 2003

Table 2. UV Doses for Multiple Log Reductions for Various Bacteria

Bacterium	Lamp Type	UV Dose (Fluence) (mJ/cm ²) for a given Log Reduction without photo-reactivation							Reference
		1	2	3	4	5	6	7	
<i>Aeromonas hydrophila</i> ATCC7966	LP	1.1	2.6	3.9	5	6.7	8.6		Wilson et al. 1992
<i>Aeromonas salmonicida</i>	LP	1.5	2.7	3.1	5.9				Liltved and Landfald 1996
<i>Campylobacter jejuni</i> ATCC 43429	LP	1.6	3.4	4	4.6	5.9			Wilson et al. 1992
<i>Citrobacter diversus</i>	LP	5	7	9	11.5	13			Giese and Darby 2000
<i>Citrobacter freundii</i>	LP	5	9	13					Giese and Darby 2000
<i>Escherichia coli</i> ATCC 11229	N/A	2.5	3	3.5	5	10	15		Harris et al. 1987
<i>Escherichia coli</i> ATCC 11229	N/A	3	4.8	6.7	8.4	10.5			Chang et al. 1985
<i>Escherichia coli</i> ATCC 11229	LP	<5	5.5	6.5	7.7	10			Zimmer et al. 2002
<i>Escherichia coli</i> ATCC 11229	MP	<3	<3	<3	<3	8			Zimmer et al. 2002
<i>Escherichia coli</i> ATCC 11229	LP	7	8	9	11	12			Hoyer 1998
<i>Escherichia coli</i> ATCC 11229	LP	3.5	4.7	5.5	6.5	7.5	9.6		Sommer et al. 2000
<i>Escherichia coli</i> ATCC 11229	LP	6	6.5	7	8	9	10		Sommer et al. 1998
<i>Escherichia coli</i> ATCC 11303	LP	4	6	9	10	13	15	19	Wu et al. 2005
<i>Escherichia coli</i> ATCC 25922	LP	6	6.5	7	8	9	10		Sommer et al. 1998
<i>Escherichia coli</i> C	LP	2	3	4	5.6	6.5	8	10.7	Otaki et al. 2003
<i>Escherichia coli</i> O157:H7	LP	1.5	3	4.5	6				Tosa and Hirata 1999
<i>Escherichia coli</i> O157:H7	LP	<2	<2	2.5	4	8	17		Yaun et al. 2003
<i>Escherichia coli</i> O157:H7 CCUG 29193	LP	3.5	4.7	5.5	7				Sommer et al. 2000
<i>Escherichia coli</i> O157:H7 CCUG 29197	LP	2.5	3	4.6	5	5.5			Sommer et al. 2000
<i>Escherichia coli</i> O157:H7 CCUG 29199	LP	0.4	0.7	1	1.1	1.3	1.4		Sommer et al. 2000
<i>Escherichia coli</i> O157:H7 ATCC 43894	LP	1.5	2.8	4.1	5.6	6.8			Wilson et al. 1992
<i>Escherichia coli</i> O25:K98:NM	LP	5	7.5	9	10	11.5			Sommer et al. 2000
<i>Escherichia coli</i> O26	LP	5.4	8	10.5	12.8				Tosa and Hirata 1999
<i>Escherichia coli</i> O50:H7	LP	2.5	3	3.5	4.5	5	6		Sommer et al. 2000
<i>Escherichia coli</i> O78:H11	LP	4	5	5.5	6	7			Sommer et al. 2000
<i>Escherichia coli</i> K-12 IFO3301	LP & MP	2	4	6	7	8.5			Oguma et al. 2002
<i>Escherichia coli</i> K-12 IFO3301	LP & MP	2.2	4.4	6.7	8.9	11.0			Oguma et al. 2004
<i>Escherichia coli</i> K-12 IFO3301	LP	1.5	2	3.5	4.2	5.5	6.2		Otaki et al. 2003
<i>Escherichia coli</i> Wild type	LP	4.4	6.2	7.3	8.1	9.2			Sommer et al. 1998

Table 2. (continued)

Bacterium	Lamp Type	UV Dose (Fluence) (mJ/cm ²) for a given Log Reduction without photo-reactivation							Reference
		1	2	3	4	5	6	7	
<i>Halobacterium elongata</i> ATCC33173	LP	0.4	0.7	1					Martin et al. 2000
<i>Halobacterium salinarum</i> ATCC43214	LP	12	15	17.5	20				Martin et al. 2000
<i>Klebsiella pneumoniae</i>	LP	12	15	17.5	20				Giese and Darby 2000
<i>Klebsiella terrigena</i> ATCC33257	LP	4.6	6.7	8.9	11				Wilson et al. 1992
<i>Legionella pneumophila</i> ATCC 43660	LP	3.1	5	6.9	9.4				Wilson et al. 1992
<i>Legionella pneumophila</i> ATCC33152	LP	1.6	3.2	4.8	6.4	8.0			Oguma et al. 2004
<i>Legionella pneumophila</i> ATCC33152	MP	1.9	3.8	5.8	7.7	9.6			Oguma et al. 2004
<i>Pseudomonas stutzeri</i>	UVB	100	150	195	230				Joux et al. 1999
RB2256	UVB	175	>300						Joux et al. 1999
<i>Salmonella spp.</i>	LP	<2	2	3.5	7	14	29		Yaun et al. 2003
<i>Salmonella anatum</i> (from human feces)	N/A	7.5	12	15					Tosa and Hirata 1998
<i>Salmonella derby</i> (from human feces)	N/A	3.5	7.5						Tosa and Hirata 1998
<i>Salmonella enteritidis</i> (from human feces)	N/A	5	7	9	10				Tosa and Hirata 1998
<i>Salmonella infantis</i> (from human feces)	N/A	2	4	6					Tosa and Hirata 1998
<i>Salmonella typhi</i> ATCC 19430	LP	1.8	4.8	6.4	8.2				Wilson et al. 1992
<i>Salmonella typhi</i> ATCC 6539	N/A	2.7	4.1	5.5	7.1	8.5			Chang et al. 1985
<i>Salmonella typhimurium</i> (from human feces)	N/A	2	3.5	5	9				Tosa and Hirata 1998
<i>Salmonella typhimurium</i> (from human feces)	N/A	2	3.5	5	9				Tosa and Hirata 1998
<i>Salmonella typhimurium</i> (in act. sludge)	LP	3	11.5	22	50				Maya et al. 2003
<i>Salmonella typhimurium</i>	UVB	50	100	175	210	250			Joux et al. 1999
<i>Shigella dysenteriae</i> ATCC29027	LP	0.5	1.2	2	3	4	5.1		Wilson et al. 1992
<i>Shigella sonnei</i> ATCC9290	N/A	3.2	4.9	6.5	8.2				Chang et al. 1985
<i>Staphylococcus aureus</i> ATCC25923	N/A	3.9	5.4	6.5	10.4				Chang et al. 1985
<i>Streptococcus faecalis</i> ATCC29212	N/A	6.6	8.8	9.9	11.2				Chang et al. 1985
<i>Streptococcus faecalis</i> (secondary effluent)	N/A	5.5	6.5	8	9	12			Harris et al. 1987
<i>Vibrio anguillarum</i>	LP	0.5	1.2	1.5	2				Liltved and Landfald 1996
<i>Vibrio cholerae</i> ATCC25872	LP	0.8	1.4	2.2	2.9	3.6	4.3		Wilson et al. 1992
<i>Vibrio natriegens</i>	UVB	37.5	75	100	130	150			Joux et al. 1999
<i>Yersinia enterocolitica</i> ATCC27729	LP	1.7	2.8	3.7	4.6				Wilson et al. 1992
<i>Yersinia ruckeri</i>	LP	1	2	3	5				Liltved and Landfald 1996

Table 3. UV Doses for Multiple Log Reductions for Various Protozoa

Protozoan	Lamp Type	UV Dose (Fluence) (mJ/cm ²) for a given Log Reduction without photo-reactivation							Reference
		1	2	3	4	5	6	7	
<i>Cryptosporidium hominis</i>	LP & MP	3	5.8						Johnson et al. 2005
<i>Cryptosporidium parvum</i> , oocysts, tissue culture assay	N/A	1.3	2.3	3.2					Shin et al. 2000
<i>Cryptosporidium parvum</i>	LP & MP	2.4	<5	5.2	9.5				Craik et al. 2001
<i>Cryptosporidium parvum</i>	MP	<5	<5	<5	~6				Amoah et al. 2005
<i>Cryptosporidium parvum</i>	MP	<10	<10	<10					Belosevic et al. 2001
<i>Cryptosporidium parvum</i>	LP	1	2	<5					Shin et al. 2001
<i>Cryptosporidium parvum</i>	MP	1	2	2.9	4				Bukhari et al. 2004
<i>Cryptosporidium parvum</i>	LP	<2	<2	<2	<4	<10			Clancy et al. 2004
<i>Cryptosporidium parvum</i>	MP	<3	<3	3-9	<11				Clancy et al. 2000
<i>Cryptosporidium parvum</i>	LP	<3	<3	3-6	<16				Clancy et al. 2000
<i>Cryptosporidium parvum</i>	LP	0.5	1	1.4	2.2				Morita et al. 2002
<i>Cryptosporidium parvum</i>	LP	2	<3	<3					Zimmer et al. 2003
<i>Cryptosporidium parvum</i>	MP	<1	<1	<1					Zimmer et al. 2003
<i>Encephalitozoon cuniculi</i> , microsporidia	LP	4	9	13					Marshall et al. 2003
<i>Encephalitozoon hellem</i> , microsporidia	LP	8	12	18					Marshall et al. 2003
<i>Encephalitozoon intestinalis</i> , microsporidia	LP & MP	<3	3	<6	6				Huffman et al. 2002
<i>Encephalitozoon intestinalis</i> , microsporidia	LP	3	5	6					Marshall et al. 2003
<i>Giardia lamblia</i> , gerbil infectivity assay	LP	<0.5	<0.5	<0.5	<1				Linden et al. 2002b
<i>Giardia lamblia</i>	LP	<10	~10	<20					Campbell et al. 2002
<i>Giardia lamblia</i>	LP	<2	<2	<4					Mofidi et al. 2002
<i>Giardia lamblia</i> , excystation assay	N/A	> 63							Rice and Hoff 1981
<i>Giardia lamblia</i> , excystation assay	N/A	40	180						Karanis et al. 1992
<i>Giardia muris</i> , excystation assay	N/A	77	110						Carlson et al. 1985
<i>G. muris</i> , cysts, mouse infectivity assay	N/A	<2	<6	10 + tailing					Craik et al. 2000
<i>Giardia muris</i>	MP	1	4.5	28 + tailing					Craik et al. 2000
<i>Giardia muris</i>	MP	<10	<10	<25	~60				Belosevic et al. 2001
<i>Giardia muris</i>	LP	<1.9	<1.9	~2	~2.3				Hayes et al. 2003
<i>Giardia muris</i>	LP	<2	<2	<4					Mofidi et al. 2002
<i>G. muris</i> , cysts	MP	<5	<5	5					Amoah et al. 2005

Table 4. UV Doses for Multiple Log Reductions for Various Viruses

Virus	Host	Lamp Type	UV Dose (Fluence) (mJ/cm ²) per Log Reduction						Reference
			1	2	3	4	5	6	
PRD-1 (Phage)	<i>S. typhimurium</i> Lt2	N/A	9.9	17.2	23.5	30.1			Meng and Gerba 1996
B40-8 (Phage)	<i>B. Fragilis</i>	LP	11	17	23	29	35	41	Sommer et al. 2001
B40-8 (Phage)	<i>B. fragilis</i> HSP-40	LP	12	18	23	28			Sommer et al 1998
MS2 (Phage)	<i>Salmonella typhimurium</i> WG49	N/A	16.3	35	57	83	114	152	Nieuwstad and Havelaar 1994

Table 4. (continued)

Virus	Host	Lamp Type	UV Dose (Fluence) (mJ/cm ²) per Log Reduction						Reference
			1	2	3	4	5	6	
MS2 DSM 5694 (Phage)	<i>E. coli</i> NCIB 9481	N/A	4	16	38	68	110		Wiedenmann et al. 1993
MS2 ATCC 15977-B1 (Phage)	<i>E. coli</i> ATCC 15977-B1	LP	15.9	34	52	71	90	109	Wilson et al. 1992
MS2 NCIMB 10108 (Phage)	<i>Salmonella typhimurium</i> WG49	N/A	12.1	30.1					Tree et al. 1997
MS2 (Phage)	<i>E. coli</i> K-12 Hfr	LP	21	36					Sommer et al. 1998
MS2 (Phage)	<i>E. coli</i> CR63	N/A	16.9	33.8					Rauth 1965
MS2 (Phage)	<i>E. coli</i> 15977	N/A	13.4	28.6	44.8	61.9	80.1		Meng and Gerba 1996
MS2 (Phage)	<i>E. coli</i> C3000	N/A	35						Battigelli et al. 1993
MS2 (Phage)	<i>E. coli</i> ATCC 15597	N/A	19	40	61				Oppenheimer et al. 1993
MS2 (Phage)	<i>E. coli</i> C3000	LP	20	42	69	92			Batch et al. 2004
MS2 (Phage)	<i>E. coli</i> ATCC 15597	LP	20	42	70	98	133		Lazarova and Savoye 2004
MS2 (Phage)	<i>E. coli</i> ATCC 15977	LP	20	50	85	120			Thurston-Enriquez et al., 2003
MS2 (Phage)	<i>E. coli</i> HS(pFamp)R	LP		45	75	100	125	155	Thompson et al. 2003
MS2 (Phage)	<i>E. coli</i> C3000	LP	20	42	68	90			Linden et al. 2002a
MS2 (Phage)	<i>E. coli</i> K-12	LP	18.5	36	55				Sommer et al. 2001
MS2 (Phage)	<i>E. coli</i> NCIMB 9481	N/A	14						Tree et al. 2005
PHI X 174 (Phage)	<i>E. coli</i> WG5	LP	2.2	5.3	7.3	10.5			Sommer et al. 1998
PHI X 174 (Phage)	<i>E. coli</i> C3000	N/A	2.1	4.2	6.4	8.5	10.6	12.7	Battigelli et al. 1993
PHI X 174 (Phage)	<i>E. coli</i> ATCC15597	N/A	4	8	12				Oppenheimer et al. 1993
PHI X 174 (Phage)	<i>E. coli</i> WG 5	LP	3	5	7.5	10	12.5	15	Sommer et al. 2001
PHI X 174 (Phage)	<i>E. coli</i> ATCC 13706	LP	2	3.5	5	7			Giese and Darby 2000
Staphylococcus aureus phage A 994 (Phage)	<i>Staphylococcus aureus</i> 994	LP	8	17	25	36	47		Sommer et al. 1989
Calicivirus canine	MDCK cell line	LP	7	15	22	30	36		Husman et al. 2004
Calicivirus feline	CRFK cell line	LP	7	16	25				Husman et al. 2004
Calicivirus feline	CRFK cell line	N/A	4	9	14				Tree et al. 2005
Calicivirus feline	CRFK cell line	LP	5	15	23	30	39		Thurston-Enriquez et al. 2003
Adenovirus type 2	A549 cell line	LP	20	45	80	110			Shin et al. 2005
Adenovirus type 2	Human lung cell line	LP	35	55	75	100			Ballester and Malley 2004
Adenovirus type 2	PLC / PRF / 5 cell line	LP	40	78	119	160	195	235	Gerba et al. 2002
Adenovirus type 15	A549 cell line (ATCC CCL-185)	LP	40	80	122	165	210		Thompson et al. 2003
Adenovirus type 40	PLC / PRF / 5 cell line	LP	55	105	155				Thurston-Enriquez et al. 2003
Adenovirus type 40	PLC / PRF / 5 cell line	LP	30	ND	ND	124			Meng and Gerba 1996
Adenovirus type 41	PLC / PRF / 5 cell line	LP	23.6	ND	ND	111.8			Meng and Gerba 1996
Poliovirus Type 1 ATCC Mahoney	N/A	N/A	6	14	23	30			Harris et al. 1987
Poliovirus Type 1 LSc2ab ()	MA104 cell	N/A	5.6	11	16.5	21.5			Chang et al. 1985

Table 4. (continued)

Virus	Host	Lamp Type	UV Dose (Fluence) (mJ/cm ²) per Log Reduction						Reference
			1	2	3	4	5	6	
Poliovirus Type 1 LSc2ab	BGM cell	LP	5.7	11	17.6	23.3	32	41	Wilson et al. 1992
Poliovirus 1	BGM cell line	N/A	5	11	18	27			Tree et al. 2005
Poliovirus 1	CaCo2 cell-line (ATCC HTB37)	LP	7	17	28	37			Thompson et al. 2003
Poliovirus 1	BGM cell line	LP	8	15.5	23	31			Gerba et al. 2002
Poliovirus Type Mahoney	Monkey kidney cell line Vero	LP	3	7	14	40			Sommer et al. 1989
Coxsackievirus B5	Buffalo Green Monkey cell line	N/A	6.9	13.7	20.6				Battigelli et al. 1993
Coxsackievirus B3	BGM cell line	LP	8	16	24.5	32.5			Gerba et al. 2002
Coxsackievirus B5	BGM cell line	LP	9.5	18	27	36			Gerba et al. 2002
Reovirus-3	Mouse L-60	N/A	11.2	22.4					Rauth 1965
Reovirus Type 1 Lang strain	N/A	N/A	16	36					Harris et al. 1987
Rotavirus SA-11	Monkey kidney cell line MA 104	LP	8	15	27	38			Sommer et al. 1989
Rotavirus SA-11	MA-104 cell line	N/A	7.6	15.3	23				Battigelli et al. 1993
Rotavirus SA-11	MA-104 cell line	N/A	7.1	14.8	25				Chang et al. 1985
Rotavirus SA-11	MA-104 cell line	LP	9.1	19	26	36	48		Wilson et al. 1992
Rotavirus	MA104 cells	LP	20	80	140	200			Caballero et al. 2004
Hepatitis A HM175	FRhK-4 cell	LP	5.1	13.7	22	29.6			Wilson et al. 1992
Hepatitis A	HAV/HFS/GBM	N/A	5.5	9.8	15	21			Wiedenmann et al. 1993
Hepatitis A HM175	FRhK-4 cell	N/A	4.1	8.2	12.3	16.4			Battigelli et al. 1993
Echovirus I	BGM cell line	LP	8	16.5	25	33			Gerba et al. 2002
Echovirus II	BGM cell line	LP	7	14	20.5	28			Gerba et al. 2002

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