

This UV Log Reduction Study Evaluates the Ultra Violet Dosage Required for Multiple Log Reduction of Spore, Bacterium, Protozoan and Virus. The stated dose represents the number of mJ/cm² required to achieve the log reduction or kill rate shown by column.

Review [Introduction to UV Log Reduction Study](#) for a more detailed explanation of the information provided below.

TABLE I

Spore	Lamp Type	1-log	2-log	3-log	4-log	5-log	6-log	7-log	Testing Reference
Bacillus subtilis ATCC6633	N/A	36	48.6	61	78				Chang
Bacillus subtilis ATCC6633	LP	24	35	47	79				Mamane-Gravetz & Linden
Bacillus subtilis ATCC6633	LP	22	38	>50					Sommer
Bacillus subtilis ATCC6633	LP	20	39	60	81				Sommer
Bacillus subtilis WN626	LP	0.4	0.9	1.3	2				Marshall

Table 2

Bacterium	Lamp Type	1-log	2-log	3-log	4-log	5-log	6-log	7-log	Testing Reference
Aeromonas hydrophila ATCC7966	LP	1.1	2.6	3.9	5	6.7	8.6		Wilson
Aeromonas salmonicida	LP	1.5	2.7	3.1	5.9				Lilved & Landfald
Campylobacter jejuni ATCC 43429	LP	1.6	3.4	4	4.6	5.9			Wilson
Citrobacter diversus	LP	5	7	9	11.5	13			Giese & Darby
Citrobacter freundii	LP	5	9	13					Giese & Darby
Escherichia coli ATCC 11229 (e.coli)	N/A	2.5	3	3.5	5	10	15		Harris
Escherichia coli ATCC11229 (e.coli)	N/A	3	4.8	6.7	8.4	10.5			Chang
Escherichia coli ATCC11229 (e.coli)	LP	< 5	5.5	6.5	7.7	10			Zimmer
Escherichia coli ATCC11229 (e.coli)	MP	< 3	< 3	< 3	< 3	8			Zimmer
Escherichia coli ATCC11229 (e.coli)	LP	7	8	9	11	12			Hoyer
Escherichia coli ATCC 11229 (e.coli)	LP	3.5	4.7	5.5	6.5	7.5	9.6		Sommer
Escherichia coli ATCC 11229 (e.coli)	LP	6	6.5	7	8	9	10		Sommer
Escherichia coli ATCC 11303 (e.coli)	LP	4	6	9	10	13	15	19	Wu
Escherichia coli ATCC 25922 (e.coli)	LP	6	6.5	7	8	9	10		Sommer
Escherichia coli C (e.coli)	LP	2	3	4	5.6	6.5	8	10.7	Otaki
Escherichia coli O157:H7 (e.coli)	LP	1.5	3	4.5	6				Tosa & Hirata
Escherichia coli O157:H7 (e.coli)	LP	< 2	< 2	2.5	4	8	17		Yaun
Escherichia coli O157:H7 CCUG 29193 (e.coli)	LP	3.5	4.7	5.5	7				Sommer
Escherichia coli O157:H7 CCUG 29197 (e.coli)	LP	2.5	3	4.6	5	5.5			Sommer

Bacterium	Lamp Type	1-log	2-log	3-log	4-log	5-log	6-log	7-log	Testing Reference
Escherichia coli O157:H7 CCUG 29199 (e.coli)	LP	0.4	0.7	1	1.1	1.3	1.4		Sommer
Escherichia coli O157:H7 ATCC 43894 (e.coli)	LP	1.5	2.8	4.1	5.6	6.8			Wilson
Escherichia coli O25:K98:NM (e.coli)	LP	5	7.5	9	10	11.5			Sommer
Escherichia coli O26 (e.coli)	LP	5.4	8	10.5	12.8				Tosa & Hirata
Escherichia coli O50:H7 (e.coli)	LP	2.5	3	3.5	4.5	5	6		Sommer
Escherichia coli O78:H11 (e.coli)	LP	4	5	5.5	6	7			Sommer
Escherichia coli K-12 IFO3301 (e.coli)	LP & MP	2	4	6	7	8.5			Oguma
Escherichia coli K12 IFO3301 (e.coli)	LP & MP	2.2	4.4	6.7	8.9	11			Oguma
Escherichia coli K12 IFO3301 (e.coli)	LP	1.5	2	3.5	4.2	5.5	6.2		Otaki
Escherichia coli Wild type (e.coli)	LP	4.4	6.2	7.3	8.1	9.2			Sommer
Halobacterium elongata ATCC33173	LP	0.4	0.7	1					Martin
Halobacterium salinarum ATCC43214	LP	12	15	17.5	20				Martin
Klebsiella pneumoniae	LP	12	15	17.5	20				Giese & Darby
Klebsiella terrigena ATCC33257	LP	4.6	6.7	8.9	11				Wilson
Legionella pneumophila ATCC43660	LP	3.1	5	6.9	9.4				Wilson
Legionella pneumophila ATCC33152	LP	1.6	3.2	4.8	6.4	8			Oguma
Legionella pneumophila ATCC33152	MP	1.9	3.8	5.8	7.7	9.6			Oguma
Pseudomonas stutzeri	UVB	100	150	195	230				Joux
RB2256	UVB	175	> 300						Joux
Salmonella spp.	LP	< 2	2	3.5	7	14	29		Yaun
Salmonella anatum (from human feces)	N/A	7.5	12	15					Tosa & Hirata
Salmonella derby (from human feces)	N/A	3.5	7.5						Tosa & Hirata
Salmonella enteritidis (from human feces)	N/A	5	7	9	10				Tosa & Hirata
Salmonella infantis (from human feces)	N/A	2	4	6					Tosa & Hirata
Salmonella typhi ATCC 19430	LP	1.8	4.8	6.4	8.2				Wilson
Salmonella typhi ATCC 6539	N/A	2.7	4.1	5.5	7.1	8.5			Chang
Salmonella typhimurium (from human feces)	N/A	2	3.5	5	9				Tosa & Hirata
Salmonella typhimurium (from human feces)	N/A	2	3.5	5	9				Tosa & Hirata

Bacterium (continued)	Lamp Type	1-log	2-log	3-log	4-log	5-log	6-log	7-log	Testing Reference
Salmonella typhimurium (in act. sludge)	LP	3	11.5	22	50				Maya
Salmonella typhimurium	UVB	50	100	175	210	250			Joux
Shigella dysenteriae ATCC29027	LP	0.5	1.2	2	3	4	5.1		Wilson
Shigella sonnei ATCC9290	N/A	3.2	4.9	6.5	8.2				Chang
Staphylococcus aureus ATCC25923	N/A	3.9	5.4	6.5	10.4				Chang
Streptococcus faecalis ATCC29212	N/A	6.6	8.8	9.9	11.2				Chang
Streptococcus faecalis (secondary effluent)	N/A	5.5	6.5	8	9	12			Harris
Vibrio anguillarum	LP	0.5	1.2	1.5	2				Lilved & Landfald
Vibrio cholerae ATCC25872	LP	0.8	1.4	2.2	2.9	3.6	4.3		Wilson
Vibrio natriegens	UVB	37.5	75	100	130	150			Joux
Yersinia enterocolitica ATCC27729	LP	1.7	2.8	3.7	4.6				Wilson
Yersinia ruckeri	LP	1	2	33	5				Lilved & Landfald

Table 3

Protozoan	Lamp Type	1-log	2-log	3-log	4-log	5-log	6-log	7-log	Testing Reference
Cryptosporidium hominis	LP & MP	3	5.8						Johnson
Cryptosporidium parvum, oocysts, tissue culture assay	N/A	1.3	2.3	3.2					Shin
Cryptosporidium parvum	LP & MP	2.4	< 5	5.2	9.5				Craik
Cryptosporidium parvum	MP	< 5	< 5	< 5	6				Amoah
Cryptosporidium parvum	MP	< 10	< 10	< 10					Belosevic
Cryptosporidium parvum	LP	1	2	< 5					Shin
Cryptosporidium parvum	MP	1	2	2.9	4				Bukhari
Cryptosporidium parvum	LP	< 2	< 2	< 2	< 4	< 10			Clancy
Cryptosporidium parvum	MP	< 3	< 3	< 3-9	< 11				Clancy
Cryptosporidium parvum	LP	< 3	< 3	3 to 6	< 16				Clancy
Cryptosporidium parvum	LP	0.5	1	1.4	2.2				Morita
Cryptosporidium parvum	LP	2	< 3	< 3					Zimmer
Cryptosporidium parvum	MP	< 1	< 1	< 1					Zimmer
Encephalitozoon cuniculi, microsporidia	LP	4	9	13					Marshall
Encephalitozoon hellem, microsporidia	LP	8	12	18					Marshall

Protozoan (continued)	Lamp Type	1-log	2-log	3-log	4-log	5-log	6-log	7-log	Testing Reference
Encephalitozoon intestinalis, microsporidia	LP & MP	< 3	3	< 6	6				Huffman
Encephalitozoon intestinalis, microsporidia	LP	3	5	6					Marshall
Giardia lamblia, gerbil infectivity assay	LP	< 0.5	< 0.5	< 0.5	< 1				Linden
Giardia lamblia	LP	< 10	-10	< 20					Campbell
Giardia lamblia	LP	< 2	< 2	< 4					Mofidi
Giardia lamblia, excystation assay	N/A	> 63							Rice & Hoff
Giardia lamblia, excystation assay	N/A	40	180						Karanis
Giardia lamblia, muris, excystation assay	N/A	77	110						Carlson
G. muris, cysts, mouse infectivity assay	N/A	< 2	< 6	10 + tailing	10 + tailing	10 + tailing	10 + tailing	10 + tailing	Craik
Giardia muris	MP	1	4.5	28 + tailing	28 + tailing	28 + tailing	28 + tailing	28 + tailing	Craik
Giardia muris	MP	< 10	< 10	< 25	-60				Belosevic
Giardia muris	LP	< 1.9	< 1.9	2	2.3				Hayes
Giardia muris	LP	< 2	< 2	< 4					Mofidi
G. muris, cysts	MP	< 5	< 5	5					Amoah

Table 4

Virus	Host	Lamp Type	1-log	2-log	3-log	4-log	5-log	6-log	Testing Reference
PRD-1 (Phage)	S.typhimurium Lt2	N/A	9.9	17.2	23.5	20.1			Meng & Gerba
B40-8 (Phage)	B. fragilis	LP	11	17	23	29	35	41	Sommer
B-40-8 (Phage)	B. fragilis HSP-40	LP	12	18	23	28			Sommer
MS2 (Phage)	Salmonella typhimurium WG49	N/A	16.3	35	57	83	114	152	Nieuwstad & Havelaar
MS2 DSM 5694 (Phage)	E. coli NCIB 9481	N/A	4	16	38	68	110		Wiedenmann
MS2 ATCC 15977-B1 (Phage)	E. coli ATCC 15977-B1	LP	15.9	34	52	71	90	109	Wilson
MS2 NCIMB 10108 (Phage)	Salmonella typhimurium WG49	N/A	12.1	30.1					Tree
MS2 (Phage)	E. coli K-12 Hfr	LP	21	36					Sommer

Virus (continued)	Host	Lamp Type	1-log	2-log	3-log	4-log	5-log	6-log	Testing Reference
MS2 (Phage)	E. coli CR63	N/A	16.9	33.8					Rauth
MS2 (Phage)	E. coli 15977	N/A	13.4	28.6	44.8	61.9	80.1		Meng & Gerba
MS2 (Phage)	E. coli C3000	N/A	35						Battigelli
MS2 (Phage)	E. coli ATCC 15597	N/A	19	40	61				Oppenheimer
MS2 (Phage)	E. coli C3000	LP	20	42	69	92			Batch
MS2 (Phage)	E. coli ATCC 15597	LP	20	42	70	98	133		Lazarova & Savoye
MS2 (Phage)	E. coli ATCC 15977	LP	20	50	85	120			Thurston-Enriquez
MS2 (Phage)	E. coli HS (pFamp) R	LP		45	75	100	125	155	Thompson
MS2 (Phage)	F. coli C3000	LP	20	42	68	90			Linden
MS2 (Phage)	E. coli K-12	LP	18.5	36	55				Sommer
MS2 (Phage)	E. coli NCIMB 9481	N/A	14						Tree
PHI X 174 (Phage)	E. coli WG5	LP	2.2	5.3	7.3	10.5			Sommer
PHI X 174 (Phage)	E. coli C3000	N/A	2.1	4.2	6.4	8.5	10.6	12.7	Battigelli
PHI X 174 (Phage)	E. coli ATCC 15597	N/A	4	8	12				Oppenheimer
PHI X 174 (Phage)	E. coli WG5	LP	3	5	7.5	10	12.5	15	Sommer
PHI X 174 (Phage)	E. coli ATCC 13706	LP	2	3.5	5	7			Giese & Darby
Staphylococcus aureus phage A 994 (Phage)	Staphylococcus aureus 994	LP	8	17	25	36	47		Sommer
Calicivirus canine	MDCK cell line	LP	7	15	22	30	36		Husman
Calicivirus feline	CRFK cell line	LP	7	16	25				Husman
Calicivirus feline	CRFK cell line	N/A	4	9	14				Tree
Calicivirus feline	CRFK cell line	LP	5	15	23	30	39		Thurston-Enriquez
Adenovirus type 2	A549 cell line	LP	20	45	80	110			Shin
Adenovirus type 2	Human lung cell line	LP	35	55	75	100			Ballester & Mallery
Adenovirus type 2	PLC / PRF 5 / cell line	LP	40	78	119	160	195	235	Gerba
Adenovirus type 15	A549 cell line (ATCC CCL-185)	LP	40	80	122	165	210		Thompson

Virus (continued)	Host	Lamp Type	1-log	2-log	3-log	4-log	5-log	6-log	Testing Reference
Adenovirus type 40	PLC / PRF / 5 / cell line	LP	55	105	155				Thurston-Enriquez
Adenovirus type 40	PLC / PRF / 5 / cell line	LP	30	ND	ND	124			Meng & Gerba
Adenovirus type 41	PLC / PRF / 5 / cell line	LP	23.6	ND	ND	111.8			Meng & Gerba
Poliovirus Type 1 ATCC Mahoney	N/A	N/A	6	14	23	30			Harris
Poliovirus Type 1 LS2ab	MA104 cell	N/A	5.6	11	16.5	21.5			Chang
Poliovirus Type 1 LSc2ab	BGM cell	LP	5.7	11	17.6	233	32	41	Wilson
Poliovirus 1	BGM cell line	N/A	5	11	18	27			Tree
Poliovirus 1	CaCo2 cell-line (ATCC HTB37)	LP	7	17	28	37			Thompson
Poliovirus 1	BGM cell line	LP	8	15.5	23	31			Gerba
Poliovirus Type Mahoney	Monkey kidney cell line Vero	LP	3	7	14	40			Sommer
Coxsackievirus B5	Buffalo Green Monkey cell line	N/A	6.9	13.7	20.6				Battigelli
Coxsackievirus B3	BGM cell line	LP	8	16	24.5	32.5			Gerba
Coxsackievirus B5	BGM cell line	LP	9.5	18	27	36			Gerba
Reovirus-3	Mouse L-60	N/A	11.2	22.4					Rauth
Reovirus Type 1 Lang strain	N/A	N/A	16	36					Harris
Rotavirus SA-11	Monkey kidney cell line MA 104	LP	8	15	27	38			Sommer
Rotavirus SA-11	MA-104 cell line	N/A	7.6	15.3	23				Battigelli
Rotavirus SA-11	MA-104 cell line	N/A	7.1	14.8	25				Chang
Rotavirus SA-11	MA-104 cell line	LP	9.1	19	26	36	48		Wilson
Rotavirus	MA104 cells	LP	20	80	140	200			Caballero
Hepatitis A HM175	FRhK-4 cell	LP	5.1	13.7	22	29.6			Wilson
Hepatitis A	HAV/HFS/GBM	N/A	5.5	9.8	15	21			Wiedenmann
Hepatitis A HM175	FRhK-4 cell	N/A	4.1	8.2	12.3	16.4			Battigelli
Echovirus 1	BGM cell line	LP	8	16.5	25	33			Gerba
Echovirus II	BGM cell line	LP	7	14	20.5	28			Gerba