

AMERICAN ULTRAVIOLET COMPANY

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DETERMINING ULTRAVIOLET INTENSITIES USING GERMICIDAL LAMPS

To determine the intensity of ultraviolet on a surface at various distances from a germicidal ultraviolet lamp multiply the **radiant energy** [shown in *microwatts per square centimeter at one meter*] by the **intensity factor** as shown in table below. The intensity factor table may be used for all germicidal lamps:

Distance from Lamp	2"	3"	4"	6"	8"	10"	12"	14"	18"
Intensity Factor	32.3	22.8	18.6	12.9	9.85	7.94	6.48	5.35	3.6

Distance from Lamp	24"	36"	39.37" (1 meter)	48"	60"	80"	100"	120"
Intensity Factor	2.33	1.22	1.00	0.681	0.452	0.256	0.169	0.115

Example: The ultraviolet intensity produced by one 782L30 (GML010) germicidal ultraviolet lamp at room temperature is 73. [This is found on the *Distribution of Radiant Energy* chart under lamp type]. An ultraviolet lamp 24 inches from surface has an intensity factor of 2.33 as shown in table above. Multiply the rated intensity of the lamp 73 microwatts per square centimeter at one meter by the intensity factor for 24 inches, which is 2.33:

$$73 \times 2.33 = 170.09 \text{ microwatts/sq.cm. at 24"}$$

In like manner, the ultraviolet intensity produced by one G36T6L (GML005) germicidal ultraviolet lamp at 420 milliamperes operating current at 120 inches is: $120 \times .115 = 13.8 \text{ microwatts/sq.cm. at 120"}$

The intensity factors listed were determined from laboratory tests using a click meter and a bare germicidal ultraviolet lamp with no reflector. If a parabolic, specular aluminum reflector is used in conjunction with the lamp, the intensity will be increased many times, depending upon the design and the efficiency of the reflector. The intensity factor table provides an easy method for quickly calculating ultraviolet intensities within ten percent accuracy. It is suggested that our Model IL-1400 sensitive ultraviolet (254nm) meter be used where additional measurements are desired.

Lamp intensity and exposure time are the main considerations for the effectiveness of UV destruction or inactivation of microorganism. The formula below can be used to calculate exposure time. Intensity required depends very much on the type of lamp, the microorganism being eliminated, and the distance from the lamp.

Example: To calculate the needed time and intensity for general green mold spores (penicillium roqueforti) for 100% destruction 26,400 microwatt seconds per square centimeter is needed. Using G36T6L (GML005) germicidal ultraviolet lamp (253.7nm) with lamp current of 420 MA, 120 microwatts/cm² @ 1 meter is the output. [Determined from Radiant Energy table.] Divide the needed 26,400 microwatts cm² by 120 which equals 220. At 3" from surface the intensity factor is 22.8. [Listed on intensity factor table.] Using two lamps the intensity doubles to 45.6. Three lamps would triple intensity, etc. The formula is: $26400 / 120 = 220$; $22.8 \times 2 = 45.6$ or $220 / 45.6 = 4.82$ seconds needed for two lamps at 3" from surface to destroy 26,400 microwatts cm².

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SPECIAL DISTRIBUTION OF RADIANT ENERGY PRODUCED BY GERMICIDAL LAMPS

The following table gives the radiant energy distribution of germicidal ultraviolet lamps operating under specified test conditions after 100 hours burning.

ENERGY RADIATED in microwatts per square centimeter at one meter

UV Lamps	782 L20	782 L10 782 H10	782 L30 782 H30	G30T8	G15T8	G8T5	G36T6L (GML005)					
Arc Length	18"	8"	28"	32"	14"	8"	30"					
Wattage	24	20	29	30	15	8	39					
Milliamps (MA)	90	90	90	340	310	170	120	200	300	420	Factors*	
Wave length in nanometers (10 nm = 1 Angstroms)	253.7	28	50	73	85	38	17	70.0	100	115	120	Measure
	265.2	.854	1.525	2.227	2.592	1.159	.518	2.135	3.05	3.51	3.66	0.0305
	280.4	.028	.050	.073	.085	.038	.017	.070	.100	.115	.120	0.0010
	289.4	.039	.070	.102	.119	.053	.024	.098	.140	.161	.170	0.0014
	296.7	.146	.260	.380	.442	.198	0.88	.364	.520	.598	.624	0.0052
	302.2	.070	.125	.184	.213	.095	.043	.175	.250	.288	.300	0.0025
	319.9	.549	.980	1.431	1.670	.745	.333	1.372	1.960	2.254	2.352	0.0196
	365.4	.468	.835	1.219	1.420	.635	.284	1.170	1.670	1.920	2.004	0.00167
	404.7	.554	.990	1.445	1.680	.752	.336	1.386	1.980	2.277	2.376	0.0198
	435.9	1.680	3.000	4.380	5.100	2.280	1.020	4.200	6.000	6.900	7.200	0.0600
	546.1	.916	1.635	2.387	2.780	1.243	0.555	2.290	3.270	3.760	3.924	0.0327
578.0	.199	.355	.518	.604	.269	.121	.497	.710	.816	.852	0.0071	

*The measured ultraviolet intensity at 253.7 nanometer units multiplied by these factors will give the intensity at other wavelength.

There is a small amount of ultraviolet radiation generated below 200 nanometers (nm) which produces ozone in the air, but the intensity depends upon the type of lamp. No figures are given for this radiation as the amount is very small and the atmosphere rapidly absorbs such energy. For comparison purposes, the transmission at 184.9 nanometer units for the types of glasses used in germicidal ultraviolet lamps is shown below:

UV Lamps	G 30T8 G 15T8 G 8T5	782 L10 782 L20 G36T6L	782 H10 752 H30 G36T6H
Type of Glass	9823	7910	7912
Transmission @ 184.9nm	Negilible	.05%	.02%