Table 1

Accessible Emission Limits for Continuous-Wave Small-Source Lasers and Laser Systems*

Wavelength Range (mm)	Emission Duration (s)	Class 1† (W)	Class 2 (W)	Class 3§ (W)	Class 4 (W)
Ultraviolet					
0.18 to 0.302	3×10^4	$\leq 9.6 \times 10^{-9}$	–	> Class 1 but ≤ 0.5	>0.5
0.302 to 0.4	3×10^4	$\leq 3.2 \times 10^{-6}$	–		>0.5
		depending on wavelength (see Table 5)			
Visible					
0.4 to 0.7	10†	$\leq 0.4 \times 10^{-3}$ (see Table 5)	> Class 1 but $\leq 1 \times 10^{-3}$	> Class 2 but ≤ 0.5	> 0.5
Near Infrared					
0.7 to 1.05	≥ 10	$\leq 0.4 \times 10^{-3}$ to $\leq 1.9 \times 10^{-3}$	–	> Class 1 but ≤ 0.5	> 0.5
1.05 to 1.15	≥ 10	$\leq 1.9 \times 10^{-3}$	–	> Class 1 but ≤ 0.5	> 0.5
1.15 to 1.2	≥ 10	$\leq 1.9 \times 10^{-3}$ to 1.5×10^{-2}			
1.2 to 1.4	≥ 10	$\leq 1.5 \times 10^{-2}$			
Far Infrared					
1.4 to 100	> 10	$\leq 9.6 \times 10^{-3}$	–	> Class 1 but > 0.5	> 0.5
Submillimeter					
10^2 to 10^3	> 10	$\leq 9.5 \times 10^{-2}$	–	> Class 1 but > 0.5	> 0.5

* Emission duration ≥ 0.25 s.

† When the design or intended use of the laser or laser system ensures personnel exposures of less than 10^4 s in any 24-hour period, the limiting exposure duration may establish a higher exempt power level, as discussed in 3.2.3. The Class 1 AELs calculated with this standard, under certain circumstances, may not be equivalent to those calculated with FLPPS or the IEC standard.

§ For 1 to 5 mW CW laser systems (Class 3a) see 3.3.3.1 and 3.3.3.2.

NOTE: The wavelength range λ_1 to λ_2 means $\lambda_1 \leq \lambda < \lambda_2$, e.g., 0.18 to 0.4 μm means $0.18 \leq \lambda < 0.4$ μm.

Table 2

Accessible Emission Levels (Radiant Energy)
for Single-Pulse Laser and Laser System Classification*

Wavelength Range (μm)	Emission Duration** (s)	Class 1 (J)	Class 3b (J)	Class 4 (J)
Ultraviolet				
0.18 to 0.302†	10^{-9} to 0.25	$\leq 2.4 \times 10^{-5}$	> Class 1 but ≤ 0.125	> 0.125
0.302 to 0.4	10^{-9} to 0.25	$\leq 2.4 \times 10^{-5}$	> Class 1 but ≤ 0.125	> 0.125
		$\leq 3.1 \times 10^{-3}$	> Class 1 but ≤ 0.125	> 0.125
Visible				
0.4 to 0.7	10^{-9} to 0.25	$\leq 0.2 \times 10^{-6}$	> Class 1 but ≤ 0.03	> 0.03
		$\leq 0.25 \times 10^{-3}$	> Class 1 but ≤ 0.03	> 0.03
Near Infrared				
0.7 to 1.05	10^{-9} to 0.25	$\leq 1.9 \times 10^{-7}$ to $\leq 1.2 \times 10^{-3}$	> Class 1 but $\leq 0.03\ C_A$	> 0.03 C_A***
1.05 to 1.4	10^{-9} to 0.25	$\leq 1.9 \times 10^{-6}$ to $\leq 9.8 \times 10^{-3}$	> Class 1 but ≤ 0.125	> 0.125
Far Infrared				
1.4 to 10^2	10^{-9} to 0.25	$\leq 79 \times 10^{-6}$ to $\leq 7.9 \times 10^{-3}$	> Class 1 but ≤ 0.125	> 0.125
Submillimeter				
10^2 to 10^3	10^{-9} to 5×10^{-6}	≤ 0.01 to 0.025	> Class 1 but ≤ 0.125	> 0.125
	5×10^{-6} to 0.25	≤ 0.025 to ≤ 0.38	> Class 1 but $\leq 5 \times$ Class 1	> 5 x Class 1

* There are no Class 2 single-pulse lasers.

** See note in Section 8 for pulse widths less than 1 ns.

† Wavelength dependent (see Table 5).

*** Not to exceed 0.125 J

NOTE: The wavelength range λ_1 to λ_2 means $\lambda_1 \leq \lambda < \lambda_2$, e.g., 0.18 to 0.4 μm means $0.18 \leq \lambda < 0.4$ μm.

Table 3

Diffusely Reflected Beam Energy in Joules Which does not Exceed the MPE Values.

Pulsed Lasers (1 ns to 50 μs Pulse Duration: Wavelengths Between 0.400 to 1.400 μm). †

Beam Diameter (cm)	Viewing Distance, r_1 (cm) 20	100	10^3
0.1	0.002 x C_A	0.016 x C_A	1.6 x C_A
0.2	0.004 x C_A	0.021 x C_A	1.6 x C_A
0.3	0.006 x C_A	0.032 x C_A	1.6 x C_A
0.4	0.008 x C_A	0.042 x C_A	1.6 x C_A
0.5	0.011 x C_A	0.053 x C_A	1.6 x C_A
0.6	0.013 x C_A	0.063 x C_A	1.6 x C_A
0.7	0.015 x C_A	0.074 x C_A	1.6 x C_A
0.8	0.017 x C_A	0.084 x C_A	1.6 x C_A
0.9	0.020 x C_A	0.095 x C_A	1.6 x C_A
1.0	0.022 x C_A	0.11 x C_A	1.6 x C_A
1.5	0.034 x C_A	0.16 x C_A	1.6 x C_A
2.0	0.046 x C_A	0.21 x C_A	2.1 x C_A
2.5	0.074 x C_A	0.27 x C_A	2.6 x C_A
3.0	0.11 x C_A	0.32 x C_A	3.2 x C_A
3.5	0.15 x C_A	0.38 x C_A	3.7 x C_A
4.0	0.20 x C_A	0.44 x C_A	4.2 x C_A
4.5	0.26 x C_A	0.49 x C_A	4.7 x C_A
5.0	0.33 x C_A	0.55 x C_A	5.3 x C_A
6.0	0.50 x C_A	0.68 x C_A	6.3 x C_A
7.0	0.7 x C_A	0.79 x C_A	7.4 x C_A
8.0	0.9 x C_A	0.91 x C_A	8.4 x C_A
9.0	1.3 x C_A	1.0 x C_A	9.5 x C_A
10.0	1.6 x C_A	1.2 x C_A	11.0 x C_A

† The table shows the values for pulsed lasers with 1 ns to 18 μs pulse durations for the wavelength region 0.400 to 1.050 μm and 1 ns to 50 μs for the wavelength region 1.050 to 1.400 μm.

Notes:

1. The diffuse reflection values Q are based on the MPE values in Table 5 and are calculated from the general equation

$$Q = \frac{\pi(\text{MPE})(r_1 + D_\rho / 2)^2}{\rho_\lambda \cos\theta_v}$$

which is valid for all exposure durations where the MPE in Table 5 is expressed in J·cm^{-2}, including those for 100 fs to 1 ns. D_ρ is the diameter of the laser beam at the reflection site, θ_v is the viewing angle, ρ_λ is the spectral reflectance as a function of wavelength (where this is not known, the value 1 is used), and r_1 is the viewing distance. In calculating the above values, the following was assumed: $\theta_v = 90°$; $\rho_\lambda = 1$; and n = 1 (that is, these values are for the single-pulse case). The MPE values substituted into the above equation must include the correction factors C_A, C_C, C_E, and C_P where appropriate, and for wavelengths between 0.4 and 0.55 μm, the MPE is the lower value of the thermal and photochemical MPE computations (see Tables 5 and 6 and Section 8.2.3.2).

2. In the wavelength region 1.050 to 1.400 μm, the tabular values above are to be multiplied by the term 2 x C_C (see Table 6).

3. For targets of known reflectance, the above values may be divided by the reflectance of the target.

Table 4a

Time Factor Recommendations for CW and Repetitive-Pulse Laser Optical Density Calculations*

Wavelength Range	Diffuse (seconds)	Intrabeam (seconds)
UV		
200 - 400 nm	30,000	30,000
Visible		
400 - 700 nm	600	0.25**
NIR		
700 - 1400 nm	600	10
FIR		
1400 - 1 mm	10	10

* For single pulse lasers (PRF < 1 Hz) use actual laser pulse time

** For unintended or accidental viewing only. For other conditions, use the time of *intended* viewing.

Table 4b

Simplified Method for Selecting Laser Eye Protection for Small-Source Viewing (Wavelengths Between 0.400 and 1.400 μm)†

Q-Switched Laser (10^{-9} - 10^{-2} s)		Non-Q-Switched Lasers (0.4×10^{-3} - 10^{-2} s)		Continuous-Wave Lasers Momentary (0.25 - 10 s)		Continuous-Wave Lasers Long-Term Staring (< 1 hr)		Attenuation	
Maximum Output Energy (J)	Max Beam Radiant Exposure ($J \cdot cm^{-2}$)	Max Laser Output Energy (J)	Max Beam Radiant Exposure ($J \cdot cm^{-2}$)	Max Power Output (W)	Max Beam Irradiance ($W \cdot cm^{-2}$)	Max Power Output (W)	Max Beam Irradiance ($W \cdot cm^{-2}$)	Attenuation Factor	OD
10	20	100	200	10^5 *	2×10^5 *	100 *	200 *	10^8	8
1	2	10	20	10^4 *	2×10^4 *	10 *	20 *	10^7	7
10^{-1}	2×10^{-1}	1	2	10^3 *	2×10^3 *	1	2	10^6	6
10^{-2}	2×10^{-2}	10^{-1}	2×10^{-1}	100 *	200 *	10^{-1}	2×10^{-1}	10^5	5
10^{-3}	2×10^{-3}	10^{-2}	2×10^{-2}	10	20	10^{-2}	2×10^{-2}	10^4	4
10^{-4}	2×10^{-4}	10^{-3}	2×10^{-3}	1	2	10^{-3}	2×10^{-3}	10^3	3
10^{-5}	2×10^{-5}	10^{-4}	2×10^{-4}	10^{-1}	2×10^{-1}	10^{-4}	2×10^{-4}	10^2	2
10^{-6}	2×10^{-6}	10^{-5}	2×10^{-5}	10^{-2}	2×10^{-2}	10^{-5}	2×10^{-5}	10	1

† Use of this table may result in optical densities (OD) greater than necessary. See 4.6.2 for other wavelengths.

* Not recommended as a control procedure at these levels. These levels of power could damage or destroy the attenuating material used in the eye protection. The skin also needs protection at these levels.

Table 5a

Maximum Permissible Exposure (MPE) for Small-Source Ocular Exposure to a Laser Beam †

Wavelength (μm)	Exposure Duration, *t* (*s*)	MPE ($J \cdot cm^{-2}$)	MPE ($W \cdot cm^{-2}$)	Notes
Ultraviolet				
0.180 to 0.302	10^{-9} to 3 x 10^{4}	3 x 10^{-3}		or $0.56t^{0.25}$ whichever is lower. (See Tables 8 and 9 for limiting apertures)
0.303	10^{-9} to 3 x 10^{4}	4 x 10^{-3}		
0.304	10^{-9} to 3 x 10^{4}	6 x 10^{-3}		
0.305	10^{-9} to 3 x 10^{4}	10 x 10^{-3}		
0.306	10^{-9} to 3 x 10^{4}	16 x 10^{-3}		
0.307	10^{-9} to 3 x 10^{4}	25 x 10^{-3}		
0.308	10^{-9} to 3 x 10^{4}	40 x 10^{-3}		
0.309	10^{-9} to 3 x 10^{4}	63 x 10^{-3}		
0.310	10^{-9} to 3 x 10^{4}	0.1		
0.311	10^{-9} to 3 x 10^{4}	0.16		
0.312	10^{-9} to 3 x 10^{4}	0.25		
0.313	10^{-9} to 3 x 10^{4}	0.40		
0.314	10^{-9} to 3 x 10^{4}	0.63		
0.315 to 0.400	10^{-9} to 10	0.56 $t^{0.25}$		
0.315 to 0.400	10 to 3 x 10^{4}	1.0		
Visible and Near Infrared				
0.400 to 0.700	10^{-13} to 10^{-11}	1.5 x 10^{-8}		(See Tables 8 and 9 for limiting apertures) For multiple pulses apply correction factor C_p given in Table 6.
0.400 to 0.700	10^{-11} to 10^{-9}	2.7 $t^{0.75}$		
0.400 to 0.700	10^{-9} to 18 x 10^{-6}	5.0 x 10^{-7}		
0.400 to 0.700	18 x 10^{-6} to 10	1.8 $t^{0.75}$ x 10^{-3}		
0.400 to 0.450	10 to 100	1 x 10^{-2}		
0.450 to 0.500	10 to T_1		1 x 10^{-3}	
0.450 to 0.500	T_1 to 100	C_B x 10^{-2}		
0.400 to 0.500	100 to 3 x 10^{4}		C_B x 10^{-4}	
0.500 to 0.700	10 to 3 x 10^{4}		1 x 10^{-3}	
0.700 to 1.050	10^{-13} to 10^{-11}	1.5 C_A x 10^{-8}		
0.700 to 1.050	10^{-11} to 10^{-9}	2.7 C_A $t^{0.75}$		
0.700 to 1.050	10^{-9} to 18 x 10^{-6}	5.0 C_A x 10^{-7}		
0.700 to 1.050	18 x 10^{-6} to 10	1.8 C_A $t^{0.75}$ x 10^{-3}		
0.700 to 1.050	10 to 3 x 10^{4}		C_A x 10^{-3}	
1.050 to 1.400	10^{-13} to 10^{-11}	1.5 C_C x 10^{-7}		
1.050 to 1.400	10^{-11} to 10^{-9}	27.0 C_C $t^{0.75}$		
1.050 to 1.400	10^{-9} to 50 x 10^{-6}	5.0 C_C x 10^{-6}		
1.050 to 1.400	50 x 10^{-6} to 10	9.0 C_C $t^{0.75}$ x 10^{-3}		
1.050 to 1.400	10 to 3 x 10^{4}		5.0 C_C x 10^{-3}	
Far Infrared				
1.400 to 1.500	10^{-9} to 10^{-3}	0.1		For multiple pulses apply correction factor C_p given in Table 6 (See Tables 8 and 9 for limiting apertures)
1.400 to 1.500	10^{-3} to 10	0.56 $t^{0.25}$		
1.400 to 1.500	10 to 3 x 10^{4}		0.1	
1.500 to 1.800	10^{-9} to 10	1.0		
1.500 to 1.800	10 to 3 x 10^{4}		0.1	
1.800 to 2.600	10^{-9} to 10^{-3}	0.1		
1.800 to 2.600	10^{-3} to 10	0.56 $t^{0.25}$		
1.800 to 2.600	10 to 3 x 10^{4}		0.1	
2.600 to 10^{3}	10^{-9} to 10^{-7}	1 x 10^{-2}		
2.600 to 10^{3}	10^{-7} to 10	0.56 $t^{0.25}$		
2.600 to 10^{3}	10 to 3 x 10^{4}		0.1	

† See Table 6 and Figures 8 and 9 for correction factors C_E, C_B and time T_1. For exposure durations greater than 10 seconds and extended sources in the retinal hazard region (0.400 to 1.4 μm), see Table 5b.

Notes:
1. For repeated (pulsed) exposures, see Section 8.2.3.
2. The wavelength region λ_1 to λ_2 means $\lambda_1 \leq \lambda < \lambda_2$, e.g., 0.180 to 0.302 μm means $0.180 \leq \lambda < 0.302$ μm.
3. Dual Limit Application: In the Dual Limit Wavelength Region (0.400 to 0.600 μm), the listed MPE is the lower value of the photochemical and thermal MPEs as determined by T_1.

Table 5b

Maximum Permissible Exposure (MPE) for Extended-Source Ocular Exposure to a Laser Beam for Long Exposure Durations†

Wavelength (μm)	Exposure Duration, *t* (*s*)	MPE (J · cm^{-2}) except as noted	MPE (W · cm^{-2}) except as noted	Notes
Visible				
0.400 to 0.700	10^{-13} to 10^{-11}	1.5 C_E x 10^{-8}		(See Tables 8 and 9 for limiting apertures)
0.400 to 0.700	10^{-11} to 10^{-9}	2.7 C_E $t^{0.75}$		
0.400 to 0.700	10^{-9} to 18 x 10^{-6}	5.0 C_E x 10^{-7}		
0.400 to 0.700	18 x 10^{-6} to 0.7	1.8 C_E $t^{0.75}$ x 10^{-3}		
	Dual Limits for 400 - 600 nm visible laser exposure for t > 0.7 s			
Photochemical				
	For α ≤ 11mrad, the MPE is expressed as irradiance and radiant exposure*			
0.400 to 0.600	0.7 to 100	C_B x 10^{-2}		
0.400 to 0.600	100 to 3 x 10^4		C_B x 10^{-4}	(See Tables 8 and 9 for limiting apertures)
	For α > 11mrad, the MPE is expressed as radiance and integrated radiance*			
0.400 to 0.600	0.7 to 1 x 10^4	100 C_B J·cm^{-2}·sr^{-1}		(See Table 8 for limiting cone angleγ)
0.400 to 0.600	1 x 10^4 to 3 x 10^4		C_B x 10^{-2} W·cm^{-2}·sr^{-1}	
	and			
Thermal				
0.400 to 0.700	0.7 to T_2	1.8 C_E $t^{0.75}$ x 10^{-3}		
0.400 to 0.700	T_2 to 3 x 10^4		1.8 C_E $T_2^{-0.25}$ x 10^{-3}	
Near Infrared				
0.700 to 1.050	10^{-13} to 10^{-11}	1.5 C_A C_E x 10^{-8}		(See Tables 8 and 9 for limiting apertures)
0.700 to 1.050	10^{-11} to 10^{-9}	2.7 C_A C_E $t^{0.75}$		
0.700 to 1.050	10^{-9} to 18 x 10^{-6}	5.0 C_A C_E x 10^{-7}		
0.700 to 1.050	18 x 10^{-6} to T_2	1.8 C_A C_E $t^{0.75}$ x 10^{-3}		
0.700 to 1.050	T_2 to 3 x 10^4		1.8 C_A C_E $T_2^{-0.25}$ x 10^{-3}	
1.050 to 1.400	10^{-13} to 10^{-11}	1.5 C_C C_E x 10^{-7}		
1.050 to 1.400	10^{-11} to 10^{-9}	27.0 C_C C_E $t^{0.75}$		
1.050 to 1.400	10^{-9} to 50 x 10^{-6}	5.0 C_C C_E x 10^{-6}		
1.050 to 1.400	50 x 10^{-6} to T_2	9.0 C_C C_E $t^{0.75}$ x 10^{-3}		
1.050 to 1.400	T_2 to 3 x 10^4		9.0 C_C C_E $T_2^{-0.25}$ x 10^{-3}	

†See Table 6 and Figures 8, 9 and 11 for correction factors C_A, C_B, C_C, C_E, C_P, and time T_2.

*For sources subtending an angle greater than 11 mrad, the limit may also be expressed as an integrated radiance L_p = 100 C_B J·cm^{-2}·sr^{-1} for 0.7 s ≤ t < 10^4 s and L_e = C_B x 10^{-2} W·cm^{-2}·sr^{-1} for t ≥ 10^4 s as measured through a limiting cone angle γ. These correspond to values of J·cm^{-2} for 10 s ≤ t < 100 s and W·cm^{-2} for t ≥ 100 s as measured through a limiting cone angle γ.

γ = 11 mrad for 0.7 s ≤ t < 100 s,

γ = 1.1x $t^{0.5}$ mrad for 100 s ≤ t < 10^4 s

γ = 110 mrad for 10^4 s ≤ t < 3 x 10^4 s

See Figure 3 for γ and Appendix B7.2 for examples.

Notes:
1. For repeated (pulsed) exposures, see Section 8.2.3.
2. The wavelength region λ_1 to λ_2 means $\lambda_1 \leq \lambda < \lambda_2$, e.g., 1.180 to 1.302 μm means 1.180 ≤ λ < 1.302 μm.
3. Dual Limit Application: In the Dual Limit wavelength region (0.400 to 0.600 μm), the exposure limit is the lower value of the determined photochemical and thermal exposure limit.

Table 6
Parameters and Correction Factors

Parameters/Correction Factors	Wavelength (μm)	Figure*
$T_1 = 10 \times 10^{20(\lambda - 0.450)}$ **	0.450 to 0.500	9a
$T_2 = 10 \times 10^{(\alpha - 1.5)/98.5}$ ***	0.400 to 1.400	9b
$C_B = 1.0$	0.400 to 0.450	8c
$C_B = 10^{20(\lambda - 0.450)}$	0.450 to 0.600	8c
$C_A = 1.0$	0.400 to 0.700	8a
$C_A = 10^{2(\lambda - 0.700)}$	0.700 to 1.050	8a
$C_A = 5.0$	1.050 to 1.400	8a
$C_P = n^{-0.25}$ ****	0.180 to 1000	13
$C_E = 1.0 \quad \alpha < \alpha_{min}$	0.400 to 1.400	—
$C_E = \alpha / \alpha_{min} \quad \alpha_{min} \leq \alpha \leq \alpha_{max}$	0.400 to 1.400	—
$C_E = \alpha^2 / (\alpha_{max}\ \alpha_{min}) \quad \alpha > \alpha_{max}$	0.400 to 1.400	—
$C_C = 1.0$	1.050 to 1.150	8b
$C_C = 10^{18(\lambda - 1.150)}$	1.150 to 1.200	8b
$C_C = 8$	1.200 to 1.400	8b

* See figures for graphic representation.

** $T_1 = 10$ s for $\lambda = 0.450$ μm, and $T_1 = 100$ s for $\lambda = 0.500$ μm.

*** $T_2 = 10$ s for $\alpha < 1.5$ mrad, and $T_2 = 100$ s for $\alpha > 100$ mrad.

**** See Section 8.2.3 for discussion of C_p and Section 8.2.3.2 for discussion of pulse repetition frequencies below 55 kHz (0.4 to 1.05 μm) and below 20 kHz (1.05 to 1.4 μm).

Notes:

1. For wavelengths between 0.400 and 1.400 μm:
   $\alpha_{min} = 1.5$ mrad $\alpha_{max} = 100$ mrad

2. Wavelengths must be expressed in micrometers and angles in milliradians for calculations.

   The wavelength region λ_1 to λ_2 means $\lambda_1 \leq \lambda < \lambda_2$, e.g., 0.550 to 0.700 μm means $0.550 \leq \lambda < 0.700$ μm.

Table 7

Maximum Permissible Exposure (MPE) for Skin Exposure to a Laser Beam

Wavelength (μm)	Exposure Duration, t (s)	MPE ($J \cdot cm^{-2}$)	MPE ($W \cdot cm^{-2}$)	Notes
Ultraviolet				
0.180 to 0.302	10^{-9} to 3×10^{4}	3×10^{-3}		or $0.56 t^{0.25}$ whichever is lower. 3.5 mm limiting aperture: (See Table 8)
0.303	10^{-9} to 3×10^{4}	4×10^{-3}		
0.304	10^{-9} to 3×10^{4}	6×10^{-3}		
0.305	10^{-9} to 3×10^{4}	1.0×10^{-2}		
0.306	10^{-9} to 3×10^{4}	1.6×10^{-2}		
0.307	10^{-9} to 3×10^{4}	25×10^{-3}		
0.308	10^{-9} to 3×10^{4}	40×10^{-3}		
0.309	10^{-9} to 3×10^{4}	63×10^{-3}		
0.310	10^{-9} to 3×10^{4}	0.1		
0.311	10^{-9} to 3×10^{4}	0.16		
0.312	10^{-9} to 3×10^{4}	0.25		
0.313	10^{-9} to 3×10^{4}	0.40		
0.314	10^{-9} to 3×10^{4}	0.63		
0.315 to 0.400	10^{-9} to 10	$0.56 t^{0.25}$		
0.315 to 0.400	10 to 10^{3}	1		
0.315 to 0.400	10^{3} to 3×10^{4}		1×10^{-3}	
Visible and Near Infrared				
0.400 to 1.400	10^{-9} to 10^{-7}	$2 C_A \times 10^{-2}$		3.5mm limiting apperture: (See Table 8)
	10^{-7} to 10	$1.1 C_A t^{0.25}$		
	10 to 3×10^{4}		$0.2 C_A$	
Far Infrared				
1.400 to 1.500	10^{-9} to 10^{-3}	0.1		(See Table 8 for limiting apertures)
1.400 to 1.500	10^{-3} to 10	$0.56 t^{0.25}$		
1.400 to 1.500	10 to 3×10^{4}		0.1	
1.500 to 1.800	10^{-9} to 10	1.0		
1.500 to 1.800	10 to 3×10^{4}		0.1	
1.800 to 2.600	10^{-9} to 10^{-3}	0.1		
1.800 to 2.600	10^{-3} to 10	$0.56 t^{0.25}$		
1.800 to 2.600	10 to 3×10^{4}		0.1	
2.600 to 10^{3}	10^{-9} to 10^{-7}	1×10^{-2}		
2.600 to 10^{3}	10^{-7} to 10	$0.56 t^{0.25}$		
2.600 to 10^{3}	10 to 3×10^{4}		0.1	

* See 8.4.2 for large beam cross-sections and Table 6 for correction factor C_A.

NOTE: The wavelength region λ_1 to λ_2 means $\lambda_1 \leq \lambda < \lambda_2$, e.g., 0.315 to 0.400 μm means $0.314 \leq \lambda < 0.400$ μm.

Table 8

Limiting Apertures (Irradiance and Radiant Exposure) and Limiting Cone Angles γ (Radiance and Integrated Radiance) for Hazard Evaluation and AEL Determination

Spectral Region (μm)	Duration† (s)	Aperture Diameter (mm) Eye	Skin
0.180 to 0.400	10^{-9} to 0.3	1.0	3.5
	0.3 to 10 *	$1.5\ t^{0.375}$	3.5
	10 to 3 x 10^4	3.5	3.5
0.400 to 1.400	10^{-13} to 3 x 10^4	7.0	3.5
1.400 to 10^2	10^{-9} to 0.3	1.0	3.5
	0.3 to 10*	$1.5\ t^{0.375}$	3.5
	10 to 3 x 10^4	3.5	3.5
10^2 to 10^3	10^{-9} to 3 x 10^4	11.0	11.0
		Limiting Cone Angle, γ (mrad)	
0.400 to 0.600	0.7 s to 100	11	
	100 s to 10^4	$1.1\ t^{0.5}$	
	10^4 s to 3 x 10^4	110	
		(See Figure 3)	

* Under normal conditions these exposure duration would not be used for hazard evaluation.
† For guidance on exposure durations less than 10^{-13} seconds, see Section 8.2.2.
NOTE: The wavelength region λ_1 to λ_2 means $\lambda_1 \leq \lambda < \lambda_2$ μm e.g., 0.315 to 0.400 μm means $0.315 \leq \lambda < 0.400$ μm.

Table 9

Measurement Apertures for Laser Classification*

Spectral Region (μm)	Duration† (s)	Aperture Diameter (mm)	Visible Optics Transmission
0.180 - 0.302	10^{-9} to 0.3 0.3 to 10*** 10 to $3x10^4$	1.0 $1.5\ t^{0.375}$ 3.5	<2%
0.302 – 0.4	10^{-9} to 0.3 0.3 to 10*** 10 to 3 x 10^4	7.0 $11\ t^{0.375}$ 25.0	70%
0.4-0.7 0.7-1.4	10^{-13} to 3 x 10^4 10^{-13} to 3 x 10^4	50.0** 50.0**	90% 70%
1.4-2.8	10^{-9} to 0.3 0.3 to 10*** 10 to 3 x 10^4	7.0 $11\ t^{0.375}$ 25.0	70%
2.8 -10^2	10^{-9} to 0.3 0.3 to 10*** 10 to 3 x 10^4	1.0 $1.5\ t^{0.375}$ 3.5	<2%
10^2 -10^3	10^{-9} to 3 x 10^4	11.0	<2%

* These apertures are used for the measurement of optical power or energy for the purpose of laser classification (see 3.3).

** When the laser output is intended to be viewed with optics (excluding ordinary eyeglasses) or the Laser Safety Officer determines that there is a reasonable probability of accidental viewing with optics, 7 power optics with a 50-mm entrance aperture and a 7 mm exit aperture is assumed if the following conditions are met:

(1) Viewing with optics presents a more severe hazard than unaided viewing.

(2) The viewing time is sufficient to constitute a hazard.

Otherwise, the limiting apertures for the eye from Table 8 apply. For the specific case of optical viewing with beam collecting instruments, the apertures listed in Table 8 for hazard evaluation apply to the exit beam of the optical instrument.

***Under normal conditions, These exposure durations would not be used for classification.

† For guidance on exposure durations less than 10^{-13} seconds, see Section 8.2.2.

NOTE: The wavelength region λ_1 to λ_2 means $\lambda_1 \leq \lambda < \lambda_2$, e.g., 0.315 to 0.400 μm means $0.315 \leq \lambda < 0.400$ μm.