

Table 3 – Accessible emission limits for Class 1 and Class 1M laser products and  $C_6 = 1$  a, b (Source: part four)

Wavelength $\lambda$ nm	Emission duration $t$ s												
	$10^{-13}$ to $10^{-11}$	$10^{-11}$ to $10^{-9}$	$10^{-9}$ to $10^{-7}$	$10^{-7}$ to $5 \times 10^{-6}$	$5 \times 10^{-6}$ to $1,3 \times 10^{-5}$	$1,3 \times 10^{-5}$ to $1 \times 10^{-3}$	$1 \times 10^{-3}$ to 0,35	0,35 to 10	10 to $10^2$	$10^2$ to $10^3$ to $3 \times 10^4$			
180 to 302,5	$3 \times 10^{10} \text{ W} \cdot \text{m}^{-2}$		$30 \text{ J} \cdot \text{m}^{-2}$										
302,5 to 315	$2,4 \times 10^4 \text{ W}$		Thermal hazard ( $t \leq T_1$ ) $7,9 \times 10^{-7} C_1 \text{ J}$		Photochemical hazard $7,9 \times 10^{-7} C_2 \text{ J}$ ( $t > T_1$ )					$7,9 \times 10^{-7} C_2 \text{ J}$			
315 to 400													
400 to 450													
450 to 500													
500 to 700	$3,8 \times 10^{-8} \text{ J}$	$7,7 \times 10^{-8} \text{ J}$		$7 \times 10^{-4} t^{0,75} \text{ J}$		$3,9 \times 10^{-3} \text{ J}$ and $c$ $3,9 \times 10^{-4} \text{ W}$		$3,9 \times 10^{-5} C_3 \text{ W}$					
700 to 1 050	$3,8 \times 10^{-8} \text{ J}$									$7,7 \times 10^{-8} C_4 \text{ J}$	$7,9 \times 10^{-3} C_4 \text{ J}$	$3,9 \times 10^{-4} \text{ W}$	
1 050 to 1 400 <sup>d</sup>	$3,8 \times 10^{-8} C_7 \text{ J}$									$7,7 \times 10^{-7} C_7 \text{ J}$	$7 \times 10^{-4} t^{0,75} C_4 \text{ J}$	$3,5 \times 10^{-3} t^{0,75} C_7 \text{ J}$	$3,9 \times 10^{-4} C_4 C_7 \text{ W}$
1 400 to 1 500	$8 \times 10^5 \text{ W}$									$8 \times 10^{-4} \text{ J}$	$4,4 \times 10^{-3} t^{0,25} \text{ J}$	$10^{-2} t \text{ J}$	
1 500 to 1 800	$8 \times 10^6 \text{ W}$	$8 \times 10^{-3} \text{ J}$		$4,4 \times 10^{-3} t^{0,25} \text{ J}$		$1,8 \times 10^{-2} t^{0,75} \text{ J}$		$1,0 \times 10^{-2} \text{ W}$					
1 800 to 2 600	$8 \times 10^5 \text{ W}$									$8 \times 10^{-4} \text{ J}$	$4,4 \times 10^{-3} t^{0,25} \text{ J}$	$10^{-2} t \text{ J}$	
2 600 to 4 000	$8 \times 10^4 \text{ W}$									$8 \times 10^{-5} \text{ J}$	$4,4 \times 10^{-3} t^{0,25} \text{ J}$	$10^{-2} t \text{ J}$	
4 000 to $10^6$	$10^{11} \text{ W} \cdot \text{m}^{-2}$									$100 \text{ J} \cdot \text{m}^{-2}$	$5 600 t^{0,25} \text{ J} \cdot \text{m}^{-2}$	$1 000 \text{ W} \cdot \text{m}^{-2}$	
NOTE Laser products that meet the requirements for classification as Class 1 by satisfying measurement Condition 1 may be hazardous when used with viewing optics having greater than $\times 7$ magnification or objective diameters greater than those specified in Table 10.													
a For correction factors and units, see Table 9.													
b The AELs for emission durations less than $10^{-13}$ s are set to be equal to the equivalent power or irradiance values of the AEL at $10^{-13}$ s.													
c In the wavelength range between 450 nm and 500 nm, dual limits apply and a product's emission shall not exceed either limit applicable to the class assigned.													
d In the wavelength range between 1 250 nm and 1 400 nm, the upper value of the AEL is limited to the AEL value for Class 3B.													

NOTE Laser products that meet the requirements for classification as Class 1 by satisfying measurement Condition 1 may be hazardous when used with viewing optics having greater than  $\times 7$  magnification or objective diameters greater than those specified in Table 10.

a For correction factors and units, see Table 9.

b The AELs for emission durations less than  $10^{-13}$  s are set to be equal to the equivalent power or irradiance values of the AEL at  $10^{-13}$  s.

c In the wavelength range between 450 nm and 500 nm, dual limits apply and a product's emission shall not exceed either limit applicable to the class assigned.

d In the wavelength range between 1 250 nm and 1 400 nm, the upper value of the AEL is limited to the AEL value for Class 3B.

**Table 4 – Accessible emission limits for Class 1 and Class 1M laser products in the wavelength range from 400 nm to 1 400 nm (retinal hazard region): extended sources a, b, c, d, e, f**

Wavelength $\lambda$ nm	Emission duration $t$ s				
	$10^{-13}$ to $10^{-11}$	$10^{-11}$ to $5 \times 10^{-6}$	$5 \times 10^{-6}$ to $1,3 \times 10^{-5}$	$1,3 \times 10^{-5}$ to $10^6$	$10^2$ to $10^4$
400 to 700	$3,8 \times 10^{-8} C_6 J$	$7,7 \times 10^{-8} C_6 J$	$7 \times 10^{-4} t^{0,75} C_6 J$		400 nm to 600 nm – Retinal photochemical hazard d,e $3,9 \times 10^{-3} C_3 J$ using $\gamma_{ph} = 11$ mrad $3,9 \times 10^{-5} C_3 W$ using $\gamma_{ph} = 1,1$ t 0,5 mrad $3,9 \times 10^{-5} C_3 W$ using $\gamma_{ph} = 110$ mrad
					AND c
					400 nm to 700 nm – Retinal thermal hazard $7 \times 10^{-4} C_6 T_2^{-0,25} W$ ( $t \leq T_2$ ) $7 \times 10^{-4} t^{0,75} C_6 J$ ( $t > T_2$ )
					$7 \times 10^{-4} C_4 C_6 T_2^{-0,25} W$ ( $t > T_2$ )
700 to 1 050	$3,8 \times 10^{-8} C_6 J$	$7,7 \times 10^{-8} C_4 C_6 J$	$7 \times 10^{-4} t^{0,75} C_4 C_6 J$		$3,5 \times 10^{-3} C_6 C_7 T_2^{-0,25} W$ ( $t > T_2$ ) $3,5 \times 10^{-3} t^{0,75} C_6 C_7 J$
1 050 to 1 400 <sup>f</sup>	$3,8 \times 10^{-8} C_6 C_7 J$	$7,7 \times 10^{-7} C_6 C_7 J$	$3,5 \times 10^{-3} t^{0,75} C_6 C_7 J$		

NOTE Laser products that meet the requirements for classification as Class 1 by satisfying measurement Condition 1 may be hazardous when used with viewing optics having greater than  $\times 7$  magnification or objective diameters greater than those specified in Table 10.

a For correction factors and units, see Table 9.

b The AELs for emission duration less than  $10^{-13}$  s are set to be equal to the equivalent power or irradiance values of the AEL at  $10^{-13}$  s.

c In the wavelength range between 400 nm and 600 nm, dual limits apply and a product's emission shall not exceed either limit applicable to the class assigned.

d The angle  $\gamma_{ph}$  is the limiting measurement angle of acceptance.

e If emission durations between 1 s and 10 s are used, for wavelengths between 400 nm and 484 nm and for apparent source sizes between 1,5 mrad and 82 mrad, the dual photochemical hazard limit of  $3,9 \times 10^{-3} C_3 J$  is extended to 1 s.

f In the wavelength range between 1 250 nm and 1 400 nm, the upper value of the AEL is limited to the AEL value for Class 3B.

Table 5 – Accessible emission limits for Class 2 and Class 2M laser products

Wavelength $\lambda$ nm	Emission duration $t$ s	Class 2 AEL
400 to 700	$t < 0,25$	Same as Class 1 AEL $C_g \times 10^{-3} \text{ W}^a$
	$t \geq 0,25$	
NOTE Laser products that meet the requirements for classification as Class 2 by satisfying measurement Condition 1 may be hazardous when used with viewing optics having aperture diameters greater than those specified in Table 10 (see also Annex C).		
a For correction factor and units, see Table 9.		



Table 6 – Accessible emission limits for Class 3R laser products and  $C_6 = 1$  a, b, c

Wavelength $\lambda$ nm	Emission duration $t$ s									
	$10^{-13}$ to $10^{-11}$	$10^{-11}$ to $10^{-9}$	$10^{-9}$ to $10^{-7}$	$10^{-7}$ to $5 \times 10^{-6}$	$5 \times 10^{-6}$ to $1,3 \times 10^{-5}$	$1,3 \times 10^{-5}$ to $1 \times 10^{-3}$	$1 \times 10^{-3}$ to 0,35	0,35 to 10	10 to $10^3$	$10^3$ to $3 \times 10^4$
180 to 302,5	$1,5 \times 10^{11} \text{ W} \cdot \text{m}^{-2}$									
302,5 to 315	$1,2 \times 10^5 \text{ W}$									
315 to 400	<div>Thermal hazard <math>4 \times 10^{-6} C_1 \text{ J}</math> (<math>t \leq T_1</math>)<sup>e</sup></div> <div>Photochemical hazard <math>4,0 \times 10^{-6} C_2 \text{ J}</math> (<math>t &gt; T_1</math>)<sup>e</sup></div>									
400 to 700	$1,9 \times 10^{-7} \text{ J}$	$3,8 \times 10^{-7} \text{ J}$	$3,5 \times 10^{-3} \text{ J}$ ( $t < 0,25 \text{ s}$ ) $5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$4,0 \times 10^{-6} C_1 \text{ J}$	$5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$5,0 \times 10^{-3} \text{ W}$	$4,0 \times 10^{-2} \text{ J}$	$4,0 \times 10^{-5} \text{ W}$		
700 to 1 050	$1,9 \times 10^{-7} \text{ J}$	$3,8 \times 10^{-7} C_4 \text{ J}$	$3,5 \times 10^{-3} \text{ J}$ ( $t < 0,25 \text{ s}$ ) $5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$3,8 \times 10^{-6} C_7 \text{ J}$	$1,8 \times 10^{-2} \text{ J}$ ( $t < 0,25 \text{ s}$ ) $5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$5,0 \times 10^{-3} \text{ W}$	$4,0 \times 10^{-2} \text{ J}$	$4,0 \times 10^{-5} \text{ W}$		
1 050 to 1 400 <sup>d</sup>	$1,9 \times 10^{-6} C_7 \text{ J}$	$3,8 \times 10^{-6} C_7 \text{ J}$	$3,5 \times 10^{-3} \text{ J}$ ( $t < 0,25 \text{ s}$ ) $5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$1,8 \times 10^{-2} \text{ J}$ ( $t < 0,25 \text{ s}$ ) $5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$5,0 \times 10^{-3} \text{ W}$	$5,0 \times 10^{-3} \text{ W}$	$4,0 \times 10^{-2} \text{ J}$	$4,0 \times 10^{-5} \text{ W}$		
1 400 to 1 500	$4 \times 10^6 \text{ W}$	$4 \times 10^6 \text{ W}$	$4 \times 10^{-3} \text{ J}$	$4 \times 10^{-2} \text{ J}$	$2,2 \times 10^{-2} \text{ J}$ ( $t < 0,25 \text{ s}$ ) $5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$5,0 \times 10^{-3} \text{ W}$	$4,0 \times 10^{-2} \text{ J}$	$4,0 \times 10^{-5} \text{ W}$		
1 500 to 1 800	$4 \times 10^7 \text{ W}$	$4 \times 10^7 \text{ W}$	$4 \times 10^{-2} \text{ J}$	$4 \times 10^{-2} \text{ J}$	$2,2 \times 10^{-2} \text{ J}$ ( $t < 0,25 \text{ s}$ ) $5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$5,0 \times 10^{-3} \text{ W}$	$4,0 \times 10^{-2} \text{ J}$	$4,0 \times 10^{-5} \text{ W}$		
1 800 to 2 600	$4 \times 10^6 \text{ W}$	$4 \times 10^6 \text{ W}$	$4 \times 10^{-3} \text{ J}$	$4 \times 10^{-2} \text{ J}$	$2,2 \times 10^{-2} \text{ J}$ ( $t < 0,25 \text{ s}$ ) $5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$5,0 \times 10^{-3} \text{ W}$	$4,0 \times 10^{-2} \text{ J}$	$4,0 \times 10^{-5} \text{ W}$		
2 600 to 4 000	$4 \times 10^5 \text{ W}$	$4 \times 10^5 \text{ W}$	$4 \times 10^{-4} \text{ J}$	$4 \times 10^{-2} \text{ J}$	$2,2 \times 10^{-2} \text{ J}$ ( $t < 0,25 \text{ s}$ ) $5,0 \times 10^{-3} \text{ W}$ ( $t \geq 0,25 \text{ s}$ )	$5,0 \times 10^{-3} \text{ W}$	$4,0 \times 10^{-2} \text{ J}$	$4,0 \times 10^{-5} \text{ W}$		
4 000 to $10^6$	$5 \times 10^{11} \text{ W} \cdot \text{m}^{-2}$	$500 \text{ J} \cdot \text{m}^{-2}$	$2,8 \times 10^4 \text{ J} \cdot \text{m}^{-2}$	$2,8 \times 10^4 \text{ J} \cdot \text{m}^{-2}$	$2,8 \times 10^4 \text{ J} \cdot \text{m}^{-2}$	$5 000 \text{ W} \cdot \text{m}^{-2}$				

a For correction factors and units, see Table 9.

b The AELs for emission durations less than  $10^{-13}$  s are set to be equal to the equivalent power or irradiance values of the AEL at  $10^{-13}$  s.

c For repetitively pulsed UV lasers neither limit should be exceeded.

d In the wavelength range between 1 250 nm and 1 400 nm, the upper value of the AEL is limited to the AEL value for Class 3B.

Table 7 – Accessible emission limits for Class 3R laser products in the wavelength range from 400 nm to 1 400 nm (retinal hazard region): extended sources a, b

Wavelength $\lambda$ nm	Emission duration $t$ s					
	$10^{-13}$ to $10^{-11}$	$10^{-11}$ to $5 \times 10^{-6}$	$5 \times 10^{-6}$ to $1,3 \times 10^{-5}$	$1,3 \times 10^{-5}$ to 0,25	0,25 to 10	10 to $3 \times 10^4$
400 to 700	$1,9 \times 10^{-7} C_6 \text{ J}$	$3,8 \times 10^{-7} C_6 \text{ J}$	$(t < 0,25 \text{ s})$ $3,5 \times 10^{-3} t^{0,75} C_6 \text{ J}$	$5,0 \times 10^{-3} C_6 \text{ W}$ $(t \geq 0,25 \text{ s})$		$5,0 \times 10^{-3} C_6 \text{ W}$
700 to 1 050	$1,9 \times 10^{-7} C_6 \text{ J}$	$3,8 \times 10^{-7} C_4 C_6 \text{ J}$				
1 050 to 1 400 <sup>c</sup>	$1,9 \times 10^{-6} C_6 C_7 \text{ J}$	$3,8 \times 10^{-6} C_6 C_7 \text{ J}$	$1,8 \times 10^{-2} t^{0,75} C_6 C_7 \text{ J}$			
<sup>a</sup> For correction factors and units, see Table 9.						
<sup>b</sup> The AELs for emission durations less than $10^{-13}$ s are set to be equal to the equivalent power or irradiance values of the AEL at $10^{-13}$ s.						
<sup>c</sup> In the wavelength range between 1 250 nm and 1 400 nm, the upper value of the AEL is limited to the AEL value for Class 3B.						

<sup>a</sup> For correction factors and units, see Table 9.

<sup>b</sup> The AELs for emission durations less than  $10^{-13}$  s are set to be equal to the equivalent power or irradiance values of the AEL at  $10^{-13}$  s.

<sup>c</sup> In the wavelength range between 1 250 nm and 1 400 nm, the upper value of the AEL is limited to the AEL value for Class 3B.

1050-1400

2020 3 B van de tabelle x e d. 4

Table 8 – Accessible emission limits for Class 3B laser products <sup>a</sup>

Wavelength $\lambda$ nm	Emission duration $t$ s		
	$<10^{-9}$	$10^{-9}$ to 0,25	$0,25$ to $3 \times 10^4$
180 to 302,5	$3,8 \times 10^5$ W	$3,8 \times 10^{-4}$ J	$1,5 \times 10^{-3}$ W
302,5 to 315	$1,25 \times 10^4$ C <sub>2</sub> W	$1,25 \times 10^{-5}$ C <sub>2</sub> J	$5 \times 10^{-5}$ C <sub>2</sub> W
315 to 400	$1,25 \times 10^8$ W	0,125 J	0,5 W
400 to 700	$3 \times 10^7$ W	0,03 J for $t < 0,06$ s 0,5 W for $t \geq 0,06$ s	0,5 W
700 to 1 050	$3 \times 10^7$ C <sub>4</sub> W	0,03 C <sub>4</sub> J for $t < 0,06$ C <sub>4</sub> s 0,5 W for $t \geq 0,06$ C <sub>4</sub> s	0,5 W
1 050 to 1 400	$1,5 \times 10^8$ W	0,15 J	0,5 W
1 400 to 10 <sup>6</sup>	$1,25 \times 10^8$ W	0,125 J	0,5 W

<sup>a</sup> For correction factors and units, see Table 9.

The correction factors  $C_1$  to  $C_7$  and breakpoints  $T_1$  and  $T_2$  used in Tables 3 to 8 are defined in Table 9.

Table 9 – Correction factors and breakpoints for use in AEL and MPE evaluations

Parameter	Spectral region nm
$C_1 = 5,6 \times 10^3 t^{0,25}$	180 to 400
$T_1 = 10^{0,8(\lambda - 295)} \times 10^{-15}$ s	302,5 to 315
$C_2 = 30$	180 to 302,5
$C_2 = 10^{0,2(\lambda - 295)}$	302,5 to 315
$T_2 = 10 \times 10^{[(\alpha - \alpha_{min})/98,5]} \times 10^{-15}$ s for $\alpha_{min} < \alpha \leq 100$ mrad	400 to 1 400
$T_2 = 10$ s for $\alpha \leq 1,5$ mrad	400 to 1 400
$T_2 = 100$ s for $\alpha > 100$ mrad	400 to 1 400
$C_3 = 1,0$	400 to 450
$C_3 = 10^{0,02(\lambda - 450)}$	450 to 600
$C_4 = 5$	700 to 1 050
$C_5 = 1^a$	180 to 400 and 1 400 to 10 <sup>6</sup>
$C_5 = N^{-1/4}$	400 to 1 400
$C_6 = 1$	180 to 400 and 1 400 to 10 <sup>6</sup>
$C_6 = 1$ for $\alpha \leq \alpha_{min}^b$	400 to 1 400
$C_6 = \alpha/\alpha_{min}$ for $\alpha_{min} < \alpha \leq \alpha_{max}^b$	400 to 1 400
$C_6 = \alpha/\alpha_{max}^b$ for $\alpha > \alpha_{max}^b$	400 to 1 400
$C_7 = 1$	700 to 1 150
$C_7 = 10^{0,018(\lambda - 1150)}$	1 150 to 1 200
$C_7 = 8 + 10^{0,04(\lambda - 1250)}$	1 200 to 1 400



$\alpha_{min} = 1,5 \text{ mrad}$	for	$t < 625 \mu\text{s}$
$\alpha_{max} = 5 \text{ mrad}$	for	$625 \mu\text{s} \leq t \leq 0,25 \text{ s}$
$200 \pm 0,5 \text{ mrad}$	for	$t > 0,25 \text{ s}$
100 mrad	for	$t > 0,25 \text{ s}$
N is the number of pulses contained within the applicable duration (4.3 f) and Clause A.3).		
NOTE 1 There is only limited evidence about effects for exposures of less than $10^{-9} \text{ s}$ for wavelengths less than 400 nm and greater than 1 400 nm. The AELs for these emission durations and wavelengths have been derived by calculating the equivalent radiant power or irradiance from the radiant power or radiant exposure applying at $10^{-9} \text{ s}$ for wavelengths less than 400 nm and greater than 1 400 nm.		
NOTE 2 See Table 10 for aperture stops and Table A.4 for limiting apertures.		
NOTE 3 In the formulae in Tables 3 to 8 and in these notes, the wavelength is expressed in nanometres, the emission duration $t$ is expressed in seconds and $\alpha$ is expressed in milliradians.		
NOTE 4 For emission durations which fall at the cell border values (for instance 10 s) in Tables 3 to 8, the lower limit applies. Where at cell borders (i.e. not applying to explicit equations) the symbol "<" is used, this means less than or equal to. When wavelength ranges are specified, wavelength range $\lambda_1$ to $\lambda_2$ means $\lambda_1 \leq \lambda < \lambda_2$ .		
a $C_g$ is only applicable to pulse durations shorter than 0,25 s. See rules to determine $C_g$ in 4.3 f).		
b $C_g$ is only applicable for thermal retinal limits.		
c The maximum limiting angle of acceptance $\gamma_{th}$ shall be equal to $\alpha_{max}$ (but see 4.3 c)).		

do Tab 12 de 8.18. ps determine de seg. e pparent

