Norwegian Labour Inspection Authority

Order No. 704-ENG

Regulations concerning

Action and Limit Values

Regulations concerning action and limit values for physical and chemical agents in the working environment and classified biological agents.

Adopted 6 December 2011 No 1358.

Last amended by the Regulations of 22 December 2014 No 1885

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This is an unofficial English translation of «Forskrift om tiltaks- og grenseverdier» for information purposes. Any disputes shall be decided on the basis of the formal regulations in Norwegian.

Table of contents

Regulations concerning action and limit values for physical and chemical agents in the working environment and classified biological agents (Regulations concerning Action and Limit Values)

Adopted by the Ministry of Labour (now the Ministry of Labour and Social Affairs) on 6 December 2011 pursuant to the Act of 17 June 2005 No 62 relating to working environment, working hours and employment protection etc. (the Working Environment Act) Section 1-3(3), Section 1-4(1), Section 3-1 final paragraph, Section 3-2 final paragraph, Section 4-4 final paragraph, Section 4-5 final paragraph. Amended by the Regulations of 19 December 2012 No 1376, of 7 January 2013 No 12, of 30 December 2013 No 1718 and 22 December 2014 No 1885.
EEA references: The EEA Agreement Annex XVIII point 3a (Directive 91/322/EEC), point 14a (Directive 2004/37/EC), point 15 (Directive 2000/54/EC), point 16h (Directive 98/24/EC), point 16j (Directive 2000/39/EC), point 16ja (Directive 2002/44/EC), point 16jb (Directive 2003/10/EC), point 16jd (Directive 2006/15/EC), point 16je (Directive 2006/25/EC) and point 16jf (Directive 2009/161/EU).

Chapter 1. Introductory provisions

Section 1-1. ***Purpose***

The purpose of these regulations is to protect employees against the dangers arising from physical, chemical and biological agents in the undertaking by listing limit values, action values and infection risk groups.

Section 1-2. ***Scope***

The regulations apply to undertakings where the employees may be exposed to physical, chemical or biological agents.

Chapter 2 does not apply to offshore petroleum activities.

Section 1-3. ***To whom the regulations apply***

Employers shall ensure that the provisions of these regulations are implemented.

Chapters 1, 4, 5 and 6 of the regulations also apply to undertakings with no employees.

Chapters 2 and 3 shall also be implemented by undertakings with no employees that engage in

– building and construction activities
– agricultural activities.

The regulations also apply to breathing air suppliers.

Section 1-4. ***Definitions – noise***

For the purpose of these regulations, the following definitions shall apply:

a) *daily noise exposure level*, $L_{EX,8h}$: the equivalent A-weighted level ($L_{pAeq,T}$) for a nominal eight-hour working day in accordance with the international standard ISO 1999:1990 points 3.5 and 3.6. It includes all noise in the workplace;
b) *limit value*: a value for noise exposure that must not be exceeded;
c) *group I*: working conditions where there are high demands for continuous concentration or a need for conducting unstrained conversations, and in mess rooms and recreation rooms;
d) *group II*: working conditions where it is important to conduct conversations or with persistently high requirements for precision, speed and attention;
e) *group III*: working conditions involving noisy machinery or equipment that are not covered by working groups I or II;
f) *peak sound pressure level,* $L_{pC,peak}$: the C-weighted peak emission sound pressure level, measured during a measurement period with the instrument set to 'peak';
g) *action value*: an exposure value that requires measures to be implemented in order to reduce the health risk and unfortunate exposure to a minimum.

Section 1-5. ***Definitions – vibrations***

For the purpose of these regulations, the following definitions shall apply:

a) *daily exposure value*: the energy equivalent mean value of the frequency-weighted acceleration throughout the working day, normalised to an eight-hour reference period (A(8)); $A(8) = A(T)\sqrt{T/8}$, where A(T) equals the daily exposure to vibration throughout a working day of a total duration of T hours. For hand and arm vibration, A(T) is determined pursu-

ant to NS-EN ISO 5349-1 (2001), Chapters 4 and 5 and Annex A. For whole-body vibration, A(T) is determined pursuant to NS ISO 2631-1 (2003), Chapters 5 to 7 and Annexes A and B as the daily exposure value in the axial direction giving the highest value where frequency-weighted acceleration values for a sitting or standing person are employed;

b) *daily exposure limit value (A(8))*: daily exposure value that shall not be exceeded;
c) *whole-body vibration*: mechanical vibration transmitted to the whole body and entailing a risk of harm to health, in particular trauma of the spine, and that may also entail a safety risk;
d) *hand and arm vibration*: mechanical vibration transmitted from work equipment to the human hand or arm and entailing a risk of vascular, bone or joint neurological or muscular disorders, and that may also entail a safety risk;
e) *daily exposure action value (A(8))*: daily exposure value that requires the implementation of measures in order to reduce the risk to a minimum.

Section 1-6. ***Definitions – chemicals***

For the purpose of these regulations, the following definitions shall apply:

a) *fibre*: a particle longer than 5 µm, with a diameter smaller than or equal to 3 µm, and with a length to width ratio greater than or equal to 3:1;
b) *limit value*: the maximum value of the average concentration of a chemical substance in an employee's breathing zone over a fixed reference period of eight hours;
c) *chemical*: any element, chemical compound or mixture thereof, whether it occurs naturally or is industrially produced or is used or released by any work operation, regardless of whether or not it is produced intentionally. This applies irrespective of whether the chemical is available on the market.

Section 1-7. ***Definitions – biological agents***

For the purpose of these regulations, the following definitions shall apply:

a) *biological agent*: live or dead micro-organisms, cell cultures, endoparasites and prions that can cause infections, allergies or toxicity in humans;

b) *micro-organism*: any cellular or non-cellular microbiological entity capable of replication or of transferring genetic material.

Section 1-8. ***Definitions – radiation***

For the purpose of these regulations, the following definitions shall apply:

a) *non-coherent optical radiation*: artificial optical radiation, with the exception of laser radiation;

b) *ionising radiation*: radiation from a radioactive substance, X radiation and particle radiation;

c) *artificial optical radiation*: electromagnetic radiation of a wavelength range between 100 nm and 1 mm that is not emitted from the sun. The spectrum of optical radiation is divided into ultraviolet radiation, visible radiation (light) and infrared radiation. Ultraviolet (UV) radiation is optical radiation of wavelength range between 100 nm and 400 nm. This range is further divided into UVA (315–400 nm), UVB (280–315 nm) and UVC (100–280 nm). Visible radiation is optical radiation of wavelength range between 380 nm and 780 nm. Infrared radiation is optical radiation of wavelength range between 780 nm and 1 mm. This range is further divided into IRA (780–1 400 nm), IRB (1,400–3,000 nm) and IRC (3,000 nm–1 mm).

Section 1-9. ***Exemption***

The Norwegian Labour Inspection Authority and the Petroleum Safety Authority Norway may grant exemption from the regulations in their respective areas if warranted on special grounds, if it is reasonable from a safety and health perspective and if it is not in breach of the EEA Agreement.

Chapter 2. Noise

Section 2-1. ***Action values***

The action values for noise exposure are set to:

a) lower action value for working conditions in group I: $L_{EX,1h} = 55$ dB

b) lower action value for working conditions in group II: $L_{EX,1h} = 70$ dB

c) lower action value for working conditions in group III: $L_{EX,8h} = 80$ dB

d) upper action values: $L_{EX,8h} = 85$ dB and $L_{pC,peak} = 130$ dB

For working conditions in groups I and II, noise from the worker's own activities shall not be a part of the assessment for the lower action values, provided that the worker can disrupt the noise. For mess rooms and recreation rooms, only background noise from installations, adjacent premises and surroundings shall be included in the assessment.

Section 2-2. ***Limit values for noise***

The limit values for noise exposure are set to:

a) daily noise exposure level, $L_{EX,8h}$: 85 dB

b) peak sound pressure level, $L_{pC,peak}$: 130 dB

The determination of the worker's effective noise exposure shall take account of the real-ear attenuation provided by the individual hearing protectors that the worker is required to wear.

Chapter 3. Vibrations

Section 3-1. ***Action values***

Action values for daily exposure (A(8)):

a) for hand and arm vibration: 2.5 m/s^2

b) for whole-body vibration: 0.5 m/s^2

Section 3-2. ***Limit values***

Limit values for daily exposure (A(8)):

a) for hand and arm vibration: 5.0 m/s^2

b) for whole-body vibration: 1.1 m/s^2

Chapter 4. Radiation

Section 4-1. ***Limit values for ionising radiation***

The following limit values shall not be exceeded:

a) The limit value for workers over the age of 18 years is set to 20 mSv per calendar year.
b) The radiation dose for the lens of the eye shall not exceed 150 mSv per calendar year.
c) The radiation dose for the skin, hands and feet shall not exceed 500 mSv per calendar year.
d) For apprentices aged between 16 and 18 years who employ radiation sources in their education, dose limits of 5, 50 and 150 mSv, respectively, per calendar year shall apply instead of the doses listed under (a)–(c).
e) In the case of pregnant women, the dose for the foetus shall not exceed 1 mSv for the remaining part of the pregnancy, i.e. from the time that pregnancy is confirmed.

Section 4-2. ***Limit values for artificial optical radiation***

The limit values for exposure to artificial optical radiation, with the exception of laser radiation, are set out in Annex 3. The limit values for exposure to laser radiation are set out in Annex 4.

Chapter 5. Chemicals

Section 5-1. ***Limit values for pollutants in the working atmosphere***

Limit values relating to pollutants in the working atmosphere are listed in Annex 1 to the regulations.

Section 5-2. ***Biological limit values***

a) The limit value for lead is 0.5 µmol/l per litre blood for women of fertile age and 1.5 µmol/l per litre blood for other employees.
b) The limit value for mercury in urine is 30 µg Hg/g creatinine.

Section 5-3. ***Limit value for sand and other blasting agents used in sand blasting***

Blasting agents must not contain lead or lead compounds, biologically available nickel or more than one per cent by weight of quartz or other crystalline silica. The blasting agents must not be carcinogenic.

Section 5-4. ***Limit value for cements and cement-containing mixtures***

Cements and cement-containing mixtures that in hydrated form contain more than 2 mg soluble hexavalent chromium per kg dry cement may not be used.

The requirement in the first paragraph does not apply to use in connection with controlled, enclosed and fully automated processes where cement and cement-containing mixtures are handled by machines only and where there is no possibility of contact with the skin.

Section 5-5. ***Limit value for breathing air from filling plant***

As far as possible, breathing air from the filling plant must be free of contaminants and be tasteless and odourless.

The following values shall not be exceeded:

a) 10 ppm (11 mg/m^3) carbon monoxide (CO)
b) 500 ppm (900 mg/m^3) carbon dioxide (CO_2)
c) 1 mg/m^3 oil
d) 50 mg/m^3 water for cylinders with a filling pressure of 200 bar and 30 mg/m3 water for cylinders with a filling pressure of 300 bar

The O_2 content shall be 21.0% +/-0.5%.

Section 5-6. ***Prohibition on work with special chemicals***

The prohibition on work with special chemicals is described in Chapter 12 of the Regulations concerning Organisation, Management and Employee Participation and in Chapters 3 and 4 of the Regulations concerning the Performance of Work.

Chapter 6. Classification of biological agents

Section 6-1. ***List of classified biological agents (infection risk groups)***

As a basis for protection measures against biological hazard sources, employers shall use the list in Annex 2 when classifying risks constituted by biological agents.

Chapter 7. Final provisions

Section 7-1. ***Penal sanctions***

Wilful or negligent violation of these regulations or decisions made pursuant to these regulations, or aiding and abetting thereto, is a criminal offence pursuant to Chapter 19 of the Working Environment Act.

Section 7-2. ***Fine for violations***

If someone who has acted on behalf of the enterprise has violated provisions in these regulations or decisions made pursuant to these regulations, the enterprise can be fined pursuant to Section 18-10 of the Working Environment Act.

Section 7-3. ***Entry into force***

These regulations enter into force on 1 January 2013.

Annex 1: List of limit values for pollutants in the working atmosphere

Offshore petroleum activities are subject to the limit values with safety factors as mentioned in Section 36 of the Activities Regulations. Activities at onshore facilities (see Section 6(e) of the Framework Regulations) shall be planned with safety factors reflecting limit values.

The list includes comments as follows:

A: Chemicals to be treated as provoking allergic reactions or other hypersensitivity in the eyes or respiratory organs, or to be treated as provoking allergic reactions in contact with skin.

E: The EU has adopted a recommended limit value for the substance.

G: The EU has adopted a binding limit value for the substance.

H: Chemicals that can be absorbed through the skin.

K: Chemicals to be treated as carcinogenic.

M: Chemicals to be treated as mutagenic.

R: Chemicals to be treated as harmful to reproduction.

S: The short-term exposure limit: the average concentration of a chemical substance in an employee's breathing zone that must not be exceeded over a given reference period. The reference period is 15 minutes unless otherwise specified.

T: The ceiling value: a momentary value indicating the maximum concentration of a chemical substance in the breathing zone, which must not be exceeded

CAS number	***Name***	***ppm***	***mg/m^3***	***Comments***	***Last amended***
75-07-0	Acetaldehyde	25	45	K	
60-35-5	Acetamide	10	25	K	
67-64-1	Acetone	125	295		
75-05-8	Acetonitril	30	50	HE	2007
	Acetylene tetrabromide, see 1,1,2,2-Tetrabromoethane				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Acetylene tetrachloride, see 1,1,2,2-Tetrachloroethane				
50-78-2	Acetylsalsylic acid	–	5		
	AES wool	0.5 fibre/cm³			2007
	Acrolein, see Acrylaldehyde				
107-02-8	Acrylaldehyde	0.1	0.25		
79-06-1	Acrylamide	–	0.03	HKM	
107-13-1	Acrylonitrile	2	4	H K	
79-10-7	Acrylic acid	10	30		
309-00-2	Aldrin	–	0.25	H	
	Allyl alcohol, see 2-Propen-1-ol				
107-11-9	Allylamine	2	5		
	Allyl (2,3-epoxypropyl) ether, see 1-Allyloxy-2,3-epoxypropane				
	Allyl glycidyl ether, see 1-Allyloxy-2,3-epoxypropane				
	Allyl chloride; see 3-Chloropropene				
106-92-3	1-Allyloxsy-2,3-epoxypropane	5	22	TA	
2179-59-1	Allyl propyl disulphide	2	12		
7429-90-5	Aluminium powder (pyrotechnics)	–	5		
	Aluminium-soluble salts (calculated as Al)	–	2		
	Aluminium alkyls	–	2		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
1344-28-1	Aluminium oxide	–	10	[1]	
	Aluminium welding fumes	–	5		
141-43-5	2-Aminoethanol	1	2.5	HE	2007
	2-Aminopropane, see 2-Propylamine				
504-29-0	2-Aminopyridine	0.5	2		
	Ammate, see Ammonium sulphamate				
7664-41-7	Ammonia	15	11	E[2]	2012
		50	36	S	
12125-02-9	Ammonium chloride	–	10	[1]	
7773-06-0	Ammonium sulphamate	–	10	[1]	
	Amorphous silicon dioxide Respirable dust	–	1.5		
625-16-1	tert-Amyl acetate	50	260	E	
	iso-Amyl alcohol, see 3-Methyl-1-butanol				
62-53-3	Aniline	1	4	HK	
	o-Anisidine and p-Anisidine, see 2-Methoxyaniline and 4-Methoxyaniline				
	Anon, see Cyclohexagon				
	Antimony and Antimony compounds (calculated as Sb)	–	0.5	K	
7803-52-3	Antimony hydride	0.05	0.25	K	
	ANTU, see 1-Naphthylthiourea				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Arsenic and inorganic Arsenic compounds (except Arsenic hydride) (calculated as As)	–	0.01	K	
7784-42-1	Arsenic hydride	0.003	0.01	K	
	Arsinic, see Arsenic hydride				
	Asbestos, all forms	0.1 fibre/cm³		GK	
8052-42-4	Asphalt (fumes)	–	5		
1912-24-9	Atrazine	–	5	K	
111-40-0	3-Azapentane-1,5-diamine	1	4	HA	
	3-Azapentane-1,5-diol, see 2,2'-Iminodiethanol				
86-50-0	Azinphos-methyl	–	0.2	H	
	Aziridin, see Ethylenimine				
	Barium and Barium compounds (except Barium sulphate) (calculated as Ba)	–	0.5	E	
17804-35-2	Benomyl	0.8	10	[1]	
71-43-2	Benzene	1	3	GHK	
	1,2-Benzenediamine, see o-Phenylenediamine				
108-46-3	1,3-Benzenediol	10	45		2007
108-98-5	Benzenethiol	0.5	2		
	1,2,4-Benzenetricarboxylic acid 1,2-anhydride, see Benzene-1,2,4-tricarboxylic acid 1,2-anhydride				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
552-30-7	Benzene-1,2,4-tricarboxylic acid 1,2-anhydride	0.005	0.04	A	
106-51-4	1,4-Benzoquinone	0.1	0.4		
94-36-0	Benzoyl peroxide	–	5	A	
85-68-7	Benzyl butyl phthalate (BBP)	–	1	RE	2007
	Benzyl chloride, see α-Chlorotoluene				
	Beryllium and Beryllium compounds (calculated as Be)	–	0.001	K	
92-52-4	Biphenyl	0.2	1		
	Bis (2,3-epoxypropyl) ether, 2,2'-[oxybis(mehtylene)] bisoxirane				
80-05-7	Bisphenol A, inhalable		10	ARE	2011
	Bis (2-chloroethyl), see 2,2'-Dichlordiethyl ether				
	Bis-chloroethyl ether, see 1,1'-Dichloromethyl ether				
	Lead and inorganic Lead compounds (calculated as Pb) (dust and fumes)	–	0.05	GR	
301-04-2	Lead acetate (calculated as Pb)	–	0.05	KR	
7446-27-7	Lead phosphate (calculated as Pb)	–	0.05	KR	
7758-97-6	Lead chromate (calculated as Cr(VI))	–	0.005	KR	2010
1335-32-6	Lead subacetate (calculated as Pb)	–	0.05	KR	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Lead tetraethyl, see Tetraethyl lead				
	Lead tetramethyl, see Tetramethyl lead				
	Hydrocyanic acid, see Hydrogen cyanide				
	Cotton dust, total dust	–	0.2	3	
	Borax, see Sodium tetraborate decahydrate				
1303-86-2	Boric oxide	–	10	1	
10294-33-4	Boron tribromide	1	10	T	
7637-07-2	Boron trifluoride	1	3	T	
7726-95-6	Bromine	0.1	0.7	E	
74-96-4	Bromoethane	5	22	H	
	Bromoform, see Tribromomethane				
	Bromoethylene, see Vinyl bromide				
74-97-5	Bromochloromethane	100	525		
	2-Bromo-2-chloro-1,1,1-trifluorethane, see Halothane				
74-83-9	Bromomethane	5	20	HK	
7789-30-2	Bromine pentafluoride	0.1	0.7		
75-63-8	Bromotrifluoromethane	500	3050		
106-99-0	1,3-Butadiene	1	2.2	K	
106-97-8	Butane	250	600		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
71-36-3	Butan-1-ol	25	75	HT	2007
78-92-2	Butan-2-ol	25	75	HT	2007
431-03-8	2,3-Butanedione	0.1	0.4		2010
	Butanol (all isomers)	25	75	HT	2007
78-93-3	Butanone	75	220	E	
1338-23-4	2-Butanone peroxide	–	1	T	
109-79-5	Butanethiol	0.5	1.5		
	2-butenal, see (E)-2-butenal				
123-73-9	(E)-2-butenal	2	6	H	
111-76-2	2-butoxy-ethanol	10	50	HE	
2426-08-6	1-butoxy-2,3-epoxypropane	5	27	A	
112-34-5	2-2(butoxyethoxy) ethanol	10	68		2007
112-07-2	2-butoxyethyl acetate	10	65	HE	
	Butyl acetate (all isomers)	75	355		
141-32-2	Butyl acrylate	2	11	AE	2007
	Butylamine (all isomers)	5	15	HT	
	Butyl ethyl ketone, see 3-heptanone				
	Butyl (2,3-epoxy-propyl) ether, see 1-butoxsy-2,3-epoxypropane				
	Butyl glycidyl ether, see 1-butoxsy-2,3-epoxypropane				
	Butyl glycol, see 2-butoxyethanol				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
1189-85-1	tert-butyl chromate (calculated as CrO_3)	–	0.1	HT	
138-22-7	Butyl lactate	5	25		
	Butyl mercaptan, see Butanethiol				
97-88-1	Butyl methacrylate	10	59	A	2007
1634-04-4	tert-butyl methyl ether (MTBE)	50	183.5	E	2011
		100	367	S	
	p-tert-butyltoluen, see 1-methyl-4-tert-butylbenzene				
2425-06-1	Captafol	–	0.1		
133-06-2	Captan	–	5	K	
1333-86-4	Carbon Black (lamp soot)	–	3.5		
	Cellosolve, see 2-etoxyethanol				
	Cellosolve acetate, see 2-etoxy ethylacetate				
21351-79-1	Cesium hydroxide	–	2		
420-04-2	Cyanamide	0.6	1	HE	2007
	Cyanides (calculated as CN)	–	5	H	
506-77-4	Cyanogen chloride	0.25	0.6	T	
13121-70-5	Cyhexatin	–	5		
	Cyklo-, see cyclo				
50-29-3	DDT	–	1	K	
17702-41-9	Decaborane	0.05	0.3	H	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Decanes and other higher aliphatic hydrocarbons	40	275		
8065-48-3	Demeton	0.01	0.1	H	
867-27-6	Demeton-O-methyl	0.05	0.5	H	
57041-67-5	Desflurane	5	35		2010
	Diacetone alcohol, see 4-Hydroxy-4- methyl-2-pentanone				
	1,2-Diaminobenzen, see o-Phenylenediamine				
	1,3-Diaminobenzen se m-Phenylenediamine				
	1,4-Diaminobenzen se p-Phenylenediamine				
	Diatomaceous earth (natural kieselguhr) Respirable dust	–	1.5		
333-41-5	Diazinon	–	0.1	H	
334-88-3	Diazomethane	0.2	0.4	K	
	Dibenzoyl peroxide, see Benzoyl peroxide				
19287-45-7	Diborane	0.1	0.1		
	Dibrome, see Dimethyl-1,2-dibromo-2,2-dichlorethyl phosphate				
75-61-6	Dibromodifluoro-methane	50	430		
106-93-4	1,2-Dibromoethane	0.1	1	K	
102-81-8	2-(dibutylamino)ethanol	2	14	H	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Dibutyl phosphate (all isomers)	1	5		
84-74-2	Dibutyl phthalate	–	3		
460-19-5	Dicyan	10	22		
60-57-1	Dieldrin	–	0.25		
	Diethanolamine, see 2,2'-Iminodiethanol	3	15		
109-89-7	Diethylamine	5	15	E	2007
100-37-8	2-(dibutylamino)ethanol	10	50	H	
111-96-6	Diethylene glycol dimethylether	–	–	HR	
	Diethylenetriamine, see 3-azapentane-1,5-diamine				2000
60-29-7	Diethyl ether	100	300	E	2007
84-66-2	Diethyl phthalate	–	3		
117-81-7	Di-2-ethylhexyl phthalate (DEHP)	–	1	R	2007
	Diethyl ketone, see Pentane-3-one				
	Diphenyl, see biphenyl				
122-39-4	Diphenylamine	–	5		
101-84-8	Diphenyl ether	1	7		
101-68-8	Diphenylmethane-4,4'-diisocyanate (MDI)	0.005	0.05	A [4]	
	Difluorodibromomethane, see Dibromodifluoro-methane				
75-71-8	Difluorodichloromethane	500	2475		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
75-45-6	Difluorochloromethane	500	1750	E	
76-12-0	1,2-difluoro-1,1,2,2-tetrachloro-ethane	250	2085		
1314-56-3	Diphosphorous(V) oxide	–	1	E	
	Diglycidyl ether, see 2,2'-[oxybis(mehtylene)] bisoxirane				
120-80-9	1,2 dihydroxybenzene	5	20		
	1,3-Dihydroxybenzene, see 1,3-benzendiol				
	Diisobutyl ketone, see 2,6-dimethyl-4- heptanone				
	Diisocyanates	0.005		A [4]	
108-18-9	Diisopropylamine	5	20	H	
108-20-3	Diisopropyl ether	125	525		
7572-29-4	Dichloroacetylene	0.1	0.4	T	
95-50-1	1,2-Dichlorobenzene	20	122	HE	2012
		50	306	S	
106-46-7	1,4-Dichlorobenzene	20	122	KE	2012
		50	306	S	
111-44-4	2,2'-Dichloroethyl ether	5	30	HK	
542-88-1	1,1'-Dichlorodimethyl ether	0.001	0.005	K	
118-52-5	1,3-Dichloro-5,5-dimethyl-hydantoin	–	0.2		
75-34-3	1,1-Dichloroethane	50	200	HE	
107-06-2	1,2-Dichloroethane	1	4	HK	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
75-35-4	1,1-Dichloroethene	1	4		
540-59-0	1,2-Dichloroethene	100	395		
	1,2-Dichloroethylene, see 1,2-Dichloroethene				
94-75-7	2,4-Dichlorophenyloxyacetic acid	–	5		
136-78-7	2-(2,4-Dichlorophenoxy) ethyl sulphate	–	5		
75-09-2	Dichloromethane	15	50	HK	2000
	Dichloromonofluoromethane, see Fluorodichloromethane				
594-72-9	1,1-Dichloro-1-nitroethane	2	12	HT	
78-87-5	1,2-Dichloropropane	40	185		
75-99-0	2,2-Dichloropropane acid	1	6		
542-75-6	1,3-Dichloropropene	1	5	H	
	2,2-Dichloropropionic acid, see 2,2-Dichloropropane acid				
	1,2-Dichloro-1,1,2,2-tetrafluoroethane, see 1,1,2,2-Tetrafluoro-1,2-dichloroethane				
62-73-7	Dichlorvos	0.1	1	HK	
85-00-7	Diquat dibromide	–	0.5		
109-87-5	Dimethoxymethane	500	1550		
127-19-5	N,N-Dimethylacetamide	10	35	HE	
124-40-3	Dimethylamine	2	4	E	2000
121-69-7	N,N-Dimethylaniline	5	25	H	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
108-84-9	1,3-Dimethylbutyl acetate	25	150		
300-76-5	Dimethyl-1,2-Dibromo-2,2-Dichloroethyl phosphate	–	3		
115-10-6	Dimethyl ether	200	384	E	2007
598-56-1	Dimethylethylamine	2	6		
68-12-2	N,N-Dimethylformamide	5	15	HRE	2011
		10	30	S	
	N,N-Dimethylmethanamide, see N,N-Dimethylformamide				
131-11-3	Dimethyl phthalate	–	3		
108-83-8	2,6-Dimethyl-4-heptanone	20	120		
57-14-7	1,1-Dimethylhydrazine	0.01	0.02	HAK	
	1,2-Dimethylhydrazine	0.01	0.02	HK	
77-78-1	Dimethyl sulphate	0.01	0.05	HK	
	Dinitrobenzene (all isomers)	0.15	1	H	
10024-97-2	Dinitrogen oxide	50	90	R	2000
534-52-1	4,6-Dinitro-o-cresol	–	0.2	H	
	Dinitrotoluene (all isomers)	–	0.15	HK	
123-91-1	1,4-Dioxane	5	18	HKE	2011
		10	36	S	
117-84-0	Dioctyl phthalate	–	3		
138-86-3	Dipentene	25	140	A	
	Dipropylene glycol methyl ether, see (2-Methoxymethylethoxy) propanol				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Dipropylene ketone, see Heptane-4-one				
	Disul, see 2-(2,4-Dichlorophenoxy) ethyl sulphate				
97-77-8	Disulfiram	–	2		
10025-67-9	Disulphur dichloride	1	6		
5124-30-1	Dicyclohexylmethane-4,4'-diisocyanate	0.005	0.05	A [4]	
77-73-6	Dicyclopentadiene	5	30		
298-04-4	Di-Syston	–	0.1	H	
330-54-1	Diuron	–	5	K	
	Divinylbenzene (all isomers)	10	53		
	Dursban, see Chlorpyriphos				
64-19-7	Acetic acid	10	25	E	
108-24-7	Acetic anhydride	5	20	T	
	Extraction benzene (largely n-hexane)	50	175		
	Extraction benzene (unspecified)	100	500		
115-29-7	Endosulfan	–	0.1	H	
72-20-8	Endrin	–	0.1	H	
13838-16-9	Enflurane	0.3	2.3	R	2000
	Epichlorohydrine, see 1-chloro-2,3-epoxypropane				
	EPN, see O-ethyl-O-4- nitrophenyl phenyl thiophosphonate				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	1,2-Epoxy-3-phenoxy-propane, see Phenyl glycidyl ether				
	1,2-Epoxypropane, see 1,2-propylene oxide				
556-52-5	2,3-Epoxy-1-propanol	25	75	A	
	2,3-Epoxypropyl phenyl ether, see Phenyl glycidyl ether				
4016-14-2	2,3-Epoxypropyl isopropyl ether	25	120		
64-17-5	Ethanol	500	950		
	Ethanolamine, see 2-Aminoethanol				
107-21-1	1,2-Ethanediol	20	52	HE[5]	2012
		40	104	S	
628-96-6	1,2-Ethanediol dinitrate	0.03	0.18	H	
75-08-1	Ethanethiol	0.5	1		
	Ether, see Diethylether				
110-80-5	2-Ethoxyethanol	5	18	HRE	2011
111-15-9	2-Ethoxyethyl acetate	2	11	HRE	2011
141-78-6	Ethyl acetate	150	550		
140-88-5	Ethyl acrylate	5	21	HAKE	2011
		10	42	S	
75-04-7	Ethylamine	2	4		2000
	Ethyl-sec-amyl ketone, see 5-Methyl-3-heptanone				
100-41-4	Ethyl benzene	5	20	HKE	2000

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Ethyl bromide, see Bromoethane				
107-15-3	Ethylendiamine	10	25	A	
	Ethylene dibromide, see 1,2-Dibromoethane				
	Ethylene dichloride, see 1,2-Dichloroethane				
	Ethylene glycol, see 1,2-Ethanediol				
	Ethylene glycol dinitrate, see 1,2-Ethandiol nitrate				
	Ethylene glycol monobutyl ether, see 2-Butoxyethanol				
	Ethylene glycol monoethyl ether, see 2-Ethoxyethanol				
	Ethylene glycol monoethyl ether acetate, see 2-Etoxy ethylacetate				
	Ethylene glycol monomethyl ether, see 2-Methoxyethanol				
	Ethylene glycol monomethyl ether acetate, see 2-Metoxy-ethyl acetate				
151-56-4	Ethyleneimine	0.5	1	HK	
	Ethylene chlorohydrine, see 2-Chloroethanol				
75-21-8	Ethylene oxide	1	–	K	
109-94-4	Ethyl formate	50	150		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Ethyl glycol, see 2-Ethoxyethanol				
	Ethyl glycol acetate, see 2-Ethoxyethyl acetate				
	Ethylidene chloride, see 1,1-Dichloroethane				
16219-75-3	5-Ethylidene-2-norbornene	5	25	T	
	Ethyl chloride, see Chloroethane				
97-63-2	Ethyl methacrylate	50	250	A	
	Ethylmercaptan, see Ethanethiol				
	Ethyl methanoate, see Ethyl formate				
100-74-3	N-Ethylmorpholine	5	23	H	
	O-ethyl-O-(4-nitrophenyl) phenyl monothiophosphonate, see O-ethyl-O-4-nitrophenyl phenyl thiophosphonate				
2104-64-5	O-ethyl-O-4-nitrophenyl phenyl thiophosphonate	–	0.5	H	
78-10-4	Ethyl silicate	10	85		
108-95-2	Phenol	1	4	HE	2011
		3	12	S	
92-84-2	Phenothiazine	–	5	H	
	1,2-Phenylenediamine, see o-Phenylenediamine				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	1,3-Phenylenediamine, see m-Phenylenediamine				
	1,4-Phenylenediamine, see p-Phenylenediamine				
	Phenyl ether, see Diphenyl ether				
108-45-2	m-Phenylenediamine	–	0.1	HA	
95-54-5	o-Phenylenediamine	–	0.1	HAK	
	p-Phenylenediamine	–	0.1	HA	
638-21-1	Phenylphosphine	0.05	0.25	T	
122-60-1	Phenyl glycidyl ether	1	5	A	
100-63-0	Phenylhydrazine	–	0.6	A	
	Phenyl mercaptan, see Benzenethiol				
98-83-9	2-Phenylpropene	50	240	E	
14484-64-1	Ferbam	–	5		
12604-58-9	Ferrovanadium	–	1		
7782-41-4	Fluorine	0.1	0.2	E	
	Fluorides (calculated as F), see Inorganic fluorides				
	Fluorine monoxide, see Oxygen difluoride				
75-43-4	Fluorodichloromethane	10	42		
75-69-4	Fluorotrichlromethane	500	2800		
	Hydrofluoric acid, see Hydrogen fluoride				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
298-02-2	Phorate	–	0.05	H	
50-00-0	Formaldehyde	0.5	0.6	AK	
		1	1.2	T	
75-12-7	Formamide	10	18	H	
	Fosdrin, see Mevinphos				
7803-51-2	Phosphine	0.1	0.15	E	
7723-14-0	Phosphorous (yellow)	–	0.1		
	Phosphoroxychloride, see Phosphoryl chloride				
10026-13-8	Phosphorus pentachloride	–	1	E	
	Phosphorus pantaoxide, see Diphosphorous(V) oxide				
1314-80-3	Phosphorus pentasulphide	–	1	E	
7664-38-2	Phosphoric acid	–	1	E	
	Phosphoric acid anhydride, see Diphosphorous(V) oxide				
7719-12-2	Phosphorous trichloride	0.2	1.5		
10025-87-3	Phosphoryl chloride	0.1	0.6		
75-44-5	Phosgene	0.05	0.2	TE	2012
	Freon 11, see Fluorotrichloromethane				
	Freon 12, see Difluorodichloromethane				
	Freon 21, Fluorodichloromethane				
	Freon 22, see Difluorochloromethane				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Freon 112, see 1,2-difluoro-1,1,2,2-tetrachloroethane				
	Freon 113, see 1,2,2-trifluoro-1,1,2-trichloroethane				
	Freon 114, see 1,1,2,2-tetrafluoro-1,2-dichloroethane				
626-17-5	m-Phthalodinitrile	–	5		
85-44-9	Phthalic acid anhydride	–	2	A	
98-01-1	2-Furaldehyde	2	8	H	
	Furfural, see 2-Furaldehyde				
98-00-0	Furfuryl alcohol	5	20	H	
7782-65-2	Germanium tetrahydride	0.2	0.6		
	Glass fibre/polyester, total dust	–	5		
	Mica Total dust Respirable dust	–	6		
		–	3		
111-30-8	Glutaraldehyde	0.2	0.8	AT	
	Glutaraldehyde (activated by alkaline)	–	0.25	T	
55-63-0	Glycerol trinitrate	0.03	0.27	H	
	Glycidol, see 2,3-Epoxy-1-propanol				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Graphite, natural Total dust Respirable dust	–	5		
		–	2		
	Graphite, synthetic Total dust Respirable dust	–	10		
		–	4		
7440-58-6	Hafnium	–	0.5		
151-67-7	Halothane	0.02	0.2	R	2000
	HDI, see Hexane-1,6-diisocyanate				
684-16-2	Hexafluoroacetone	0.1	0.7	H	
	Hexahydro-1,3,5-trinitro-1,s-triazine, see Perhydro-1,3,5-trinitro-1,3,5-triazine				
87-68-3	Hexachlorobutadiene	0.02	0.24	H	
67-72-1	Hexachloroethane	1	10	H	
1335-87-1	Hexachloronaphthalene	–	0.2	H	
77-47-4	Hexachlorocyclopentadiene	0.01	0.1		
	Hexamethylene diisocyanate, see Hexane-1,6-diisocyanate				
100-97-0	Hexamethylenetetramine	–	3		
110-54-3	n-Hexane	20	72	RE	2007
	Hexane (except n-Hexane)	250	1050		
124-09-4	Hexsanediamine	0.5	1	HT	2007

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
822-06-0	Hexane-1,6-diisocyanate	0.005	0.035	A [4]	
	2-Hexanon, see Hexane-2-one				
591-78-6	Hexane-2-one	1	4	H	
	sec-Hexyl acetate, see 1,3-Dimethylbutyl acetate				
	Hexylene glycol, see 2-Methyl-2.4-pentandiol				
76-44-8	Heptachlor	–	0.5	H	
142-82-5	Heptane	200	800	E	
123-19-3	Heptane-4-one	25	115		
110-43-0	2-Heptanone	25	115	HE	
106-35-4	3-Heptanone	20	95	E	2014
		50	95	S	
	4-Heptanone, see Heptane-4-one				
302-01-2	Hydrazine	0.01	0.01	HAK	
10035-10-6	Hydrogen bromide	2	7	STE	2014
74-90-8	Hydrogen cyanide	5	5	HT	
	Hydro-generated terphenyls	0.4	4.4		
7664-39-3	Hydrogen fluoride		0.5	HE	2010
		1.8	1.5	S	
	Hydrogen phosphide, see Phosphine				
7647-01-0	Hydrogen chloride	5	7	TE	
7722-84-1	Hydrogen peroxide	1	1.4		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
7783-07-5	Hydrogen selenide	0.01	0.05	E	
7783-06-4	Hydrogen sulphide	5	7	E	2011
		10	14	T	
123-31-9	Hydroquinone	–	0.5	AK	
868-77-9	2-Hydroxyethyl methacrylate	2	11	A	2007
123-42-2	4-Hydroxy-4-methyl-2-pentanone	25	120		
999-61-1	2-Hydroxypropylacrylate	0.5	2.9	HA	
	Refractory ceramic fibres	0.1 fibre/cm³		K	2007
111-42-2	2,2'-Iminodiethanol	3	15		
	2,2'-Iminodi(ethylamine), see 3-Azapentane-1,5-diamine				
95-13-6	Indene	10	45		
	Indium and Indium compounds (calculated as In)	–	0.1		
	Isoamyl acetate, see (3-Methylbutyl) acetate				
	Isoamyl alcohol , see 3-Methyl-1-butanol				
	Isobutyl acetate, see Butyl acetate (all isomers)				
97-86-9	Isobutyl methacrylate	50	300	A	
	Isocyanates, see diisocyanates				
26675-46-7	Isoflurane	2	15	R	2010
78-59-1	Isophorone	5	25	T	
4098-71-9	Isophorone diisocyanate	0.005	0.045	A [4]	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
26952-21-6	Isooctan-1-ol	25	135		
	Isooctyl alcohol, see Isooctan-1-ol				
78-78-4	Isopentane	250	750	E	2007
123-92-2	Isopentyl acetate	50	260	E	
	Isopropanol, see 2-propanol				
109-59-1	2-Isopropoxyethanol	20	80		
	2-Isopropoxypropane, see Diisopropyl ether				
108-21-4	Isopropyl acetate	100	420		
	Isopropylamine, see 2-Propylamine				
768-52-5	Isopropylaniline	2	11	H	
	Isopropyl glycidyl ether, see 2,3-Epoxypropyl isopropyl ether				
1309-37-1	Iron(III)oxide (calculated as Fe)	–	3		
13463-40-6	Iron pentacarbonyl	0.01	0.08		
	Iron salts (calculated as Fe)	–	1		
7553-56-2	Iodine	0.1	1	T	
74-88-4	Iodomethane	1	5	H	
	Iodoform, see Triiodomethane				
	Cadmium and inorganic Cadmium compounds (except cadmium sulphate) (calculated as Cd)	–	0.05	K	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
1306-19-0	Cadmium oxide (calculated as Cd)	–	0.02	KT	
1310-58-3	Potassium hydroxide	–	2	T	
156-62-7	Calcium cyanamide	–	0.5		
1305-62-0	Calcium hydroxide	–	5	E	
1305-78-8	Calcium oxide	–	2	T	
8001-35-2	Camphechlor	–	0.5	H	
76-22-2	Camphor (synthetic)	2	12		
105-60-2	ε-Caprolactam	10	40	E[5]	2012
63-25-2	Carbaryl	–	5	H	
1563-66-2	Carbofuran	–	0.1	H	
124-38-9	Carbon dioxide	5000	9000	E	
75-15-0	Carbon disulphide	5	15	HRE	2011
630-08-0	Carbon monoxide	25	29	[6]	
558-13-4	Carbon tetrabromide	0.1	1.4		
	Carbon tetrachloride; see Tetrachloromethane				
353-50-4	Carbonyl fluoride	2	5		
	Carbonyl chloride, see Phosgene				
13466-78-9	δ-Carene	25	140	A	
	Catechol, see 1,2-Dihydroxybenzene				
463-51-4	Ketene	0.5	0.9		
	Quinone, see 1,4-Benzoquinone				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Steatite Total dust Respirable dust	– –	6 3		
7782-50-5	Chlorine	0.5	1.5	E	2007
		1	3	T	
107-20-0	Chloroacetaldehyde	1	3	T	
532-27-4	α-Chloroacetophenone	0.05	0.3		
79-04-9	Chloroacetyl chloride	0.05	0.2	H	
108-90-7	Chlorobenzene	5	23	E	2007
2698-41-1	o-Chlorobenzylidenemalono-nitrile	0.05	0.4	H	
	Chlorobromomethane, see Bromochloromethane				
57-74-9	Chlordane	–	0.5	H	
	Chlorodifluoromethane, see Difluorochloromethane				
10049-04-4	Chlorine dioxide	0.1	0.3		
106-89-8	1-chloro-2,3-epoxypropane	0.5	1.9	HAK	
55720-99-5	Chlorinated diphenyl oxide	–	0.5	H	
	Chlorinated camphene, see Toxaphene				
75-00-3	Chloroethane	100	270	K	2007
107-07-3	2-Chloroethanol	1	3	HT	
	Chloroethene, see Vinyl chloride				
74-87-3	Chloromethane	25	50	K	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Chloromethylbenzene, see Chlorotoluene				
100-00-5	1-Chloro-4-nitrobenzene	–	1	H	
600-25-9	1-Chloro-1-nitropropane	2	10		
	Chloroform, see Trichloromethane				
	Chloropicrin, see Trichloronitromethane				
126-99-8	2-Chloroprene	1	3.6	H	
107-05-1	3-Chloropropene	1	3	H	
2921-88-2	Chlorpyrifos	–	0.2	H	
2039-87-4	o-Chlorostyrene	25	140		
100-44-7	α-Chlorotoluene	1	5		
95-49-8	o-Chlorotoluene	25	125	H	
7790-91-2	Chlorotrifluoride	0.1	0.4		
7440-50-8	Copper Fumes Dust	– –	0.1 1		
	Cobalt (fumes) and inorganic Cobalt compounds (calculated as Co, except Co(II)	–	0.02	AR	2000
	Cobalt, Co(II) compounds (fumes) and inorganic (calculated as Co)	–	0.02	AKR	2000
	Cobalt hydrocarbonyl (calculated as Co)	–	0.1		
	Cobalt carbonyl (calculated as Co)	–	0.1		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
1319-77-3	Cresols (all isomers)	5	22	HE	
14464-46-1	Cristobalite Total dust Respirable dust	– –	0.15 0.05	K [7] K [7]	
	Chromium and Cr^2 ± and Cr^3 ± compounds (calculated as Cr)	–	0.5	E	
	Chromic acid and chromates (calculated as Cr(VI))	–	0.005	AK	2010
	Chrotonaldehyde, see (E)-2-butenal				
	(E)-chrotonaldehyde, see (E)-2-butenal				
	Coal dust Total dust Respirable dust	– –	4 1.5		
	Cumene, see 1-Methylethyl benzene				
14808-60-7	α-quartz Total dust Respirable dust	– –	0.3 0.1	K [7] K [7]	
	Mercury and Mercury compounds (except alkyl compounds) (calculated as Hg) Biological limit value for urine	– 30 µg Hg/g creatinine	0.02	AE [8]	2007
	Mercury, alkyl compounds (calculated as Hg)	–	0.01	AH	
	Limonene, see d-Limonene, i-Limonene and Dipentene				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
5989-27-5	d-Limonene	25	140	A	
5989-54-8	i-Limonene	25	140		
58-89-9	Lindane	–	0.5	H	
7580-67-8	Lithium hydride	–	0.025	E	
	Soldering wire with resin-containing core (calculated as formaldehyde)	–	0.1		
	Laughing gass, see Dinitrogen oxide				
1309-48-4	Magnesium oxide	–	10	[1]	
121-75-5	Malathion	–	5	H	
108-31-6	Maleic acid anhydride	0.2	0.8	A	
7439-96-5	Manganese and inorganic Managenese compounds (calculated as Mn) Inhalable fraction Respirable fraction	 – –	 1 0.1		2007
12079-65-1	Manganese cyclopentadienyl tricarbonyl (calculated as Mn)	–	0.1	H	
64-18-6	Formic acid	5	9	E	
	MDI, see Diphenylmethane-4,4'-diisocyanate				
	Flour dust, inhalable		3	A [9]	2000
	Mercaptoacetic acid, see Thioglycolic acid				
108-67-8	Mesitylene (trimethylbenzenes)	20	100		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Mesityloxide, see 4-methyl-3-penten-2-one				
79-41-4	Methacrylic acid	20	70		
	Methacrylic acid methyl ester, see Methyl methacrylate				
67-56-1	Methanol	100	130	HE	
74-93-1	Methanthiol	0.5	1		
90-04-0	2-Methoxyaniline	0.1	0.5	HK	
104-94-9	4-Methoxyaniline	0.1	0.5	H	
109-86-4	2-Methoxyethanol	1	3.1	HRE	2011
111-77-3	2-(2-Methoxyethoxy)ethanol	10	50	HRE	2007
110-49-6	2-Metoxyethyl acetate	1	4.9	HRE	2011
150-76-5	4-Methoxyphenol	–	5		
72-43-5	Methoxychlor	–	5		
34590-94-8	(2-Methoxymethylethoxy) propanol	50	300	HE	
107-98-2	1-Methoxy-2-propanol	50	180	HE	
108-65-6	1-Methoxy-2-propyl acetate	50	270	HE	
1589-47-5	2-Methyloxy-1-propanol	20	75	HR	
70657-70-4	2-Methoxy-1-propyl acetate	20	110	HR	
16752-77-5	Methomyl	–	2.5	H	
79-20-9	Methyl acetate	100	305		
	Methylacetylene, see Propyne				
	Methyl acetylene-Propadien mixture	500	900		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
96-33-3	Methyl acrylate	5	18	HAE	2011
		10	36	S	
126-98-7	Methylacrylonitrile	1	3	HA	
74-89-5	Methylamine	10	12		
	Methylamyl alcohol, see 4-Methyl-2-pentanol				
	Meholamyl ketone, see 2-Heptanone				
100-61-8	N-Methylaniline	0.5	2	H	
75-55-8	2-Methylaziridine	2	5	HK	
	Methyl bromide, see Bromomethane				
	3-Methyl butanone, see 3-Methyl-2-butanone				
563-80-4	3-Methyl-2-butanone	100	350	H	
123-51-3	3-Methyl-1-butanol	50	180		
626-38-0	1-Methylbutyl acetate	50	260	E	
	3-methylbutyl acetate, see Isopentyl acetate				
98-51-1	1-Methyl-4-tert-butylbenzene	10	60		
	Methylbutyl ketone, see Hexane-2-one				
137-05-3	Methyl -2-cyanoacrylate	2	8	A	
	Methylene-bis(4- cyclohexyl isocyanate), see Dicyclohexyl-methane-4,4'-diisocyanate				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Methylene-bis-phenyl diisocyanate, see Diphenylmethane- 4,4'-diisocyanate				
101-77-9	4,4'-Methylenedianiline	0.1	0.8	HAK	
	Methylene chloride, see Dichloromethane				
98-82-8	1-Methylethyl benzene	20	100	HKE	2012
		50	250	S	
	Methylethyl ketone, see Butanone				
	Methylethyl ketone peroxide, see 2-Butanone peroxide				
	Methylphenol, see Cresols				
	Methyl formate, see Methyl methanoate				
	Methyl glycol, see 2-Methoxyethanol				
	Methyl glycol acetate, see 2-Methoxyethyl acetate				
110-12-3	5-Methyl-2-hexanone	20	95	E	2014
		50	250	S	
541-85-5	5-Methyl-3-heptanone	20	100	E	2014
		20	107	S	
60-34-4	Methyl hydrazine	0.01	0.02	HK	
	Methyl isobutyl carbinol, see 4-Methyl-2-pentanol				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Methyl ispbutyl ketone, see 4-Methylpentan-2-one				
624-83-9	Methyl isocyanate	0.02	0.05	S (5min) AE[10]	2011
	Methyl isopropyl ketone, see 3-Methyl-2-butanone				
	Methyl iodide, see Iodomethane				
	Methyl chloride, see Chloromethane				
	Methyl chloroform, see 1,1,1-Trichloroethane				
	Methyl mercaptan, see Methanthiol				
80-62-6	Methyl methacrylate	25	100	AE	2011
		100	400	S	
107-31-3	Methyl methanate	50	125	H	
107-41-5	2-Methyl-2,4-pendandiol	20	100	T	
872-50-4	N-Methyl-2-pyrrolidone	5	20	HRE	2011
		20	80	S	
108-11-2	4-Methyl-2-pentanol	20	80	H	
108-10-1	4-Methylpentan-2-one	20	83	HE	2012
		50	208	S	
141-79-7	4-Methyl-3-penten-2-one	10	40		
	4-Methylpentyl-2-acetate, see 1,3-Dimethylbutyl acetate				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
78-83-1	2-Methylpropan-1-ol	25	75	HT	2007
75-65-0	2-Methyl-2-propanol	25	75	HT	2007
	Methyl propyl ketone, see 2-Pentanone				
681-84-5	Methyl silicate	1	6		
	α-Methylstyrene, see 2-Phenylpropene				
108-87-2	Methylcyclohexane	200	800		
	Methylcyclohexanol (all isomers)	25	120		
583-60-8	2-Methylcyclohexanon	25	115	H	
12108-13-3	Methylcyclopentadienyl manganese tricarbonyl (calculated as Mn)	0.1	0.2	H	
479-45-8	N-Methyl-2,4,6-N-tetranitroaniline	–	1.5	HA	
7786-34-7	Mevinphos	0.01	0.1	H	
	MMMF (Man Made Mineral Fibers), see Refractory ceramic fibres, thin glass fibres for special purposes, mineral wool and AES wool				
	Mineral wool	1 fibre/cm³		[11]	
	Molybdenum compounds, soluble (calculated as Mo)	–	5		
	Molybdenum compounds, insoluble (calculated as Mo)	–	10		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Monofluorodichloromethane, see Fluorodichloromethane				
110-91-8	Morpholine	10	36	HE	2007
91-20-3	Naphthalene	10	50	E	
3173-72-6	Naphthalene-1,5-diisocyanate	0.005	0.04	A [4]	
86-88-4	1-Naphthylthiourea	–	0.3		
26628-22-8	Sodium azide	–	0.1	E	2014
		–	0.3	S	
	Sodium bisulphite, see Sodium hydrogen sulphite				
62-74-8	Sodium fluoroacetate	–	0.05	H	
7631-90-5	Sodium hydrogen sulphite	–	5		
1310-73-2	Sodium hydroxide	–	2	T	
7681-57-4	Sodium methabisulphite (Sodium pyrosulphate)	–	5		
	Sodium tetraborates:				
1330-43-4	Anhydrous	–	1		
1303-96-4	Decahydrates	–	5		
12447-40-4	Pentahydrates	–	1		
463-82-1	Neopenthane	250	750	E	2007
	Nickel and Nickel compounds (calculated as Ni)	–	0.05	AKR	2000
	Nickel carbonyl, see Nickel tetracarbonyl				
13463-39-3	Nickel tetracarbonyl	0.001	0.007	HKR	
54-11-5	Nicotine	–	0.5	HE	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
100-01-6	p-Nitroaniline	–	3	H	
98-95-3	Nitrobenzene	0.2	1	HKRE	2007
79-24-3	Nitroethane	50	155		
10102-44-0	Nitrogen dioxide	0.6	1.1	[12]	2007
10102-43-9	Nitrogen oxide	25	30	E	
7783-54-2	Nitrogen trifluoride	10	29		
	Nitroglycerol, see Glycerol trinitrate				
	Nitroglycol, see 1,2-Ethandiol dinitrate				
	p-Nitrochlorobenzene, see 1-chloro-4-nitrobenzene				
75-52-5	Nitromethane	50	125		
108-03-2	1-Nitropropane	20	70		
79-46-9	2-Nitropropane	10	35	K	
	Nitrotoluene (all isomers)	1	5.5	H	
111-84-2	Nonane	100	525		
144-62-7	Oxalic acid	–	1	E	
	2-oxo-Hexamethylenimine, see Caprolactam				
05/07/2238	2,2'-[oxybis(mehtylene)] bisoxirane	0.1	0.5	AT	
7783-41-7	Oxygen difluoride	0.05	0.1		
2234-13-1	Octachloronaphthalene	–	0.1	H	
111-65-9	Octane	150	725		
	2-Octanol, see Isooctan-1-ol				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Oil vapour	–	50		
	Oil mist (mineral oil particles)	–	1		
	Organic dust, total dust	–	5		
20816-12-0	Osmium tetraoxide	0.0002	0.002		
10028-15-6	Ozone	0.1	0.2		
	PAH (polyaromatic hydrocarbons)	–	0.04	K [13] [14]	2010
8002-74-2	Paraffin (fumes)	–	2		
4685-14-7	Paraquat	–	0.1	H	
56-38-2	Paration	–	0.05	H	
298-00-0	Parathion-methyl	–	0.2	H	
1336-36-3	PCB (polychlorinated biphenyls)	–	0.01	HK	
19624-22-7	Pentaborane	0.005	0.01		
76-01-7	Pentachloroethane	5	40	H	
87-86-5	Pentachlorophenol	0.05	0.5	HK	
1321-64-8	Pentachloronaphtalene	–	0.5	H	
109-66-0	Pentane	250	750	E	
96-22-0	Pentane-3-one	100	350		
	Pentanol (all isomers)	50	180		
107-87-9	2-Pentanone	75	260		
	3-Pentanone, see Pentane-3-one				
620-11-1	3-Pentyl acetate	50	260	E	
628-63-7	Pentyl acetate	50	260	E	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Pentyl acetat (all isomers)	50	260		
121-82-4	Perhydro-1,3,5-trinitro-1,3,5-triazine	–	1.5	H	
	Perchloroethylene, see Tetrachloroethene				
	Perchloromethyl mercaptan, see Trichloromethane sulfenyl chloride				
7616-94-6	Perchloril fluoride	3	14		
	Perlite Total dust	–	10		
	Respirable dust	–	4		
	Persulphates	–	2	A	
88-89-1	Picric acid	–	0.1	HE	
83-26-1	Pindone	–	0.1		
80-56-8	α-Pinene	25	140	H	
127-91-3	β-Pinene	25	140		
110-85-0	Piperazine	0.1	–	AE	2014
			0.3	S	
	Pival, see Pindone				
	2-Pivaloyl-1,3-indandione, see Pindone				
	Platinum compounds, soluble (calculated as Pt)	–	0.002		
7440-06-4	Platinum, metallic	No prescribed limit value		E	2012
	Plictran, see Cyhexatin				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Polyester/glass fibre, total dust	–	5		
74-98-6	Propane	500	900		
57-55-6	Propane-1,2-diol	25	79		2007
6423-43-4	Propane-1,2-diyl dinitrate	0.05	0.3	H	
	1,2-Propanediol dinitrate, see Propane-1,2-diyl dinitrate				
71-23-8	1-Propanol	100	245	H	
67-63-0	2-Propanol	100	245		
	Propargyl alcohol, see 2-Propyne-1-ol				
	Propenal, see acrylaldehyde				
107-18-6	2-Propen-1-ol	2	5	HE	
79-09-4	Propionic acid	10	30	E	
57-57-8	β-Propiolactone	0.5	1.5	K	
	2-Propoxyethanol, see 2-Isopropoxy ethanol				
114-26-1	Propoxur	–	0.5		
	2-Propyl acetate, see isopropyl acetate				
109-60-4	n-Propyl acetate	100	420		
75-31-0	2-Propylamine	5	12		
	1,2-Propylene glycol dinitrate, see Propane-1,2-diyl dinitrate				
	Propylene glycol monomethyl ether, see 1-Methoxy-2-propanol				

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	2-Propyl glycidyl ether, see 2,3-Epoxypropyl isopropyl ether				
	Propylenimine, see 2-Methylaziridine				
75-56-9	1,2-Propylene oxide	1	2	HAK	
	iso-Propyl glycidyl ether, see 2,3-Epoxypropyl isopropyl ether				
627-13-4	Propyl nitrate	20	90		
74-99-7	Propyne	500	825		
107-19-7	2-Propyne-1-ol	1	2.5	H	
8003-34-7	Pyrethrin	–	1	E	2007
110-86-1	Pyridine	5	15	E	
	Pyrocatechol, see 1,2-Dihydroxybenzene				
	Resorcinol, see 1,3-Benzenediol				
	Respirable dust in the silicon carbide industry, in furnace houses and furnace-house-related departments in the silicon carbide industry		0.5		
7440-16-6	Rhodium	–	0.1		
	Rhodium compounds, soluble (calculated as Rh)	–	0.001		
299-84-3	Ronnel	–	5		
83-79-4	Rotenone	–	5		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
7697-37-2	Nitric acid	2	5	E	2007
	Hydrochloric acid, see Hydrogen chloride				
	Selenium and inorganic Selenium compounds (except selenium sulphide, hydrogen selenide and selenium hexsafluoride) (calculate as Se)	–	0.05	A	2000
7783-79-1	Selenium hexafluoride	0.05	0.4		
7446-34-6	Selenium sulphide		0.05	AK	2000
28523-86-6	Sevoflurane	5	35		2010
7803-62-5	Silane	0.5	0.7		
7440-21-3	Silicon	–	10	[1]	
	Silicon carbide fibres	0.1 fibre/cm³		K	
	Silicon carbide, see Respirable dust in the silicon carbide industry				
	Silicon tetrahydride, see Silanium				
7646-85-7	Zinc chloride	–	1		
1314-13-2	Zinc oxide	–	5		
	Irritating dust Total dust Respirable dust	– –	10 5		
	Stibin, see Antimony hydride				
57-24-9	Strychnine	–	0.15	T	
100-42-5	Styrene	25	105	M	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
1395-21-7	Subtilisins (enzymes used in detergents)	–	0.00006	T	
3689-24-5	Sulfotep	–	0.1	HE	2014
2699-79-8	Sulphuryl fluoride	5	20		
	Welding fumes (unspecified)	–	5	[15]	
7446-09-5	Sulphur dioxide:	0.8	2	[12]	2007
2551-62-4	Sulphur hexafluoride	1000	6000		
	Sulphur monochloride, see Disulphur dichloride				
5714-22-7	Sulphur pentafluoride	0.01	0.1	T	
7664-93-9	Sulphuric acid aerosol, thoracic fraction	–	0.1	KE	2011
7783-60-0	Sulphur tetrafluoride	0.1	0.4		
110-82-7	Cyclohexane	150	525	E	
108-93-0	Cyclohexanol	25	100		
108-94-1	Cyclohexanon	10	40	HE	2014
		20	80	S	
110-83-8	Cyclohexene	150	510		
108-91-8	Cyclohexylamine	10	40	H	
	Cyclonite, see Perhydro-1,3,5-trinitro-1,3,5-triazine				
542-92-7	1,3-Cyclopentadiene	40	110		
	Synthetic mineral fibres, see MMMF				
7440-22-4	Silver, metal dust and fumes	–	0.1	E	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Silver, soluble compounds (calculated as Ag)	–	0.01	E	
	2,4,5-T, see 2,4,5-Trichlorophenoxyacetic acid				
	Talcum without fibres Total dust	–	6		
	Respirable dust	–	2		
	TDI, see 2,4- and 2,6-Toluene diisocyanate				
13494-80-9	Tellurium	–	0.1		
7783-80-4	Tellurium hexsafluoride	0.02	0.2		
	TEPP, see Tetraethyl pyrophosphate				
	Terphenyls	0.5	4.5	T	
8006-64-2	Terpentine (of plant origin)	25	140	HA	
79-27-6	1,1,2,2-Tetrabromoethane	1	14		
	Tetrabromomethane, see Carbon tetrabromide				
78-00-2	Tetraethyl lead	0.01	0.075	HR	
107-49-3	Tetraethyl pyrophosphate	0.004	0.05	H	
76-14-2	1,1,2,2-tetrafluoro-1,2-dichloroethane	500	3500		
109-99-9	Tetrahydrofuran	50	150	HE	
79-34-5	1,1,2,2-Tetrachloroethane	1	7	H	
127-18-4	Tetrachloroethene	6	40	HKR	2000

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	Tetrachloroethylene, see Tetrachloroethene				
56-23-5	Tetrachloromethane	2	13	HK	
1335-88-2	Tetrachloronaphtalene	–	2	H	
75-74-1	Tetramethyl lead	0.01	0.075	HR	
3333-52-6	Tetramethylsuccinonitrile	0.5	3	H	
7722-88-5	Tetrasodium pyrophosphate	–	5		
509-14-8	Tetranitromethane	0.005	0.04	K	
	Tetryl, see N-Methyl-2,4,6-N-tetranitroaniline				
	Thallium and soluble Thallium compounds (calculated as Tl)	–	0.1	H	
7719-09-7	Thionyl chloride	1	5	T	
	Tin compounds, organic (calculated as Sn)	–	0.1	H	
	Tin compounds, inorganic (calculated as Sn)	–	2	E	
68-11-1	Thioglycolic acid	1	5		
137-26-8	Thiram	–	5	AM	
13463-67-7	Titanium dioxide	–	5		
	TNT, see 2,4,6-Trinitrotoluene				
	Toxaphene, see Camphechlor				
108-88-3	Toluene	25	94	HE	
584-84-9	2,4-Toluene diisocyanate	0.005	0.035	AK [4]	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
91-08-7	2,6-Toluene diisocyanate	0.005	0.035	AK [4]	
95-53-4	o-Toluidine	1	4.5	HK	
	Wood dust from exotic hardwoods, oak and beech, total dust	–	1	GK [16]	
	Wood dust from Nordic woods, except oak and beech, total dust	–	2	K	
75-25-2	Tribromomethane	0.5	5	HK	
126-73-8	Tributyl phosphate	0.2	2.5		
	Tri(cyclohexyl)tin hydroxide, see Cyhexatin				
15468-32-3	Tridymite				
	Total dust	–	0.15	K [7]	
	Respirable dust	–	0.05	K [7]	
102-71-6	Triethanolamine	–	5		
121-44-8	Triethylamine	2	8	HE	
112-24-3	Triethylenetetramine	1	6	A	2007
603-34-9	Triphenylamine	–	5		
115-86-6	Triphenylphosphate	–	3		
	Trifluoromonobromomethane, see Bromotrifluoromethane				
76-13-1	1,2,2-Trifluoro-1,1,2-trichloro-ethane	500	3800		
75-47-8	Triiodomethane	0.2	3		
120-82-1	1,2,4-Trichlorobenzene	2	15	HE	2014

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
76-03-9	Trichloroacetic acid	0.75	5		
71-55-6	1,1,1-Trichloroethane	50	270	E	
79-00-5	1,1,2-Trichloroethane	10	54	H	
79-01-6	Trichloroethene	10	50	K	
	Trichloroethylene, see Trichloroethene				
	Trichlorofluoromethane, see Fluorotrichloromethane				
93-76-5	(2,4,5-Trichlorophenoxy) acetic acid	–	5	H	
67-66-3	Trichloromethane	2	10	HKRE	
594-42-3	Trichloromethanesulphenyl chloride	0.1	0.8		
1321-65-9	Trichloronaphtalene	–	5	H	
76-06-2	Trichloronitromethane	0.1	0.7		
96-18-4	1,2,3-Trichloropropane	10	60	H	
	Trimellitic acid anhydride, see Benzene-1,2,4-tricarboxylic acid-1,2-anhydride				
75-50-3	Trimethylamine	10	24		
526-73-8	1,2,3-Trimethylbenzene	20	100	E	
95-63-6	1,2,4-Trimethylbenzene	20	100	E	
	Trimethylbenzene (all isomers), see Mesitylene				
121-45-9	Trimethyl phosphite	0.5	2.6		
118-96-7	2,4,6-Trinitrotoluene	–	0.1	H	

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
78-30-8	Triorthocresyl phosphate	–	0.1		
	Tricyclohexylhydroxytin, see Cyhexatin				
	Thin glass fibres for special purposes	0.1 fibre/cm³		K 17	2007
	Inorganic fluorides (calculated as F)	–	0.5	E	2010
	Uranium and Uranium compounds (calculated as U)	–	0.2		
110-62-3	Valeraldehyde	25	90		
7440-62-2	Vanadium				
	Fumes (calculated as V)	–	0.05	T	
	Dust (calculated as V)	–	0.2		
108-05-4	Vinyl acetate	5	17.6	KE	2011
		10	35.2	S	
	Vinyl benzene, see Styrene				
593-60-2	Vinyl bromide	1	4	K	
	Vinylidene chloride, see 1,1-Dichloroethane				
75-01-4	Vinyl chloride	1	3	G K	
106-87-6	Vinylcyclohexene dioxide	10	60		
	Vinyl toluene (all isomers)	50	240		
1304-82-1	Bismuth telluride	–	10	[1]	
	Bismuth telluride (with added Selenium)	–	5		
81-81-2	Warfarin	–	0.1		

CAS number	*Name*	*ppm*	*mg/m³*	*Comments*	*Last amended*
	White Spirit (content of aromatic compounds <22%)	50	275		
	White Spirit (content of aromatic compounds >22%)	25	120		
	Tungsten and insoluble Tungsten compounds (calculated as W)	–	5		
	Tungsten compounds, soluble (calculated as W)	–	1		
1330-20-7	Xylene (all isomers)	25	108	HE	
108-38-3	m-Xylene	25	108	HE	
106-42-3	p-Xylene	25	108	HE	
95-47-6	o-Xylene	25	108	HE	
1477-55-0	m-Xylene-α-,α-Diamine)	–	0.1	T	
	Xylidine (all isomers)	1	5	H	
7440-65-5	Yttrium	–	1		
	Zirconium compounds (calculated as Zr)	–	5		

Footnotes

1 The limit value is set equal to the value for nuisance dust.

2 In agriculture, a limit value equal to 20 ppm is applicable during a transitional period (2013–2024) for livestock production in older farm buildings (farm buildings erected before 2002).

3 The limit value applies to raw cotton of less than 15 µm.

4 The short-term value for diisocyanates is 0.01 ppm.

5 The limit value is based on the calculated aggregate sum of the gaseous and particulate (aerosol) form of the substance.

6 Short-term exposure should not exceed 100 ppm. If such values can occur, written instructions shall be prepared for work in CO atmospheres.

7 Dust containing α-Quartz, Cristobalite and/or Tridymite shall be assessed on the basis of the summation equation. At the same time, the values for nuisance dust must be must be complied with.

8 Measurements of compliance with this biological limit value is conditional on voluntary cooperation by employees.

9 The limit value for flour dust is set equal to the value for inhalable dust.

10 The short-term value is below the odour threshold.

11 By 'mineral wool' is meant glass wool (except thin glass fibres for special purposes), rock wool and slag wool.

12 Some undertakings will be unable to comply with this value for technical/financial reasons. These undertakings are responsible for documenting a sound working environment. Such undertakings are required to have or be affiliated to an occupational health service, and their employees shall undergo regular medical examinations.

13 The limit value applies to particulate PAH collected by filtration and is based on the sum of the following 21 PAH compounds: Anthracene (3), Benzo(a)anthracene (2A), benzo[a]fluorene (3), benzo[b]fluorene (3), benzo[b]fluoranthene (2A), benzo[j] fluoranthene (2A), benzo[k]fluoranthene (2A), Benzo[a]pyrene (1), Benzo[e]pyrene (3), benzo[ghi]perylene (3), dibenzo[a,h])anthracene (2A), dibenzo[a,e]pyrene (3), dibenzo[a,h]pyrene (2A), dibenzo[a,i]pyrene (2A), dibenzo[a,l]pyrene (2A), phenanthrene (3), fluoranthene (3), indeno((1,2,3-cd)pyrene (2B), Chrysen (2A), Pyrene (3) and triphenylene (3).

14 Naphthalene and Biphenyl are gaseous PAHs that have accumulated in the absorbent. These two substances shall be assessed separately in relation to the respective limit values that apply to each of them.

15 Welding/metal fumes contain different substances. In addition to the limit value for welding fumes (unspecified), the value for each individual substance in the welding fumes shall be complied with.

16 The limit value applies to the inhalable fraction of the wood dust. If dust from hardwoods is mixed with other wood dust, the limit value shall apply to all wood dust that is present in the mixture.

17 These fibres correspond to 'Special-purpose glass fibres' in the International Agency for Research on Cancer (IARC) monographs on the evaluation of carcinogenic risks to humans. Man-made vitreous fibres 2002: Vol 81. http://monographs.iarc.fr/ENG/Monographs/vol81/ volume81.pdf

Annex 2: List of classified biological agents (infection risk groups)

Micro-organisms shall be classified into four risk groups, according to their level of risk of infection:

a) *Infection risk group 1*: a biological agent that is unlikely to cause infectious disease in humans.
b) *Infection risk group 2*: a biological agent that can cause infectious disease in humans and might be a hazard to employees; it is unlikely to spread to the community; there is usually effective prophylaxis or treatment available.
c) *Infection risk group 3*: a biological agent that can cause severe infectious disease in humans and present a serious hazard to employees; it may present a risk of spreading to the community, but there is usually effective prophylaxis or treatment available.
d) *Infection risk group 4*: a biological agent that causes severe infectious disease in human and is a serious hazard to employees; it may present a high risk of spreading to the community; there is usually no effective prophylaxis or treatment available.

The list is limited to biological agents that cause infectious disease in humans. In addition, the list provides an overview of the following comments:

– A: may cause allergic reactions
– D: Registers of employees who are exposed to the biological agent shall be stored for at least ten years after the most recently known exposure event
– T: Induces the formation of toxins, may cause toxic reactions
– V: Effective vaccine available

	Infection risk group	***Comment***
Actinobacillus actinomycetemcomitans	2	
Actinomadura madurae	2	
Actinomadura pelletieri	2	
Actinomyces gerencseriae	2	
Actinomyces israelii	2	
Actinomyces pyogenes	2	
Actinomyces spp. [1]	2	
Arcanobacterium haemolyticum (Corynebacterium haemolyticum)	2	
Bacillus anthracis	3	
Bacteroides fragilis	2	
Bartonella bacilliformis	2	
Bartonella (Rochalimea) spp. [1]	2	
Bordetella bronchiseptica	2	
Bordetella parapertussis	2	
Bordetella pertussis	2	V
Borrelia burgdorferi	2	
Borrelia duttonii	2	
Borrelia recurrentis	2	
Borrelia spp. [1]	2	
Brucella abortus	3	
Brucella canis	3	

	Infection risk group	*Comment*
Brucella melitensis	3	
Brucella suis	3	
Burkholderia mallei (Pseudomonas mallei)	3	
Burkholderia pseudomallei (Pseudomonas pseudomallei)	3	
Campylobacter fetus	2	
Campylobacter jejuni	2	
Campylobacter spp. [1]	2	
Cardiobacterium hominis	2	
Chlamydia pneumoniae	2	
Chlamydia trachomatis	2	
Chlamydia psittaci (avian strains)	3	
Chlamydia psittaci (other strains)	2	
Clostridium botulinum	2	T
Clostridium perfringens	2	
Clostridium tetani	2	T, V
Clostridium spp. [1]	2	
Corynebacterium diphtheriae	2	T, V
Corynebacterium minutissimum	2	
Corynebacterium pseudotuberculosis	2	
Corynebacterium spp. [1]	2	
Coxiella burnetii	3	
Edwardsiella tarda	2	

	Infection risk group	*Comment*
Ehrlichia sennetsu (Rickettsia sennetsu)	2	
Ehrlichia spp. [1]	2	
Eikenella corrodens	2	
Enterobacter aerogenes/cloacae	2	
Enterobacter spp. [1]	2	
Enterococcus spp. [1]	2	
Erysipelothrix rhusiopathiae	2	
Escherichia coli [2]	2	
Escherichia coli, verocytotoxic strains e.g. O157:H7 or O103	3 [3]	T
Flavobacterium meningosepticum	2	
Fluoribacter bozemanae (Legionella)	2	
Francisella tularensis (Type A)	3	
Francisella tularensis (Type B)	2	
Fusobacterium necrophorum	2	
Gardnerella vaginalis	2	
Haemophilus ducreyi	2	
Haemophilus influenzae	2	V
Haemophilus spp. [1]	2	
Helicobacter pylori	2	
Klebsiella oxytoca	2	
Klebsiella pneumoniae	2	
Klebsiella spp. [1]	2	

	Infection risk group	*Comment*
Legionella pneumophila	2	
Legionella spp. [1]	2	
Leptospira interrogans (all serotypes)	2	
Listeria monocytogenes	2	
Listeria ivanovii	2	
Morganella morganii	2	
Mycobacterium africanum	3	V
Mycobacterium avium/intracellulare	2	
Mycobacterium bovis (except BCG strains)	3	V
Mycobacterium chelonae	2	
Mycobacterium fortuitum	2	
Mycobacterium kansasii	2	
Mycobacterium leprae	3	
Mycobacterium malmoense	2	
Mycobacterium marinum	2	
Mycobacterium microti	3 [3]	
Mycobacterium paratuberculosis	2	
Mycobacterium scrofulaceum	2	
Mycobacterium simiae	2	
Mycobacterium szulgai	2	
Mycobacterium tuberculosis	3	V
Mycobacterium ulcerans	3 [3]	
Mycobacterium xenopi	2	

	Infection risk group	*Comment*
Mycoplasma caviae	2	
Mycoplasma hominis	2	
Mycoplasma pneumoniae	2	
Neisseria gonorrhoeae	2	
Neisseria meningitidis	2	V
Nocardia asteroides	2	
Nocardia brasiliensis	2	
Nocardia farcinica	2	
Nocardia nova	2	
Nocardia otitidiscaviarum	2	
Pasteurella multocida	2	
Pasteurella spp. [1]	2	
Peptostreptococcus anaerobius	2	
Plesiomonas shigelloides	2	
Porphyromonas spp. [1]	2	
Prevotella spp. [1]	2	
Proteus mirabilis	2	
Proteus penneri	2	
Proteus vulgaris	2	
Providencia alcalifaciens	2	
Providencia rettgeri	2	
Providencia spp. [1]	2	
Pseudomonas aeruginosa	2	

	Infection risk group	*Comment*
Rhodococcus equi	2	
Rickettsia akari	3 [3]	
Rickettsia canada	3 [3]	
Rickettsia conorii	3	
Rickettsia montana	3 [3]	
Rickettsia typhi (mooseri)	3	
Rickettsia prowazekii	3	
Rickettsia rickettsii	3	
Rickettsia tsutsugamushi	3	
Rickettsia spp. [1]	2	
Bartonella quintana (Rochalimaea quintana)	2	
Salmonella arizonae	2	
Salmonella enteritidis	2	
Salmonella typhimurium	2	
Salmonella paratyphi A, B, CC	2	
Salmonella typhi	3 [3]	V
Salmonella (other serotypes)	2	
Serpulina spp. [1]	2	
Shigella boydii	2	
Shigella dysenteriae (Type 1)	3 [3]	T
Shigella dysenteriae (except Type 1)	2	
Shigella flexneri	2	
Shigella sonnei	2	

	Infection risk group	*Comment*
Staphylococcus aureus	2	
Streptobacillus moniliformis	2	
Streptococcus pneumoniae	2	V
Streptococcus pyogenes	2	
Streptococcus suis	2	
Streptococcus spp. [1]	2	
Treponema carateum	2	
Treponema pallidum	2	
Treponema pertenue	2	
Treponema spp. [1]	2	
Vibrio cholerae (including El Tor)	2	V
Vibrio parahaemoloyticus	2	
Vibrio spp. [1]	2	
Yersinia enterocolitica	2	
Yersinia pestis	3	V
Yersinia pseudotuberculosis	2	
Yersinia spp. [1]	2	

Notes

1 The term 'spp.' refers to other species of the same genus known to be human pathogens.

2 With the exception of non-pathogenic strains.

3 Usually not spread by airborne transmission.

4 Hepatitis D virus infections is pathogenic in employees only in the presence of simultaneous or secondary infection caused by the hepatitis B virus. Vaccination against the hepatitis B virus will therefore protect employees who are not infected by the virus against the hepatitis D virus (Delta).

5 Only for types A and B.

6 Recommended for work involving direct contact with these agents.

7 Two viruses are identified: one a type of the buffalopox virus and the other a variant of the Vaccinia virus.

8 Variant of the cowpox virus.

9 Variant of the Vaccinia virus.

10 At present, there is no evidence of disease in humans caused by retroviruses of simian origin. As a precaution, containment level 3 is recommended for work involving exposure to such retroviruses.

11 There is no evidence of in humans of infections caused by the agents responsible for other TSEs than BSE in animals. The containment level used for agents in infection risk group 3 (with pertaining footnote 3) is nevertheless recommended as a precaution for laboratory work, with the exception of laboratory work involving identified Scrapie agents for which containment level 2 is sufficient.

Annex 3: Non-coherent optical radiation

The biophysically relevant exposure values to optical radiation can be determined with the formulae below. The formulae to be used depend on the range of radiation emitted by the source and the results should be compared with the corresponding exposure limit values indicated in Table 3.1. More than one exposure value and corresponding exposure limit can be relevant for a given source of optical radiation.

Numbering (a) to (o) refers to corresponding rows of Table 3.1.

a) $$H_{eff} = \int_0^t \int_{\lambda=180\ nm}^{\lambda=400\ nm} E_\lambda(\lambda,t)\cdot S(\lambda)\cdot d\lambda \cdot dt$$ (H_{eff} is only relevant in the range 180 to 400 nm)

b) $$H_{UVA} = \int_0^t \int_{\lambda=315\ nm}^{\lambda=400\ nm} E_\lambda(\lambda,t)\cdot \lambda d \cdot dt$$ (H_{UVA} is only relevant in the range 315 to 400 nm)

c), d) $$L_B = \int_{\lambda=300\ nm}^{\lambda=700\ nm} L_\lambda(\lambda)\cdot B(\lambda)\cdot d\lambda$$ (L_B is only relevant in the range 300 to 700 nm)

e), f) $$E_B = \int_{\lambda=300\ nm}^{\lambda=700\ nm} E_\lambda(\lambda)\cdot B(\lambda)\cdot d\lambda$$ (E_B is only relevant in the range 300 to 700 nm)

g)–l) $$L_R = \int_{\lambda_1}^{\lambda_2} L_\lambda(\lambda)\cdot R(\lambda)\cdot d\lambda$$ (See Table 1.1 for appropriate values of λ_1 and λ_2)

m), n) $$E_{IR} = \int_{\lambda=780\ nm}^{\lambda=3000\ nm} E_\lambda(\lambda)\cdot d\lambda$$ (E_{IR} is only relevant in the range 780 to 3000 nm)

o) $$H_{skin} = \int_0^t \int_{\lambda=380\ nm}^{\lambda=3000\ nm} E_\lambda(\lambda,t)\cdot \lambda d \cdot dt$$ (H_{skin} is only relevant in the range 380 to 3000 nm)

For the purposes of these regulations, the formulae above can be replaced by the following expressions and the use of discrete values as set out in the following tables:

a) $E_{eff} = \sum_{\lambda=180\ nm}^{\lambda=400\ nm} E\lambda \cdot S(\lambda) \cdot \Delta\lambda$ and ($H_{eff} = E_{eff} \cdot \Delta t$)

b) $E_{UVA} = \sum_{\lambda=315\ nm}^{\lambda=400\ nm} E\lambda \cdot \Delta\lambda$ and ($H_{UVA} = E_{UVA} \cdot \Delta t$)

c), d) $L_B = \sum_{\lambda=300\ nm}^{\lambda=700\ nm} L\lambda \cdot B(\lambda) \cdot \Delta\lambda$

e), f) $E_B = \sum_{\lambda=300\ nm}^{\lambda=700\ nm} E\lambda \cdot B(\lambda) \cdot \Delta\lambda$

g)–l) $L_R = \sum_{\lambda_1}^{\lambda_2} L\lambda \cdot R(\lambda) \cdot \Delta\lambda$ (See Table 1.1 for appropriate values of λ_1 and λ_2)

m), n) $E_{IR} = \sum_{\lambda=780\ nm}^{\lambda=3000\ nm} E\lambda \cdot \Delta\lambda$

o) $E_{skin} = \sum_{\lambda=380\ nm}^{\lambda=3000\ nm} E\lambda \cdot \Delta\lambda$ and ($H_{skin} = E_{skin} \cdot \Delta t$)

Notes:

$E\lambda$ (λ,t), $E\lambda$	*spectral irradiance or spectral power density*: the radiant power incident per unit area upon a surface, expressed in watts per square metre per nanometre [Wm^{-2} nm-1]; [Wm^{-2} nm^{-1}]; values of $E\lambda$ (λ, t) and E_{λ} come from measurements or may be provided by the manufacturer of the equipment;
E_{eff}	*effective irradiance (UV range)*: calculated irradiance within the UV wavelength range 180 to 400 nm spectrally weighted by S (λ); expressed in watts per square metre [Wm^{-2}];
H	*radiant exposure*: the time integral of the irradiance, expressed in joules per square metre (Jm^{-2});
H_{eff}	effective radiant exposure: radiant exposure spectrally weighted by S (λ), expressed in joules per square metre [Jm^{-2}];
E_{UVA}	*total irradiance (UVA)*: calculated irradiance within the UVA wavelength range 315 to 400 nm, expressed in watts per square metre [Wm^{-2}];
H_{UVA}	*radiant exposure*: the time and wavelength integral or sum of the irradiance within the UVA wavelength range 315 to 400 nm, expressed in joules per square metre [Jm^{-2}];
S (λ)	*spectral weighting*: taking into account the wavelength dependence of the health effects of UV radiation on eye and skin (Table 1.2) [dimensionless];
t, Δt	*time, duration of the exposure*, expressed in seconds [s];
λ	*wavelength*, expressed in nanometres [nm];
$\Delta\lambda$	*bandwidth*: expressed in nanometres [nm], of the calculation or measurement intervals;
$L\lambda$ (λ), L_{λ}	spectral radiance of the source expressed in watts per square metre per steradian per nanometre [W m^{-2} sr^{-1} nm^{-1}];

$R(\lambda)$ *spectral weighting*: taking into account the wavelength dependence of the thermal injury caused to the eye by visible and IRA radiation (Table 1.3) [dimensionless];

L_R *effective radiance (thermal injury)*: calculated radiance spectrally weighted by R (λ) (λ), expressed in watts per square metre per steradian [Wm^{-2} sr^{-1}];

$B(\lambda)$ *spectral weighting*: taking into account the wavelength dependence of the photochemical injury caused to the eye by blue light radiation (Table 1.3) [dimensionless];

L_R *effective radiance (blue light)*: calculated radiance spectrally weighted by R (λ) (λ), expressed in watts per square metre per steradian [Wm^{-2} sr^{-1}];

E_B *effective irradiance (blue light)*: calculated irradiance, spectrally weighted by B (λ), expressed in watts per square metre [Wm^{-2}];

E_{IR} *total irradiance (thermal injury)*: calculated irradiance within the infrared wavelength range 780 nm to 3 000 nm expressed in watts per square metre [Wm^{-2}];

E_{skin} *total irradiance (visible, IRA and IRB)*: calculated irradiance within the visible and infrared wavelength range 380 nm to 3 000 nm, expressed in watts per square metre [Wm^{-2}];

H_{skin} radiant exposure: the time and wavelength integral or sum of the irradiance within the visible and infrared wavelength range 380 to 3 000 nm, expressed in joules per square metre [Jm^{-2}];

α *angular subtense*: the angle subtended by an apparent source, as viewed at a point in space, expressed in milliradians (mrad). Apparent source is the real or virtual object that forms the smallest possible retinal image.

Table 3.1. Exposure limit values for non-coherent optical radiation

Index	Wavelength nm	Exposure limit value	Unit	Comment	Part of the body	Hazard
a.	180–400 (UVA, UVB and UVC)	H_{eff} = 30 Daily value 8 hours	[J m^{-2}]		Eye: retina conjuctiva lens Skin:	photokeratitis cataractogenesis erythema elastosis skin cancer
b.	315 – 400 (UVA)	$H_{UVA} = 10^4$ Daily value 8 hours	[J m^{-2}]		Eye: lens	cataractogenesis
c.	300–700 (Blue light) *see note 1*	$(L_B = (10^6)/(t))$ for t ≤ 10 000 s	L_B: [W m^{-2} sr^{-1}] t: [seconds]	for α ≥ 11 mrad	Eye: retina	photoretinitis
d.	300 – 700 (Blue light) *see note 1*	L_B = 100 for t > 10 000 s	[W m^{-2} sr^{-1}]			
e.	300–700 (Blue light) *see note 1*	$(E_B = (100)/(t))$ for t ≤ 10 000 s	E_B: [W m^{-2}] t: [seconds]	for α < 11 mrad *see note 2*		
f.	300–700 (Blue light) *see note 1*	E_B = 0.01 t >10 000 s	[W m^{-2}]			
g.	380–1400 (Visible and IRA)	$L_R = (2{,}8 \cdot 10^7)/(C_\alpha)$ for t > 10 s	[W m^{-2} sr^{-1}]	C_α = 1,7 for α ≤ 1,7 mrad C_α = α for 1,7 ≤ α ≤ 100 mrad C_α = 100 for α > 100 mrad λ_1 = 380; λ_2 = 1400	Eye: retina	retinal burn
h.	380–1400 (Visible and IRA)	$L_R = (5 \cdot 10^7)/(C_\alpha t^{0,25})$ for 10 μs ≤ t ≤ 10 s	L_R: [W m^{-2} sr^{-1}] t: [seconds]			
i.	380–1400 (Visible and IRA)	$L_R = (8{,}89 \cdot 10^8)/(C_\alpha)$ for t <10 μs	[W m^{-2} sr^{-1}]			

Index	Wavelength nm	Exposure limit value	Unit	Comment	Part of the body	Hazard
j.	780–1400 (IRA)	$L_R = (6 \cdot 10^6)/(C_\alpha)$ for $t > 10$ s	[W m^{-2} sr^{-1}]	$C_\alpha = 11$ for $\alpha \leq 11$ mrad $C_\alpha = \alpha$ for $11 \leq \alpha \leq 100$ mrad $C_\alpha = 100$ for $\alpha > 100$ mrad (measurement field-of-view: 11 mrad) $\lambda_1 = 780$; $\lambda_2 = 1400$	Eye: retina	retinal burn
k.	780–1400 (IRA)	$L_R = (5 \cdot 10^7)/(C_\alpha\, t^{0,25})$ for 10 µs ≤ t ≤ 10 s	LR: [W m^{-2} sr^{-1}] t: [seconds]			
l.	780–1 400 (IRA)	$L_R = (8.89 \cdot 10^8)/(C_\alpha)$ for $t < 10$ µs	[W m^{-2} sr^{-1}]			
m.	780–3 000 (IRA and IRB)	$E_{IR} = 18\,000\ t^{-0,75}$ for $t \leq 1000$ s	E: [W m^{-2}] t: [seconds]		Eye: cornea Lens	corneal burn cataractogenesis
n.	780–3 000 (IRA and IRB)	$E_{IR} = 100$ for $t > 1\,000$ s	[W m^{-2}]			
o.	380–3 000 (Visible, IRA) and IRB)	$H_{skin} = 20\,000\ t^{0,25}$ for $t < 10$ s	H: [J m^{-2}] t: [seconds]		Skin:	burn

Note 1:
The range of 300 to 700 nm covers parts of UVB, all UVA and most of visible radiation; however, the associated hazard is commonly referred to as 'blue light' hazard. Blue light strictly speaking covers only the range of approximately 400 to 490 nm.

Note 2:
For steady fixation of very small sources with an angular subtense < 11 mrad, L_B can be converted to E_B. This normally applies only to ophthalmic instruments or a stabilised eye during anaesthesia. The maximum 'stare time' is found by: $t_{max} = 100/EB$, where E_B is expressed in W m^{-2}. Due to eye movements during normal visual tasks this does not exceed 100 s.

Table 3.2. S (λ) [dimensionless], 180 nm to 400 nm

λ *in nm*	*S (λ)*	λ *in nm*	*S (λ)*	λ *in nm*	*S (λ)*	λ *in nm*	*S (λ)*
180	0.0120	211	0.0786	242	0.3227	273	0.9758
181	0.0126	212	0.0824	243	0.3347	274	0.9679
182	0.0132	213	0.0864	244	0.3471	275	0.9600
183	0.0138	214	0.0906	245	0.3600	276	0.9434
184	0.0144	215	0.0950	246	0.3730	276	0.9434
185	0.0151	216	0.0995	247	0.3865	277	0.9272
186	0.0158	217	0.1043	248	0.4005	278	0.9112
187	0.0166	218	0.1093	249	0.4150	279	0.8954
188	0.0173	219	0.1145	250	0.4300	280	0.8800
189	0.0181	220	0.1200	251	0.4465	281	0.8568
190	0.0190	221	0.1257	252	0.4637	282	0.8342
191	0.0199	222	0.1316	253	0.4815	283	0.8122
192	0.0208	223	0.1378	254	0.5000	284	0.7908
193	0.0218	224	0.1444	255	0.5200	285	0.7700
194	0.0228	225	0.1500	256	0.5437	286	0.7420
195	0.0239	226	0.1583	257	0.5685	287	0.7151
196	0.0250	227	0.1658	258	0.5945	288	0.6891
197	0.0262	228	0.1737	259	0.6216	289	0.6641
198	0.0274	229	0.1819	260	0.6500	290	0.6400
199	0.0287	230	0.1900	261	0.6792	291	0.6186
200	0.0300	231	0.1995	262	0.7098	292	0.5980
201	0.0334	232	0.2089	263	0.7417	293	0.5780
202	0.0371	233	0.2188	264	0.7751	294	0.5587
203	0.0412	234	0.2292	265	0.8100	295	0.5400
204	0.0459	235	0.2400	266	0.8449	296	0.4984
205	0.0510	236	0.2510	267	0.8812	297	0.4600
206	0.0551	237	0.2624	268	0.9192	298	0.3989
207	0.0595	238	0.2744	269	0.9587	299	0.3459
208	0.0643	239	0.2869	270	1.0000	300	0.3000
209	0.0694	240	0.3000	271	0.9919	301	0.2210
210	0.0750	241	0.3111	272	0.9838	302	0.1629

λ *in nm*	*S (λ)*	λ *in nm*	*S (λ)*	λ *in nm*	*S (λ)*	λ *in nm*	*S (λ)*
303	0.1200	328	0.000440	353	0.000175	378	0.000069
304	0.0849	329	0.000425	354	0.000167	379	0.000066
305	0.0600	330	0.000410	355	0.000160	380	0.000064
306	0.0454	331	0.000396	356	0.000153	381	0.000062
307	0.0344	332	0.000383	357	0.000147	382	0.000059
308	0.0260	333	0.000370	358	0.000141	383	0.000057
309	0.0197	334	0.000355	359	0.000136	384	0.000055
310	0.0150	335	0.000340	360	0.000130	385	0.000053
311	0.0111	336	0.000327	361	0.000126	386	0.000051
312	0.0081	337	0.000315	362	0.000122	387	0.000049
313	0.0060	338	0.000303	363	0.000118	388	0.000047
314	0.0042	339	0.000291	364	0.000114	389	0.000046
315	0.0030	340	0.000280	365	0.000110	390	0.000044
316	0.0024	341	0.000271	366	0.000106	391	0.000042
317	0.0020	342	0.000263	367	0.000103	392	0.000041
318	0.0016	343	0.000255	368	0.000099	393	0.000039
319	0.0012	344	0.000248	369	0.000096	394	0.000037
320	0.0010	345	0.000240	370	0.000093	395	0.000036
321	0.000819	346	0.000231	371	0.000090	396	0.000035
322	0.000670	347	0.000223	372	0.000086	397	0.000033
323	0.000540	348	0.000215	373	0.000083	398	0.000032
324	0.000520	349	0.000207	374	0.000080	399	0.000031
325	0.000500	350	0.000200	375	0.000077	400	0.000030
326	0.000479	351	0.000191	376	0.000074		
327	0.000459	352	0.000183	377	0.000072		

Table 3.3. B (λ), R (λ) [dimensionless], 380 nm to1400 nm

λ *in nm*	*B (λ)*	*R (λ)*
300 ≤ λ < 380	0.01	-
380	0.01	0.1
385	0.013	0.13
390	0.025	0.25
395	0.05	0.5
400	0.1	1
405	0.2	2
410	0.4	4
415	0.8	8
420	0.9	9
425	0.95	9.5
430	0.98	9.8
435	1	10
440	1	10
445	0.97	9.7
450	0.94	9.4
455	0.9	9
460	0.8	8
465	0.7	7
470	0.62	6.2
475	0.55	5.5
480	0.45	4.5
485	0.32	3.2
490	0.22	2.2
495	0.16	1.6
500	0.1	1
500 < λ ≤ 600	$10^{0,02 \cdot (450-\lambda)}$	1
600 < λ ≤ 700	0.001	1
700 < λ ≤ 1050	–	$10^{0,002 \cdot (700-\lambda)}$
1050 < λ ≤ 1150	–	0.2
1150 < λ ≤ 1200	–	$0.2 \cdot 10^{0,02 \cdot (1150-\lambda)}$
1200 < λ ≤ 1400	–	0.02

Annex 4: Optical radiation from lasers

The biophysically relevant exposure values to optical radiation can be determined with the formulae below. The formulae to be used depend on the wavelength and duration of radiation emitted by the source and the results should be compared with the corresponding exposure limit values indicated in Tables 4.2 to 4.4. More than one exposure value and corresponding exposure limit can be relevant for a given source of laser optical radiation.

Coefficients used as calculation tools within Tables 4.2 to 4.4 are listed in Table 4.5 and corrections for repetitive exposure are listed in Table 4.6.

$$E = \frac{dP}{dA}[W\ m^{-2}]$$

$$H = \int_0^t E(t) \cdot dt[J\ m^{-2}]$$

Notes

dP	*power*, expressed in watts [W];
dA	*surface*, expressed in square metres [m^2];
E(t), E	*irradiance or power density*, the radiant power density per unit area upon a surface, generally expressed in watts per square metre (Wm^{-2}). Values of E(t), E come from measurements or may be provided by the manufacturer of the equipment;
H	*radiant exposure*: the time integral of the irradiance, expressed in joules per square metre (Jm^{-2});
t	*time, duration of the exposure*, expressed in seconds [s];
λ	*wavelength*, expressed in nanometres [nm];
γ	*limiting cone angle of measurement in field-of-view*, expressed in milliradians [mrad];
γ_m	*measurement field of view*, expressed in milliradians [mrad];
α	*angular subtense of a source*, expressed in milliradians [mrad]; limiting aperture the circular area over which irradiance and radiant exposure are averaged;
G	*integrated radiance*: the integral of the radiance over a given exposure time expressed as radiant energy per unit area of a radiating surface per unit solid angle of emission, in joules per square metre per steradian [$Jm^{-2}\ sr^{-1}$].

Table 4.1 Radiation hazards

Wavelength [nm] λ	***Radiation range***	***Affected organ***	***Hazard***	***Exposure limit value table***
180 to 400	UV	Eye	photochemical damage and thermal damage	4.2, 4.3
180 to 400	UV	Skin	erythema	4.4
400 to 700	visible	Eye	Retinal damage	4.2
400 to 600	visible	Eye	photochemical damage	4.3
400 to 700	visible	Skin	thermal damage	4.4
700 to 1400	IRA	Eye	thermal damage	4.2, 4.3
700 to 1400	IRA	Skin	thermal damage	4.4
1400 to 2600	IRB	Eye	thermal damage	4.2
2600 to 10 6	IRC	Eye	thermal damage	4.2
1400 to 10 6	IRB, IRC	Eye	thermal damage	4.3
1400 to 10 6	IRB, IRC	Skin	thermal damage	4.4

Table 4.2 Exposure limit values for laser exposure to the eye – Short exposure duration < 10 s

Wavelength[a] [nm]		Aperture	Duration [s]						
			$10^{-13} – 10^{-11}$	$10^{-11} – 10^{-9}$	$10^{-9} – 10^{-7}$	$10^{-7} – 1{,}8 \cdot 10^{-5}$	$1{,}8 \cdot 10^{-5} – 10^{-3}$	$5 \cdot 10^{-5} – 10^{-3}$	$10^{-3} – 10^{-1}$
UVC	180–280	1 mm for t < 0.3 s; $1.5 \cdot t^{0.375}$ for 0.3 < t < 10 s	$E = 3 \cdot 10^{10} \cdot [W\,m^{-2}]$ (c)		$H = 30\ [J\,m^{-2}]$				
UVB	280–302								
	303				$H = 40\ [J\,m^{-2}]$; if $t < 2.6 \cdot 10^{-9}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				
	304				$H = 60\ [J\,m^{-2}]$; if $t < 1.3 \cdot 10^{-8}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				
	305				$H = 100\ [J\,m^{-2}]$; if $t < 1.0 \cdot 10^{-7}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				
	306				$H = 160\ [J\,m^{-2}]$; if $t < 6.7 \cdot 10^{-7}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				
	307				$H = 250\ [J\,m^{-2}]$; if $t < 4.0 \cdot 10^{-6}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				
	308				$H = 400\ [J\,m^{-2}]$; if $t < 2.6 \cdot 10^{-5}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				
	309				$H = 630\ [J\,m^{-2}]$; if $t < 1.6 \cdot 10^{-4}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				
	310				$H = 10^3\ [J\,m^{-2}]$; if $t < 1.0 \cdot 10^{-3}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				
	311				$H = 1.6 \cdot 10^3\ [J\,m^{-2}]$; if $t < 6.7 \cdot 10^{-3}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				
	312				$H = 2.5 \cdot 10^3\ [J\,m^{-2}]$; if $t < 4.0 \cdot 10^{-2}$ then $H = 5.6 \cdot 10^3\ t^{0.25}\ [J\,m^{-2}]$ (d)				

(contd.)	313	*(contd.)*	*(contd.)*		$H = 4.0 \cdot 10^3$ [J m^{-2}]; if $t < 2.6 \cdot 10^{-1}$ then $H = 5.6 \cdot 10^3\ t^{0,25}$ [J m^{-2}] (d)	
	314				$H = 6{,}3 \cdot 10^3$ [J m^{-2}]; if $t < 1.6 \cdot 10^0$ then $H = 5.6 \cdot 10^3\ t^{0.25}$ [J m^{-2}] (d)	
UVA	315–400				$H = 5.6 \cdot 10^3\ t^{0,25}$ [J m^{-2}]	
Visible and IR-A	400–700	7 mm	$H = 1.5 \cdot 10^{-4}$ C_E [J m^{-2}]	$H = 2.7 \cdot 10^4$ $t^{0,75}$ C_E [J m^{-2}]	$H = 5 \cdot 10^{-3}\ C_E$ [J m^{-2}]	$H = 18 \cdot t^{0,75}\ C_E$ [J m^{-2}]
	700–1050		$H = 1.5 \cdot 10^{-4}$ $C_A\ C_E$ [J m^{-2}]	$H = 2.7 \cdot 10^4$ $t^{0,75}\ C_A\ C_E$ [J m^{-2}]	$H = 5 \cdot 10^{-3}\ C_A\ C_E$ [J m^{-2}]	$H = 18 \cdot t^{0,75}\ C_A\ C_E$ [J m^{-2}]
	1050–1400		$H = 1{,}5 \cdot 10^{-3}$ $C_C\ C_E$ [J m^{-2}]	$H = 2{,}7 \cdot 10^5$ $t^{0,75}\ C_C\ C_E$ [J m^{-2}]	$H = 5 \cdot 10^{-2}\ C_C\ C_E$ [J m^{-2}]	$H = 90 \cdot t^{0,75}\ C_C\ C_E$ [J m^{-2}]
IR-B and IR-C	1400–1500	See c	$E = 10^{12}$ [W m^{-2}] See c		$H = 10^3$ [J m^{-2}]	$H = 5.6 \cdot 10^3 \cdot t^{0,25}$ [J m^{-2}]
	1500–1800		$E = 10^{13}$ [W m^{-2}] See c		$H = 10^4$ [J m^{-2}]	
	1800–2600		$E = 10^{12}$ [W m^{-2}] See c		$H = 10^3$ [J m^{-2}]	$H = 5.6 \cdot 10^3 \cdot t^{0,25}$ [J m^{-2}]
	2600–106		$E = 10^{11}$ [W m^{-2}] See c		$H = 100$ [J m^{-2}]	$H = 5.6 \cdot 10^3 \cdot t^{0,25}$ [J m^{-2}]

a. If the wavelength of the laser is covered by two limits, then the more restrictive applies.

b. When $1400 \le \lambda < 105$ nm: aperture diameter = 1 mm for $t \le 0{,}3$ s og $1{,}5\ t^{0,375}$ mmfor 0.3 s < t < 10 s; when $10^5 \le \lambda < 10^6$ m: aperture diameter = 11 mm.

c. Due to the lack of data at these pulse lengths, ICNIRP recommends the use of the 1 ns irradiance limits.

d. The table states values for single laser pulses. In case of multiple laser pulses, the sum of the laser pulse durations falling within an interval of T_{min} (see Table 4.6) shall be entered in the equation $5.6\ 10^3\ t^{0.25}$.

Table 4.3. Exposure limit values for laser exposure to the eye – Long exposure duration ≥ 10 s

Wave length[a] [nm]		Aperture	Duration [s]		
			$10^1 – 10^2$	$10^2 – 10^4$	$10^4 – 3 \cdot 10^4$
UVC	180–280	3.5 mm	$H = 30$ [J m^{-2}]		
UVB	280–302		$H = 30$ [J m^{-2}]		
	303		$H = 40$ [J m^{-2}]		
	304		$H = 60$ [J m^{-2}]		
	305		$H = 100$ [J m^{-2}]		
	306		$H = 160$ [J m^{-2}]		
	307		$H = 250$ [J m^{-2}]		
	308		$H = 400$ [J m^{-2}]		
	309		$H = 630$ [J m^{-2}]		
	310		$H = 1.0 \cdot 10^3$ [J m^{-2}]		
	311		$H = 1.6 \cdot 10^3$ [J m^{-2}]		
	312		$H = 2.5 \cdot 10^3$ [J m^{-2}]		
	313		$H = 4.0 \cdot 10^3$ [J m^{-2}]		
	314		$H = 6.3 \cdot 10^3$ [J m^{-2}]		
UVA	315–400		$H = 10^4$ [J m^{-2}]		

E = 1	400–600 Photochemical[b] Retinal damage	7 mm	$H = 100\ C_B$ $[J\ m^{-2}]$ (γ= 11 mrad)[d]	$E = 1\ C_B$ $[W\ m^{-2}]$; ($\gamma = 1{,}1\ t^{0,5}$ mrad)[d]	$E = 1\ C_B$ $[W\ m^{-2}]$ (γ = 110 mrad)[d]
	400–700 Thermal[b] Retinal damage		If $\alpha < 1.5$ mrad then $E = 10\ [W\ m^{-2}]$ If $\alpha > 1.5$ mrad and $t \le T_2$ then $H = 18\ C_E\ t^{0.75}\ [J\ m^{-2}]$ If $\alpha > 1.5$ mrad and $t > T_2$ then $E = 18\ C_E\ T_2^{-0.25}\ [W\ m^{-2}]$		
IRA	700–1400	7 mm	If $\alpha < 1.5$ mrad then $E = 10\ C_A\ C_C\ [W\ m^{-2}]$ If $\alpha > 1.5$ mrad and $t \le T_2$ then $H = 18\ C_A\ C_C\ C_E\ t^{0.75}\ [J\ m^{-2}]$ If $\alpha > 1.5$ mrad and $t > T_2$ then $E = 18\ C_A\ C_C\ C_E\ T_2^{-0.25}\ [W\ m^{-2}]$ (must not exceed 1000 W m^{-2})		
IRB and IRC	$1400–10^6$	See c	$E = 1000\ [W\ m^{-2}]$		

a. If the wavelength or another condition of the laser is covered by two limits, then the more restrictive applies.

b. For small sources subtending an angle of 1.5 mrad or less, the visible dual limits E from 400 mm to 600 mm reduce the thermal hazard limits for $10\ s \le t < T_1$, and to photochemical limits for longer times. For T_1 and T_2, see Table 4.5. The photochemical retinal hazard limit may also be expressed as a time integrated radiance $G = 10^6\ C_B\ [J\ m^{-2}\ sr^{-1}$ for t > 10s up to 10,000 s and $L = 100\ C_B\ [W\ m^{-2}\ sr^{-2}]$ for t > 10 000 s. For the measurement of G and L γm must be used as averaging field of view. The official border between visible and infrared is 780 nm as defined by the CIE. The column with wavelength band names is only meant to provide a better overview for the user. (The notation G is used by CIE, the notation L_t is used by CIE, the notation L_p is used by IEC and CENELEC).

c. For wavelengths $1{,}400–10^5$ nm: aperture diameter = 3.5 mm; for wavelengths $10^5–10^6$ nm: aperture diameter = 11 mm.

d. For measurements of the exposure value the consideration of γ is defined as follows: If α (angular subtense of a source) > γ (limited cone angle, indicated in brackets in the corresponding column) then the measurement field of view γ_m should be given the value of γ. If a larger measurement field of view is used, then the hazard would be overestimated. If $\alpha < \gamma$ then the measurement field of view γ_m must be large enough to fully enclose the source, but is otherwise not limited and may be larger than γ.

Table 4.4. Exposure limit values for laser exposure of skin

Wavelength[a] [nm]		Aperture	Duration [s]					
			$< 10^{-9}$	10^{-9}–10^{-7}	10^{-7}–10^{-3}	10^{-3}–10^{1}	10^{1}–10^{3}	10^{3}–$3 \cdot 10^{4}$
UV (A, B, C)	180–400	3.5 mm	$E = 3 \cdot 10^{10}$ [W m^{-2}]	Same as eye exposure limits				
Visible and IRA	400–700	3.5 mm	$E = 2 \cdot 10^{11}$ [W m^{-2}]	$H = 200$ C_A [Jm^{-2}]	$H = 1{,}1 \cdot 10^{4}\ C_A\ t^{0,25}$ [J m^{-2}]		$E = 2 \cdot 10^{3}\ C_A$ [W m^{-2}]	
	700–1400		$E = 2 \cdot 10^{11}\ C_A$ [Wm^{-2}]					
IRB and IRC	1400–1500		$E = 10^{12}$ [W m^{-2}]	Same as eye exposure limits				
	1500–1800		$E = 10^{13}$ [W m^{-2}]					
	1800–2600		$E = 10^{12}$ [W m^{-2}]					
	2600–106		$E = 10^{11}$ [Wm^{-2}]					

a If the wavelength or another condition of the laser is covered by two limits, then the more restrictive applies.

Table 4.5 Applied correction factors and other calculation parameters

Parameter as listed in ICNIRP	***Valid spectral range (nm)***	***Value***
C_A	$\lambda < 700$	$C_A = 1.0$
	700 – 1050	$C_A = 10^{0,002(\lambda-700)}$
	1050 – 1400	$C_A = 5.0$
C_B	400 – 450	$C_B = 1.0$
	450 – 700	$C_A = 10^{0,02(\lambda-450)}$
C_C	700 – 1150	$C_C = 1.0$
	1150 – 1200	$C_C = 10^{0,018(\lambda-1150)}$
	1200 – 1400	$C_C = 8,0$
T_1	$\lambda < 450$	$T_1 = 10$ s
	450 – 500	$T_1 = 10 \cdot [10^{0,02((\lambda-450)]}$ s
	$\lambda > 500$	$T_1 = 100$ s
Parameter as listed in ICNIRP	Valid for biological effect	Value
α_{min}	all thermal effects	$\alpha_{min} = 1.5$ mrad
Parameter as listed in ICNIRP	Valid angular range (mrad)	Value
C_E	$\alpha < \alpha_{min}$	$C_E = 1,0$
	$\alpha_{min} < \alpha < 100$	$C_E = \alpha/\alpha_{min}$
	$\alpha > 100$	$C_E = \alpha^2 /(\alpha_{min} \cdot \alpha_{max})$ mrad with $\alpha_{max} = 100$ mrad
T_2	$\alpha < 1.5$	$T_2 = 10$ s
	$1.5 < \alpha < 100$	$T_2 = 10 \cdot [10\ (\alpha-1,5)/98,5]$ s
	$\alpha > 100$	$T_2 = 100$ s
Γ	$t \leq 100$	$\gamma = 11$ [mrad]
	$100 < t < 10^4$	$\gamma = 1.1\ t^{0,5}$ [mrad]
	$t > 10^4$	$\gamma = 110$ [mrad]

Table 4.6 Correction for repetitive exposure

Each of the following three general rules should be applied to all repetitive exposures as occur from repetitively pulsed or scanning laser systems:

1. The exposure from any single pulse in a train of pulses shall not exceed the exposure limit value for a single pulse of that pulse duration.
2. The exposure from any group of pulses (or sub-group of pulses in a train) delivered in time t shall not exceed the exposure limit value for time t.
3. The exposure from any single pulse within a group of pulses shall not exceed the single-pulse exposure limit value multiplied by a cumulative-thermal correction factor $C_p=N^{-0.25}$, where N is the number of pulses. This rule applies only to exposure limits to protect against thermal injury, where all pulses delivered in less than T_{min} are treated as a single pulse.

Parameter	Valid spectral range (nm)	Value
T_{min}	315 < ≤ 400	$T_{min} = 10^{-9}$ s (= 1 ns)
	400 < λ ≤ 1050	$T_{min} = 18 \cdot 10^{-6}$ s (= 18 μs)
	1050 < λ ≤ 1400	$T_{min} = 50 \cdot 10^{-6}$ s (= 50 μs)
	1400 < λ ≤ 1500	$T_{min} = 10^{-3}$ s (= 1 ms)
	1500 < λ ≤ 1800	$T_{min} = 10$ s
	1800 < λ ≤ 2600	$T_{min} = 10^{-3}$ s (= 1 ms)
	2600 < λ ≤ 10^{6}	$T_{min} = 10^{-7}$ s (= 100 ns)

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