Appendix A

OSHA PERMISSIBLE EXPOSURE LIMITS

The Occupational Safety and Health Administration publishes information on various toxic and hazardous substances. Some of the information is included in this appendix. The information is often referred to as permissible exposure limits (PELs). The PELs are subject to change at any time. OSHA publishes the justification and technical support for the exposure limits in the *Federal Register*. The tables limit an employee's exposure to various substances.

Below are some notes associated with the three tables included in the OSHA standard.

To achieve compliance with these standards, administrative or engineering controls first must be determined and implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants with the prescribed limits. Any equipment and/or technical measures used for this purpose must be approved for each particular use by a competent industrial hygienist or other technically qualified person. Respirators must comply with OSHA respirator standards.

Table A-1

Only a portion of the chemicals included in OSHA Table Z-1 appear here. Readers should refer to the full table in 29 CFR 1910.1000 for a complete list of regulated chemicals. The PELs are 8-hr time-weighted averages (TWAs) unless otherwise noted. A **C** designation denotes a ceiling limit. They are to be determined from breathing-zone air samples.

*Substance with limits preceded by "**C**": Ceiling Values.* An employee's exposure to any substance shall at no time exceed the exposure limit given for that substance. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute TWA exposure which shall not be exceeded at any time during the working day.

Other substances: 8-hr TWAs. An employee's exposure to any substance that is not preceded by a **C** shall not exceed the 8-hr TWA given for that substance in any 8-hr work shift of a 40-hr work week.

Table A-2

An employee's exposure to any substance listed in OSHA Table Z-2 shall not exceed the exposure limits specified as follows:

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TABLE A-1 Limits of Air Contaminants[a]

Substance	CAS No.[b]	ppm[c]	mg/m^3[d]	Skin Designation
Acetic acid	64-19-7	10	25	
Acetone	67-64-1	1,000	2,400	
Acrolein	107-02-8	0.1	0.25	
Acrylamide	79-27-6	—	0.3	X
Allyl glycidyl ether (AGE)	106-92-3	**C** 10	**C** 45	
Ammonia	7664-06-0	50	35	
n-Amyl acetate	628-63-7	100	525	
sec-Amyl acetate	628-38-0	125	650	
Aniline and homologs	62-53-3	5	19	X
Arsine	7784-42-1	0.05	0.2	
Boron oxide	1303-86-2			
Total dust		—	15	
Boron triflouide	7637-07-2	**C** 1	**C** 3	
Bromine	7726-95-6	0.1	0.7	
Bromoform	75-25-2	0.5	5	X
2-Butanone (methyl ethyl ketone)	78-93-3	200	590	
2-Butoxyethanol	111-76-2	50	240	X
n-Butyl alcohol	71-36-3	100	300	
Butylamine	109-73-9	**C** 5	**C** 15	X
Butyl mercaptan	109-79-5	10	35	
Calcium carbonate	1317-65-3			
Total dust		—	15	
Carbon dioxide	124-38-9	5,000	9,000	
Clorine	7782-50-5	**C** 1	**C** 3	
Clorine dioxide	10049-04-4	0.1	0.3	
Chlorine triflouride	7790-91-2	**C** 0.1	**C** 0.4	
Chloroacetaldehyde	107-20-0	**C** 1	**C** 3	
Chlorobenzene	108-90-7	75	350	
Chlorobromomethane	74-97-5	200	1,050	
Chloroform (trichloromethane)	67-66-3	**C** 50	**C** 240	
Cyclohexane	110-82-7	300	1,050	
Cyclohexene	110-83-8	300	1,015	
Dichlorodiphenyltrichloroethane (DDT)	50-29-3	—	1	X
Dichloroethyl ether	111-44-4	**C** 15	**C** 90	X
Endrin	72-20-8	—	0.1	X
Ethyl acetate	141-78-6	400	1,400	
Ethyl acrylate	140-88-5	25	100	X
Ethyl ether	60-29-7	400	1,200	
Ethyl mercaptan	75-08-1	**C** 10	**C** 25	
Ethylene chlorohydrin	107-07-3	5	16	X
Ethyl acrylate	140-88-5	25	100	X
Heptane (n-heptane)	142-82-5	500	2,000	
Hexachloroethane	67-72-1	1	10	X
n-Hexane	110-54-3	500	1,800	
Hydrazine	302-01-2	1	1.3	X
Hydrogen chloride	7647-01-0	**C** 5	**C** 7	
Hydrogen cyanide	74-90-8	10	11	X
Hydrogen peroxide	7722-84-1	1	1.4	
Iodine	7553-56-2	**C** 0.1	**C** 1	
Isopropyl alcohol	67-63-0	400	980	

TABLE A-1 continued

Substance	CAS No.[b]	ppm[c]	mg/m^3[d]	Skin Designation
Lindane	58-89-9	—	0.5	X
L.P.G. (liquified petroleum gas)	68476-85-7	1,000	1,800	
Magnesite	546-93-0			
Total dust		—	15	
Respirable fraction		—	5	
Magnesium oxide fume	1309-48-4			
Total particulate		—	15	
Manganese compounds (as Mn)	7439-96-5	—	**C** 5	
Marble	1317-65-3			
Total dust		—	15	
Respirable fraction		—	5	
Methyl alcohol	67-56-1	200	260	
Methyl ethyl ketone (MEK); see 2-butanone				
Methyl formate	107-31-3	100	250	
Methyl hydrazine (monomethyl hydrazine)	60-34-4	**C** 0.2	**C** 0.35	X
Naphthalene	91-20-3	10	50	
Nicotine	54-11-5	—	0.5	X
Nitric acid	769737-2	2	5	
Nitric oxide	10102-43-9	25	30	
Nitrobenzene	98-95-3	1	5	X
Nitroglycerin	55-63-0	**C** 0.2	**C** 2	X
Paraquat, respirable dust	4685-14-7; 1910-42-5; 2074-50-2	—	0.5	X
Particulates not otherwise regulated				
Total dust		—	15	
Respirable fraction		—	5	
Phosgene (carbonyl chloride)	75-44-5	0.1	0.4	
Phosphoric acid	7664-38-2	—	1	
Phosphorus (yellow)	7723-14-0	—	0.1	
Picric acid	88-89-1	—	0.1	X
Plaster of Paris	26499-65-0			
Total dust		—	15	
Respirable fraction		—	5	
Portland cement	65997-15-1			
Total dust		—	15	
Respirable fraction		—	5	
Propane	74-98-6	1,000	1,800	
Stoddard solvent	8052-41-3	500	2,900	
Sucrose	57-50-1			
Total dust		—	15	
Respirable fraction		—	5	
Sulfur dioxide	7446-09-5	5	15	
Sulfuric acid	7664-93-9	—	1	
Tetraethyl lead (as Pb)	78-00-2	—	0.075	X
Turpentine	8006-64-2	100	560	
Xylenes (o-, m-, p-isomers)	1330-20-7	100	435	
Xylidine	1300-73-8	5	25	X

[a] This listing includes selected contaminants only. Refer to 29 CFR 1910.1000, Table Z-1, for a complete listing.
[b] The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound, measured as the metal, the CAS number for the metal is given—not CAS numbers for the individual compounds.
[c] Parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 torr.
[d] Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.

TABLE A-2 Exposure Limits from OSHA Table Z-2 (29 CFR 1910.1000)[a]

Substance	8-hr Time-Weighted Average	Acceptable Maximum Peak Above the Acceptable Ceiling Concentration for an 8-hr Shift: Acceptable Ceiling Concentration	Concentration	Maximum Duration
Benzene (Z37.40-1969)[b]	10 ppm	25 ppm	50 ppm	10 minutes
Beryllium and berylllium compounds (Z37.29-1970)	2 µg/m^3	5 µg/m^3	25 µg/m^3	30 minutes
Cadmuim fume[c]	0.1 mg/m^3	0.3 mg/m^3	—	
Cadmium dust (Z37.5-1970)[c]	0.2 mg/m^3	0.6 mg/m^3		
Carbon disulfide (Z37.3-1968)	20 ppm	30 ppm	100 ppm	30 minutes
Carbon tetrachloride (Z37.17-1967)	10 ppm	25 ppm	200 ppm	5 min in any 4 hrs
Chromic acid and chromates (Z37.7-1971)	—	1 mg/10 m^3		
Ethylene dibromide (Z37.31-1970)	20 ppm	30 ppm	50 ppm	5 minutes
Ethylene dichloride (Z37.21-1969)	50 ppm	100 ppm	200 ppm	5 min in any 3 hrs
Flouride as dust (Z37.28-1969)	2.5 mg/m^3	—	—	
Formaldehyde; see 1910.1048	—	—	—	
Hydrogen flouride (Z37.28-1969)	3 ppm	—	—	
Hydrogen sulfide (Z37.2-1966)	—	20 ppm	50 ppm	10 min once, only if no other meas. exp. occurs
Mercury (Z37.8-1971)	—	1 mg/10 m^3	—	
Methyl chloride (Z37.18-1969)	100 ppm	200 ppm	300 ppm	5 min in any 3 hrs
Methylene chloride: See §1919.52				
Organo (alkyl) mercury (Z37.30-1969)	0.1 mg/m^3	0.04 mg/m^3	—	
Styrene (Z37.15-1969)	100 ppm	200 ppm	600 ppm	5 min in any 3 hrs
Tetrachloroethylene (Z37.22-1967)	100 ppm	200 ppm	300 ppm	5 min in any 3 hrs
Toluene (Z37.12-1967)	200 ppm	300 ppm	500 ppm	10 minutes
Trichloroethylene (Z37.19-1967)	100 ppm	200 ppm	300 ppm	5 min in any 2 hrs

[a] References are to specific OSHA standards.
[b] This standard applies to the industry segments exempt from the 1 ppm 8-hr TWA and 5 ppm STEL of the benzene standard at 1910.1028.
[c] This standard applies to any operations or sectors for which the Cadmium standard, 1910.1027, is stayed or otherwise not in effect.

8-hr TWAs. An employee's exposure to any substance listed in OSHA Table Z-2 in any 8-hr work shift of a 40-hr work week shall not exceed the 8-hr TWA limit of a 40-hr work week given for that substance.

Acceptable ceiling concentration. An employee's exposure to a substance listed in Table A-2 shall not exceed at any time during an 8-hr shift the acceptable ceiling concentration limit given for the substance, except for a time period and up to a concentration not exceeding the maximum duration and concentration allowed in the column under "acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift."

Table A-3

An employee's exposure to any substance listed in OSHA Table Z-3 in any 8-hr work shift of a 40-hr work week, shall not exceed the 8-hr TWA limit given for that substance in the table.

TABLE A-3 Mineral Dusts (From 29 CFR 1910.1000 Table Z-3)

Substance	mppcf[a]	mg/m^3
Silica		
Quartz (respirable)	$\frac{250}{\%SiO_2+5}-\frac{1}{\mu}$[b]	$\frac{10\ mg/m^3}{\%SiO_2+2}$[e]
Quartz (total dust)	—	$\frac{30\ mg/m^3}{\%SiO_2+2}$
Cristobalite: use $^1/_2$ the value calculated from the count or mass formulae for quartz		
Tridymite: use $^1/_2$ the value calculated from the formulae for quartz		
Amorphous, including natural diatamaceous earth	20	$\frac{80\ mg/m^3}{\%SiO_2}$
Silicates (less than 1% crystalline silica):		
Mica	20	
Soapstone	20	
Talc (not containing asbestos)	20[c]	
Talc (containing asbestos)—use asbestos limit.		
Tremolite, asbestiform (see 29 CFR 1910.1001)		
Portland cement	50	
Graphite (natural)	15	
Coal dust		
Respirable fraction less than 5% SiO_2	—	$2.4\ mg/m^3$[e]
Respirable fraction greater than 5% SiO_2	—	$\frac{10\ mg/m^3}{\%SiO_2+2}$[e]
Insert or nuisance dust[d]		
Respirable fraction	15	$5\ mg/m^3$
Total dust	50	$15\ mg/m^3$

[a] Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.
[b] The percentage of crystalline silica in the in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.
[c] Containing less than 1% quartz; if 1% quartz or more, use quartz limit.
[d] All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are converted by this limit, which is the same as the particulates not otherwise regulated (PNOR) limit in OSHA Table Z-1.
[e] Bother concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
3.5	50
5.0	25
10	0

The measurements under this note refer to the use of an AEC (now NRC) instrument. The respirable fraction of coal dust is determined with an MRE; the figure corresponding to that of $2.4\ mg/m^3$.

Computation Formulae

The computation formula which shall apply to employee exposure to more than one substance for which 8-hr time weighted averages are listed in subpart Z of 29 CFR 1910 to determine whether an employee is exposed over the regulatory limit is as follows:

The cumulative exposure for an 8-hr work shift shall be computed as follows:

$$E = (C_a T_a + C_b T_b + \cdots C_n T_n) \div 8,$$

where

E is the equivalent exposure for the working shift,

C is the concentration during any period of time T where the concentration remains constant, and

T is the duration in hours of the exposure at the concentration C.

The value of E shall not exceed the 8-hr TWA specified in subpart Z of 29 CFR 1910 for the substance involved.