

TOXICITY

**MAXIMUM ACCEPTABLE CONCENTRATIONS
OF AIR CONTAMINANTS**

**SAFETY AND WELFARE
ENGINEERING STANDARD**

ISSUED

APRIL 1961

REVISED

S 2 T

Page 1 of 3

1. GENERAL

1.1 This Standard provides a list of maximum acceptable concentrations (MAC's) of air contaminants to provide criteria for safe Company work environments. (MAC refers to the maximum acceptable concentration of air contaminants in the atmosphere of working places from the viewpoint of occupational disease prevention.)

2. INTERPRETATION OF MAC'S

2.1 The listed MAC's are recommended values of the American Conference of Governmental Industrial Hygienists. These values are reviewed and are published annually by ACGIH, with modifications and additions, if any, to the previous list.

2.2 The MAC's should be used as guides in the control of potential health hazards and should not be regarded as fine lines between safe and dangerous concentrations. It is important that the tabulated MAC's be used with discretion, and also as bench marks towards the establishment of safe working environments. Many situations may require detailed review by specialized engineers, toxicologists, or both, to avoid over or under design of control measures.

2.3 The ACGIH values refer to time-weighted average concentrations for a normal eight-hour workday. According to ACGIH, the amount by which the listed MAC's may be exceeded for short periods without injury to health depends upon a number of factors, such as the nature of the contaminant, whether very high concentrations even for short periods produce acute poisoning, whether the effects are cumulative, the frequency with which high concentrations occur, and the duration of such periods. Therefore, it is recommended in this Standard that the amount by which the tabulated MAC's may safely be exceeded for short durations be given additional evaluation for individual cases. For additional information on the toxicity of chemicals, reference can be made to the Haskell Laboratory for Toxicology and Industrial Medicine.

2.4 The MAC's are based on various criteria of toxic effects or on pronounced discomfort.

Thus, the listed values should not be used to rank the toxicity or the potential health hazard of chemicals. Nor are the tabulated values intended for use, or for modification for use, in the evaluation or control of community air pollution, since other factors become important in these problems, such as prolonged exposure and the age and health of an individual. In addition, with the control of concentrations in a community to the MAC values only, air-pollution nuisances may result. (For many chemicals the odor thresholds are considerably below the MAC's.)

3. LIMITATIONS

3.1 The listed MAC's apply to normal, healthy workers only.

3.2 Where State codes or local plant rules specify MAC's different from those in Tables 1 thru 4 the lower of the two values should be used for the design of control facilities.

3.3 Special consideration should be given to the application of the recommended MAC values in the evaluation of health hazards where there is exposure to combinations of two or more substances, because effects may be disproportionate to concentration of individual chemicals.

4. DESCRIPTION OF TABLES

4.1 The recommended MAC values are arranged in three sections as follows:

Table 1 - Gases and Vapors

Table 2 - Toxic Dusts, Fumes, and Mists

Table 3 - Mineral and Nonmetallic Inorganic Dusts

4.2 The definitions of abbreviations in the table are given herein:

PPM = Parts of vapor or gas per million parts of air by volume
Approx Mg per Cu M = Approximate milligrams per cu meter of air
Mg per Cu M = Milligrams per cu meter of air
MPPCF = Millions of particles per cu ft of air, based on impinger samples counted by light-field techniques

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

THIS DOCUMENT IS THE PROPERTY OF E. I. DU PONT DE NEMOURS AND COMPANY. THE TECHNICAL INFORMATION HEREON MAY NOT BE USED NOR REPRODUCED WITHOUT THE PERMISSION OF DU PONT.

4.3 Sample Calculation. What concentration of sulfur dioxide (SO₂) is ppm by volume results from mixing 0.01 lb per min SO₂ with 1,000 cfm of air at 70 degrees F and 29.92 in. mercury pressure.

$$\text{CFM SO}_2 = \frac{0.01}{64.1} \times 359 \times \frac{460 + 70}{460 + 32} = 0.0608$$

$$\text{PPM by volume (SO}_2\text{)} = \frac{\text{cfm SO}_2}{\text{cfm Air}} \times 10^6$$

$$\text{PPM by volume (SO}_2\text{)} = \frac{0.0608}{1000} \times 10^6 = 60.8$$

$$1 \text{ lb mol of gas} = 359 \text{ cu ft at } 32^\circ\text{F and } 29.92 \text{ in. mercury pressure}$$

$$1 \text{ Cu M} = 35.3 \text{ cu ft}$$

$$1 \text{ lb} = 454 \text{ grams}$$

$$\text{Mol wt of SO}_2 = 64.1$$

$$0.01 \text{ lb SO}_2 \text{ per min} = 0.01 \times 454 \times 1000 = 4540 \text{ MgSO}_2 \text{ per min}$$

$$\text{Lb mol SO}_2 \text{ per min} = \frac{0.01}{64.1}$$

$$\text{MgSO}_2 \text{ per Cu M} = \frac{4540}{1000/35.3} = 160$$

TABLE 1 - GASES AND VAPORS

Substance	PPM	Approx Mg per Cu M	Substance	PPM	Approx Mg per Cu M
Acetaldehyde	200	360	Carbon monoxide	100	110
Acetic acid	10	25	Carbon tetrachloride	25	160
Acetic anhydride	5	20	Cellulose		
Acetone	1000	2400	(2-ethoxyethanol)	200	740
Acetylene tetrachloride	1	14	Cellulose acetate		
Acrolein	0.5	1.2	(2-ethoxyethyl acetate)	100	540
Acrylonitrile	20	45	Chlorine	1	3
Allyl alcohol	5	12	Chlorine dioxide	0.1	0.3
Allyl chloride	5	15	Chlorine trifluoride	0.1	0.4
Allyl propyl disulfide	2	12	Chlorobenzene		
Ammonia	100	70	(monochlorobenzene)	75	350
Amyl acetate	200	1050	Chloroform		
Amyl alcohol			(trichloromethane)	50	240
(isomyl alcohol)	100	360	1-Chloro-1-nitropropane	20	100
Aniline	5	19	Chloropicrin	0.1	0.7
Arsine	0.05	0.2	Chloroprene (2-chloro-1, 3-butadiene)	25	90
Benzene (benzol)	25	80	Cresol (all isomers)	5	22
Benzyl chloride	1	5	Cyclohexane	400	1400
Boron trifluoride	1	3	Cyclohexanol	100	410
Bromine	0.1	0.7	Cyclohexanone	100	400
Butadiene (1, 3-butadiene)	1000	2200	Cyclohexene	400	1350
2-Butanone			Decabenzene	0.05	0.3
(methyl ethyl ketone)	250	740	Diacetone alcohol		
Butyl acetate			(4-hydroxy-1-methyl-2-pentanone)	50	240
(n-butyl acetate)	200	950	Dibenzene	0.1	0.1
Butyl alcohol			o-Dichlorobenzene	50	300
(n-butanol)	100	300	Dichlorodifluoromethane	1000	4950
Butylamine	5	15	1, 1-Dichloroethane	100	400
Butyl cellosolve			1, 2-Dichloroethane		
(2-butoxyethanol)	50	240	(ethylene dichloride)	100	400
Carbon dioxide	5000	9000	1, 2-Dichloroethylene	200	700
Carbon disulfide	20	60			

CONFIDENTIAL

DUP 0960002

APRIL 1961

MAXIMUM ACCEPTABLE CONCENTRATIONS OF AIR CONTAMINANTS

S 2 T

Page 3

TABLE 1 - GASES AND VAPORS (CONT'D)

Substance	PPM	Approx Mg per Cu M	Substance	PPM	Approx Mg per Cu M
Dichloroethyl ether	15	90	Hydrogen bromide	5	17
Dichloromono-fluoromethane	1000	4200	Hydrogen chloride	5	7
1, 1-Dichloro- 1-nitroethane	10	60	Hydrogen cyanide	10	11
Dichlorotetrafluoroethane	1000	7000	Hydrogen fluoride	3	2
Diethylamine	25	75	Hydrogen peroxide, 90%	1	1.4
Difluorodibromomethane	100	860	Hydrogen selenide	0.05	0.2
Diisobutyl ketone	50	290	Hydrogen sulfide	20	30
Dimethylaniline (N-dimethylaniline)	5	25	Iodine	0.1	1
Dimethylformamide	20	60	Isophenone	25	140
1, 1-Dimethylhydrazine	0.5	1	Isopropylamine	5	12
Dimethylsulfate	1	5	Mesityl oxide	25	100
Dipropylene glycol methyl ether	100	600	Methyl acetate	200	610
Dioxane (dithylene dioxide)	100	360	Methyl acrylate	1000	1650
Ethyl acetate	400	1400	Methyl acrylate	10	35
Ethyl acrylate	25	100	Methylal (dimethoxymethane)	1000	3100
Ethyl alcohol (ethanol)	1000	1900	Methyl alcohol (methanol)	200	260
Ethylamine	25	45	Methyl bromide	20	80
Ethylbenzene	200	870	Methyl cellosolve (2-methoxyethanol)	25	80
Ethyl bromide	200	890	Methyl cellosolve acetate (ethylene glycol mono- methyl ether acetate)	25	120
Ethyl chloride	1000	2600	Methyl chloride	100	210
Ethyl ether	400	1200	Methyl chloroform (1, 1, 1-trichloroethane)	500	2700
Ethyl formate	100	300	Methylcyclohexane	500	2000
Ethyl silicate	100	850	Methylcyclohexanol	100	470
Ethylene chlorohydrin	5	16	Methylcyclohexanone	100	460
Ethylenediamine	10	30	Methyl formate	100	250
Ethylene dibromide (1, 2-dibromoethane)	25	190	Methyl isobutyl carbinol (methyl amyl alcohol)	25	100
Ethylene imine	5	9	p-Methyl styrene	100	480
Ethylene oxide	50	90	Methylene chloride (dichloromethane)	500	1750
Fluorine	0.1	0.2	Monomethyl aniline	2	9
Fluorotrichloromethane	1000	5600	Naphtha (coal tar)	200	800
Formaldehyde	5	6	Naphtha (petroleum)	500	2000
Furfural	5	20	Nickel carbonyl	0.001	0.007
Furfuryl alcohol	50	200	Nitric acid	10	25
Gesoline	500	2000	p-Nitroaniline	1	6
Heptane (n-heptane)	500	2000	Nitrobenzene	1	5
Hexane (n-hexane)	500	1800	Nitroethane	100	310
Hexanone (methyl butyl ketone)	100	410	Nitrogen dioxide	5	9
Hexane (methyl isobutyl ketone)	100	410	Nitroglycerin	0.5	5
Hydrazine	1	1.3	Nitromethane	100	250

CONFIDENTIAL

DUP

DUP 0960003

TABLE 1 - GASES AND VAPORS (CONT'D)

Substance	PPM	Approx Mg per Cu M	Substance	PPM	Approx Mg per Cu M
2-Nitropropane	50	180	Stibine	0.1	0.5
Nitrotoluene	5	30	Stoddard solvent	500	2900
Octane	500	2350	Styrene monomer	100	420
Ozone	0.1	0.2	(phenylethylene)	5	13
Paradichlorobenzene	75	450	Sulfur dioxide	1000	6000
Pentane	1000	2950	Sulfur hexafluoride	1	6
Pentanone (methyl propyl ketone)	200	700	Sulfur monochloride	0.025	0.25
Perchloroethylene	200	1350	Sulfur pentafluoride	100	300
(tetrachloroethylene)	5	19	p-Tertiary butyltoluene	10	60
Phenol	5	22	1, 1, 2, 2-Tetrachloroethane	5	35
Phenylhydrazine	5	22	Tetrahydrofuran	200	590
Phosgene (carbonyl chloride)	1	4	Tetranitromethane	1	8
Phosphine	0.05	0.07	Toluene (toluol)	200	750
Phosphorus trichloride	0.5	3	o-Toluidine	5	22
Propyl acetate	200	840	Tolylene	0.1	0.7
Propyl alcohol	400	980	2, 4-diisocyanate	200	1030
(isopropyl alcohol)	500	2100	Trichloroethylene	25	100
Propyl ether	300	2100	Triethylamine	1000	6100
(isopropyl ether)	75	350	Trifluoromethylbromo- methane	100	560
Propylene dichloride	25	60	Turpentine	500	1300
(1, 2-dichloropropane)	100	240	Vinyl chloride	100	480
Propylene imine	10	30	(chloroethylene)	200	870
Propylene oxide	0.1	0.4	Vinyl toluene	5	25
Pyridine			Xylene (xylol)		
Quinone			Xylidine		

TABLE 2 - TOXIC DUSTS, FUMES AND MISTS

Substance	Mg per Cu M	Substance	Mg per Cu M
Aldrin (1, 2, 3, 4, 10, 10-hexachloro- 1, 4, 4a, 5, 8, 8a-hexahydro-1, 4, 5, 8-dimethanonaphthalene)	0.25	Chlordane (1, 2, 4, 5, 6, 7, 8, 8-tetrachloro- 3a, 4, 7, 7a-tetrahydro-4, 7 - methanoindane)	2
Arsenite (arsenious sulfonate)	15	Chlorinated camphene, 60%	0.5
Antimony	0.5	Chlorinated diphenyl oxide	0.5
ANTU (alpha-naphthyl thiourea)	0.3	Chlorodiphenyl (42% chlorine)	1
Arsenic	0.5	Chlorodiphenyl (54% chlorine)	0.5
Berium (soluble compounds)	0.5	Chromic acid and chromates (as Cr ₂ O ₃)	0.1
Beryllium	0.002	Crop herbicide (sodium 2-[2, 4-dichloro- phenoxy] ethanol hydrogen sulfate)	15
Cadmium oxide fume	0.1	Cyanide (as CN)	5
Calcium arsenate	0.1		



DUP 0960004

CONFIDENTIAL