Bureau of Mines
Information Circular 7682

ACCEPTED LIMIT VALUES OF AIR POLLUTANTS

BY J. F. BARKLEY

United States Department of the Interior—May 1954

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UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary
BUREAU OF MINES
J. J. Forbes, Director

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CONTENTS

TABLE

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Information Circular 7682

INTRODUCTION AND ACKNOWLEDGMENTS

As part of the work of serving as Chairman of Subcommittee 3, Health and Industrial Requirements, of the American Society of Mechanical Engineers' Committee on Air-Pollution Controls, the author assembled the following information on accepted maximum permissible concentrations of air pollutants from the standpoints of health, damage to vegetation, damage to property, and requirements of industrial processes. A search in technical literature was made followed by direct inquiry to all State governments as to their regulations.

The subcommittee membership - G. D. Clayton, senior sanitary engineer, Public Health Service, United States Department of Health, Education, and Welfare, Detroit, Mich., Dr. L. Greenburg, commissioner, Department of Air Pollution Control, New York, N.Y., Dr. M. Katz, Defence Research Chemical Laboratories, Ottawa, Ontario, Canada, and Dr. H. H. Schrenk, research director, Industrial Hygiene Foundation of America, Inc., Mellon Institute, Pittsburgh, Pa. - reviewed the information and made very helpful comments and corrections.

STANDPOINT OF HEALTH

As regards health, the outstanding and principal source of information is the Threshold Limit Values adopted from year to year by the American Conference of Governmental Industrial Hygienists.2/ Each value expresses the average concentration of a substance in the air to which an industrial worker can be exposed for 8 hours daily for an indefinite period without injury or occupational disease. With some differences, these values are used by all the State governments that have accepted values along these lines. The accompanying tabulation shows the Threshold Limit Values, together with the variations, including the additions, adopted by certain States. Delaware, Illinois, Maine, North Dakota, Oregon, South Dakota, and Utah reported that they had no adopted values as to air pollutants.

The tabulation of values presents a clear-cut picture, but those who wish to consider or use any of these values in a practical way should have considerable knowledge regarding their origin. According to Schrenk:3/

> This definition (as to the values of the table) is made up of the following items: (1) Average concentration, (2) 8-hour day, (3) indefinite exposure period, and (4) lack of injury or occupational disease. There is some controversy regarding item (1), items (2) and (3) are usually though not invariably accepted, and there is definite disagreement regarding the interpretation of item (4).

2/ Reprinted and copyrighted by the American Medical Association, 535 Dearborn Street, Chicago 10, Ill.

3/ Schrenk, H. H., Bureau of Mines Inf. Circ. 7457, Interpretation of Permissible Limits in the Breathing of Toxic Substances in Air, 1948, 7 pp.

To reach a more satisfactory interpretation of maximum allowable concentration, attention is directed to (1) the development of tables of maximum allowable concentrations, (2) criteria on which limits are based, and (3) methods used to obtain data on which limits are based.

Although these values, backed by experimental data, came from deliberations regarding "confined" or "inside" spaces, it could be assumed that the values would also be conservative for "outside" spaces for no longer than an 8-hour period. In the use of such values for the general populace, however, questions arise as to their applicability to the very young, the aged, and to those with impaired health who are markedly more susceptible to various air pollutants than a person in good health. Recent experience, also, indicates that mixtures of pollutants of much lower concentrations than given in the tabulation can be quite damaging, apparently the result of a type of synergistic action on simultaneous exposure to several toxic substances.

STANDPOINT OF VEGETATION

As regards vegetation, there are few generally accepted standards. According to Katz,4/ "low concentrations (of SO_2 in the atmosphere) in the range up to 0.10 to 0.20 p.p.m. do not appear to have any visible effect on plant life. In concentrations higher than approximately 0.4 p.p.m., SO_2 may be toxic to sensitive plants--------." Although mention in technical literature is made of the effect of other types of air pollutants on vegetation such as chlorine, hydrofluoric acid gas, hydrogen sulfide, ammonia mercury, carbon monoxide, and ethylene, no definite limit values have gained general acceptance.

STANDPOINT OF PROPERTY

As regards property damage, virtually any concentration of a pollutant, such as sulfuric acid or hydrogen sulfide, that will attack materials will do some damage. Since property cannot repair itself like a living organism, it is a question of what can be tolerated.

STANDPOINT OF INDUSTRIAL PROCESSES

As regards industrial processes, nothing as to limit standards was found either in literature or by personal inquiry.

GENERAL

It is apparent that the whole subject yet requires much research and field experience before many needed satisfactory, stabilized, operating standards of limit values of air pollutants can be determined.

4/ Katz, M., Sulfur Dioxide in the Atmosphere and its Relation to Plant Life, Ind. and Eng. Chem., vol. 41, No. 11, 1949, pp. 2450-2465.

TABLE 1. - Maximum allowable concentrations of (industrial) atmospheric contaminants

Gases and vapors	Threshold limit values adopted by Conference of Governmental Industrial Hygienists - 1953	California - 1949	Colorado - 1941	Florida - 1947	Kentucky	Massachusetts - 1951	Maryland - 1944	Michigan - 1952	Mississippi - 1948	Ohio - 1946	New York - 1952	South Carolina	Vermont	Virginia - 1952	West Virginia - 1951
Substance	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.	p.p.m.
Acetaldehyde	200														
Acetic acid	10														
Acetic anhydride	5														
Acetone	1,000	400				500									
Acrolein	0.5														
Acrylonitrile	20														
Allyl alcohol		15													
Allyl chloride		50													
Ammonia	100														
Amyl acetate	200									400					
Iso-amyl alcohol	100														
Aniline	5														
Arsine	.05	0.10		1						1		1			
Acetonitrile														1/150	
Benzene hexachloride														1/15	
Benzene (bensol)	35	50		75			75			100		100			
Bromine	1					0.5									
1,3-Butadiene	1,000														
n-Butanol (Butyl alcohol)	100	50	50	50	50	50	50		50						
2-Butanone	250					300				300					
n-Butyl acetate	200									400					
Butyl cellesolve (2-Butoxyethanol)	200														
Carbon dioxide	5,000										10,000				
Carbon disulfide	20														
Carbon monoxide	100											75			
Carbon tetrachloride	25					35	50			100					
Cellosolve (2-Ethoxyethanol)	200														
Cellosolve acetate	100														
Chlorine	1			5						5					
Chlorobenzene (Monochlorobenzene)	75														
2-Chlorobutadiene	25														
Chloroform	100														
1-Chloro - 1-Nitropropane	20														
Cresol	5														
Cyanogen and compounds as CN		20													
Cyclohexane	400														
Cyclohexanol	100														
Cyclohexanone	100														
Cyclohexene	400														
Cyclopropane (propane)	400														

1/ Tentative

TABLE 1. - Maximum allowable concentrations of (industrial) atmospheric contaminants (con.)

Gases and vapors Substance	Threshold limit values adopted by Conference of Governmental Industrial Hygienists - 1953 p.p.m.	California - 1949 p.p.m.	Colorado - 1941 p.p.m.	Florida - 1947 p.p.m.	Kentucky p.p.m.	Massachusetts - 1951 p.p.m.	Maryland - 1944 p.p.m.	Michigan - 1952 p.p.m.	Mississippi - 1948 p.p.m.	Ohio - 1946 p.p.m.	New York - 1952 p.p.m.	South Carolina p.p.m.	Vermont p.p.m.	Virginia - 1952 p.p.m.	West Virginia - 1951 p.p.m.
1-2 Dibromoethane (ethylene dibromide)	25														
O-Dichlorobenzene	50									75		75			
p-Dichlorobenzene								50							
Dichlorodifluoromethane	1,000														
1,1-Dichloroethane	100														
1,2-Dichloroethane (ethylene dichloride)	100					75									
1,2-Dichloroethylene	200														
Dichloroethylether	15														
Dichloromethane	500					250									
Dichloromonofluoromethane	1,000														
1,1-Dichloro- 1-nitroethane	10														
1,2-Dichloropropane (propylene dichloride)	75														
Dichloromonochloromethane			1,000												
Dichlorotetrafluoroethane	1,000														
Diethylamine	25														
Dimethylaniline	5														
Dimethylsulfate	1														
Dioxane	100														
Etyyl acetate	400														
Ethyl alcohol	1,000														
Ethyl amine	25														
Ethyl benzene	200														
Ethyl bromide	200			400											
Ethyl chloride	1,000			5,000											
Ethyl ether	400														
Ethyl formate	100														
Ethyl silicate	100														
Ethylene chlorohydrin	5														
Ethylene oxide	100														
Ethyl methacrylate		400													
Fluorine (gas)	.1														
Fluorotrichloromethane	1,000														
Formaldehyde	5			10		10	10			10					
Gasoline	500	1,000		1,000		1,000	1,000								
Heptane	500	1,000													
Hexane	500	1,000													
Hydrogen chloride	5			10			10	5		10		10			
Hydrogen cyanide	10			20			20			20		20			
Hydrogen fluoride	3			2		1.5									
Hydrogen selenide	.05														
Hydrogen sulfide	20														
Iodine	1			2/0.1											
Isophorone	25														
Iso-propyl alcohol	400														
Iso-propyl ether	500														
Mesityl oxide	50														
Methanol	200						100								
Methylal	1,000														
Methyl acetate	200														
Methyl bromide	20														
Methyl butanone	100														
Methyl butyl ketone								100							
Methyl cellosolve (2-methoxyethanol)	25									100					
Methyl cellosolve acetate	25														
Methyl chloride	100			200						200					
Methylcyclohexane	500														
Methylcyclohexanol	100														
Methylcyclohexanone	100														
Methyl formate	100														
Methyl iso-butyl ketone	100														
Methyl methacrylate		500													
Monochlorophenol		5													
Monofluorotrichloromethane			1,000		1,000			1,000	1,000						1,000
Naphtha (coal tar)	200														
Naphtha (petroleum)	500			1,000						1,000		1,000			
Nickel carbonyl	1														
Nitrobenzene	1			1 - 5								5			
Nitroethane	100														
Nitrogen dioxide						10									
Nitrogen oxides (other than N_2O)	25						10					20			
Nitroglycerin	:5														
Nitromethane	100														
2-Nitropropane	50					25									
Nitrotoluene (Mononitrotoluene)	5														

Substance															
Octane	500														
Ozone	1														
Pentane	1,000														
Pentanone	200														
Phenol	5														
Phosgene	1														
Phosphine	.05			1								1			
Phosphorous trichloride	.5														
Propyl acetate	200														
Quinone											0.1				
Stibine	.1														
Stoddard solvent	500														
Styrene monmer	200									400					
Sulfur chloride	1														
Sulfur dioxide	10														
Sulfur trioxide		10													
1,1,2,2-Tetrachloroethane	5			10						10		10			
Tetrachloroethylene	200					150									
Toluene	200														
Toluidine	5														
Trichloroethylene	200					150									
1-1-1 Trichloroethane	500														
Turpentine	100			200		200				200		200			
Vinyl chloride	500														
Xylene	200														
Toxic dusts, fumes, and mists															
Substance	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3	mg./m3
Ammonium picrate								10							
Antimony	0.5														
Arsenic	0.5			0.15		0.25									
Barium	0.5														
Cadmium	0.1														
Chlorodiphenyl	1														
Chromic acid and chromates as CrO3	0.1														
Cyanide as CN	5			18											
Chlorinated naphthalenes						1 - 5									
Tri and mixtures of tri and tetra		5													
Tetra, penta, and mixtures of tetra and penta		1													
Hexa and mixtures of penta and hexa		0.5													
Below penta				1.5											
Above penta				0.5											
Tri										5					
Penta										0.5					
Dichlorodiphenyltrichlorethane (DDT)						2		5							1/10
o,o-Diethyl-o-p-nitrophenyl thiophosphate (parathion)	0.1														
Dinitrotoluene	1.5														
o-Dinitrocresol	0.2														
Fluoride	2.5					1									
Hydroquinone											2				
Iron oxide fume	15														
Lead	0.15														
Magnesium oxide fume	15														
Manganese	6														
Mercury	0.1														
Metal fumes (total)		30													
Nicotine				30											
Pentachloronaphthalene	0.5														
Pentachlorophenol	0.5														
Phosphorus (yellow)	0.1														
Phosphorus pentachloride	1														
Phosphorus pentasulfide	1														
Selenium, as Se	0.1														
Sulfuric acid	1			0.5											
Tellurium	0.1														
Tetraethyl pyrophosphate						0.1									
Tetryl	1.5														
Trichloronaphthalene	5														
Trinitrotoluene	1.5														
Uranium (soluble compounds)	0.05														
Uranium (insoluble compounds)	0.25														
Zinc chromate						0.2									
Zinc oxide fume	15														

1/ Tentative
2/ mg./m3

TABLE 1. - Maximum allowable concentrations of (industrial) atmospheric contaminants (con.)

Mineral dusts Substance	Threshold limit values adopted by Conference of Governmental Industrial Hygienists - 1953 m.p/ft.^{3}	California - 1949 m.p/ft.^{3}	Colorado - 1941 m.p/ft.^{3}	Florida - 1947 m.p/ft.^{3}	Kentucky m.p/ft.^{3}	Massachusetts - 1951 m.p/ft.^{3}	Maryland - 1944 m.p/ft.^{3}	Michigan - 1952 m.p/ft.^{3}	Mississippi - 1948 m.p/ft.^{3}	Ohio - 1946 m.p/ft.^{3}	New York - 1952 m.p/ft.^{3}	South Carolina m.p/ft.^{3}	Vermont m.p/ft.^{3}	Virginia - 1952 m.p/ft.^{3}	West Virginia - 1951 m.p/ft.^{3}
Alundum	50														
Asbestos	5														
Carborundum	50														
Dust (nuisance, no free silica)	50														
Foundry dust						25									
Granite						15									
Limestone						50									
Mica (below 5 percent free silica)	20		50						50						50
Portland cement	50														
Silica (free SiO_2)												5			
Silica (over 40 percent free SiO_2)										5					
Silica (20 to 40 percent free SiO_2)										10					
Silica (10 to 20 percent free SiO_2)										20					
Silica (high, above 50 percent free SiO_2)	5														
Silica (medium, 5-50 percent free SiO_2)	20												10		
Silica (low, below 5 percent free SiO_2)	50														
Silica (below 10 percent free SiO_2)						50									
Silicates												50			
Siliceous dusts (less than 10 percent by weight free SiO_2)											100				
Siliceous dusts (10-70 percent by weight free SiO_2)											10				
Siliceous dusts (70 percent or above by weight free SiO_2)											5				
Silicon carbide						50									
Slate (below 5 percent free SiO_2)	50														
Soapstone (below 5 percent free SiO_2)	20														
Talc	20	50													
Total dust (below 5 percent free SiO_2)	50														
All mineral dusts other than siliceous dusts											100				
Radiations **Material or radiation**															
Alpha (roentgens per day)			0.05												
Beta (roentgens per day)			.05			0.04									
Gamma (roentgens per week)	0.3				0.7										
Polonium (airborne)						$3/10^{-12}$									
Radium (roentgens per day)						$3/8 \times 10^{-12}$				0.1					
Roentgen (roentgens per week)	0.3				0.7										
Radon (curies per cu. meter)			10^{-8}			10^{-8}									
Radon gas (curies per liter)										10^{-11}					
Thoren (curies per cu. meter)			10^{-8}												
X-ray (roentgens per day)			.05			.04				0.1					

3/ Curies per cubic meter