PROPOSED

N.J.A.C. 12:131

THRESHOLD LIMIT VALUES

STATE OF NEW JERSEY
DEPARTMENT OF LABOR AND INDUSTRY
Bureau of Engineering and Safety
Trenton, New Jersey

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TABLE OF CONTENTS

TABLE OF CONTENTS

FOREWORD

This Chapter of Title 12 of the New Jersey Administrative Code replaces N.J.A.C. 12:131, Threshold Limit Values, effective December 1, 1967, which in turn replaced Safety Regulation No. 3, Threshold Limit Values, effective August 19, 1963.

This Chapter establishes Threshold Limit Values for various toxic substances which may be present in the atmosphere in places of employment. The values, which are contained in this Chapter, are taken from the Threshold Limit Values of Airborne Contaminants for 1970, adopted by the American Conference of Governmental Industrial Hygienists.

Threshold limit values refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. Because of wide variation in individual susceptibility, however, a small percentage of workers may experience discomfort from some substances at concentrations at or below the threshold limit, a smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by development of an occupational illness.

Simple tests are now available (J. Occup. Med. 9, 537, 1967; Ann. N.Y. Acad. Sci., 151 Art. 2, p. 968, 1968) that may be used to detect those individuals hypersusceptible to a variety of industrial chemicals (respiratory irritants, hemolytic chemicals, organic isocyanates, carbon disulfide). These tests may be used to screen out by appropriate job placement the hyperreactive worker and thus in effect improve this "coverage" of the TLVs.

Threshold limit values refer to time-weighted concentrations for a 7 or 8-hour workday and 40-hour workweek. They should be used as guides in the control of health hazards and should not be used as fine lines between safe and dangerous concentrations. (Exceptions are the substances listed in Appendices A and E and those substances designated with a "C" or Ceiling value, Appendix C.)

Time-weighted averages permit excursions above the limit provided they are compensated by equivalent excursions below the limit during the workday. In some instances it may be permissible to calculate the average concentration for a workweek rather than for a workday. The degree of permissible excursion is related to the magnitude of the threshold limit value of a particular substance as given in Appendix C. The relationship between threshold limit and permissible excursion is a rule of thumb and in certain cases may not apply. The amount by which threshold limits 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. All factors must be taken into consideration in arriving at decision as to whether a hazardous condition exists.

Threshold limits are based on the best available information from industrial experience, from experimental human and animal studies, and, when possible, from a combination of the three. The basis on which the values are established may differ from substance to substance; protection against impairment of health may be a guiding factor for some, whereas reasonable freedom from irritation, narcosis, nuisance or other forms of stress may form the basis for others.

The committee holds to the opinion that limits based on physical irritation should be considered no less binding than those based on physical impairment. There is increasing evidence that physical irritation may initiate, promote or accelerate physical impairment through interaction with other chemical or biologic agents.

In spite of the fact that serious injury is not believed likely as a result of exposure to the threshold limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.

These limits are intended for use in the practice of industrial hygiene and should be interpreted and applied only by a person trained in this discipline. They are not intended for use, or for modification for use, (1) as a relative index of hazard or toxicity, (2) in the evaluation or control of community air pollution or air pollution nuisances, (3) in estimating the toxic potential of continuous uninterrupted exposures, (4) as proof or disproof of an existing disease or physical conditions, or (5) for adoption by countries whose working conditions differ from those in the United States of America and where substances and processes differ.

Ceiling vs Time-Weighted Average Limits. Although the time-weighted average concentration provides the most satisfactory, practical way of monitoring airborne agents for compliance with the limits, there are certain substances for which it is inappropriate. In the latter group are substances which are predominantly fast acting and whose threshold limit is more appropriately based on this particular response. Substances with this type of response are best controlled by a ceiling "C" limit that should not be exceeded. It is implicit in these definitions that the manner of sampling to determine compliance with the limits for each group must differ; a single brief sample, that is applicable to a "C" limit, is not appropriate to the time-weighted limit; here, a sufficient number of samples are needed to permit a time-weighted average concentration throughout a complete cycle of operations or throughout the work shift.

Whereas the ceiling limit places a definite boundary which concentrations should not be permitted to exceed, the time-weighted average limit requires an explicit limit to the excursions that are permissible above the listed values. The magnitude of these excursions may be pegged to the magnitude of the threshold limit by an appropriate factor shown in Appendix C. It should be noted that the same factors are used by the Committee in making a judgment whether to include or exclude a substance for a "C" listing.

"Skin" Notation. Listed substances followed by the designation "Skin" refer to the potential contribution to the over-all exposure by the cutaneous route including mucous membranes and eye, either by airborne, or more particularly, by direct contact with the substance. Vehicles can alter skin absorption. This attention-calling designation is intended to suggest appropriate measures for the prevention of cutaneous absorption so that the threshold limit is not invalidated.

Mixtures. Special consideration should be given also to the application of the TLVs in assessing the health hazards which may be associated with exposure to mixtures of two or more substances. A brief discussion of basic considerations involved in developing threshold limit values for mixtures, and methods for their development, amplified by specific examples are given in Appendix B.

Nuisance Dusts. In contrast to fibrogenic dusts which cause scar tissue to be formed in lungs when inhaled in excessive amounts, so-called "nuisance" dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amount. However, the lung-tissue reaction caused by inhalation of nuisance dusts has the following characteristics: 1) The architecture of the air spaces remains intact. 2) Collagen (scar tissue) is not formed to a significant extent. 3) The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility (iron oxide), may cause unpleasant deposits in the eyes, ears and nasal passages (Portland Cement dust), or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by the rigorous skin cleansing procedures necessary for their removal.

A threshold limit of 10mg/M^3, or 30 mppcf, of total dust < 1% SiO_2, whichever is less, is recommended for substances in these categories and for which no specific threshold limits have been assigned. This limit, for a normal workday, does not apply to brief exposures at higher concentrations. Neither does it apply to those substances which may cause physiologic impairment at lower concentrations but for which a threshold limit has not yet been adopted. Some "inert" particulates are given in Appendix D.

Simple Asphyxiants - "Inert" Gases or Vapors. A number of gases and vapors, when present in high concentrations in air, act primarily as simple asphyxiants without other significant physiologic effects. A TLV may not be recommended for each simple asphyxiant because the limiting factor is the available oxygen. The minimal oxygen content should be 18 percent by volume under normal atmospheric pressure (equivalent to a partial pressure, pO_2 of 135 mm Hg). Atmospheres deficient in O_2 do not provide adequate warning and most simple asphyxiants are ordorless. Several simple asphyxiants present an explosion hazard. Account should be taken of this factor in limiting the concentration of the asphyxiant. Specific examples are listed in Appendix E.

Physical Factors. It is recognized that such physical factors as heat, ultraviolet and ionizing radiation, humidity, abnormal pressure (altitude) and the like may place added stress on the body so that the effects from exposure at a threshold limit may be altered. Most of these stresses act adversely to increase the toxic response of a substance. Although most threshold limits have built-in safety factors to guard against adverse effects to moderate deviations from normal environments, the safety factors of most substances are not of such a magnitude as to take care of gross deviations. For example, continuous work at temperatures above 90°F or over-time extending the workweek more than 25%, might be considered gross deviations. In such instances judgment must be exercised in the proper adjustments of the threshold limit values.

This Chapter is promulgated by the Commissioner of Labor and Industry of the State of New Jersey, under authority vested in him by Section 9 of the Worker Health and Safety Act, P.L. 1965, Chapter 154, N.J.S.A. 34:6A, as follows:

> The commissioner shall make and promulgate rules and regulations reasonably necessary to implement the purposes of this act. Such rules and regulations shall have the force and effect of law and shall be enforced in the manner provided in this act.....

This same statute provides authority for the Commissioner to grant exceptions from the requirements of this Chapter in accordance with Section 23, as follows:

> The commissioner shall have the power and authority to grant exceptions from the literal requirements of rules and regulations promulgated under this act. Such exception shall be granted in any particular case only where it is clearly evident that it is necessary to prevent undue hardship or where existing conditions prevent compliance. In no case shall any exception be granted unless in the opinion of the commissioner reasonable protection of the health and safety of workers and the public will be maintained hereby. An application for an exception shall be filed in writing with the commissioner, setting forth specifically the requirements of the rules and regulation from which an exception is desired and the reason why enforcement of the applicable provisions of the rules and regulations is unreasonable. The commissioner shall grant or deny the exception within 30 days from the date of receipt by him of the application. The commissioner shall maintain a record of all exceptions granted and shall make such record reasonably available for public examination and shall mail a copy of all rulings granting exceptions to the members of the board.

Prior to promulgation, this Chapter was submitted to the New Jersey State Industrial Safety Committee, Public Hearing, and the New Jersey State Industrial Safety Board in accordance with the requirements of the Worker Health and Safety Act.

SUBCHAPTER 1
GENERAL PROVISIONS

12:131-1.1 TITLE AND CITATION.

This regulation shall be known and may be titled as Chapter 131, Threshold Limit Values of Title 12, N.J.A.C.

12:131-1.2 PURPOSE.

The purpose of this Chapter is to protect the health and safety of employees by establishing threshold limit values for toxic vapors, gases, fumes, mists and dusts which may be present in the atmosphere in a place of employment.

12:131-1.3 SCOPE.

The Chapter shall apply to places of employment included in the Worker Health and Safety Act, P.L. 1965, Chapter 154, N.J.S.A. 34:6A.

12:131-1.4 EFFECTIVE DATE.

This Chapter shall take effect on October 12, 1971.

12:131-1.5 REPEAL OF PRIOR CHAPTER:

Chapter 131, Threshold Limit Values of Title 12, N.J.A.C. effective December 1, 1967 is hereby repealed.

12:131-1.6 VALIDITY.

1.6.1 Nothing in this Chapter shall be construed to prevent the enforcement of other Chapters of Title 12, N.J.A.C., which prescribe more restrictive requirements.

1.6.2 Should any section, paragraph, sentence, or word of this Chapter be declared for any reason to be invalid such decision shall not affect the remaining portions of this Chapter.

SUBCHAPTER 2
DEFINITIONS

Bureau. Bureau of Engineering and Safety, Division of Labor Standards, Department of Labor and Industry, State of New Jersey.

Commissioner. Commissioner of Labor and Industry or his authorized representative.

Dust. Solid particles generated by handling, crushing, grinding, rapid impact, detonation and decrepitation of organic or inorganic materials such as rock, ore, metal, coal, wood, or grain.

Employee. Any person engaged in service to an employer for wages, salary or other compensation.

Employer. Any person or corporation, partnership, individual proprietorship, joint venture, firm, company or legal entity who engages the services of an employee and who pays his wages, salary, or other compensation; and any person exercising supervision of employees on an employer's behalf.

Fume. Solid particles generated by condensation from the gaseous state, generally after volatilization from molten metals, and often accompanied by a chemical reaction such as oxidation. Fumes flocculate and sometimes coalesce.

Gas. A normally formless fluid which occupies the space of enclosure and which can be changed to the liquid or solid state by the effect of increased pressure or decreased temperature or both. A gas diffuses.

MG/M^3. Approximate milligrams of particulate per cubic meter of air.

Mist. Suspended liquid droplets generated by condensation from the gaseous to the liquid state or by breaking up a liquid into a dispersed state, such as by splashing, foaming and atomizing.

N.J.A.C. New Jersey Administrative Code.

Place of employment. Any building or other premises occupied by an employer in or about which an employee customarily is suffered or permitted to work.

Ppm. Parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm Hg pressure.

Qualified person. A person selected and directed by an employer to perform a specific task or duty involving threshold limit values, who has the degree of competence to accomplish the work in a safe manner..

Shall. Indicates a mandatory requirement.

Vapor. The gaseous form of a substance which is normally in the solid or liquid state. A vapor diffuses.

SUBCHAPTER 3
THRESHOLD LIMIT VALUES

12:131-3.1 VALUES.

3.1.1 Time-weighted average atmospheric concentrations of dusts, fumes, gases, mists or vapors to which the employee may be exposed for an eight-hour working day shall not exceed the applicable limits presented in Table 3.3.1 except as provided in 3.1.2, 3.1.3 and 3.1.4.

3.1.2 When two or more substances are simultaneously present in the atmosphere the time-weighted average atmospheric concentrations shall not exceed those calculated in accordance with Appendix B.

3.1.3 The atmospheric concentrations of those substances in Table 3.1.1 preceded by the letter "C" shall not exceed the threshold limit vlaues at any time.

3.1.4 Excursions above the threshold limit values may be permitted for those substances not preceded by the letter "C" in accordance with Appendix C.

12:131-3.2 SAMPLING, TESTING AND ANALYSIS.

3.2.1 Sampling, testing and analysis to determine the atmospheric concentration of dusts, fumes, gases, mists or vapors shall be performed only by a qualified person.

3.2.2 Sampling, testing and analysis shall be done in accordance with accepted and reliable methods.

3.2.3 Samples of the atmosphere in the place of employment shall be taken wherever there may exist hazardous exposure to any toxic dust, fume, gas, mist or vapor.

Table 3.1.1

ADOPTED VALUES
(In Alphabetical Order)

	Substance	ppm[a]	mg/M^3 [b]
	Abate	--	15
	Acetaldehyde	200	360
	Acetic acid	10	25
	Acetic anhydride	5	20
	Acetone	1,000	2,400
	Acetonitrile	40	70
	Acetylene	E	--
	Acetylene dichloride, see 1, 2-Dichloroethylene	--	--
	Acetylene tetrabromide	1	14
	Acrolein	0.1	0.25
	Acrylamide-Skin	--	0.3
	Acrylonitrile-Skin	20	45
	Aldrin-Skin	--	0.25
	Allyl alcohol-Skin	2	5
	Allyl chloride	1	3
**C	Allyl glycidyl ether (AGE)	10	45
	Allyl propyl disulfide	2	12
	Alundum (Al_2O_3)	--	D
	2-Aminoethanol, see Ethanolamine	--	--
	2-Aminopyridine	0.5	2
**	Ammonia	50	35
	Ammonium sulfamate (Ammate)	--	15
	n-Amyl acetate	100	525
	sec-Amyl acetate	125	650
	Aniline-Skin	5	19
	Anisidine (o, p-isomers)-Skin	--	0.5
	Antimony & compounds (as Sb)	--	0.5
	ANTU (alpha naphthyl thiourea)	--	0.3
	Argon	E	--
	Arsenic & Compounds (as As)	--	0.5
	Arsine	0.05	0.2
	Azinphos-methyl-Skin	--	0.2
	Barium (soluble compounds)	--	0.5
C	Benzene (benzol)-Skin	25	80
	Benzidine-Skin	--	A1
	p-Benzoquinone, see Quinone	--	--
	Benzoyl peroxide	--	5
	Benzyl chloride	1	5
	Beryllium	--	0.002
	Biphenyl, see Diphenyl	--	--
	Bisphenol A, see Diglycidyl ether	--	--
	Boron oxide	--	15
	Boron tribromide	1	10
C	Boron trifluoride	1	3
	Bromine	0.1	0.7
*	Bromine pentafluoride	0.1	0.7
	Bromoform-Skin	0.5	5
	Butadiene (1, 3-butadiene)	1,000	2,200
	Butanethiol, see Butyl mercaptan	--	--
	2-Butanone	200	590
	2-Butoxy ethanol (Butyl Cellosolve) - Skin	50	240
	Butyl acetate (n-butyl acetate)	150	710

Substance	ppm[a]	mg/M^3 [b]
sec-Butyl acetate	200	950
tert-Butyl acetate	200	950
Butyl alcohol	100	300
sec-Butyl alcohol	150	450
tert-Butyl alcohol	100	300
C Butylamine-Skin	5	15
C tert-Butyl chromate (as CrO_3) - Skin	--	0.1
n-Butyl glycidyl ether (BGE)	50	270
* Butyl mercaptan	0.5	1.5
p-tert-Butyltoluene	10	60
Cadmium (Metal dust and soluble salts)	--	0.2
*C Cadmium oxide fume (as Cd)	--	0.1
Calcium carbonate	--	D
Calcium arsenate	--	1
Calcium oxide	--	5
** Camphor (Synthetic)	2	--
Carbaryl (Sevin ®)	--	5
Carbon black	--	3.5
Carbon dioxide	5,000	9,000
Carbon disulfide-Skin	20	60
Carbon monoxide	50	55
Carbon tetrachloride-Skin	10	65
Cellulose (paper fiber)	--	D
Chlordane-Skin	--	0.5
Chlorinated camphene-Skin	--	0.5
Chlorinated diphenyl oxide	--	0.5
* Chlorine	1	3
Chlorine dioxide	0.1	0.3
C Chlorine trifluoride	0.1	0.4
C Chloroacetaldehyde	1	3
∝-Chloroacetophenone (phenacyl-chloride)	0.05	0.3
Chlorobenzene (monochlorobenzene)	75	350
o-Chlorobenzylidene malononitrile (OCBM)	0.05	0.4
Chlorobromomethane	200	1,050
2-Chloro-1, 3-butadiene, see Chloroprene	--	--
Chlorodiphenyl (42% Chlorine) - Skin	--	1
Chlorodiphenyl (54% Chlorine) - Skin	--	0.5
1- Chloro, 2, 3-epoxypropane, see Epichlorhydrin	--	--
2-Chloroethanol, see Ethylene chlorohydrin	--	--
Chloroethylene, see Vinyl choride	--	--
C Chloroform (trichloromethane)	50	240
1-Chloro-1-nitropropane	20	100
Chloropicrin	0.1	0.7
Chloroprene (2-chloro-1, 3-butadiene) -Skin	25	90
Chromic acid and chromates (as CrO_3)	--	0.1
Chromium, sol. chromic, chromous salts as Cr	--	0.5
Metal & insol. salts	--	1
Coal tar pitch volatiles (benzene soluble fraction) anthracene, BaP, phenanthrene, acridine, chrysene, pyrene)	--	0.2

	Substance	ppm[a]	mg/M[3] [b]
	Cobalt, metal fume & dust	--	0.1
	Copper fume	--	0.1
	Dusts and Mists	--	1
	Corundum (Al_2O_3)	--	D
	Cotton dust (raw)	--	1
	Crag® herbicide	--	15
	Cresol (all isomers) - Skin	5	22
	Crotonaldehyde	2	6
	Cumene-Skin	50	245
	Cyanide (as CN)-Skin	--	5
*	Cyanogen	10	--
	Cyclohexane	300	1,050
	Cyclohexanol	50	200
	Cyclohexanone	50	200
	Cyclohexene	300	1,015
	Cyclopentadiene	75	200
	2, 4-D	--	10
	DDT-Skin	--	1
	DDVP, see Dichlorvos	--	--
	Decaborane-Skin	0.05	0.3
	Demeton® -Skin	--	0.1
	Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	50	240
	1, 2-Diaminoethane, see Ethylenediamine	--	--
	Diazomethane	0.2	0.4
	Diborane	0.1	0.1
C	1, 2-Dibromoethane (ethylene dibromide)-Skin	25	190
	Dibutyl phosphate	1	5
	Dibutylphthalate	--	5
*C	Dichloroacetylene	0.1	0.4
C	o-Dichlorobenzene	50	300
	p-Dichlorobenzene	75	450
	Dichlorodifluoromethane	1,000	4,950
	1, 3-Dichloro-5, 5-dimethyl hydantoin	--	0.2
	1, 1-Dichloroethane	100	400
	1, 2-Dichloroethane	50	200
	1, 2-Dichloroethylene	200	790
C	Dichloroethyl ether-Skin	15	90
	Dichloromethane, see Methylene-chloride	--	--
	Dichloromonofluoromethane	1,000	4,200
C	1, 1-Dichloro-1-nitroethane	10	60
	1, 2-Dichloropropane, see Propylenedichloride	--	--
	Dichlorotetrafluoroethane	1,000	7,000
	Dichlorvos (DDVP)-Skin	--	1
	Dieldrin-Skin	--	0.25
	Diethylamine	25	75
	Diethylamino ethanol-Skin	10	50
**C	Diethylene triamine-Skin	10	42
	Diethylether, see Ethyl ether	--	--
	Difluorodibromomethane	100	860
C	Diglycidyl ether (DGE)	0.5	2.8
	Dihydroxybenzene, see Hydroquinone	--	--
	Diisobutyl ketone	50	290
	Diisopropylamine-Skin	5	20

Substance	ppm[a]	mg/M^3 [b]
Dimethoxymethane, see Methylal	--	--
Dimethyl acetamide-Skin	10	35
Dimethylamine	10	18
Dimethylaminobenzene, see Xylidene .	--	--
Dimethylaniline (N-dimethylaniline)-Skin	5	25
Dimethylbenzene, see Xylene	--	--
Dimethyl 1, 2-dibromo-2, 2-dichloroethyl phosphate, (Dibrom) ...	--	3
Dimethylformamide-Skin	10	30
2, 6-Dimethylheptanone, see Diisobutyl ketone	--	--
1, 1-Dimethylhydrazine-Skin	0.5	1
Dimethylphthalate	--	5
Dimethylsulfate-Skin	1	5
Dinitrobenzene (all isomers)-Skin	--	1
Dinitro-o-cresol-Skin	--	0.2
Dinitrotoluene-Skin	--	1.5
Dioxane (Diethylene dioxide)-Skin	100	360
Diphenyl	0.2	1
Diphenyl amine	--	10
Diphenylmethane diisocyanate (see Methylene bisphenyl isocyanate (MDI)	--	--
Dipropylene glycol methyl ether-Skin .	100	600
Di-sec, octyl phthalate (Di-2-ethylhexylphthalate).....	--	5
Emery	--	D
* Endosulfan (Thiodan ®)-Skin	--	0.1
Endrin-Skin	--	0.1
Epichlorhydrin-Skin	5	19
EPN-Skin	--	0.5
1, 2-Epoxypropane, see Propylene-oxide	--	--
2, 3-Epoxy-1-propanol, see Glycidol .	--	--
Ethane	E	--
Ethanethiol, see Ethylmercaptan	--	--
Ethanolamine	3	6
2-Ethoxyethanol-Skin	200	740
2-Ethoxyethylacetate (Cellosolve acetate)-Skin	100	540
Ethyl acetate	400	1,400
Ethyl acrylate-Skin	25	100
Ethyl alcohol (ethanol)	1,000	1,900
Ethylamine	10	18
Ethyl sec-amyl ketone (5-methyl-3-heptanone)	25	130
Ethyl benzene	100	435
Ethyl bromide	200	890
Ethyl butyl ketone (3-Heptanone)	50	230
Ethyl chloride	1,000	2,600
Ethyl ether	400	1,200
Ethyl formate	100	300
Ethyl mercaptan	0.5	1
Ethyl silicate	100	850
Ethylene	E	--
Ethylene chlorohydrin-Skin	5	16

Substance	ppm[a]	mg/M[3] [b]
Ethylenediamine	10	25
Ethylene dibromide, see 1, 2-Dibromoethane	--	--
Ethylene dichloride, see 1, 2-Dichloroethane	--	--
C Ethylene glycol dinitrate and/or Nitroglycerin-Skin	0.2[d]	--
Ethylene glycol monomethyl ether acetate, see Methyl cellosolve acetate	--	--
Ethylene imine-Skin	0.5	1
Ethylene oxide	50	90
Ethylidine chloride, see 1, 1-Dichloroethane	--	--
N-Ethylmorpholine-Skin	20	94
Ferbam	--	15
Ferrovanadium dust	--	1
Fibrous glass	--	D
Fluoride (as F)	--	2.5
Fluorine	0.1	0.2
Fluorotrichloromethane	1,000	5,600
**C Formaldehyde	5	6
Formic acid	5	9
Furfural-Skin	5	20
Furfuryl alcohol	50	200
Gasoline	--	A[3]
Glycerine mist	--	D
Glycidol (2, 3-Epoxy-1-propanol)	50	150
Glycol monoethyl ether, see 2-Ethoxyethanol	--	--
Graphite, (Synthetic)	--	D
Guthion, ® see Azinphosmethyl	--	--
Gypsum	--	D
Hafnium	--	0.5
Helium	E	--
Heptachlor-Skin	--	0.5
Heptane (n-heptane)	500	2,000
Hexachloroethane-Skin	1	10
Hexachloronaphthalene-Skin	--	0.2
Hexane (n-hexane)	500	1,800
2-Hexanone	100	410
Hexone (Methyl isobutyl ketone)	100	410
sec-Hexyl acetate	50	300
Hydrazine-Skin	1	1.3
Hydrogen	E	--
Hydrogen bromide	3	10
C Hydrogen chloride	5	7
Hydrogen cyanide-Skin	10	11
Hydrogen fluoride	3	2
Hydrogen peroxide	1	1.4
Hydrogen selenide	0.05	0.2
Hydrogen sulfide	10	15
Hydroquinone	--	2
* Indene	10	45

Substance	ppm[a]	mg/M³ [b]
Indium and compounds, as In	--	0.1
C Iodine	0.1	1
Iron oxide fume	--	10
Iron salts, soluble, as Fe	--	1
Isoamyl acetate	100	525
Isoamyl alcohol	100	360
Isobutyl acetate	150	700
Isobutyl alcohol	100	300
Isophorone	25	140
Isopropyl acetate	250	950
Isopropyl alcohol	400	980
Isopropylamine	5	12
Isopropylether	500	2,100
Isopropyl glycidyl ether (IGE)	50	240
Kaolin	--	D
Ketene	0.5	0.9
Lead	--	0.2
Lead arsenate	--	0.15
Limestone	--	D
Lindane-Skin	--	0.5
Litnium hydride	--	0.025
L.P.G. (Liquified petroleum gas)	1,000	1,800
Magnesite	--	D
Magnesium oxide fume	--	15
Malathion-Skin	--	15
Maleic anhydride	0.25	1
C Manganese and compounds, as Mn	--	5
Marble	--	D
** Mercury-Skin	--	0.1
** Mercury (organic compounds)-Skin	--	0.01
Mesityl oxide	25	100
Methane	E	--
Methanethiol, see Methyl mercaptan	--	--
Methoxychlor	--	15
2-Methoxyethanol, see Methyl cellosolve	--	--
Methyl acetate	200	610
Methyl acetylene (propyne)	1,000	1,650
Methyl acetylene-propadiene mixture (MAPP)	1,000	1,800
Methyl acrylate-Skin	10	35
Methylal (dimethoxymethane)	1,000	3,100
Methyl alcohol (methanol)	200	260
Methylamine	10	12
Methyl amyl alcohol, see Methyl isobutyl carbinol	--	--
* Methyl isoamyl ketone	100	475
Methyl (n-amyl) ketone (2-Heptanone)	100	465
C Methyl bromide-Skin	20	80
Methyl butyl ketone, see 2-Hexanone	--	--
Methyl cellosolve-Skin	25	80
Methyl cellosolve acetate-Skin	25	120
**C Methyl chloride	100	210
Methyl chloroform	350	1,900
Methylcyclohexane	500	2,000
Methylcyclohexanol	100	470

	Substance	ppm[a]	mg/M^3 [b]
	o-Methylcyclohexanone-Skin	100	460
	Methyl ethyl ketone (MEK), see 2-Butanone	--	--
	Methyl formate	100	250
	Methyl iodide - Skin	5	28
	Methyl isobutyl carbinol-Skin	25	100
	Methyl isobutyl ketone, see Hexone	--	--
	Methyl isocyanate - Skin	0.02	0.05
*	Methyl mercaptan	0.5	1
	Methyl methacrylate	100	410
	Methyl propyl ketone, see 2-Pentanone	--	--
C	Methyl silicate	5	30
C	α Methyl styrene	100	480
C	Methylene bisphenyl isocyanate (MDI)	0.02	0.2
	Methylene chloride (dichloromethane)	500	1,740
	Molybdenum (soluble compounds)	--	5
	(insoluble compounds)	--	15
	Monomethyl aniline-Skin	2	9
C	Monomethyl hydrazine-Skin	0.2	0.35
	Morpholine-Skin	20	70
	Naphtha (coal tar)	100	400
	Naphthalene	10	50
	β-Naphthylamine	--	A[1]
	Neon	E	--
	Nickel carbonyl	0.001	0.007
	Nickel, metal and soluble cmpds, as Ni	--	1
	Nicotine-Skin	--	0.5
	Nitric acid	2	5
	Nitric oxide	25	30
	p-Nitroaniline-Skin	1	6
	Nitrobenzene-Skin	1	5
	p-Nitrochlorobenzene-Skin	--	1
	Nitroethane	100	310
	Nitrogen	E	--
	Nitrogen dioxide	5	9
	Nitrogen trifluoride	10	29
	Nitroglycerin-Skin	0.2	2
	Nitromethane	100	250
	1-Nitropropane	25	90
	2-Nitropropane	25	90
	N-Nitrosodimethylamine (dimethyl-nitrosoamine)-Skin	--	A[1]
	Nitrotoluene-Skin	5	30
	Nitrotrichloromethane, see Chloropicrin	--	--
	Nitrous oxide	E	--
	Octachloronaphthalene-Skin	--	0.1
*	Octane	400	1,900
*	Oil mist, particulate	--	5[h]
*	Oil mist, vapor	i) A[3]	--
	Osmium tetroxide	--	0.002
	Oxalic acid	--	1
	Oxygen difluoride	0.05	0.1
	Ozone	0.1	0.2
	Paraquat-Skin	--	0.5

Substance	ppm[a]	mg/M^3 [b]
Parathion-Skin	--	0.1
Pentaborane	0.005	0.01
Pentachloronaphthalene-Skin	--	0.5
Pentachlorophenol-Skin	--	0.5
Pentaerythritol	--	D
* Pentane	500	1,500
2-Pentanone	200	700
Perchloroethylene	100	670
Perchloromethyl mercaptan	0.1	0.8
Perchloryl fluoride	3	13.5
* Petroleum Distillates (naphtha)	i) A[3]	--
Phenol-Skin	5	19
p-Phenylene diamine-Skin	--	0.1
Phenyl ether (vapor)	1	7
Phenyl ether-Biphenyl mixture (vapor)	1	7
Phenylethylene, see Styrene	--	--
Phenyl glycidyl ether (PGE)	10	60
Phenylhydrazine-Skin	5	22
Phosdrin (Mevinphos ®)-Skin	--	0.1
Phosgene (carbonyl chloride)	0.1	0.4
Phosphine	0.3	0.4
Phosphoric acid	--	1
Phosphorus (yellow)	--	0.1
Phosphorus pentachloride	--	1
Phosphorus pentasulfide	--	1
Phosphorus trichloride	0.5	3
Phthalic anhydride	2	12
Picric acid-Skin	--	0.1
Pival ®(2-Pivalyl-1, 3-indandione)	--	0.1
Plaster of Paris	--	D
Platinum (Soluble Salts) as Pt	--	0.002
Polytetrafluoroethylene decomposition products	--	A[2]
Propane	E	--
β Propiolactone	--	A[1]
Propargyl alcohol-Skin	1	--
n-Propyl acetate	200	840
Propyl alcohol	200	500
n-Propyl nitrate	25	110
Propylene dichloride	75	350
Propylene imine-Skin	2	5
Propylene oxide	100	240
Propyne, see Methylacetylene	--	--
Pyrethrum	--	5
Pyridine	5	15
Quinone	0.1	0.4
RDX-Skin	--	1.5
Rhodium, Metal fume and dusts, as Rh	--	0.1
Soluble salts	--	0.001
Ronnel	--	10
Rotenone (commercial)	--	5
Rouge	--	D
Selenium compounds (as Se)	--	0.2
Selenium hexafluoride	0.05	0.4
Silicon carbide	--	D

	Substance	ppm[a]	mg/M^3 [b]
	Silver, metal and soluble compounds .	--	0.01
	Sodium fluoroacetate (1080)-Skin	--	0.05
	Sodium hydroxide	--	2
	Stibine	0.1	0.5
	Starch	--	D
*	Stoddard solvent	200	1,150
	Strychnine	--	0.15
**C	Styrene monomer (phenylethylene) ...	100	420
	Sucrose	--	D
	Sulfur dioxide	5	13
	Sulfur hexafluoride	1,000	6,000
	Sulfuric acid	--	1
	Sulfur monochloride	1	6
	Sulfur pentafluoride	0.025	0.25
	Sulfuryl fluoride	5	20
	Systox, see Demeton ®	--	--
	2, 4, 5 T	--	10
	Tantalum	--	5
	TEDP-Skin	--	0.2
	Teflon ® decomposition products	--	A[2]
	Tellurium	--	0.1
	Tellurium hexafluoride	0.02	0.2
	TEPP-Skin	--	0.05
C	Terphenyls	1	9
	1, 1, 1, 2-Tetrachloro-2, 2-difluoroethane	500	4,170
	1, 1, 2, 2-Tetrachloro-1, 2-difluoroethane	500	4,170
	1, 1, 2, 2-Tetrachloroethane-Skin ...	5	35
	Tetrachloroethylene, see Perchloroethylene	--	--
	Tetrachloromethane, see Carbon tetrachloride	--	--
	Tetrachloronaphthalene-Skin	--	2
	Tetraethyl lead (as Pb)-Skin	--	0.100 j)
	Tetrahydrofuran	200	590
	Tetramethyl lead (as Pb)-Skin	--	0.150 j)
	Tetramethyl succinonitrile-Skin	0.5	3
	Tetranitromethane	1	8
	Tetryl (2, 4, 6-trinitrophenylmethylnitramine)-Skin	--	1.5
	Thallium (soluble compounds)-Skin as Tl	--	0.1
	Thiram	--	5
	Tin (inorganic cmpds, except SnH_4 and SnO_2)	--	2
	Tin (organic cmpds)	--	0.1
	Tin oxide	--	D
	Titanium dioxide	--	D
	Toluene (toluol)	200	750
C	Toluene-2, 4-diisocyanate	0.02	0.14
	o-Toluidine-Skin	5	22
	Toxaphene, see Chlorinated camphene	--	--
	Tributyl phosphate	--	5
	1, 1, 1-Trichloroethane, see Methyl chloroform	--	--
	1, 1, 2-Trichloroethane-Skin	10	45

Substance	ppm[a)]	mg/M^3 [b)]
Trichloroethylene	100	535
Trichloromethane, see Chloroform	--	--
Trichloronaphthalene-Skin	--	5
1, 2, 3-Trichloropropane	50	300
1, 1, 2-Trichloro 1, 2, 2-trifluoroethane	1,000	7,600
Triethylamine	25	100
Trifluoromonobromomethane	1,000	6,100
* Trimethyl benzene	25	120
2, 4, 6-Trinitrophenol, see Picric acid	--	--
2, 4, 6-Trinitrophenylmethylnitramine, see Tetryl	--	--
Trinitrotoluene-Skin	--	1.5
Triorthocresyl phosphate	--	0.1
Triphenyl phosphate	--	3
Tungsten & compounds, as W		
Soluble	--	1
Insoluble	--	5
Turpentine	100	560
Uranium (natural) sol. & insol. compounds as U	--	0.2
C Vanadium (V_2O_5 dust)	--	0.5
(V_2O_5 fume)	--	0.1
Vinyl benzene, see Styrene	--	--
**C Vinyl chloride	500	1,300
Vinylcyanide, see Acrylonitrile	--	--
Vinyl toluene	100	480
Warfarin	--	0.1
Xylene (xylol)	100	435
Xylidine-Skin	5	25
Yttrium	--	1
Zinc chloride fume	--	1
Zinc oxide fume	--	5
Zirconium compounds (as Zr)	--	5

MINERAL DUSTS

Substance	m.p.p.c.f.[e]
SILICA	
Crystalline	
** Quartz, Threshold Limit calculated from the formula	$\frac{250}{\%SiO_2+5}$ [f]
** Cristobalite " " "	
Amorphous, including natural diatomaceous earth	20
SILICATES (less than 1% crystalline silica)	
** Asbestos, all types	5
Mica	20
Portland Cement	50
Soapstone	20
Talc (non-asbestiform).....	20
Talc (fibrous), use asbestos limit.....	--
Tremolite, see asbestos	--
Graphite (natural)	15
** "Inert" or Nuisance Particulates see Appendix D	50 (or 15 mg/M^3 whichever is the smaller) of total dust $<1\%$ SiO_2

Conversion factors
mppcf x 35.3 = million particles per cubic meter
= particles per c.c.

NOTICE OF INTENDED CHANGES
(for 1970)

These substances, with their corresponding values, comprise those for which either a limit has been proposed for the first time, or for which a change in the "Adopted" listing has been proposed. In both cases, the proposed limits should be considered trial limits that will remain in the listing for a period of at least two years. During this time, the previously Adopted Limit will remain in effect. If, after two years no evidence comes to light that questions the appropriateness of the values herein, the values will be placed in the "Adopted" list. Documentation is available for each of these substances.

Substance	ppm	mg/M^3
2-Acetylaminofluorene-Skin	--	A[1]
+ Allyl glycidyl ether	5	22
4-Aminodiphenyl-Skin	--	A[1]
+ Ammonia	25	18
+ Ammonium chloride fume	--	10
Asphalt (petroleum) fumes	--	5
+ Butyl lactate	1	5
+ Camphor (synthetic)	2	12
+ Diazinon-Skin	--	0.1
+ 2-N Dibutylamino ethanol-Skin	2	14
Dichlorobenzidine-Skin	--	A[1]
+ Diethylene triamine-Skin	1	4
4-Dimethylaminoazobenzene	--	A[1]
Fibrous glass	g) --	D
+ C Formaldehyde	2	3
+ Iron pentacarbonyl	0.01	0.08
+ Mercury (Alkyl compounds) - Skin	--	0.01
+ Methyl chloride	100	210
Methyl 2-cyanoacrylate	2	8
+ Methylcylopentadienyl manganese tricarbonyl (as Mn)	0.1	0.2
Methyl demeton-Skin	--	0.5
Methyl parathion-Skin	--	0.2
Phenothiazine-Skin	--	5
+ Rosin Core Solder, pyrolysis products	--	0.1 (as aldehyde)
Styrene	100	420
+ C Subtilisins (Proteolytic enzymes)	--	0.0003 (as 100% pure crystalline enzyme)
+ Vanadium (V_2O_5 Fume) as V	--	0.05
Vinyl acetate	10	30
+ Vinyl chloride	200	770
+ Wood dust (non allergenic)	--	5

MINERAL DUSTS

SUBSTANCE	TLV
+ Asbestos (All types)	5 fibers/ml > 5 μ in length[k]
+ Coal dust (bituminous)	2 mg/m^3 (respirable dust)[m]
Cristobalite	Use one-half the value calculated from the count or mass formulae for quartz.
+ 'Inert' or Nuisance Particulates	10 mg/M3 or 30 mppcf (whichever is the smaller) of total dust < 1% SiO_2[n]
+ Quartz	TLV in mppcf: $\frac{300}{\%SiO_2+10}$ TLV for respirable dust in mg/m^3: $\frac{10\ mg/M^3[p]}{\%\ Respirable\ quartz + 2}$ TLV for "total dust", respirable and nonrespirable: $\frac{30\ mg/M^3}{\%\ quartz + 3}$
Silica, fused	Use quartz formulae
Tridymite	Use one-half the value calculated from formulae for quartz.

1970 addition.
See notice of intended changes.
1970 revision or addition to Notice of Intended Changes.
See Appendix A.
See Appendix B.
See Appendix C.
See Appendix D.

d) Parts of vapor or gas per million parts of contaminated air by volume at 25° C and 760 mm Hg. pressure.

e) Approximate milligrams of particulate per cubic meter of air.

f) An atmospheric concentration of not more than 0.02 ppm, or personal protection may be necessary to avoid headaches.

g) Millions of particles per cubic foot of air, based on impinger samples counted by light-field technics.

h) The percentage of crystalline silica in the formula is the amount determined from air-borne samples, except in those instances in which other methods have been shown to be applicable.

i) < 5-7M diameter. No TLV for coarse fibrous glass has yet been set.

j) As sampled by method that does not collect vapors.

k) According to analytically determined composition.

l) For control of general room air, biologic monitoring is essential for personnel control.

m) As determined by the membrane filter method at 430 x magnification phase contrast illumination. Concentrations > 5 fibers/ml, but not to exceed 10, may be permitted for 15 minute periods each hour up to five times daily.

n) "Respirable" dust as defined by the British Medical Research Council Criteria (1) and as sampled by a device producing equivalent results (2).

(1) Hatch T. E. and Gross, P., Pulmonary Deposition and Retention of Inhaled Aerosols, p. 149. Academic Press, New York, New York, 1964.

(2) Interim Guide for Respirable Mass Sampling, AIHA Aerosol Technology Committee. AIHA J31, 2, 1970, p. 133.

p) This automatically reduces all particulate substances in Adopted list with TLV of 15 mg/M^3 to 10 mg/M3.

q) Both 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 (m) (unit density sphere)	% passing selector
≤ 2	90
2.5	75
3.5	50
5.0	25
10	0

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APPENDIX A

A1 Because of the high incidence of cancer, either in man or in animals, no exposure or contact by any route, respiratory, oral or skin should be permitted for the compounds:

2-Acetylaminofluorene	beta-Naphthylamine
4-Aminodiphenyl	4-Nitrodiphenyl
Benzidine & its salts	N-Nitrosodimethylamine
Dichlorobenzidine	beta-Propiolactone
4-Dimethylaminoazobenzene	

Because of the extremely high incidence of bladder tumors in workers handling beta-naphthylamine and the potential carcinogenic activity of the other compounds, the State of Pennsylvania prohibits the manufacture, use and other activities that involve human exposure without express approval by the Department of Health.

A2 **Polytetrafluoroethylene* decomposition products.** Thermal decomposition of the fluorocarbon chain in air leads to the formation of oxidized products containing carbon, fluorine and oxygen. Because these products decompose in part by hydrolysis in alkaline solution, they can be quantitatively determined in air as fluoride to provide an index of exposure. No TLV is recommended pending determination of the toxicity of the products, but air concentrations should be minimal.

A3 **Gasoline and/or Petroleum Distillates.** The composition of these materials varies greatly and thus a single TLV for all types of these materials is no longer applicable. In general, the aromatic hydrocarbon content will determine what TLV applies. Consequently the content of benzene, other aromatics and additives should be determined to arrive at the appropriate TLV (Elkins, et al. A.I.H.A.J. 24, 99, 1963).

* Trade Names: Algoflon, Fluon, Halon, Teflon, Tetran

APPENDIX B

B.1 THRESHOLD LIMIT VALUES FOR MIXTURES

When two or more hazardous substances are present, their combined effect, rather than that of either individually, should be given primary consideration. In the absence of information to the contrary, the effects of the different hazards should be considered as additive. That is, if the sum of the following fractions,

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \text{-----} \frac{C_n}{T_n}$$

exceeds unity, then the threshold limit of the mixture should be considered as being exceeded. C_1 indicates the observed atmospheric concentration, and T_1 the corresponding threshold limit, (See Example 1A.a.).

Exceptions to the above rule may be made when there is good reason to believe that the chief effects of the different harmful substances are not in fact additive, but independent as when purely local effects on different organs of the body are produced by the various components of the mixture. In such cases the threshold limit ordinarily is exceeded only when at least one member of the series $\left(\frac{C_1}{T_1} \text{ or } + \frac{C_2}{T_2} \text{ etc.}\right)$ itself has a value exceeding unity, (See Example 1A.b.).

Antagonistic action or potentiation may occur with some combinations of atmospheric contaminants. Such cases at present must be determined individually. Potentiating or antagonistic agents are not necessarily harmful by themselves. Potentiating effects of exposure to such agents by routes other than that of inhalation is also possible, e.g. imbibed alcohol and inhaled narcotic (trichloroethylene). Potentiation is characteristically exhibited at high concentrations, less probably at low.

When a given operation or process characteristically emits a number of harmful dusts, fumes, vapors or gases, it will frequently be only feasible to attempt to evaluate the hazard by measurement of a single substance. In such cases, the threshold limit used for this substance should be reduced by a suitable factor, the magnitude of which will depend on the number, toxicity and relative quantity of the other contaminants ordinarily present.

Examples of processes which are typically associated with two or more harmful atmospheric contaminants are welding, automobile repair, blasting, painting, lacquering, certain foundry operations, diesel exhausts, etc., (Example 2.)

THRESHOLD LIMIT VALUES FOR MIXTURES
EXAMPLES

1A. General case, where air is analyzed for each component

a. Additive effects. (note: It is essential that the atmosphere be analyzed both qualitatively and quantitatively for each component present, in order to evaluate compliance or noncompliance with this calculated TLV.)

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \frac{C_3}{T_3} + \cdots\cdots = 1$$

Example No. 1: Air contains 5 ppm of carbon tetrachloride (TLV = 10 ppm) 20 ppm of ethylene dichloride (TLV = 50 ppm) and 10 ppm of ethylene dibromide (TLV = 25 ppm)

Atmospheric concentration of mixture =

5 + 20 + 10 = 35 ppm of mixture

$$\frac{5}{10} + \frac{20}{50} + \frac{10}{25} = \frac{25 + 20 + 20}{50} = 1.3$$

Threshold Limit is exceeded. Furthermore, the TLV of this mixture may be calculated by reducing the total fraction to 1.0; i.e.

$$\text{TLV of mixture} = \frac{35}{1.3} = 27 \text{ ppm}$$

Example No. 2: Air contains 200 ppm of hexane (TLV = 500 ppm) 100 ppm of methylene chloride (TLV = 500 ppm) and 20 ppm of perchlorethylene (TLV = 100 ppm)

Atmospheric concentration of mixture =

200 + 100 + 20 = 320 ppm of mixture

$$\frac{200}{500} + \frac{100}{500} + \frac{20}{100} = \frac{200 + 100 + 100}{500} = \frac{400}{500} = 0.8$$

Threshold Limit is not exceeded. The TLV of this mixture $= \frac{320}{0.8} = 400$ ppm

1B. Special case when the source of contaminant is a liquid mixture and the atmospheric composition is assumed to be similar to that of the original material; e.g. on a time weighted average exposure basis, all of the liquid (solvent) mixture eventually evaporates.

a. Additive effects (approximate solution)

1. The percent composition (by weight) of the liquid mixture is known, the TLVs of the constituents must be listed in mg/M^3.

(NOTE: In order to evaluate compliance with this TLV, field sampling instruments should be calibrated, in the laboratory, for response to this specific quantitative and qualitative air-vapor mixture, and also to fractional concentrations of this mixture; e.g., 1/2 the TLV; 1/10 the TLV; 2 X the TLV; 10 X the TLV; etc.)

$$\text{TLV of mixture} = \frac{1}{\frac{f_a}{TLV_a} + \frac{f_b}{TLV_b} + \frac{f_c}{TLV_c} + \cdots\cdots \frac{f_n}{TLV_n}}$$

Example No. 1: Liquid solvent contains (by weight) 50% heptane (TLV = 2000 mg/M^3) 30% methylene chloride (TLV = 1740 mg/M^3) 20% perchlorethylene (TLV = 670 mg/M^3)

$$\text{TLV of mixture} = \frac{1}{\frac{0.5}{2000} + \frac{0.3}{1740} + \frac{0.2}{670}} = \frac{1}{.00025 + .00017 + .0003}$$

$$= \frac{1}{.00072} = 1390 \text{ mg/M}^3$$

Of this mixture: 50% or 695 mg/M^3 is heptane, 30% or 417 mg/M^3 is methylene chloride and 20% or 278 mg/M^3 is perchlorethylene

These values can be converted to ppm as follows:

heptane:
2000 mg/M^3 = 500 ppm
1 mg/M^3 = 0.25 ppm
695 mg/M^3 = 174 ppm

methylene chloride:
1740 mg/M^3 = 500 ppm
1 mg/M^3 = 0.287 ppm
417 mg/M^3 = 119 ppm

perchlorethylene: 670 mg/M^3 = 100 ppm
1 mg/M^3 = 0.15 ppm
278 mg/M^3 = 42 ppm

The TLV of this mixture = 174 + 119 + 42 = 335 ppm.

1B.b. General Exact Solution for Mixtures of N Components With Additive Effects and Different Vapor Pressures.

(1) $\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots\ldots + \frac{C_n}{T_n} = 1;$

(2) $C_1 + C_2 + \ldots\ldots + C_n = T;$

(2.1) $\frac{C_1}{T} + \frac{C_2}{T} + \ldots\ldots + \frac{C_n}{T} = 1.$

By the Law of Partial Pressures,

(3) $C_1 = ap_1,$

and by Raoult's Law,

(4) $p_1 = F_1 p_1^{\circ}.$

Combine (3) and (4) to obtain

(5) $C_1 = aF_1 p_1^{\circ}.$

Combining (1), (2, 1) and (5), we obtain

(6) $\frac{F_1 p_1^{\circ}}{T} + \frac{F_2 p_2^{\circ}}{T} + \ldots\ldots + \frac{F_n p_n^{\circ}}{T} =$

$\frac{F_1 p_1^{\circ}}{T_1} + \frac{F_2 p_2^{\circ}}{T_2} + \ldots\ldots + \frac{F_n p_n^{\circ}}{T_n}$

and solving for T,

(6.1) $T = \frac{F_1 p_1^{\circ} + F_2 p_2^{\circ} + \ldots\ldots + F_n p_n^{\circ}}{\frac{F_1 p_1^{\circ}}{T_1} + \frac{F_2 p_2^{\circ}}{T_2} + \ldots\ldots + \frac{F_n p_n^{\circ}}{T_n}}$

or $\sum_{i}^{i} = n\ F_1 p_1^{\circ}$

(6.2) $T = \frac{i = 1}{\sum_{i}^{i = n}}$

$i = 1 \quad \frac{F_1 p_1^{\circ}}{T_1}$

T = Threshold Limit Value in ppm.
C = Vapor concentration in ppm.
p = Vapor pressure of component in solution.
p^o = Vapor pressure of pure component.
F = Mol fraction of component in solution.
a = A constant of proportionality.

Subscripts 1, 2, . . . n relate the above quantities to components 1, 2, . . . n, respectively.

Subscript i refers to an arbitrary component from 1 to n.

Absence of subscript relates the quantity to the mixture.

1B. c. Solution to be applied when there is a reservoir of the solvent mixture whose composition does not change appreciably by evaporation.

Exact Arithmetic Solution of Specific Mixture

		Mol. wt.	Density	TLV	p^o at 25°C	Mol fraction in half-and-half solution by volume
Trichloro-ethylene	(1)	131.4	1.46g/ml	100	73mm Hg	0.527
Methylchlo-roform	(2)	133.42	1.33g/ml	350	125mm Hg	0.473

$F_1 p_1^o = (0.527)\ (73) = 38.2$

$F_2 p_2^o = (0.473)\ (125) = 59.2$

$$TLV = \frac{38.2 + 59.2}{\frac{38.2}{100} + \frac{59.2}{350}} = \frac{(97.4)\ (350)}{133.8 + 59.2} = \frac{(97.4)\ (350)}{193.0} = 177$$

TLV = 177 ppm (Note difference in TLV when account is taken of vapor pressure and mol fraction in comparison with above sample where such account is not taken.)

2. A mixture of one part of (1) parathion (TLV, 0.1) and two parts of (2) EPN (TLV, 0.5).

$$\frac{C_1}{0.1} + \frac{C_2}{0.5} = \frac{C_m}{T_m} \qquad C_2 = 2C_1$$

$$C_m = 3C_1$$

$$\frac{C_1}{0.1} + \frac{2C_1}{0.5} = \frac{3C_1}{T_m}$$

$$\frac{7C_1}{0.5} = \frac{3C_1}{T_m}$$

$$T_m = \frac{1.5}{7} = 0.21 \text{ mg/M}^3$$

1C. TLV for Mixtures of Mineral Dusts.

For mixtures of biologically active mineral dusts the general formula for mixtures may be used.

For a mixture containing 80% talc and 20% quartz, the TLV for 100% of the mixture is given by:

$$TLV = \frac{1}{\frac{0.8}{20} + \frac{0.2}{2.5}} = 8.4 \text{ mppcf}$$

Essentially the same result will be obtained if the limit of the more (most) toxic component is used provided the effects are additive. In the above example the limit for 20% quartz is 10 mppcf.

For another mixture of 25% quartz, 25% amorphous silica and 50% talc:

$$TLV = \frac{1}{\frac{0.25}{2.5} + \frac{0.25}{20} + \frac{0.5}{20}} = 7.3 \text{ mppcf}$$

The limit for 25% quartz approximates 8 mppcf.

APPENDIX C

PERMISSIBLE EXCURSIONS FOR TIME-WEIGHTED AVERAGE (TWA) LIMITS

The Excursion TLV Factor in the Table automatically defines the magnitude of the permissible excursion above the limit for those substances not given a "C" designation; i.e., the TWA limits. Examples in the Table show that nitrobenzene, the TLV for which is 1 ppm, should never be allowed to exceed 3 ppm. Similarly, carbon tetrachloride, TLV 10 ppm, should never be allowed to exceed 20 ppm. By contrast, those substances with a "C" designation are not subject to the excursion factor and must be kept below the TLV.

These limiting excursions are to be considered to provide a 'rule-of-thumb' guidance for listed substances generally, and may not provide the most appropriate excursion for a particular substance. Efforts are being made to develop such specific excursions, when indicated to be significantly different from that recommended by the present excursion factors.

Substance	TLV	Excursion Factor	Max. Conc. Permitted for short time
Nitrobenzene	1 ppm	3	3 ppm
Carbon tetrachloride	10 ppm	2	20 ppm
Carbon monoxide	50 ppm	1.5	75 ppm
Acetone	1000 ppm	1.25	1250 ppm
Boron trifluoride	C 1 ppm	-	1 ppm
Butylamine	C 5 ppm	-	5 ppm
Styrene monomer	C 100 ppm	-	100 ppm

For all substances:

TLV = 0 - 1 (ppm or mg/m^3), Excursion Factor = 3
TLV = 1 - 10 " " " = 2
TLV = 10 - 100 " " " = 1.5
TLV = 100 - 1000 " " " = 1.25

BASIS FOR ASSIGNING LIMITING "C" VALUES

By definition in the forward a listed value bearing a "C" designation refers to a 'ceiling' value that should not be exceeded; all values should fluctuate below the listed value. This, in effect, makes the "C" designation a maximal allowable concentration (MAC). In general, the bases for assigning or not assigning a "C" value rest on whether excursions of concentration above a proposed limit for periods up to 15 minutes may result in a) intolerable irritation, b) chronic, or irreversible tissue change, or c) narcosis of sufficient degree to increase accident proneness, impair self-rescue or materially reduce work efficiency.

APPENDIX D

Some "Inert" or Nuisance Particulates q)

Alundum (Al_2O_3)
Calcium carbonate
Cellulose (paper fiber)
Portland Cement
Corundum (Al_2O_3)
Emery
Glycerine Mist
Graphite (synthetic)
Gypsum
Vegetable oil mists (except castor, cashew nut, or similar irritant oils)
Kaolin
Limestone
Magnesite
Marble
Pentaerythritol
Plaster of Paris
Rouge
Silicon Carbide
Starch
Sucrose
Tin Oxide
Titanium Dioxide

q) When toxic impurities are not present, e. g. quartz < 1%.

APPENDIX E

Some Simple Asphyxiants - "Inert" Gases and Vapors

Acetylene
Argon
Ethane
Ethylene
Helium
Hydrogen
Methane
Neon
Nitrogen
Nitrous Oxide
Propane