PLAINTIFF'S EXHIBIT DUP-1809

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THREshold LIMIT VALUES OF AIR-BORNE CONTAMINANTS

SAFETY ENGINEERING STANDARD

ISSUED	APRIL 1961
THIS PAGE REVISED	JAN 1975
STANDARD REAFFIRMED	JAN 1975

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This standard includes requirements of the Occupational Safety and Health Act of 1970 (OSHA) as published in the Federal Register. OSHA information is printed in red.

1. SCOPE

1.1 This standard provides a list of threshold limit values (TLVs) of air contaminants to provide criteria for safe Company work environments. TLV is defined in 4.1.2.

1.2 The TLVs listed in Tables 1 through 4† are recommended values of the American Conference of Governmental Industrial Hygienists (ACGIH), and are reprinted with their permission, together with the accompanying preface, see section 4, and Appendices A through E. The values are reviewed and published annually by ACGIH.*

1.3 Table 5 lists substances for which time weighted average (TWA),†† ceiling†† and peak†† concentrations have been established under OSHA†. Each of these substances also is included in Table 1 with references to Table 5 for the ceiling and peak concentrations.

2. APPLYING TLVs

2.1 Many situations where toxic substances are handled may require detailed review by specialized engineers, industrial hygienists, and toxicologists to obtain the optimum in design controls. When additional information is needed on the toxicity of other materials and the health hazard that may be associated with them, consultation should be made with the Haskell Laboratory for Toxicology and Industrial Medicine.

2.2 Safety precautions in DR176X shall be followed when handling radioactive materials.

2.3 TLVs for a few materials listed in Table 1 are higher (less restrictive) than those shown in OSHA Regulations, Section 1910.93, Table G-1, which is based on 1968 ACGIH values. For a few other materials, Table 1 values are higher than or augmented by additional restrictions in Table 5, which also is based upon OSHA regulations. In these cases, individual listings are referenced to explanatory footnotes to Table 1. In selecting an appropriate TLV, it should be noted that changes by ACGIH are based upon information which may not have been available when OSHA regulations were adopted, see 4.1.4.1.

2.4 Carcinogens. Substances which have proven, or are alleged to be, carcinogenic in man as considered by ACGIH are listed and discussed in Appendix A. In addition, rules applying to the manufacture, processing, packaging, handling and storage of these materials are specified in OSHA regulations 1910.93a-q as listed below. The list also includes materials, indicated by ♦, which are not included by ACGIH in Appendix A.

1910.93a	Asbestos
1910.93b	Coal tar pitch volatiles
1910.93c	4-Nitrobiphenyl
1910.93d	alpha-Napthylamine♦
1910.93e	4, 4-Methylene bis (2-chloroaniline)
1910.93f	Methyl chloromethyl ether♦
1910.93g	3, 3-Dichlorobenzidine (and its salts)
1910.93h	bis-Chloromethyl ether
1910.93i	beta-Naphthylamine
1910.93j	Benzidine
1910.93k	4-Aminodiphenyl
1910.93l	Ethyleneimine
1910.93m	beta-Propiolactone
1910.93n	2-Acetylaminofluorene♦
1910.93o	4-Dimethylaminoazobenzene
1910.93p	N-Nitrosodimethylamine
1910.93q	Vinyl chloride

3. DOCUMENTATION OF PLANT EXPERIENCE

3.1 TLVs were intended to be used only as guidelines toward the establishment of safe working environments. However, the U.S. Department of Labor has incorporated these established TLVs and other toxicity information into its regulations. In addition, government agencies at other levels that have not already done so, will undoubtedly follow suit, thereby increasing the Company's stake in factual and realistic TLVs.

3.2 Where state codes or local plant rules specify contaminant airborne concentrations different from those in the following tables, the lowest value should be used for the design of control facilities.

3.3 Each department, in consultation with the Safety and Fire Protection Division and Haskell Laboratory,

† The values in Tables 1, 2, and 3 are equal to or lower (more restrictive) than those promulgated under OSHA per 1910.93, except for a few cases in Table 1 identified by ▼. See discussion in 2.3, 4.12, and Notes to Table 1.

†† "TWA" is defined in 4.1.2, "peak" in 4.1.3, and "ceiling" in 4.2.

* Section 4 and Tables 1 through 4 in this revision are the 1974 ACGIH preface, tables and appendices.

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should consider the expansion of its sampling program to accumulate data on the levels of employee exposure to those contaminants which may be significant in Company operations. The data derived from such studies could, at an appropriate time, be submitted to the Secretary of Labor to establish, support, or refute the value for any specific material.

4. PREFACE TO ACGIH TABLES AIRBORNE CONTAMINANTS*

4.1 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.

4.1.1 Simple tests are now available (J Occup Med 9, 537, 1967; Ann. NY Acad Sci. 151. Art. 2, 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 the "coverage" of the TLVs.

4.1.2 Threshold limit values (TLVs) refer to time-weighted concentrations (TWA) 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 E and F and those substances designated with a "C" or Ceiling value, Appendix D.)

4.1.3 Time-weighted averages permit excursions above the limit (peaks) 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 D. 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.

(Note: TLVs sometimes are referred to as MACs, maximum acceptable concentrations, maximum allowable concentrations, or maximal acceptable concentrations. The American National Standards Institute publishes a series of standards (Z37 series) listing MACs, which are peak values that should not be exceeded in a normal work day. A number of these are included in Table 3.)

4.1.4 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.

4.1.4.1 The amount and nature of the information available for establishing a TLV varies from substance to substance; consequently, the precision of the estimated TLV is also subject to variation and the latest Documentation** should be consulted in order to assess the extent of the data available for a given substance.

4.1.5 The committee (ACGIH) 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.

4.1.6 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.

4.1.7 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 nuisances, (3) in estimating the toxic potential of continuous, uninterrupted exposure, (4) as proof or disproof of an existing disease or physical condition, or (5) for adoption by countries whose working conditions

* Section 4 and Tables 1 through 4 in this revision are the 1974 ACGIH preface, tables and appendices.
** "Documentation of the Threshold Limit Values for Substances in Workroom Air", ACGIH, P.O. Box 1937, Cincinnati, OH 45201 (1973).

differ from those in the United States of America and where substances and processes differ.

4.2 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.

4.2.1 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 D. 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.

4.3 "Skin" Notation. Listed substances followed by the designation "Skin" refer to the potential contribution to the overall 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 notation-calling designation is intended to suggest appropriate measures for the prevention of cutaneous absorption so that the threshold limit is not invalidated.

4.4 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 C.

4.5 Nuisance Particulates. 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.

4.5.1 Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility (iron oxide, carbon black), 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.

4.5.2 A threshold limit of 10 mg/m³, or 30 mppcf, of total dust < 1 percent quartz 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 nuisance particulates are given in Appendix E.

4.6 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 odorless. 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 F.

4.7 Short-Term Limits (STLs). Because many industrial exposures are not continuous, 8-hour daily exposures, but are short-term, or intermittent, to which the TLVs do not necessarily apply, STLs for 5, 15, or 30 minutes for 142 substances have been put into the regulations of the Pennsylvania Department of Health (Chapter 4, Art

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432. Revised Jan 25. 1968*). These STLs represent the maximal average atmospheric concentration of a contaminant to which a worker may be exposed for the stipulated time. The concentration represents an upper limit of exposure and assumes that there is sufficient recovery between exposures before another is initiated. The daily average exposure including that provided by the STL shall be such that the TLV shall not be exceeded. Similar STLs for a more restricted number of substances have been recommended by the American National Standards Institute. This standard-setting body refers to these short-term limits as "peaks." (See note under 4.1.3.)

4.8 **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 overtimes extending the workweek more than 25 percent, might be considered gross deviations. In such instances judgment must be exercised in the proper adjustments of the threshold limit values.

4.9 **Biologic Limit Values (BLVs).** Other means exist and may be necessary for monitoring worker exposure other than reliance on the Threshold Limit Values for industrial air, namely, the Biologic Limit Values. These values represent limiting amounts of substances (or their effects) to which the worker may be exposed without hazard to health or well-being as determined in his tissues and fluids or in his exhaled breath. The biologic measurements on which the BLVs are based can furnish two kinds of information useful in the control of worker exposure: (1) measure of the individual worker's overall exposure; (2) measure of the worker's individual and characteristic response. Measurements of response furnish a superior estimate of the physiologic status of the worker, and may be made of (a) changes in amount of some critical biochemical constituent, (b) changes in activity of a critical enzyme, (c) changes in some physiologic function. Measurement of exposure may be made by (1) determining in blood, urine, hair, nails in body tissues and fluids, the amount of substance to which the worker was exposed; (2) determination of the amount of the metabolite(s) of the substance in tissues and fluids; (3) determination of the amount of the substance in the exhaled breath. The biologic limits may be used as an adjunct to the TLVs for air, or in place of them. The U. S. National Institute for Occupational Safety and Health is proposing a series of these BLVs which will be issued from time to time as part of the Criteria Documents for recommended industrial air standards.

4.10 **Unlisted Substances.** There are a number of reasons why a substance does not appear in the Threshold Limit list; either insufficient information is available or it has not been brought to the attention of the Threshold Limits Committee from which a limit can be developed, or it is a substance that could be included in the Appendices E and F pertaining to Nuisance Particulates and Simple Asphyxiants. Substances appearing in these appendices serve as examples only; the appendices are not intended to be inclusive.

4.11 **"Notice of Intent."** At the beginning of each year, proposed actions of the Committee for the forthcoming year are issued in the form of a "Notice of Intended Changes." This Notice provides not only an opportunity for comment, but solicits suggestions of substances to be added to the list. The suggestions should be accompanied by substantiating evidence. The list of Intended Changes follows the Adopted Values in the TLV booklet.

4.12 **Legal Status.** By publication in the Federal Register (Vol 36, No. 105, May 29, 1971) the Threshold Limit Values (1968) are now official federal standards for industrial air.

* Pennsylvania Dept. of Health, Harrisburg, PA

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TABLE 1 – ADOPTED VALUES †
(In Alphabetical Order)

Notes, Table 1

Capital letters refer to Appendices (Except for "C" shown to the left of substances in Tables 1 and 3. This indicates data for that substance relate to Ceiling Limits. See 4.2 and 4.2.1 for discussion.)

* 1974 Addition
** See Notice of Intended Changes, Table 3
♦ See Table 5 for ceiling and peak concentrations
♦♦ See Table 5 for TLV, or ceiling concentrations, or both, which are more restrictive and are OSHA requirements
▼ TLV listed is higher (less restrictive) than those shown in OSHA regulations, Section 1910.93 Table G-1. See discussion in 2.3.
†† See 1974 Revised Documentation, 4.1.4.1

Footnotes:

(a) Parts of vapor or gas per million parts of contaminated air by volume at 25 C and 760 mm Hg pressure.
(b) Approximate milligrams of substance per cubic meter of air.
(d) An atmospheric concentration of not more than 0.02 ppm, or personal protection may be necessary to avoid headache.
(e) <7μm in diameter.
(f) As sampled by method that does not collect vapor.
(g) According to analytically determined composition.
(h) For control of general room air, biologic monitoring is essential for personnel control.
(m) See note (m), Table 2.

Radioactivity: For permissible concentrations of radioisotopes in air, see U. S. Department of Commerce, National Bureau of Standards Handbook 69, "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure," June 5, 1969. Also, see U. S. Department of Commerce National Bureau of Standards, Handbook 59, "Permissible Dose from External Sources of Ionizing Radiation," September 24, 1954, and addendum of April 15, 1958. A report, Basic Radiation Protection Criteria, published by the National Committee on Radiation Protection, revises and modernizes the concept of the NCRP standards of 1954, 1957 and 1958; obtainable as NCRP Rept. No. 39, P. O. Box 4867, Washington, D. C. 20008. (Also see 2.2.)

Substance	ppm[a]	mg/m³[b]	Substance	ppm[a]	mg/m³[b]
Abate	—	10	Alundum (Al_2O_3)	—	E
Acetaldehyde	100	180	4-Aminodiphenyl—Skin	—	A[1]
Acetic acid	10	25	2-Aminoethanol, see Ethanolamine	—	—
C Acetic anhydride	5	20	2-Aminopyridine	0.5	2
Acetone	1,000	2,400	Ammonia	25	18
Acetonitrile	40	70	Ammonium chloride, fume	—	10
Acetylene	F	—	Ammonium sulfamate (Ammate)	—	10
Acetylene dichloride, see 1, 2-Dichloroethylene	—	—	n-Amyl acetate	100	525
Acetylene tetrabromide	1	14	sec-Amyl acetate	125	650
Acrolein	0.1	0.25	Aniline—Skin	5	19
Acrylamide—Skin	—	0.3	Anisidine (o, p-isomers) —Skin	0.1	0.5
Acrylonitrile—Skin	20	45	Antimony & compounds (as Sb)	—	0.5
Aldrin—Skin	—	0.25	ANTU (alpha naphthyl thiourea)	—	0.3
Allyl alcohol—Skin	2	5			
Allyl chloride	1	3			
Allyl glycidyl ether (AGE)—Skin	5	22			
Allyl propyl disulfide	2	12			

† Table 1 values are equal to or lower (more restrictive) than those promulgated under OSHA per 1910.93 except in a few cases identified by ▼. See Table 1 Notes, and discussion in 2.3.

See above for all notes

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TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M³[b]
Argon	F	—
**Arsenic & compounds (as As)	—	0.5
Arsine	0.05	0.2
Asphalt (petroleum) fumes	—	5
Azinphos methyl — Skin.	—	0.2
* Bagon (Propaxur)	—	0.5
Barium (soluble compounds)	—	0.5
** C Benzene—Skin	25	80 ◆◆
Benzidine — Skin	—	A[18]
p-Benzoquinone, see Quinone	—	—
Benzoyl peroxide	—	5
Benzyl chloride	1	5
Beryllium	—	0.002 ◆◆
Biphenyl, see Diphenyl.	—	—
Bismuth telluride	—	10
Bismuth telluride (Se-doped)	—	5
Boron oxide	—	10
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
** Butane	500	1,200
Butanethiol, see Butyl mercaptan	—	—
2-Butanone	200	590
2-Butoxy ethanol (Butyl Cellosolve) — Skin	50	240
Butyl acetate (n-butyl acetate)	150	710
sec-Butyl acetate	200	950
tert-Butyl acetate	200	950
** n-Butyl alcohol—Skin	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 lactate	—	—
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)	—	0.05 ◆

Substance	ppm[a]	mg/M³[b]
Calcium carbonate	—	E
Carbaryl (Sevin®)	—	5
Carbon black	—	3.5
Carbon dioxide	5,000 ††1	9,000
Carbon disulfide — Skin.	20	60 ◆
Carbon monoxide	50	55
Carbon tetrachloride — Skin	10	65 ◆
Cellulose (paper fiber)	—	E
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
α-Chloroacetophenone (phenacylchloride)	0.05	0.3
Chlorobenzene (monochlorobenzene)	75	350
o-Chlorobenzylidene malononitrile (OCBM) — Skin	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- epoxy-propane, see Epichlorhydria	—	—
Calcium arsenate	—	1
Calcium oxide	—	5
Camphor (Synthetic)	2	12
Caprolactam Dust	—	1
Vapor	5	20
2-Chloroethanol, see Ethylene chlorohydrin.	—	—
Chloroethylene, see Vinyl chloride	—	—
* Chloroform (Trichloromethane)	25	120
* bis-Chloromethyl ether	0.001	A[18]
1-Chloro-1-nitropropane.	20	100
Chloropicrin	0.1	0.7
Chloroprene (2-chloro-1, 3-butadiene) — Skin	25	90
* O-Chlorotoluene	50	250
Chromates, certain insoluble forms	—	A[18]

See p 5 for all notes

TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M[3][a]
Chromic acid and chromates (as CrO_3)	—	0.1◆
Chromium, sol. chromic, chromous salts as Cr	—	0.5
Coal tar pitch volatiles (benzene soluble fraction: anthracene, BaP, phenanthrene, acridine, chrysene, pyrene)	A[bc]	0.2
Cobalt, metal fume & dust	—	0.1
** Copper fume	—	(0.1)
Dusts and Mists	—	1
Corundum (Al_2O_3)	—	E
◆ Cotton Dust (raw)	-	0.2[mg]
Crag® herbicide	—	10
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
* Cyclohexylamine — Skin	10	40
Cyclopentadiene	75	200
2, 4-D	—	10
DDT	—	1
DDVP, see Dichlorvos	—	—
Decaborane — Skin	0.05	0.3
Demeton® — Skin	0.01	0.1
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	50	240
1, 2-Diaminoethane, see Ethylenediamine	—	—
Diazinon — Skin	—	0.1
Diazomethane	0.2	0.4
Diborane	0.1	0.1
1, 2-Dibromoethane (ethylene dibromide) — Skin	20	145◆
Dibrom®	—	3
2-N Dibutylaminoethanol — Skin	2	14
Dibutyl phosphate	1	5
Dibutylphthalate	—	5
C Dichloroacetylene	0.1	0.4
C o-Dichlorobenzene	50	300
p-Dichlorobenzene	75	450
Dichlorobenzidine — Skin	—	A[bb]
Dichlorodifluoromethane	1,000	4,950
1, 3-Dichloro-5, 5-dimethyl hydantoin	—	0.2
1, 1-Dichloroethane	200	320 ▼
1, 2-Dichloroethane	50	200 ◆
1, 2-Dichloroethylene	200	790
Dichloroethyl ether — Skin	5	30
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	0.1	1
Dieldrin — Skin	—	0.25
Diethylamine	25	75
Diethylamino ethanol — Skin	10	50
Diethylene triamine — Skin	1	4
Diethylether, see Ethyl ether	—	—
Difluorodibromomethane	100	860
C Diglycidyl ether (DGE)	0.5	2.8
Dihydroxybenzene, see Hydroquinone	—	—
Diisobutyl ketone	25	150
Diisopropylamine — Skin	5	20
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-dichloroethyl phosphate, see DiBrom	—	—

See p 5 for all notes

TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M³[b]
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	0.15	1
Dinitro-o-cresol — Skin.	—	0.2
Dinitrotoluene — Skin	—	1.5
* Dioxane, technical grade — Skin	50	180
Diphenyl	0.2	1
Diphenyl amine	—	10
Diphenylmethane diisocyanate, see Methylene bisphenyl isocyanate (MDI)	—	—
Dipropylene glycol methyl ether — Skin.	100	600
Diquat	—	0.5
Di-sec. octyl phthalate (Di-2-ethylhexyl-phthalate)	—	5
* Dowtherm — Skin	—	0.1
Emery	—	E
Endosulfan (Thiodan®) — Skin	—	0.1
Endrin — Skin	—	0.1
Epichlorhydrin — Skin	5	19
EPN — Skin	—	0.5
1, 2-Epoxypropane, see Propyleneoxide	—	—
2, 3-Epoxy-1-propanol, see Glycidol	—	—
Ethane	F	—
Ethanethiol, see Ethylmercaptan	—	—
Ethanolamine	3	6
2-Ethoxyethanol — Skin.	100	370
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	F	—
Ethylene chlorohydrin — Skin	5	16
Ethylenediamine	10	25
Ethylene dibromide, see 1, 2-Dibromoethane	—	—
Ethylene dichloride, see 1, 2-Dichloroethane	—	—
Ethylene glycol, particulate	—	10
Ethylene glycol, vapor	100	260
C Ethylene glycol dinitrate and/or Nitroglycerin — Skin	0.2[n]	—
Ethylene glycol monomethyl ether acetate (Methyl cellosolve acetate) — Skin	25	120
Ethylene imine — Skin.	0.5	1
Ethylene oxide	50	90
Ethylidine chloride, see 1, 1-Dichloroethane	—	—
*C Ethylidene norbornene	5	25
N-Ethylmorpholine — Skin	20	94
Ferbam	—	10
Ferrovanadium dust	—	1
Fluoride (as F)	—	2.5[o]
Fluorine	1	2[r]
Fluorotrichloromethane.	1,000	5,600
C Formaldehyde	2	3[o]
Formic acid	5	9
Furfural — Skin	5	20
* Furfuryl alcohol	5	20
Gasoline	—	B[s]
Germanium tetrahydride	0.2	0.6
Glass, fibrous[u] or dust	—	E
Glycerin mist	—	E
Glycidol (2, 3-Epoxy-1-propanol)	50	150
Glycol monoethyl ether, see 2-Ethoxyethanol	—	—
Graphite, (Synthetic)	—	E
Guthion,® see Azinphosmethyl	—	—
Gypsum	—	E
Hafnium	—	0.5
Helium	F	—
Heptachlor — Skin	—	0.5
** Heptane (n-heptane)	500	2,000

See p 5 for all notes

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TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M³[b]
Chromic acid and chromates (as CrO_3)	—	0.1 ♦
Chromium, sol. chromic, chromous salts as Cr	—	0.5
Coal tar pitch volatiles (benzene soluble fraction: anthracene, BaP, phenanthrene, acridine, chrysene, pyrene)	A[16]	0.2
Cobalt, metal fume & dust	—	0.1
** Copper fume	—	(0.1)
Dusts and Mists	—	1
Corundum (Al_2O_3)	—	E
* Cotton Dust (raw)	—	0.2[20]
Crag® herbicide	—	10
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
* Cyclohexylamine — Skin	10	40
Cyclopentadiene	75	200
2, 4-D	—	10
DDT	—	1
DDVP, see Dichlorvos	—	—
Decaborane — Skin	0.05	0.3
Demeton® — Skin	0.01	0.1
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	50	240
1, 2-Diaminoethane, see Ethylenediamine	—	—
Diazinon — Skin	—	0.1
Diazomethane	0.2	0.4
Diborane	0.1	0.1
1, 2-Dibromoethane (ethylene dibromide) — Skin	20	145 ♦
Dibrom®	—	3
2-N Dibutylaminoethanol — Skin	2	14
Dibutyl phosphate	1	5
Dibutylphthalate	—	5
C Dichloroethylene	0.1	0.4
C o-Dichlorobenzene	50	300
p-Dichlorobenzene	75	450
Dichlorobenzidine — Skin	—	A[16]
Dichlorodifluoromethane	1,000	4,950
1, 3-Dichloro-5, 5-dimethyl hydantoin	—	0.2
1, 1-Dichloroethane	200	320 ▼
1, 2-Dichloroethane	50	200 ♦
1, 2-Dichloroethylene	200	790
Dichloroethyl ether — Skin	5	30
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	0.1	1
Dieldrin — Skin	—	0.25
Diethylamine	25	75
Diethylamino ethanol — Skin	10	50
Diethylene triamine — Skin	1	4
Diethylether, see Ethyl ether	—	—
Difluorodibromomethane	100	860
C Diglycidyl ether (DGE)	0.5	2.8
Dihydroxybenzene, see Hydroquinone	—	—
Diisobutyl ketone	25	150
Diisopropylamine — Skin	5	20
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-dichloroethyl phosphate, see DiBrom	—	—

See p 5 for all notes

TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M[3][b]
• Hexachlorocyclopentadiene	0.01	0.11
Hexachloroethane — Skin	1	10
Hexachloronaphthalene — Skin	—	0.2
Hexafluoroacetone	0.1	0.7
•• 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	F	—
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
Indium and compounds, as In	—	0.1
C Iodine	0.1	1
•• Iron oxide fume	—	(10)
Iron pentacarbonyl	0.01	0.08
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—Skin	400	980
Isopropylamine	5	12
Isopropylether	250	1,050
Isopropyl glycidyl ether (IGE)	50	240
Kaolin	—	E
Ketene	0.5	0.9
Lead, inorg., fumes and dusts	—	0.15♦
Lead arsenate	—	0.15
Limestone	—	E
Lindane	—	0.5
Lithium hydride	—	0.025
L.P.G. (Liquified petroleum gas)	1,000	1,800
Magnesite	—	E
Magnesium oxide fume	—	10
Malathion — Skin	—	10
Maleic anhydride	0.25	1
C Manganese and compounds, as Mn	—	5
• Manganese cyclopentadienyl tricarbonyl (as Mn)—Skin	—	0.1
Marble	—	E
Mercury (Alkyl compounds) — Skin	0.001	0.01♦
Mercury (All forms except alkyl)	—	0.05♦
Mesityl oxide	25	100
Methane	F	—
Methanethiol, see Methyl mercaptan	—	—
Methoxychlor	—	10
2-Methoxyethanol—Skin (Methyl cellosolve)	25	80
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
Methyl acrylonitrile — Skin	1	3
Methylal (dimethoxymethane)	1,000	3,100
Methyl alcohol (methanol)—Skin	200	260
Methylamine	10	12
Methyl amyl alcohol, see Methyl isobutyl carbinol	—	—
Methyl 2-cyanoacrylate	2	8
Methyl isoamyl ketone	100	475
Methyl (n-amyl) ketone (2-Heptanone)	100	465
Methyl bromide — Skin	15	60
Methyl butyl ketone, see 2-Hexanone	—	—
Methyl cellosolve — Skin see 2-Methoxyethanol	—	—
Methyl cellosolve acetate — Skin, see Ethylene glycol monomethyl ether acetate	—	—
Methyl chloride	100	210♦
Methyl chloroform	350	1,900
•• Methylcyclohexane	500	2,000
Methylcyclohexanol	50	235
o-Methylcyclohexanone — Skin	50	230
Methylcyclopentadienyl manganese tricarbonyl (as Mn) — Skin	0.1	0.2

See p 5 for all notes

TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M³[b]
Methyl demeton — Skin.	—	0.5
Methyl ethyl ketone (MEK), see 2-Butanone	—	—
°C Methyl ethyl ketone peroxide	0.2	1.5
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 parathion—Skin.	—	0.2
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)♦
* 4,4'-Methylene bis (2-chloraniline)—Skin	0.02	A[i]
°C Methylene bis (4-cyclohexylisocyanate)	0.1	0.11
Molybdenum (soluble compounds)	—	5
(insoluble compounds)	—	10
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[ic]
Neon	F	—
Nickel carbonyl	0.001	A[ic] 0.007
Nickel, metal and insoluble compounds (as Ni)	—	1
** Nickel, soluble compounds (as Ni)	—	1
Nicotine — Skin	0.075	0.5
Nitric acid	2	5
Nitric oxide	25	30
p-Nitroaniline — Skin	1	6
Nitrobenzene — Skin	1	5
p-Nitrochlorobenzene — Skin	—	1
4-Nitrodiphenyl	—	A[ic]
Nitroethane	100	310
C 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 (dimethylnitrosoamine) — Skin	—	A[i]
Nitrotoluene — Skin	5	30
Nitrotrichloromethane, see Chloropicrin	—	—
Nitrous oxide	F	—
Octachloronaphthalene — Skin	—	0.1
** Octane	400	1,900
Oil mist, particulate	—	5[f]
Oil mist, vapor	[f]B[i]	—
Osmium tetroxide	0.0002	0.002
Oxalic acid	—	1
Oxygen difluoride	0.05	0.1
Ozone	0.1	0.2
* Paraffin wax fume	—	0.2
Paraquat — Skin	—	0.5
Parathion — Skin	—	0.1
Pentaborane	0.005	0.01
Pentachloronaphthalene — Skin	—	0.5
Pentachlorophenol — Skin	—	0.5
Pentaerythritol	—	E
** Pentane	500	1,500
2-Pentanone	200	700
Perchloroethylene	100	670♦
Perchloromethyl mercaptan	0.1	0.8
Perchloryl fluoride	3	14
Petroleum Distillates (naphtha)	[a]B[i]	—
Phenol — Skin	5	19
Phenothiazine — Skin	—	5
p-Phenylene diamine — Skin	—	0.1
Phenyl ether (vapor)	1	7
Phenyl ether-Diphenyl mixture (vapor)	1	7
Phenylethylene, see Styrene	—	—
Phenyl glycidyl ether (PGE)	10	60
Phenylhydrazine — Skin.	5	22
C Phenylphosphine	0.05	0.25
* Phorate (Thimet®)—Skin	—	0.05
Phosdrin (Mevinphos)® — Skin	0.01	0.1
** Phosgene (carbonyl chloride)	0.1	0.4

See p 5 for all notes

TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M³[b]
* Hexachlorocyclopentadiene	0.01	0.11
Hexachloroethane — Skin	1	10
Hexachloronaphthalene — Skin	—	0.2
Hexafluoroacetone	0.1	0.7
** 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	F	—
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
Indium and compounds, as In	—	0.1
C Iodine	0.1	1
** Iron oxide fume	—	(10)
Iron pentacarbonyl	0.01	0.08
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 — Skin	400	980
Isopropylamine	5	12
Isopropylether	250	1,050
Isopropyl glycidyl ether (IGE)	50	240
Kaolin	—	E
Ketene	0.5	0.9
Lead, inorg., fumes and dusts	—	0.15◆
Lead arsenate	—	0.15
Limestone	—	E
Lindane	—	0.5
Lithium hydride	—	0.025
L.P.G. (Liquified petroleum gas)	1,000	1,800
Magnesite	—	E
Magnesium oxide fume	—	10
Malathion — Skin	—	10
Maleic anhydride	0.25	1
C Manganese and compounds, as Mn	—	5
* Manganese cyclopentadienyl tricarbonyl (as Mn) — Skin	—	0.1
Marble	—	E
Mercury (Alkyl compounds) — Skin	0.001	0.01◆
Mercury (All forms except alkyl)	—	0.05◆
Mesityl oxide	25	100
Methane	F	—
Methanethiol, see Methyl mercaptan	—	—
Methoxychlor	—	10
2-Methoxyethanol — Skin (Methyl cellosolve)	25	80
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
Methyl acrylonitrile — Skin	1	3
Methylal (dimethoxymethane)	1,000	3,100
Methyl alcohol (methanol) — Skin	200	260
Methylamine	10	12
Methyl amyl alcohol, see Methyl isobutyl carbinol	—	—
Methyl 2-cyanoacrylate	2	8
Methyl isoamyl ketone	100	475
Methyl (n-amyl) ketone (2-Heptanone)	100	465
Methyl bromide — Skin	15	60
Methyl butyl ketone, see 2-Hexanone	—	—
Methyl cellosolve — Skin	—	—
see 2-Methoxyethanol	—	—
Methyl cellosolve acetate — Skin, see Ethylene glycol monomethyl ether acetate	—	—
Methyl chloride	100	210◆
Methyl chloroform	350	1,900
** Methylcyclohexane	500	2,000
Methylcyclohexanol	50	235
o-Methylcyclohexanone — Skin	50	230
Methylcyclopentadienyl manganese tricarbonyl (as Mn) — Skin	0.1	0.2

See p 5 for all notes

TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M³[a]
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	—	E
Platinum (Soluble Salts) as Pt	—	0.002
Polychlorobiphenyls, see Chlorodiphenyls	—	—
Polytetrafluoroethylene decomposition products	—	B[1]
°C Potassium hydroxide	—	2
Propane	F	—
β Propiolactone	—	A[3]
Propargyl alcohol — Skin	1	2
n-Propyl acetate	200	840
Propyl alcohol — Skin	200	500
n-Propyl nitrate	25	110
Propylene dichloride (1, 2-Dichloropropane)	75	350
Propylene glycol monomethyl ether	100	360
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
Rosin Core Solder, pyrolysis products (as formaldehyde)	—	0.1
Rotenone (commercial)	—	5
Rouge	—	E
Selenium compounds (as Se)	—	0.2
Selenium hexafluoride	0.05	0.4
* Sevin® (see Carbaryl)	—	—
* Silane (see Silicon tetrahydride)	—	—
Silicon	—	E
Silicon carbide	—	E
* Silicon tetrahydride (Silane)	0.5	0.7
Silver, metal and soluble compounds	—	0.01
Sodium fluoroacetate (1080) — Skin	—	0.05
°°C Sodium hydroxide	—	(2)
Starch	—	E
Stibine	0.1	0.5
°° Stoddard solvent	200	1,150
Strychnine	—	0.15
Styrene (Monomer) (Phenyl ethylene)	100	420◆
Sucrose	—	E
Sulfur dioxide	5	13
Sulfur hexafluoride	1,000	6,000
Sulfuric acid	—	1
Sulfur monochloride	1	6
Sulfur pentafluoride	0.025	0.25
Sulfur tetrafluoride	0.1	0.4
Sulfuryl fluoride	5	20
Systox, see Demeton®	—	—
2, 4, 5-T	—	10
Tantalum	—	5
TEDP — Skin	—	0.2
Teflon® decomposition products	—	B[1]
Tellurium	—	0.1
Tellurium hexafluoride	0.02	0.2
TEPP — Skin	0.004	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[4]▼
Tetrahydrofuran	200	590
Tetramethyl lead (as Pb) — Skin	—	0.150[4]▼
Tetramethyl succinonitrile — Skin	0.5	3
Tetranitromethane	1	8
Tetryl (2, 4, 6-trinitrophenylmethylnitramine) — Skin	—	1.5

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TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M³[b]
Thallium (soluble compounds)—Skin (as Tl)	—	0.1
Thiram●	—	5
Tin (inorganic compounds, except SnH_4 and SnO_2) as Sn	—	2
Tin (organic compounds) —Skin (as Sn)	—	0.1
Tin oxide	—	E
Titanium dioxide	—	E
Toluene (toluol) — Skin	100	375 ♦
C Toluene-2, 4-diisocyanate	0.02	0.12
o-Toluidine	5	22
Toxaphene, see Chlorinated camphene	—	—
Tributyl phosphate	—	5
1, 1, 1-Trichloroethane, see Methyl chloroform	—	—
1, 1, 2-Trichloroethane —Skin	10	45
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	0.2	1.5
Triorthocresyl phosphate	—	0.1
Triphenyl phosphate	—	3
Tungsten & compounds, as W		
Soluble	—	1
Insoluble	—	5
Turpentine	100	560
Uranium (natural) soluble & insoluble compounds, as U	—	0.2 ▼
Vanadium (V_2O_5), as V		
Dust	—	0.5
C Fume	—	0.05
Vinyl acetate	10	30
Vinyl benzene, see Styrene	—	—
Vinyl bromide	250	1,100
** Vinyl chloride (See Table 3 and its note †) ▼		
Vinylcyanide, see Acrylonitrile	—	—
Vinyl toluene	100	480
Warfarin	—	0.1
Wood dust (nonallergenic)	—	5
Xylene (xylol) — Skin	100	435
Xylidine — Skin	5	25
Yttrium	—	1
Zinc chloride fume	—	1
Zinc oxide fume	—	5
* Zinc stearate	—	E
Zirconium compounds (as Zr)	—	5

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See p 5 for all notes

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TABLE 1 — ADOPTED VALUES (CONT'D)

Substance	ppm[a]	mg/M³[a]
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	—	E
Platinum (Soluble Salts) as Pt	—	0.002
Polychlorobiphenyls, see Chlorodiphenyls	—	—
Polytetrafluoroethylene decomposition products	—	B[t]
°C Potassium hydroxide	—	2
Propane	F	—
β Propiolactone	—	A[s]
Propargyl alcohol — Skin	1	2
n-Propyl acetate	200	840
Propyl alcohol — Skin	200	500
n-Propyl nitrate	25	110
Propylene dichloride (1, 2-Dichloropropane)	75	350
Propylene glycol monomethyl ether	100	360
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
Rosin Core Solder, pyrolysis products (as formaldehyde)	—	0.1
Rotenone (commercial)	—	5
Rouge	—	E
Selenium compounds (as Se)	—	0.2
Selenium hexafluoride	0.05	0.4
• Sevin® (see Carbaryl)	—	—
• Silane (see Silicon tetrahydride)	—	—
Silicon	—	E
Silicon carbide	—	E
• Silicon tetrahydride (Silane)	0.5	0.7
Silver, metal and soluble compounds	—	0.01
Sodium fluoroacetate (1080) — Skin	—	0.05
°°C Sodium hydroxide	—	(2)
Starch	—	E
Stibine	0.1	0.5
°° Stoddard solvent	200	1,150
Strychnine	—	0.15
Styrene (Monomer) (Phenyl ethylene)	100	420 ♦
Sucrose	—	E
Sulfur dioxide	5	13
Sulfur hexafluoride	1,000	6,000
Sulfuric acid	—	1
Sulfur monochloride	1	6
Sulfur pentafluoride	0.025	0.25
Sulfur tetrafluoride	0.1	0.4
Sulfuryl fluoride	5	20
Systox, see Demeton®	—	—
2, 4, 5-T	—	10
Tantalum	—	5
TEDP — Skin	—	0.2
Teflon® decomposition products	—	B[t]
Tellurium	—	0.1
Tellurium hexafluoride	0.02	0.2
TEPP — Skin	0.004	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[u] ▼
Tetrahydrofuran	200	590
Tetramethyl lead (as Pb) — Skin	—	0.150[u] ▼
Tetramethyl succinonitrile — Skin	0.5	3
Tetranitromethane	1	8
Tetryl (2, 4, 6-trinitrophenylmethylnitramine) — Skin	—	1.5

See p 5 for all notes

TABLE 2 – MINERAL DUSTS†

Notes, Table 2

* 1974 Addition

** See Notice of Intended Changes for Mineral Dusts, Table 4

†† A more stringent TLV for crocidolite may be required

Footnotes:

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

(j) The percentage of quartz in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

(k) 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 (μm) (Unit Density Sphere)	% Passing Selector
≤2.0	90
2.5	75
3.5	50
5.0	25
10.0	0

(l) Containing <1% quartz; if quartz content >1%, use formulae for quartz.

(n) As determined by the membrane filter method at 400–450 X magnification (4 mm objective) phase contrast illumination.

(p) "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. F. 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. AHIA J. 31: 2. 1970, p 133.

Substance	TLV
***SILICA*, SiO_2**	
Crystalline	
Quartz	TLV in mppcf: $\frac{300^{(j)}}{\%\ \text{quartz} + 10}$ TLV for respirable dust in mg/m³: $\frac{10\ \text{mg/m}^{3(k)}}{\%\ \text{Respirable quartz} + 2}$ TLV for "total dust," respirable and nonrespirable: $\frac{30\ \text{mg/m}^3}{\%\ \text{quartz} + 3}$
Cristobalite	Use one-half the value calculated from the count or mass formulae for quartz.
Tridymite	Use one-half the value calculated from formulae for quartz.
Silica, fused	Use quartz formulae.
Amorphous	20 mppcf(l)

SILICATES (<1% quartz)	
*Asbestos, all forms†	5 fibers/cc > 5μm in length(n); A(p)
Graphite (natural)	15 mppcf
Mica	20 mppcf
*Mineral wool fiber	10 mg/m³
Perlite	30 mppcf
Portland Cement	30 mppcf
Soapstone	20 mppcf
Talc (nonasbestiform)	20 mppcf
Talc (fibrous) use Asbestos limit.	
Tremolite, see Asbestos.	
*Tripoli, use respirable(p)	mass quartz formula
COAL DUST (bituminous).	2 mg/m³ (respirable dust fraction <5% quartz). If >5% quartz use respirable mass formula.
NUISANCE PARTICULATES (see Appendix E)	30 m.p.p.c.f. or 10 mg/m³(j) of total dust <1% quartz

Conversion factors

mppcf × 35.3 = million particles per cubic meter = particles per c.c.

† Table 2 values are equal to or lower (more restrictive) than those promulgated under OSHA per 1910.93, and 1910.93a.

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TABLE 3 — NOTICE OF INTENDED CHANGES (FOR 1974)

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. If, after two years no evidence comes to light that questions the appropriateness of the values herein, the values will be reconsidered for the "Adopted" list. Documentation is available for each of these substances.

Notes for Table 3

Capital letters refer to Appendices (Except for "C" shown to the left of substances in Table 3. This indicates data for that substance relate to Ceiling Limits. See 4.2 and 4.2.1 for discussion.)

\+ 1974 Revision or Addition

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

(b) Approximate milligrams of substance per cubic meter of air.

(c) Based on "high volume" sampling.

Substance	ppm[a]	mg/m³[b]
+Arsenic, inorganic compounds (as As)	—	0.25
+Benzene—Skin	10	30
+Butane	600	1,450
+n-Butyl alcohol	50	150
+n-Butyl lactate	5	25
+Cadmium dusts & salts	—	0.05
C Cadmium oxide fume	—	0.05
+Calcium cyanamide	—	0.5
+Calcium hydroxide	—	2
+Captan	—	5
+Carbofuran	—	0.10
Carbon tetrabromide	0.1	1.4
Catechol (Pyrocatechol)	1	4.5
Cesium hydroxide	—	2
Chlorodifluoromethane	1000	3500
Chlorpyrifos (Dursban®)—Skin	—	0.2
o-Chlorostyrene	50	285
2-Chloro-6-(trichloromethyl) pyridine (N-Serve®)	—	10
Clopidol (Coyden®)	—	10
Copper fume	—	0.2
Crufomate (Ruelene®)	—	5
+Dicyclopentadiene	5	30
Dicyclopentadienyliron	—	10
Diethylphthalate	—	5
+Dimethyl sulfate—Skin	—	A[d]
3,5-Dinitro-o-toluamide (Zoalene®)	—	5
+Disulfuram	—	2
2,6-Ditert. butyl-p-cresol	-	10
+Dyfonate	—	0.1
+C Ethylene chlorohydrin—Skin	1	3
+Fensulfothion (Dasanit)	—	0.1
Formamide	20	30
+C Glutaraldehyde	2	8
+C Glutaraldehyde (Alkaline activated)	—	0.25
+Heptane	400	1,000
+Hexane	100	300
+Hexylene glycol	25	125
+Hydrogenated terphenyls	0.4	4.4
+Iodoform	0.2	3.0
Iron oxide fume	B[c]	5
+Isobutyl alcohol	50	150
+Isophorone	5	25
+Methylcyclohexane	400	1,600
+Methylene chloride (Dichloromethane)	100	360
+Nickel, soluble salts (as Ni)	—	0.1
+Nonane	200	1,050
+Octane	300	1,450
+Pentane	600	1,800
+C Phosgene	0.05	0.2
Picloram (Tordon®)	—	10
+Resorcinol	10	45
+C Sodium azide	0.1	0.3
C Sodium hydroxide	—	2.0
+Stoddard Solvent	100	575
C Subtilisins (Proteolytic enzymes as 100% pure crystalline enzyme)	—	0.00006[e]
+Succindialdehyde (see Glutaraldehyde)	—	—
+4,4'-Thiobis (6-tert butyl-m-cresol)	—	10
Tricyclohexyltin hydroxide (Plictran®)	—	5
+Triphenylamine	—	5
+Vinyl chloride	Pending	A[d]
Vinylidene chloride	10	40
+Welding fumes (Total Particulate)	—	5&B[c]
+m-Xylene,α,α'-Diamine	—	0.1

[a] See OSHA regulation, section 1910.93u. Vinyl Chloride TLV: 1 ppm, 5 ppm average in a 15 minute period

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TABLE 4 — NOTICE OF INTENDED CHANGES FOR 1974 — MINERAL DUSTS

Notes for Table 4

\+ 1974 Addition

(p) "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. AHIA J. 31: 2, 1970, p 133.

Substance	TLV
+ Diatomaceous earth (Natural, uncalcined)	0.1 mg/m³
Silica flour	Use respirable (p) mass formula for quartz

TABLE 5 — ACCEPTABLE TLV (TWA), CEILING AND PEAK CONCENTRATIONS

Material and Referenced ANSI Standard▲	TLV (TWA) 8-Hour Time Weighted Average	Acceptable Ceiling Concentration	Acceptable Maximum Peak Above the Acceptable Ceiling Concentration for an 8-Hour Shift	
			Concentration	Maximum Duration
Benzene (ANSI Z37.4)	10 ppm	25 ppm	50 ppm	10 minutes
Beryllium and beryllium compounds (Z37.29)	2μ g/M³	5μ g/M³	25μ g/M³	30 minutes
Cadmium fume (Z37.5)	0.1 mg/M³	0.3 mg/M³		
Cadmium dust (Z37.5)	0.2 mg/M³	0.6 mg/M³		
Carbon disulfide (Z37.3)	20 ppm	30 ppm	100 ppm	30 minutes
Carbon tetrachloride (Z37.17)	10 ppm	25 ppm	200 ppm	5 min in any 4 hr
Ethylene dibromide (Z37.31)	20 ppm	30 ppm	50 ppm	5 minutes
Ethylene dichloride (Z37.21)	50 ppm	100 ppm	200 ppm	5 min in any 3 hr
Formaldehyde (Z37.16)	3 ppm	5 ppm	10 ppm	30 minutes
Hydrogen fluoride (Z37.28)	3 ppm			
Fluoride as dust (Z37.28)	2.5 mg/M³			
Lead and its inorganic compounds (Z37.11)	0.2 mg/M³			
Methyl chloride (Z37.18)	100 ppm	200 ppm	300 ppm	5 min in any 3 hr
Methylene chloride (Z37.23)	500 ppm	1000 ppm	2000 ppm	5 min in any 2 hr
Organo (alkyl) mercury (Z37.30)	0.01 mg/M³	0.04 mg/M³		
Styrene (Z37.15)	100 ppm	200 ppm	600 ppm	5 min in any 3 hr
Trichloroethylene (Z37.19)	100 ppm	200 ppm	300 ppm	5 min in any 2 hr
Tetrachloroethylene (Z37.22)	100 ppm	200 ppm	300 ppm	5 min in any 3 hr
Toluene (Z37.12)	100 ppm	200 ppm	500 ppm	10 minutes once/day
Hydrogen sulfide (Z37.2)		20 ppm	50 ppm	10 minutes once*
Mercury (Z37.8)		1 mg/10 M³		
Chromic acid and chromates (Z37.7)		1 mg/10 M³		

* 10 minutes once only if no other measurable exposure occurs

▲ Consensus standards referenced in OSHA regulations by issue date may not be the latest edition. However, it is Company practice to use for reference the current edition of consensus standards.

Portions printed in red meet or exceed OSHA regulations per 1910.93.

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APPENDIX A

Carcinogens ◊

The committee lists below those substances in industrial use that have proven carcinogenic in man, or have induced cancer in animals under appropriate experimental conditions. Present listing of those substances carcinogenic for man takes three forms, those for which a TLV has been assigned (1a), those for which environmental conditions have not been sufficiently defined to assign a TLV (1b), and 1c, those whose reassignment of a TLV is awaiting more definitive data, and hence should be treated as a 1b carcinogen.

1a **Human Carcinogens** – Substances recognized as occupational carcinogens with an assigned TLV:
Asbestos, all forms, 5 fibers/cc >5μm in length
bis (Chloromethyl) ether, 1 ppb
Chromates, certain insoluble forms (Pb, Zn, and chromate-chromite ore, 100μg/m³, as Cr)
Coal tar pitch volatiles 200μg/m³
Nickel carbonyl, 1 ppb

1b **Human Carcinogens** – Substances known to be potent occupational carcinogens without an assigned TLV:
4-Aminodiphenyl (p-Xenylamine)
Benzidine & its salts
beta-Naphthylamine
4-nitrodiphenyl

1c **Human Carcinogens** – Substances awaiting reassignment of TLV because of recently discovered carcinogenicity. Vinyl chloride, TLV pending.

For the substances in 1b, no exposure or contact by any route, respiratory, skin or oral, as detected by the most sensitive methods, shall be permitted. "No exposure or contact" means hermitizing the process or operation by the best practicable engineering methods. The worker should be properly equipped to ensure virtually no contact with the carcinogen.

2 **Experimental Carcinogens** – Industrial substances found to be capable of inducing tumors under experimental conditions in animals
Beryllium (TLV: 0.002 mg/m³)
3, 3'-Dichlorobenzidine
Dimethyl sulfate
Ethyleneimine
4, 4'-Methylene bis (2-Chloroaniline)
N-Nitrosodimethylamine
beta-Propiolactone

For the above, worker exposure by all routes should be carefully controlled to levels consistent with the animal and human experience data, except for those substances with a listed TLV.

Trade Names: Algoflon, Fluon, Halon, "Teflon," Teroon

◊ Also see discussion in 2.4

APPENDIX B

B¹ **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 kept below the limit of sensitivity of the analytic method.

B² **Gasoline.** The composition of gasoline 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, AIHAJ 24:99, 1963).

B³ **Petroleum Distillates.** For petroleum distillates for which no specific TLV's are listed, approximate values can be obtained by use of the following equation:

$$TLV = \frac{100}{x + y} \text{ ppm}$$

where

$$x = \frac{\%Al}{3.6(200 - B.P.°C.) + 20}$$

$$y = \frac{\%Ar}{1.3(200 - B.P.°C.) + 10}$$

and where

Al = Aliphatic component
Ar = Aromatic component
B.P. = Mean boiling point in degrees centigrade (normally the 50% distillation temperature).

The equation cannot be used if the benzene content of the fraction exceeds 1%, nor if the mean boiling point is above 200 C.

It may also lead to error if there are large amounts of hexane or cyclohexane in the distillate.

If the molecular weight (average) is not known for the mixture, it can be approximated by the following equation:

$$M.W. = \%Al + 0.89\%Ar + 0.5(B.P.°C.) - 100$$

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APPENDIX A

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4-Aminodiphenyl (p-Xenylamine)
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◊ Also see discussion in 2-A.

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B² **Gasoline.** The composition of gasoline 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. AIHAJ 24:99, 1963).

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and where

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B.P. = Mean boiling point in degrees centigrade (normally the 50% distillation temperature).

The equation cannot be used if the benzene content of the fraction exceeds 1%, nor if the mean boiling point is above 200 C.

It may also lead to error if there are large amounts of hexane or cyclohexane in the distillate.

If the molecular weight (average) is not known for the mixture, it can be approximated by the following equation:

$$M.W. = \%Al + 0.88\%Ar + 0.5(B.P.°C.) - 100$$

B[q] Welding Fumes – Total Particulate
5 mg/m³ (N.O.C)[q]

In electric or oxy-gas welding of iron or steel, galvanized iron or aluminum, the chief components of the fume are ordinarily oxides of iron, zinc or aluminum. Other fumes, as well as toxic gases may be present in significant amounts, however. Manganese, silicate and organic binders are commonly present in the coatings of welding rods for ferrous metals; fluoride in those for aluminum. And elements such as arsenic, copper, are sometimes found. Many aluminum rods contain appreciable quantities of silicon, and some have traces of beryllium. In shielded arc welding, ozone is often formed, and carbon monoxide has been reported when CO_2 was utilized as shield gas. Oxides of nitrogen are more likely to be associated with oxy-gas than with electric arc welding.

Because of the additional hazard created by toxic gases and traces to small amounts of fumes of more toxic elements, the total fume concentration, when welding iron, mild steel or aluminum, should not exceed 5 mg/m³ in the breathing zone of the welder or others in the area.
The fumes from stainless steel, cadmium- or lead-coated steel, and other metals such as copper and nickel are considerably more toxic and concentrations should generally be kept at a lower level, depending on the TLV's of the metals involved. In addition, in the shielded arc welding of aluminum, relatively large amounts of ozone may be generated, and the concentration of this gas may largely determine the health hazard.

APPENDIX C

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 sums of the following fractions,

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

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 and 1A.c).

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

$$\frac{C_1}{T_1} + \text{or} + \frac{C_2}{T_2} \text{ etc}$$

itself has a value exceeding unity (see Example 1A.c).

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 frequently will 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 in 1A.a).

THRESHOLD LIMIT VALUES FOR MIXTURES

EXAMPLES

1A.a 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.)

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

q) Not otherwise classified

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Example No. 1A.a: 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 = 20 ppm)

Atmospheric concentration of mixture =

$$5 + 20 + 10 = 35 \text{ ppm of mixture}$$

$$\frac{5}{10} + \frac{20}{50} + \frac{10}{20} = \frac{25 + 20 + 25}{50} = 1.4$$

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

$$\text{TLV of mixture} = \frac{35}{1.4} = 25 \text{ ppm}$$

1A.b. 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.

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/m³.

(Note: In order to evaluate compliance with this TLV, field sampling instruments should be calibrated, in the laboratory, for response to this specification quantitative and qualitative air-vapor mixture, and also to fractional concentrations of this mixture; e.g., ½ the TLV; 1/10 the TLV; 2 x the TLV; 10 x the TLV; etc.)

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

Example No. 1: Liquid solvent contains (by weight) 50% heptane (TLV = 2000 mg/m³) 30% methylene chloride (TLV = 1740 mg/m³) 20% perchloroethylene (TLV = 670 mg/m³)

$$\text{TLV of mixture} = \frac{1}{\frac{0.5}{1600} + \frac{0.3}{360} + \frac{0.2}{670}}$$

$$= \frac{1}{0.00031 + 0.00083 + 0.0003}$$

$$= \frac{1}{0.00144} = 692 \text{ mg/m}^3$$

To convert to ppm, consult TLV list:

50% heptane = 200 ppm
30% methylene chloride = 33 ppm
20% perchloroethylene = 20 ppm

TLV of mixture: 200 + 33 + 20 = 253 ppm

1.A.c Independent Effects. Air contains 0.15 mg/m³ of lead (TLV, 0.15) and 0.7 mg/m³ of sulfuric acid (TLV, 1).

$$\frac{0.15}{0.15} = 1; \quad \frac{0.7}{1} = 0.7$$

Threshold limit is not exceeded.

1B.a. General exact solution for mixtures of N components with additive effects and different vapor pressures.

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

(2) $$C_1 + C_2 + \cdots + C_n = T.$$

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

(3) $$C_1 = ap_1,$$

and by Raoult's Law,

(4) $$p_1 = F_1P_1^\circ.$$

Combine (3) and (4) to obtain

(5) $$C_1 = aF_1P_1^\circ$$

Combining (1), (2.1) and (5), we obtain

(6) $$\frac{F_1P_1^\circ}{T} + \frac{F_2P_2^\circ}{T} + \cdots + \frac{F_nP_n^\circ}{T} = \frac{F_1P_1^\circ}{T_1} + \frac{F_2P_2^\circ}{T_2} + \cdots + \frac{F_nP_n^\circ}{T_n}$$

and solving for T,

(6.1) $$T = \frac{F_1P_1^\circ + F_2P_2^\circ + \cdots + F_nP_n^\circ}{\frac{F_1P_1^\circ}{T_1} + \frac{F_2P_2^\circ}{T_2} + \cdots + \frac{F_nP_n^\circ}{T_n}}$$

or $$\frac{1}{\Sigma} = n\,F_1P_1^\circ$$

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B* Welding Fumes — Total Particulate
5 mg/m³ (N.O.C)[1]

In electric or oxy-gas welding of iron or steel, galvanized iron or aluminum, the chief components of the fume are ordinarily oxides of iron, zinc or aluminum. Other fumes, as well as toxic gases may be present in significant amounts, however. Manganese, silicate and organic binders are commonly present in the coatings of welding rods for ferrous metals; fluoride in those for aluminum. And elements such as arsenic, copper, zinc sometimes found. Many aluminum rods contain appreciable quantities of silicon, and some have traces of beryllium. In shielded arc welding, ozone is often formed, and carbon monoxide has been reported when CO_2 was utilized as shield gas. Oxides of nitrogen are more likely to be associated with oxy-gas than with electric arc welding.

Because of the additional hazard created by toxic gases and traces to small amounts of fumes of more toxic elements, the total fume concentration, when welding iron, mild steel or aluminum, should not exceed 5 mg/m³ in the breathing zone of the welder or others in the area.

The fumes from stainless steel, cadmium- or lead-coated steel, and other metals such as copper and nickel are considerably more toxic and concentrations should generally be kept at a lower level, depending on the TLV's of the metals involved. In addition, in the shielded arc welding of aluminum, relatively large amounts of ozone may be generated, and the concentration of this gas may largely determine the health hazard.

APPENDIX C

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 sums of the following fractions,

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

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 and 1A.c).

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

$$\frac{C_1}{T_1} \text{ or } \frac{C_2}{T_2} \text{ etc}$$

itself has a value exceeding unity (see Example 1A.c).

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 (trichlorethylene). 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 frequently will 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 in 1A.a).

THRESHOLD LIMIT VALUES FOR MIXTURES EXAMPLES

1A.a 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.)

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

[1] Not otherwise classified

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

$$i = \frac{F_1 P_1^{\circ}}{T_1}$$

T = Threshold Limit Value in ppm
C = Vapor concentration in ppm
p = Vapor pressure of component in solution
p° = 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.

18.b. Solution to be applied when there is a reservior of the solvent mixture whose composition does not change appreciably by evaporation.

Exact Arithmetic Solution of Specific Mixture

Solvent	Mol wt	Density	TLV	p° 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

$$F_{1P1}^{\circ} = (0.527)(73) = 38.2$$

$$F_{2P2}^{\circ} = (0.473)(125) = 59.2$$

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

$$= \frac{(97.4)(350)}{193.0} = 177$$

TLV = 177 ppm (Note difference in TLV when account is taken of vapor pressure and mol fraction in comparison with above example 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).

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

$$C_m = 3C_1$$

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

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

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

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:

$$TLV = \frac{1}{\frac{0.8}{20} + \frac{0.2}{2.9}} = 8.0 \text{ mppcf}$$

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:

$$TLV = \frac{1}{\frac{0.25}{2.9} + \frac{0.25}{20} + \frac{0.5}{20}} = 7.0 \text{ mppcf}$$

The limit for 25% quartz approximates 8 mppcf.

APPENDIX B
Permissible Excursions for Time-Weighted Average (TWA) Limits

The Excursion TLV Factor in the Table enumerates 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, never should be allowed to exceed 3 ppm.

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Similarly, carbon tetrachloride, TLV 10 ppm, never should 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 at or below the TLV ceiling.

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 e.g., the permissible excursion for CO is 400 ppm for 15 minutes.

For appropriate excursions for 142 substances consult, Pennsylvania Rules & Regs, Chap. 4, Art. 432, (see 4.7), and "Acceptable Concentrations," ANSI Z37 Series.

Substance	TLV	Excursion Factor	Max Conc Permitted for Short Time
Nitrobenzene	1 ppm	3	3 ppm
Carbon tetrachloride	10 ppm	2	20 ppm
o-Dichlorobenzene	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

Excursion Factors

For all substances not bearing C notation

TLV > 0–1 (ppm or mg/m³), Excursion Factor = 3
TLV > 1–10 (ppm or mg/m³), Excursion Factor = 2
TLV > 10–100 (ppm or mg/m³), Excursion Factor = 1.5
TLV > 100–1000 (ppm or mg/m³), Excursion Factor = 1.25

The number of times the excursion above the TLV is permitted is governed by conformity with the Time-Weighted Average TLV.

Basis for Assigning Limiting "C" Values

By definition in the Preface, 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 basis 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 E

Some Nuisance Particulates [q]

TLV, 30 mppcf or 10 mg/m³ (see 4.5, 5.1, 4.5.2)

Aluminum (Al_2O_3)	Kaolin
Calcium carbonate	Limestone
Calcium silicate*	Marble
Cellulose (paper fiber)	Mineral wool fiber*
Portland cement	Pentaerythritol
Corundum (Al_2O_3)	Plaster of Paris
Emery	Rouge
Glass, fibrous[r] or dust	Silicon*
Glycerin mist	Silicone carbide
Graphite (synthetic)	Starch
Gypsum	Sucrose
Vegetable oil mists	Tin oxide
(except castor, cashew nut, or similar irritant oils)	Titanium dioxide
	Zinc stearate*

* 1974 Addition

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

(r) < 7 μm in diameter

APPENDIX F

Some Simple Asphyxiants [s]

TLV, 1,000 ppm (see 4.6)

Acetylene	Hydrogen
Argon	Methane
Butane	Neon
Ethane	Nitrous oxide
Helium	Propane

(s) As defined in 4.6

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