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TOXICITY

# THRESHOLD LIMIT VALUES OF AIRBORNE CONTAMINANTS

SAFETY ENGINEERING STANDARD

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| ISSUED | APRIL 1961 |
| THIS PAGE REVISED | JAN 1976 |
| STANDARD REAFFIRMED | JAN 1976 |

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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, with the values listed here being taken from the 1975 list.

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 1910.1000, Table Z-1, which is based on 1968 ACGIH values. For several other materials, Table 1 values are higher than or augmented by additional restrictions listed in Table 5, which is based upon OSHA regulations, Section 1910.1000, Table Z-2. In these cases, individual listings are referenced to explanatory footnotes to Table 1. Also, specific OSHA regulations have been developed for a number of materials, in addition to their TLVs listed in Table Z-1. These materials are listed in 2.4 and are cross-referenced where they appear in Tables 1 and 2. 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 1910.1001 – 1910.1017 as listed below. The list also includes materials, indicated by ♦, which are not included by ACGIH in Appendix A.

1910.1001 Asbestos
1910.1002 Coal tar pitch volatiles ♦
1910.1003 4-Nitrobiphenyl
1910.1004 alpha-Napthylamine ♦
1910.1005 4, 4-Methylene bis (2-chloroaniline)
1910.1006 Methyl chloromethyl ether
1910.1007 3, 3-Dichlorobenzidine (and its salts)
1910.1008 bis-Chloromethyl ether ♦
1910.1009 beta-Naphthylamine
1910.1010 Benzidine
1910.1011 4-Aminodiphenyl
1910.1012 Ethyleneimine
1910.1013 beta-Propiolactone
1910.1014 2-Acetylaminofluorene ♦
1910.1015 4-Dimethylaminoazobenzene ♦
1910.1016 N-Nitrosodimethylamine
1910.1017 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 interpreted 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.

† The values in Tables 1, 2, and 3 are equal to or lower (more restrictive) than those promulgated under OSHA per 1910.1000, except for a few cases referenced to footnotes as discussed in 2.3.
†† "TWA" is defined in 4.1.2, "peak" in 4.1.3, and "ceiling" in 4.2.

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3.3 Each department, in consultation with the Safety and Fire Protection Division and Haskell Laboratory, 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 15, 564, 1973; 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 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 Appendixes 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 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 a 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 workday. A number of these are included in Table 5.)

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

* Section 4 and Tables 1 through 4 in this revision are the 1978 ACGIH prefaces, notices, and explanations.
** "Documentation of the Threshold Limit Values for Substances in Workroom Air", ACGIH, P.O. Box 1937, Cincinnati, OH 45201

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nuisances, (3) in estimating the toxic potential of continuous, uninterrupted exposures, (4) as proof or disproof of an existing disease or physical condition, or (5) for adoption by countries whose working conditions 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 noncompliance 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 attention-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, 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. 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 overtime extending the work-week 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 BTLs, and their associated procedures for determining compliance with them, should thus be regarded as an effective means of providing health surveillance of the worker.

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 for 1968 are now official federal standards for industrial air.

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* Pennsylvania Dept of Health, Harrisburg, PA

Portions printed in red refer to OSHA regulations per 1910.1000.

DUP 0960156

DU 040466

## TABLE 1 – ADOPTED VALUES †
See Documentation for Basis of TLVs (1974)

**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.)

* 1975 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 1910.1000 Table Z–1. See discussion in 2.3.
▼▼ Additional restrictions have been placed on this substance by OSHA. See reference listed in 2.4.
†† 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, 1963. 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, DC 20008. (Also see 2.2.)

| Substance | ppm [a] | mg/m³ [b] | Substance | ppm [a] | mg/m³ [b] |
|---|---|---|---|---|---|
| Abate | – | 10 | Ammonium sulfamate (Ammate) | – | 10 |
| Acetaldehyde | 100 | 180 | n-Amyl acetate | 100 | 525 |
| Acetic acid | 10 | 25 | sec-Amyl acetate | 125 | 650 |
| C Acetic anhydride | 5 | 20 | Aniline – Skin | 5 | 19 |
| Acetone | 1,000 | 2,400 | Anisidine (o-, p-isomers) – Skin | 0.1 | 0.5 |
| Acetonitrile | 40 | 70 | ** Antimony & compounds (as Sb) | – | (0.5) |
| Acetylene | F | – | ANTU (alpha naphthyl thiourea) | – | 0.3 |
| Acetylene dichloride, see 1, 2-Dichloroethylene | – | – | Argon | F | – |
| Acetylene tetrabromide | 1 | 14 | ** Arsenic & compounds (as As) | – | (0.5) |
| Acrolein | 0.1 | 0.25 | Arsine | 0.05 | 0.2 |
| Acrylamide – Skin | – | 0.3 | Asbestos (all forms) | – | A1a▼▼ |
| Acrylonitrile – Skin | 20 | 45 | Asphalt (petroleum) fumes | – | 5 |
| Aldrin – Skin | – | 0.25 | Azinphos methyl – Skin | – | 0.2 |
| Allyl alcohol – Skin | 2 | 5 | Baygon (Propoxur) | – | 0.5 |
| Allyl chloride | 1 | 3 | Barium (soluble compounds) | – | 0.5 |
| Allyl glycidyl ether (AGE) – Skin | 5 | 22 | **C Benzene – Skin | (25) | (80) |
| Allyl propyl disulfide | 2 | 12 | Benzidine production – Skin | – | A1a▼▼ |
| Aluminum (Al2O3) | – | E | p-Benzoquinone, see Quinone | – | – |
| 4-Aminodiphenyl – Skin | – | A1a▼▼ | Benzoyl peroxide | – | 5 |
| 2-Aminoethanol, see Ethanolamine | – | – | | | |
| 2-Aminopyridine | 0.5 | 2 | | | |
| Ammonia | 25 | 18 | | | |
| Ammonium chloride, fume | – | 10 | | | |

† Table 1 values are equal to or lower (more restrictive) than those promulgated under OSHA per 1910.1000, except in a few cases identified by ▼. See Table 1 Notes, and discussion in 2.3.
See above for all notes.

TABLE 1 – ADOPTED VALUES (CONT'D)

| Substance | ppm [a] | mg/m³ [b] |
|---|---|---|
| Benzyl chloride | 1 | 5 |
| Beryllium | – | 0.002 |
| Biphenyl | 0.2 | 1 |
| 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 | (800) | (1,900) |
| 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 | 460 |
| tert-Butyl alcohol | 100 | 300 |
| C Butylamine – Skin | 5 | 15 |
| C tert-Butyl chromate (as CrO3) – Skin | – | 0.1 |
| n-Butyl glycidyl ether (BGE) | 50 | 270 |
| ** Butyl lactate | (1) | (5) |
| Butyl mercaptan | 0.5 | 1.5 |
| p-tert-Butyltoluene | 10 | 60 |
| ** Cadmium (Metal dust and soluble salts, as Cd) | – | (0.2) |
| C Cadmium oxide fume (as Cd) | – | 0.05 |
| Calcium carbonate | – | 5 |
| Calcium arsenate, as As | – | 1 |
| Calcium oxide | – | 5 |
| Camphor (Synthetic) | 2 | 12 |
| Caprolactam | | |
| Dust | – | 1 |
| Vapor | 5 | 20 |
| Carbaryl (Sevin) | – | 5 |
| Carbon black | – | 3.5 |
| Carbon dioxide | 5,000 | 9,000 |
| Carbon disulfide – Skin | 20 | 60 |
| Carbon monoxide | 50 | 55 |
| Carbon tetrabromide | 0.1 | 1.4 |
| Carbon tetrachloride – Skin | 10 | 65 |
| Cellulose (paper fiber) | – | 5 |
| * Cesium hydroxide | – | 2 |
| Chlordane – Skin | – | 0.5 |
| Chlorinated camphene – Skin | – | 0.5 |
| Chlorinated diphenyl oxide | – | 0.5 |

| Substance | ppm [a] | mg/m³ [b] |
|---|---|---|
| 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 | – | – |
| Chlorodifluoromethane | 1,000 | 3,500 |
| Chlorodiphenyl (42% Chlorine) – Skin | – | 1 |
| Chlorodiphenyl (54% Chlorine) – Skin | – | 0.5 |
| 1-Chloro, 2, 3-epoxy-propane, see Epichlorhydrin | – | – |
| 2-Chloroethanol, see Ethylene chlorohydrin | – | – |
| Chloroethylene, see Vinyl chloride | – | – |
| Chloroform (Trichloromethane) | 25 | 120 |
| bis-Chloromethyl ether | 0.001 | A1a [vv] |
| 1-Chloro-1-nitropropane | 20 | 100 |
| Chloroplatin | 0.1 | 0.7 |
| Chloroprene (2-chloro-1, 3-butadiene) – Skin | 25 | 90 |
| * Chlorpyrifos (Dursban) – Skin | – | 0.2 |
| * o-Chlorostyrene | 50 | 285 |
| o-Chlorotoluene | 50 | 250 |
| * 2-Chloro-6-trichloro-methyl) pyridine (N-Serve) | – | 10 |
| Chromates, certain insoluble forms | – | A1a |
| Chromic acid and chromates (as CrO3) | – | 0.1 |
| Chromium, sol. chromic, chromous salts as Cr | – | 0.5 |
| * Clopidol (Coyden) | – | 10 |
| Coal tar pitch volatiles (see Particulate Polycyclic Organic Matter (PPOM)) | – | – [vv] |
| ** Cobalt, metal fume & dust | – | 0.01 |
| * Copper fume | – | 0.2 [v] |
| Dusts and Mists | – | 1 |
| Corundum ($Al_2O_3$) | – | 5 |
| Cotton Dust (raw) | – | 0.2 [m] |
| Crag herbicide | – | 10 |
| Cresol (all isomers) – Skin | 5 | 22 |
| Crotonaldehyde | 2 | 6 |
| * Crufomate (Ruelene) | – | 50 |

See page 5 for all notes

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TABLE 1 – ADOPTED VALUES (CONT'D)

| Substance | ppm [a] | mg/m³ [b] |
|---|---|---|
| Cumene – Skin | 50 | 245 |
| Cyanide (as CN) – Skin | – | 5 |
| Cyanogen | 10 | 20 |
| 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 [19] [y] |
| Dichlorodifluoromethane | 1,000 | 4,950 |
| 1, 3-Dichloro-5,5-dimethyl hydantoin | – | 0.2 |
| 1, 1-Dichloroethane | 200 | 820 |
| 1, 2-Dichloroethane | 50 | 200 |
| 1, 2-Dichloroethylene | 200 | 790 |
| Dichloroethyl ether – Skin | 5 | 30 |
| Dichloromethane, see Methylene chloride | – | – |
| Dichlorotetrafluoroethane | 1,000 | 4,200 |
| C 1, 1-Dichloro-1-nitroethane | 10 | 60 |
| 1, 2-Dichloropropane, see Propylene dichloride | – | – |
| Dichlorotetrafluoroethane | 1,000 | 7,000 |
| Dichlorvos (DDVP) – Skin | 0.1 | 1 |
| * Dicyclopentadienyl-iron | – | 10 |
| Dieldrin – Skin | – | 0.25 |
| Diethylamine | 25 | 75 |
| Diethylamine ethanol – Skin | 10 | 50 |
| Diethylene triamine – Skin | 1 | 4 |
| Diethylether, see Ethyl ether | – | – |
| Diethylphthalate | – | 5 |
| Difluorodibromomethane | 10 | 860 |
| C Diglycidyl ether (DGE) | 0.5 | 2.8 |
| Dihydroxybenzene, see Hydroquinone | – | – |
| Diisobutyl ketone | 25 | 150 |

| Substance | ppm [a] | mg/m³ [b] |
|---|---|---|
| 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 | – | – |
| Dimethylformamide – Skin | 10 | 30 |
| 2, 6-Dimethylheptanone, see Diisobutyl ketone | – | – |
| 1, 1-Dimethylhydrazine – Skin | 0.5 | 1 |
| Dimethylphthalate | – | 5 |
| ** Dimethyl sulfate – Skin | (0.01) | (A2) |
| Dinitrobenzene (all isomers) – Skin | 0.15 | 1 |
| Dinitro-o-cresol – Skin | – | 0.2 |
| * 3,5-Dinitro-o-toluamide (Zoalene) | – | 5.0 |
| Dinitrotoluene – Skin | – | 1.5 |
| Dioxane, technical grade – Skin | 50 | 180 |
| Diphenyl, see Biphenyl | – | – |
| 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-ethylhexylphthalate) | – | 5 |
| Dowtan – Skin | – | 0.1 |
| * 2,6-Ditert-butyl-p-cresol | – | 10 |
| Emery | – | E |
| 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 | F | – |
| Ethanethiol, see Ethylmercaptan | – | – |
| Ethanolamine | 3 | 6 |
| 2-Ethoxyethanol – Skin | 100 | 370 |
| 2-Ethoxyethylacetate (Cellosolve acetate) – Skin | 100 | 540 |
| Ethyl acetate | 400 | 1,400 |

See page 5 for all notes

## TABLE 1 – ADOPTED VALUES (CONT'D)

| Substance | ppm [a] | mg/m³ [b] |
|---|---|---|
| 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 |
| Ethylene glycol dinitrate | 0.2[d] | – |
| C Ethylene glycol dinitrate and/or Nitroglycerin – Skin | 0.2[d] | – |
| Ethylene glycol monomethyl ether acetate (Methyl cellosolve acetate) – Skin | 25 | 120 |
| Ethylene oxide | 50 | 90 |
| Ethylenimine – Skin | 0.5 | 1 [99] |
| Ethylidine chloride, see 1, 1-Dichloroethane | – | – |
| C Ethylidene norbornene | 5 | 25 |
| N-Ethylmorpholine – Skin | 20 | 94 |
| Fenbam | – | 15 |
| Ferrovanadium dust | – | 1 |
| Ferrovanadium dust | – | 1 |
| Fluoride (as F) | – | 2.5 |
| Fluorine | 1 | 2 |
| Fluorotrichloromethane | 1,000 | 5,600 |
| C Formaldehyde | 2 | 3 |
| * Formamide | 20 | 30 |
| Formic acid | 5 | 9 |
| Furfural – Skin | 5 | 20 |
| Furfuryl alcohol | 5 | 20 |
| Gasoline | – | 5[d] |
| Germanium tetrahydride | 0.2 | 0.6 |
| Glass, fibrous[d] | – | 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) |
| 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 (Methyl-butyl ketone) – Skin | (100) | (410) |
| Hexone (Methyl isobutyl ketone) – Skin | 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 | 5[c] | 5 |
| 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 | (10) | (50) |
| Isopropyl acetate | 250 | 950 |
| Isopropyl alcohol – Skin | 400 | 980 |
| Isopropylamine | 5 | 12 |
| Isopropyl ether | 250 | 1,050 |
| Isopropyl glycidyl ether (IGE) | 50 | 240 |
| Kaolin | – | E |
| Ketene | 0.5 | 0.9 |
| Lead, inorg., fumes and dusts, as Pb | – | 0.15 |
| Lead arsenate, as Pb | – | 0.15 |
| Limestone | – | E |
| Lindane – Skin | – | 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 |

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TABLE 1 – ADOPTED VALUES (CONT'D)

| Substance | ppm[a] | mg/m³[b] |
|---|---|---|
| Manganese cyclopentadienyl tricarbonyl (as Mn) – Skin | – | 0.1 |
| Marble | – | E |
| Mercury (Alkyl compounds) – Skin, as Hg | 0.001 | 0.01 |
| Mercury (All forms except alkyl) as Hg | – | 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 |
| 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) | (100) | (360) |
| 4,4'-Methylene bis (2-chloraniline)–Skin | 0.02 | A2[††] |
| C Methylene bis (4-cyclohexylisocyanate) | 0.01 | 0.11 |
| Molybdenum, as Mo Soluble compounds | – | 5 |
| Insoluble compounds | – | 10 |
| Monomethyl aniline – Skin | 2 | 9 |
| C Monomethyl hydrazine – Skin | 0.2 | 0.35 |
| Morpholine – Skin | 20 | 70 |
| Naphthalene | 10 | 50 |
| β-Naphthylamine | – | A1b[††] |
| Neon | F | – |
| ** Nickel carbonyl | (0.001 A1a) | (0.007) |
| Nickel, metal and insoluble compounds (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 |
| 4-Nitrodiphenyl | – | A1b[††] |
| Nitroethane | 100 | 310 |
| C Nitrogen dioxide | 5 | 9 |
| Nitrogen trifluoride | 10 | 29 |
| Nitroglycerin[d] – Skin | 0.2 | 2 |
| Nitromethane | 100 | 250 |
| 1-Nitropropane | 25 | 90 |
| 2-Nitropropane | 25 | 90 |
| N-Nitrosodimethylamine (dimethylnitrosamine) – Skin | – | A2[††] |
| Nitrotoluene – Skin | 5 | 30 |
| Nitrotrichloromethane, see Chloropicrin | – | – |
| Nitrous oxide | F | – |

See page 8 for all notes

DUP 0960161

DU 040471

TABLE 1 – ADOPTED VALUES (CONT'D)

| Substance | ppm [a] | mg/m³ [b] |
|---|---|---|
| Octachloronaphthalene – Skin | – | 0.1 |
| ** Octane | (400) | (1,900) |
| Oil mist, particulate | – | 5[f] |
| Oil mist, vapor | 5[g] | – |
| Osmium tetroxide, as Os | 0.0002 | 0.002 |
| Oxalic acid | – | 1 |
| Oxygen difluoride | 0.05 | 0.1 |
| Ozone | 0.1 | 0.2 |
| * Paraffin wax fume | – | 2 |
| Paraquat – Skin | – | 0.5 |
| Parathion – Skin | – | 0.1 |
| Particulate polycyclic organic matter (PPOM) as benzene solubles | – | 0.2 |
| Pentaborane | 0.005 | 0.01 |
| Pentachloronaphthalene – Skin | – | 0.5 |
| Pentachlorophenol – Skin | – | 0.5 |
| Pentaerythritol | – | E |
| ** Pentane | (300) | (1,300) |
| 2-Pentanone | 200 | 700 |
| Perchloroethylene – Skin | 100 | 670 |
| Perchloromethyl mercaptan | 0.1 | 0.8 |
| Perchloryl fluoride | 3 | 14 |
| Petroleum Distillates (naphtha) | 5[g] | – |
| 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) | (0.10) | (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) |
| * Pieloram (Tordon) | – | 10 |
| Picric acid – Skin | – | 0.1 |
| Pival® (2-Pivalyl-1, 3-indandione) | – | 0.1 |
| Plaster of Paris | – | E |
| Platinum (Soluble Salts) as Pt | – | 0.002 |

| Substance | ppm [a] | mg/m³ [b] |
|---|---|---|
| Polychlorobiphenyls, see Chlorodiphenyls | – | – |
| Polytetrafluoroethylene decomposition products | – | B[i] |
| C Potassium hydroxide | – | 2 |
| Propane | F | – |
| β Propiolactone | – | A2[vv] |
| 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 |
| Rosin | – | 10 |
| Rosin Core Solder pyrolysis products (as formaldehyde) | – | 0.1 |
| Rotenone (commercial) | – | 5 |
| Rouge | – | E |
| Selenium compounds (as Se) | – | 0.2 |
| Selenium hexafluoride, as Se | 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, as Ag | – | 0.01 |
| Sodium fluoroacetate (1080) – Skin | – | 0.05 |
| C Sodium hydroxide | – | 2.0 |
| Starch | – | E |
| Stibine | 0.1 | 0.5 |
| ** Stoddard solvent | (200) | (1,150) |
| Strychnine | – | 0.15 |
| Styrene, monomer (Phenylethylene) | 100 | 420 |
| **C Subtilisins Proteolytic enzymes as 100% pure crystalline enzyme) | – | 0.00006[dd] |
| Sucrose | – | E |
| Sulfur dioxide | 5 | 13 |

See page 5 for all notes

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TABLE 1 – ADOPTED VALUES (CONT'D)

| Substance | ppm [a] | mg/m³ [b] |
|---|---|---|
| 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 | – | see [f] |
| Tellurium | – | 0.1 |
| Tellurium hexafluoride, as Te | 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 [h] |
| Tetrahydrofuran | 200 | 590 |
| Tetramethyl lead (as Pb) – Skin | – | 0.150 [h] |
| Tetramethyl succinonitrile – Skin | 0.5 | 3 |
| Tetranitromethane | 1 | 8 |
| Tetryl (2, 4, 6-trinitrophenyl-methylnitramine) – Skin | – | 1.5 |
| 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 (TDI) | 0.02 | 0.14 |
| 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 |
| Tricyclohexyltin hydroxide (Plictran) | – | 5 |
| Trifluoromonobromomethane | 1,000 | 6,100 |
| Trimethyl benzene | 25 | 120 |
| 2, 4, 6-Trinitrophenol, see Picric acid | – | – |
| 2, 4, 6-Trinitrophenyl-methylnitramine, 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 | (200) | (510) [y] |
| Vinyl cyanide, see Acrylonitrile | – | – |
| Vinylidene chloride | 10 | 40 |
| Vinyl toluene | 100 | 480 |
| Warfarin | – | 0.1 |
| Wood dust (nonallergenic) | – | 5 |
| Xylene (o-, m-, p-isomers) – 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 |

See page 6 for all notes

## TABLE 2 – MINERAL DUSTS†

Notes, Table 2

* 1975 Addition

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

†† A more stringent TLV for crocidolite may be required

††† Additional restrictions have been placed on this substance by OSHA. See reference listed in 2.4

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) Silica 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 formulas for quartz.

(m) Lint-free dust as measured by the vertical-elutriator, cotton-dust sampler described in the Transactions of the National Conference on Cotton Dust, J. R. Lynch, p 33, May 2, 1970.

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

(o) Based on "high volume" sampling.

(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 148, Academic Press, New York, New York, 1964.

(2) Interim Guide for Respirable Mass Sampling, AIHA Aerosol Technology Committee, AIHA J. 31: 2, 1970, p 133.

| Substance | |
|---|---|
| SILICA, SiO2 | |
| Crystalline | |
| Quartz | TLV in mppcf[i]: $\frac{300^{j}}{\%\ \text{quartz} + 10}$<br>TLV for respirable dust in mg/m³: $\frac{10\ \text{mg/m}^3\ ^{k}}{\%\ \text{Respirable quartz} + 2}$<br>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 formulas for quartz |
| Tridymite | Use one-half the value calculated from formulas for quartz. |
| Silica, fused | Use quartz formulas. |
| Tripoli | Use respirable[p] mass quartz formula |
| ** Amorphous | 20 mppcf[i] |

| SILICATES (< 1% quartz) | |
|---|---|
| Asbestos, all forms †† | 5 fibers/cc > 5μm in length[n]; Also ††† |
| 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 | |
| COAL DUST | |
| (bituminous) | 2 mg/m³ (respirable dust fraction < 5% quartz).<br>If > 5% quartz, use respirable mass formula. |

**NUISANCE PARTICULATES**
(see Appendix E)

30 mppcf or 10 mg/m³[i]
of total dust < 1% quartz

Conversion factors:
mppcf x 35.3 = million particles per cubic meter
= particles per cc

† Table 2 values are equal to or lower (more restrictive) than those promulgated under OSHA par 1910.1000 and 1910.1001.

## TABLE 3 – NOTICE OF INTENDED CHANGES (FOR 1975)

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.)

\+ 1975 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.

| Substance | a) ppm | b) mg/m³ |
|---|---|---|
| + Antimony trioxide, handling & use, as Sb | – | 0.5 |
| + Antimony trioxide production | A2 | 0.05 |
| + Arsenic trioxide, handling & use | – | 0.25 |
| + Arsenic trioxide production | A1a | 0.05 |
| + Benzene – Skin | 10A2 | 30 |
| + Borates, tetra, sodium salts | | |
| Anhydrous | – | 1 |
| Decahydrate | – | 5 |
| Pentahydrate | – | 1 |
| Butane | 800 | 1,450 |
| C n-Butyl alcohol | 50 | 150 |
| n-Butyl lactate | 5 | 25 |
| Cadmium dusts & salts, as Cd | – | 0.05 |
| +C Cadmium oxide production | A1a | 0.05 |
| Calcium cyanamide | – | 0.5 |
| Calcium hydroxide | – | 2 |
| Captan | – | 5 |
| + Captafol (Difolatan) – Skin | – | 0.1 |
| Carbofuran | – | 0.1 |
| + Catechol (Pyrocatechol) | 5 | 20 |
| + Chromite ore processing (as $CrO_3$) | A1a | 0.1 |
| + Cobalt, metal fume & dust | – | 0.1 |
| + Cyanamide | – | 2 |
| + Dieldrin/ss (Eldrin) – Skin | – | 0.25 |
| Dicyclopentadiene | 5 | 30 |
| +C Dimethyl sulfate | 1 | A2 |
| + Diazinon (Dalmar) | – | 0.2 |
| Disulfuram | – | 2 |
| + Diuron | – | 10 |
| Dylanex | – | 0.1 |
| Ethion (Nialate) – Skin | – | 0.4 |
| 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 | 1,600 |
| Hexane | 100 | 360 |
| 2-Hexanone (Methyl butyl ketone) | 25 | 100 |
| C Hexylene glycol | 25 | 125 |
| + Hydrazine | 0.1 | 0.1 |
| Hydrogenated terphenyls | 0.5 | 5.0 |
| Iodoform | 0.2 | 3.0 |
| Isobutyl alcohol | 50 | 150 |
| C Isophorone | 5 | 25 |
| + Isophorone diisocyanate – Skin | 0.01 | 0.05 |
| + Methomyl (Lannate®) – Skin | – | 2.5 |
| Methylcyclohexane | 400 | 1,600 |
| Methylene chloride (Dichloromethane) | 200 | 720 |
| + Monocrotophos (Azodrin) | – | 0.25 |
| Nickel, soluble salts (as Ni) | – | 0.1 |
| + Nickel carbonyl | 0.05 | 0.35 |
| Nonane | 200 | 1,050 |
| Octane | 300 | 1,450 |
| Pentane | 600 | 1,800 |
| C Phosgene | 0.05 | 0.2 |
| + Phthalic anhydride | 1 | 6 |
| + m-Phthalodinitrile | – | 5 |
| +C 1, 2-Propylene glycol dinitrate – Skin | 0.05 | 0.35 |
| Resorcinol | 10 | 45 |
| + Rubber Solvent | 400 | – |
| C Sodium azide | 0.1 | 0.3 |
| Stoddard Solvent | 100 | 175 |
| Suxcinaldehyde (see Glutaraldehyde) | – | – |
| 4, 4'-Thiobis (6-tert butyl-m-cresol) | – | 10 |
| C 1, 2, 4-Trichlorobenzene | 5 | 40 |
| Triphenylamine | – | 5 |
| Vinyl chloride | Pending | A1c † |
| + Vinyl cyclohexene dioxide | 10 | 60 |
| + VM & P Naphtha | 200 | – |
| Welding fumes (Total Particulate) | – | 5 & 8* |
| C m-Xylene α, α' diamine | – | 0.1 |
| + Zinc chromate, as $CrO_3$ | – | 0.1 |

† By OSHA regulation, section 1910.1017, Vinyl Chloride TLV: 1 ppm, 5 ppm average in a 15-minute period

+ S
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TABLE 4 – NOTICE OF INTENDED CHANGES FOR 1975 – MINERAL DUSTS

Notice for Table 4

+ 1975 Addition

| Substance | TLV |
|---|---|
| + Silica, amorphous (including natural diatomaceous earth) | 3 mg/m³ total dust (all sampled sizes)<br>1 mg/m³ respirable dust (<5μm) |

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 | | | |
| Fluorides 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 min once/day |
| Hydrogen sulfide (Z37.2) | | 20 ppm | 50 ppm | 10 minutes once* |
| Mercury (Z37.8) | 0.05 mg/M³ | | | |
| Chromic acid and chromates (Z37.7) | 0.1 mg/M³ | | | |

* 10 minutes 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 1910.1000.

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## APPENDIX A

### Occupational 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 these 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, or substances associated with occupational processes, recognized to have carcinogenic or cocarcinogenic potential, with an assigned TLV.

| | TLV |
|---|---|
| Arsenic trioxide production | $As_2O_3$, 0.05 mg/m³ as As |
| | $SO_2$, C 5.0 ppm |
| | $Sb_2O_3$, 0.05 mg/m³ as Sb |
| Asbestos, all forms* | 5 fibers/cc, >5μ in length |
| Cadmium oxide production | 0.05 mg/m³ as Cd |
| bis (Chloromethyl) ether | 1.0 ppb |
| Chromite ore processing | 0.1 mg/m³ as $CrO_3$ |
| Particulate polycyclic organic matter | 0.2 mg/m³, as benzene soluble |

1b **Human Carcinogens** – Substances, or substances associated with industrial processes, recognized to have carcinogenic potential without an assigned TLV:

4–Aminodiphenyl (p-Xenylamine)
Benzidine production – Skin
beta–Naphthylamine
4–nitrodiphenyl

1c **Human Carcinogens** – Substances with recognized carcinogenic potential awaiting reassignment of TLV pending further data acquisition:

Vinyl chloride

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.

A2 **Occupational Substances Suspect of Oncogenic Potential for Workers.** Chemical substances, or substances associated with occupational processes, which are suspected of inducing malignant neoplasms, based on either a) limited epidemiologic evidence, exclusive of clinical reports of single cases, or b) demonstration of benign or malignant growths in one or more animal species by appropriate methods. Present evidence indicates that the assigned TLVs are below the threshold of response for inducing cancer in workers under ordinary conditions of employment. For those substances without an assigned TLV, exposure by all routes should be carefully controlled to levels consistent with the animal and human experience data (see Documentation).

| Substance or Operation | TLV |
|---|---|
| Antimony trioxide production [c] | 0.05 mg/m³ |
| Benzene[a] | 10 ppm |
| Benzo(a)pyrene[b] – skin | |
| Beryllium[a][b] | 2.0μg/m³ |
| 3,3' Dichlorobenzidine[b] – skin | |
| Dimethyl sulfate[b] | C 1.0 ppm |
| Hydrazine[b] – skin | 0.1 ppm |
| 4,4'–Methylene bis (2–chloroaniline)[b] – Skin | 0.02 ppm |
| Nickel production ($NiS_x$)[a][b] | |
| Nitrosamines (Dimethyl nitrosamine)[b] | |
| Propane sultone[b] | |
| beta–Propiolactone[b] | |
| Zinc Chromate[a] | 0.1 mg/m³ as $CrO_3$ |

Letters in parentheses refer to kinds of information bases qualifying the substance or operation to be included in A2. (See Documentation).

* Cigarette smoking may substantially enhance the incidence of bronchogenic carcinoma from this and others of these listed substances or processes.

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## 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 minimal.

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); Runion, ibid. 36, 338, 1975)

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

$$TLV = \frac{100}{\frac{\%\ Al}{3.6(200-B.P.°C.)+20} + \frac{\%\ Ar}{1.3(200-B.P.°C.)+10}}\ ppm$$

where

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

This 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 equations:

$$M.W. = \%Al + 0.86\%Ar + 0.5(B.P.°C. - 100)$$

B⁴ **Welding Fumes – Total Particulate (NOC)****
TLV, 5 mg/m³

Welding fumes cannot be classified simply. The composition and quantity of both are dependent on the alloy being welded and the process and electrodes used. Reliable analysis of fumes cannot be made without considering the nature of the welding process and system being examined; reactive metals and alloys such as aluminum and titanium are arc-welded in a protective, inert atmosphere such as argon. These arcs create relatively little fume, but an intense radiation which can produce ozone. Similar processes are used to arc-weld steels, also creating a relatively low level of fume. Ferrous alloys also are arc-welded in oxidizing environments which generate considerable fume, and can produce carbon monoxide instead of ozone. Such fumes generally are composed of discreet particles of amorphous slags containing iron, manganese, silicon and other metallic constituents depending on the alloy system involved. Chromium and nickel compounds are found in fumes when stainless steels are arc-welded. Some coated and flux-cored electrodes are formulated with fluorides and the fumes associated with them can contain significantly more fluorides than oxides. Because of the above factors, arc-welded fumes frequently must be tested for individual constituents which are likely to be present to determine whether specific TLVs are exceeded. Conclusions based on total fume concentration are generally adequate if no toxic elements are present in welding rod, metal, or metal coating and conditions are not conducive to the formation of toxic gases.

Most welding, even with primitive ventilation, does not produce exposures inside the welding helmet above 5mg/m³. That which does, should be controlled.

## APPENDIX C

### C.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,

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

* Trade Names: Algoflon, Fluon, Halon, "Teflon", Teflon
** Not otherwise classified

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.

## C1A Examples of THRESHOLD LIMIT VALUES FOR MIXTURES

The following formulas apply only when the components in a mixture have similar toxicologic effects; they should not be used for mixtures with widely differing reactivities, e.g., hydrogen cyanide and sulfur dioxide. In such case the formula for Independent Effects (1A.c.) should be used.

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.)

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

**Example No. 1A.a:** Air contains 5 ppm of carbon tetrachloride (TLV = 10 ppm) 20 ppm of 1, 2-dichloroethane (TLV = 50 ppm) and 10 ppm of 1, 2-dibromoethane (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 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 × the TLV; 10 × the TLV; etc.)

$$\text{TLV of mixture} = \frac{1}{\frac{f_a}{\text{TLV}_a} + \frac{f_b}{\text{TLV}_b} + \frac{f_c}{\text{TLV}_c} + \text{---} \frac{f_n}{\text{TLV}_n}}$$

Example No. 1: Liquid solvent contains (by weight) 50% heptane (TLV = 1600 mg/m³) 30% methylene chloride (TLV = 720 mg/m³) 20% perchloroethylene (TLV = 670 mg/m³)

$$\text{TLV of mixture} = \frac{1}{\frac{0.5}{1600} + \frac{0.3}{720} + \frac{0.2}{670}}$$

$$= \frac{1}{0.00031 + 0.00042 + 0.0003}$$

$$= \frac{1}{0.00103} = 1{,}000 \text{ mg/m}^3 \text{ (approximately)}$$

To convert to ppm, consult TLV list:

50% heptane = 200 ppm
30% methylene chloride = 60 ppm
20% perchloroethylene = 20 ppm

TLV of mixture: 200 + 60 + 20 = 280 ppm

1.A.8 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. 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% nonasbestiform talc and 20% quartz, the TLV for 100% of the mixture is given by:

$$\text{TLV} = \frac{1}{\frac{0.8}{20} + \frac{0.2}{10}} = 16 \text{ mppcf}$$

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:

$$\text{TLV} = \frac{1}{\frac{0.25}{10} + \frac{0.25}{20} + \frac{0.5}{20}} = 16 \text{ mppcf}$$

The limit for 25% quartz approximates 9 mppcf.

## APPENDIX D
### 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, never should be allowed to exceed 3 ppm. 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 |
| Beryllium | 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.

### Interpretation of Measured Peak Concentrations

With increasing use of rapid, direct-reading analytical instruments for airborne contaminants in the work area, the question of interpretation of essentially "instantaneous" peaks arises. Although no general statement can be made covering all occupational

substances, the following guidelines should prove helpful, assuming peak excursions conform to time-weighted average TLV as stated above.

The toxicologic importance of momentary peak concentrations depends on whether the substance is fast or slow acting. If slow acting, as for quartz, lead, or carbon monoxide, momentary peaks are of no toxicologic concern provided, of course, they are not astronomic. On the other hand, fast acting substances that rapidly produce disabling narcosis, e.g., $H_2S$, or intolerable irritation or asphyxiation, $NH_3$, $SO_2$, $CO_2$, or initiate sensitization – the organic isocyanates, even "instantaneous" peaks, appreciably above the permissible excursion, should not be permitted, unless information exists to the contrary. Other more specific excursions will be developed in the future.

### 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, 4.5.1, 4.5.2)

| | |
|---|---|
| Alundum ($Al_2O_3$) | Limestone |
| Calcium carbonate | Magnesite |
| 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 (except castor, cashew nut, or similar irritant oils) | Titanium dioxide |
| | Zinc oxide dust* |
| Kaolin | Zinc stearate |

## APPENDIX F

### Some Simple Asphyxiants [s]

TLV, 1,000 ppm (see 4.6)

| | |
|---|---|
| Acetylene | Hydrogen |
| Argon | Methane |
| Butane | Neon |
| Ethane | Nitrous oxide |
| Ethylene | Propane |
| Helium | |

* 1975 Addition

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

(r) < 7 μm in diameter

(s) As defined in 4.6



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