

TOXIC COMPOUNDS IN INDUSTRY

Principles and Practices of Industrial Air Standards

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INTRODUCTION

In discussing toxic substances in industry, I believe it is important to familiarize each of you with the nature of two of the organizations in the United States that evaluate toxicologic, clinical, and epidemiological data and recommend industrial air standards. These are the National Institute for Occupational Safety and Health (NIOSH) in the Department of Health, Education, and Welfare and the Threshold Limit Values Committee of the American Conference of Governmental Industrial Hygienists (ACGIH).

Private organizations, other than ACGIH, such as the American Industrial Hygiene Association (AIHA), American National Standards Institute (ANSI), and the American Society for Testing and Materials (ASTM), have also made valuable contributions to occupational safety and health guidelines. Time limitations preclude a detailed discussion of their respective activities. It should be noted, however, that each recommended standard of the ASTM Committee on Occupational Health and Safety Aspects of Materials, Physical and Biological Agents, contains a thorough review of the literature on which that standard is based.

NIOSH/OSHA

NIOSH was established under the Occupational Safety and Health Act of 1970 (the Act) with four main responsibilities. These are:

1. the conduct of occupational health and safety research for new and improved standards,
2. the transmission of recommended standards to the Occupational Safety and Health Administration.

3. the furnishing of technical assistance to employers, employees, and others in the occupational safety and health fields, and
4. the development of an adequate supply of health and safety professionals to carry out the Act.

OSHA, also established under the Act, has the responsibility for

1. promulgating standards,
2. enforcing standards,
3. operating a national recordkeeping and reporting system,
4. providing employer/employee education, and
5. interfacing with state regulation of employment activities.

While NIOSH and OSHA have distinct specific responsibilities under the Act, it should be pointed out that each has a supportive role in several of the other's activities. One important difference in responsibilities is that NIOSH does not have the authority to issue citations, warnings, or fines, even if employers are in violation of OSHA regulations. NIOSH can only recommend corrective actions to the Department of Labor. NIOSH must, however, notify OSHA and affected workers in cases where imminent danger is discovered.

At the time of the preparation of this presentation (8/15/77), NIOSH had transmitted more than 60 criteria documents to OSHA. These criteria documents address the degree of hazard (including an environmental limit for worker exposure), provide procedures for monitoring worker exposure, and stipulate control measures to be taken for the physical agent, chemical, class of chemicals, or industrial processes addressed. Furthermore, NIOSH has developed, under a joint effort with OSHA, draft technical standards for most of the consensus health standards contained in Section 1910.1000 of Title 29 of the U.S. Code of Federal Regulations. The consensus health standards consist of the 400-plus Threshold Limit Values (TLVs) in the ACGIH 1968 list and the several ANSI Standards (22) adopted by OSHA in 1971 to rapidly implement the Act. The draft technical standards developed by NIOSH/OSHA in their Standards Completion Program include, in addition to the numerical air standards, provisions for

1. informing the employee of potential hazards,
2. monitoring techniques,

3. engineering and control mechanisms,
4. medical surveillance programs, and
5. fire and other safety hazard evaluations.

ACGIH TLV COMMITTEE

The ACGIH TLV Committee was a pioneer and prime contributor to the establishment of safe industrial exposure limits. This endeavor was initiated during World War II and has continued with the publication of annual lists which are continually revised and added to. Over 600 substances of industrial interest appear in the 1976 TLV booklet (1). Until August 27, 1971, the day of promulgation of the 1968 TLVs into Federal standards by OSHA, the TLVs served only as recommended limits of good industrial hygiene practice and were used as guidelines by various states (sometimes with force and effect of law) and industries within the states. On August 27, 1971, the Department of Labor promulgated the 1968 TLVs as Federal Standards with which all industry must comply.

TLV CONCEPTS

The first category of TLVs represents, with certain exceptions, time-weighted average (TWA) concentrations of airborne substances associated with industrial operations and manufacture designed to protect the health and well-being of nearly all workers repeatedly exposed during a 7- or 8-hour workday and 40-hour workweek, not only for their working lifetime, but also after retirement. Because of wide variation in individual susceptibility, however, a small percentage of workers may experience discomfort from some substances at low concentrations at or below the threshold limit; a smaller (very low) percentage may be affected more seriously by aggravation of a preexisting condition or by development of an occupational illness (2). One means of improving the coverage of the TLVs would be tests to detect those individuals hypersusceptible to industrial chemicals to which they may be exposed.

TWAs (1) permit excursions above the limit provided there is compensation in the extent of exposure by equivalent deviations below the limit during the workday. The degree of permissible excursion for a particular substance is related to the numerical value of the TLV-TWA.

A second category of TLVs are those designated with a ceiling value, i.e., a maximum value that should not be exceeded. There are 36 substances with a ceiling (C) value in the 1976 booklet (1). Ceiling values are placed on substances essentially fast-acting in nature.

A third category of TLVs, one added in 1976, is the Short Term Exposure Limit (STEL)--the maximum concentration to which workers can be exposed for a period up to 15 minutes continuously without suffering from

1. intolerable irritation,
2. chronic or irreversible tissue change, or
3. narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency.

In addition, no more than four excursions per day are permitted, with at least 60 minutes between periods, and the TLV-TWA cannot be exceeded.

The TLVs are intended for use in the practice of industrial hygiene and should be interpreted and applied only by a person 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 exposures or workshifts differing from the 5-day per week, 8-hour per day, 40-hour per workweek.
4. as proof or disproof for 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.

OPERATIONAL PRACTICES

Where two or more organizations recommend air limits, what should be done if their recommendations differ? The long-term approach is to await the promulgating action of OSHA following public hearing

and the weighing of the respective evidence for each recommended limit. The more immediate approach is to carefully examine the toxicologic information, economic impact, and factors relating to exposure control to arrive at a carefully considered decision of the limit you wish to apply, remembering that you must comply with existing Federal standards. The differences in the limits recommended usually reflect differing interpretations of the knowledge at hand. When NIOSH limits are different from others, they tend to be lower and reflect its statutory mandate to recommend standards that protect the health and safety of all members of the workforce at all times.

Special policies are applied in evaluating those substances used industrially that have proven carcinogenic in man, or have induced cancers in animals under appropriate experimental conditions. Governmental policy makers operate under the premise that the state of the art of carcinogenic etiology and control is insufficient to define safe exposure levels. Thus, in practice, permissible exposures to carcinogenic substances must be the minimum feasible exposure limit.

BIOLOGIC THRESHOLD LIMITS

A second means of monitoring and controlling worker exposure in addition to environmental air monitoring, is the utilization of biologic threshold limits. Such limits have been utilized for a number of years in the lead industry and are recognized by medical and legal professionals as indices of overexposure. The unique features of biologic values are they measure the worker's overall exposure and they measure the worker's individual and characteristic response to the toxic agent. These measurements of response furnish an assessment of toxic insult and consist of

1. changes in amount of some critical biochemical constituents,
2. changes in activity of a critical enzyme, or
3. changes in a physiologic function.

Determination of a worker's exposure to a substance, or the biologic values, may be made by

1. analysis of blood, urine, hair, nails, tissues, and fluids for the substance,

2. analysis of tissues and fluids to determine the metabolite or metabolites of the substance, and
3. analysis of the exhaled breath to determine the concentration of the substance.

Biologic measurements furnish two types of information: an index of exposure and an index of response. Major difficulties in establishing biologic threshold limits are the difficulty in establishing norms due to individual differences among workers, the greater difficulties in developing sampling and analytical methods, and variables such as functional derangements in the organs of metabolism and excretion and metabolic interactions with drugs. In addition, biologic monitoring has very limited applications for assessing carcinogenic response to industrial chemicals. Biologic monitoring and environmental air monitoring are utilized as complementary means of addressing worker exposure and protecting his health.

PROBLEMS OF DATA ACQUISITION

One of the greatest problems facing standards developers, e.g., NIOSH, OSHA, and the TLV Committee of ACGIH, is the acquisition of appropriate data. This is a major, but not the sole, factor why only 24 or so new limits are established yearly, although several hundred new products are placed on the market annually. It is paramount to remember that industrial air standards or limits are values for industry. However, industry in general does not develop anywhere near enough kinds and amounts of data on its own products. This is unfortunate. Since the state and Federal governments are not in a position to provide qualified manpower and accessible facilities to handle this problem in toto, nor should they, a major portion of the burden of toxicologic assessment of its articles of commerce must be borne by industries. It does have recourse, though they be a limited resource, to reliable toxicology consultants and laboratories in the private sector to address such endeavors.

As the last portion of my presentation, suggested sources of information on industrial toxicology are appended along with suggested sources for ready referral as follows:

Given these low levels, we cannot prove that fibrous glass does not produce disease. We can only show that at low levels, disease does or does not appear. We cannot say what might happen at other levels of exposure, or with exposure under a different set of conditions. For fibrous glass, this happens to be an important question. Of particular interest is the question whether the inhalation of glass fibers produces lung cancer.

On the other hand, what we can do with epidemiologic studies of working populations is demonstrate whether there is or is not an increased risk of disease in man under conditions which prevailed in the past. If we cannot find an excess in a well designed investigation, it seems ethically and morally responsible to assume that, despite any other evidence, an increased risk does not exist. That does not say anything conclusive about the substance with which we are dealing, or whether it might not under some other conditions pose a hazard to man's health.

I hope you will agree epidemiology is common sense. On the other hand, the application of epidemiologic techniques does require, in my opinion, special training if epidemiologic evidence is to be believable.

OCCUPATIONAL SAFETY AND HEALTH

Selected List of Informational Sources

1. Referral Services

National Referral Center for Science and Technology, Library of Congress, Washington, DC 20540

Science Information Exchange, Smithsonian Institute, 1730 M Street, NW, Washington, DC 20036

2. Government Agencies

Bureau of Mines, Department of Interior, 4800 Forbes Avenue, Pittsburgh, PA 15213

Environmental Protection Agency, 401 M Street, SW, Washington DC 20460

Federal Regional Offices (10), NIOSH, OSHA

Region I-Boston, MA	Region VI-Dallas, TX
Region II-New York, NY	Region VII-Kansas City, MO
Region III-Philadelphia, PA	Region VIII-Denver, CO
Region IV-Atlanta, GA	Region IX-San Francisco, CA
Region V-Chicago, IL	Region X-Seattle, WA

National Institute for Occupational Safety and Health, DHEW, Danac Building, 5600 Fishers Lane, Rockville, MD 20857

Occupational Safety and Health Administration, DOL, 200 Constitution Avenue, NW, Washington, DC 20210

State and local Occupational Safety and Health Units (Health Departments, Labor Departments, Industrial Commissions, Department of Labor and Industry; also State Regional, County and City Offices)

3. Associations and Organizations

American Conference of Governmental Industrial Hygienists, P.O. Box 1937, Cincinnati, OH 45201

American Industrial Hygiene Association, 66 South Miller Road,
Akron, OH 44313

Information Sources

American Insurance Association, Engineering & Safety Department,
85 John Street, New York, NY 10038

American National Standards Institute, 10 E. 40th Street, New
York, NY 10016

American Public Health Association, 1015 Eighteenth Street, NW,
Washington, DC 20036

American Society for Testing & Materials, 1916 Race Street,
Philadelphia, PA 19103

Department of Environmental, Public, and Occupational Health,
American Medical Association, 535 North Dearborn Street, Chicago,
IL 60610

Industrial Health Foundation, 5231 Centre Avenue, Pittsburgh,
PA 15232

Manufacturing Chemists Association, Inc., 1825 Connecticut
Avenue, NW, Washington, DC 20009

National Fire Protection Association, 60 Batterymarch Street,
Boston, MA 02110

National Safety Council, 444 N. Michigan Avenue, Chicago, IL
60611

4. Journals and Periodicals

American Industrial Hygiene Association Journal (monthly), 66
South Miller Road, Akron, OH 44313

Annals of Occupational Hygiene (quarterly), Pergamon Press,
Maxwell House, Fairview Park, Elmsford, NY 10523

Archives of Dermatology (monthly), Circulation Department,
American Medical Association, 535 North Dearborn Street,
Chicago, IL 60610

Archives of Environmental Health, Heldref Publications, 4000 Albemarle Street, NW, Washington, DC 20016

Atmospheric Environment (monthly), Pergamon Press, Maxwell House, Fairview Park, Elmsford, NY 10523

Bulletin of Hygiene (monthly), Keppel Street, London, England WC1E 7HT

Chemical Reviews (bimonthly), American Chemical Society, 20th and Northampton Streets, Easton, PA 18042

Industrial Hygiene Digest (monthly), Industrial Health Foundation, 5231 Centre Avenue, Pittsburgh, PA 15232

Information Sources

Journal of the Acoustical Society of America (monthly), American Institute of Physics, 335 E. 45th Street, New York, NY 10017

Journal of the Air Pollution Control Association (monthly), APCA, 440 Fifth Avenue, Pittsburgh, PA 15213

Journal of Hygiene (quarterly), 32 E. 57th Street, New York, NY 10022

Journal of Occupational Medicine (monthly), published for American Occupational Medical Association, Mayo Publications, 1007 Burlington Avenue, Downers Grove, IL 60515

Modern Plastics (monthly), (Annual Encyclopedia Issue included in subscription rates), McGraw-Hill, Inc., 330 W. 42nd Street, New York, N.Y. 10036

National Safety News (monthly), National Safety Council, 444 N. Michigan Avenue, Chicago, IL 60611

Occupational Health Review (quarterly), Occupational Health Division, Department of National Health and Welfare, Ottawa, Canada

Occupational Hazards (monthly), The Industrial Publishing Corporation, 614 Superior Avenue, West Cleveland, OH 49113

Occupational Safety and Health (monthly), The Royal Society for Prevention of Accidents, 6 Buckingham Place, London, SW1E 6HR

Safety Standards (bimonthly), OSHA publication. Available from Superintendent of Documents, GPO, Washington, DC 20402

5. Reference Texts

Air Sampling Instruments--for Evaluation of Atmospheric Contaminants. 5th Edition. 1977. American Conference of Governmental Industrial Hygienists

Browning, E. 1969. Toxicity of Industrial Metals. Butterworth & Co., Ltd., London

Browning, E. 1953. Toxicity of Industrial Organic Solvents, Revised Edition. H. M. Stationery Office, London

Browning, E. 1965. Toxicity and Metabolism of Industrial Solvents. Elsevier Publishing Company, New York

Casarett, L. J. and J. Doull. 1975. Toxicology, the Basic Science of Poisons. MacMillan Publishing Company, Inc. New York

Information Sources

Documentation of the Threshold Limit Values for Substances in Workroom Air. 1971. American Conference of Governmental Industrial Hygienists

Dorland's Illustrated Medical Dictionary, 25th Edition. 1974. W. B. Saunders Company, Philadelphia

Elkins, H. B. 1959. The Chemistry of Industrial Toxicology, 2nd Edition. Wiley Publishers, New York

Encyclopedia of Occupational Health and Safety, Vol 1 & 2. 1971. International Labour Office, Geneva, Switzerland.

Fairhall, L. T. 1959. Industrial Toxicology, 2nd Edition. The Williams & Wilkins Co., Baltimore

- Gafafer, W. M., Ed. 1964. Occupational Diseases--A Guide to Their Recognition. PHS No. 1097. U.S. Government Printing Office, Washington
- Gerarde, H. W. 1960. Toxicology and Biochemistry of Aromatic Hydrocarbons. Elsevier Publishing Company, New York
- Gleason, M. N., et al. 1969. Clinical Toxicology of Commercial Products. 3rd Edition. Williams & Wilkins Company, Baltimore
- Handbook of Organic Industrial Solvents, Technical Guide No. 6, 3rd Edition. American Mutual Insurance Alliance, Chicago
- Handley, W. 1970. Industrial Safety Handbook. McGraw-Hill Book Company, New York
- Hunter, D. 1969. The Disease of Occupations, 4th Edition. Little, Brown and Company, Boston
- Loomis, T. A. 1968. Essentials of Toxicology. Lea & Febiger, Philadelphia
- Meidl, J. H. 1970. Explosive and Toxic Hazardous Materials. Glencoe Press, Beverly Hills
- Meidl, H. H. 1970. Flammable Hazardous Materials. Glencoe Press, Beverly Hills
- Methods of Air Sampling and Analysis. 1972. American Public Health Association, Washington
- Accident Prevention Manual for Industrial Operations, 6th Edition. 1969. National Safety Council, Chicago
- Fundamentals of Industrial Hygiene. 1970. National Safety Council, Chicago
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- Sax, N. I. 1968. Dangerous Properties of Industrial Materials. Reinhold Publishing Company, New York

Schwartz, L., et al. 1961. Occupational Diseases of the Skin, 3rd Edition. Lea & Febiger, Philadelphia

Stecher, P. G., Ed. 1968. The Merck Index of Chemicals & Drugs, 8th Ed. Merck & Company, Ind. Rahway, N.J.

von Oettinger, W. F. 1963. Poisoning--A Guide to Clinical Diagnosis and Treatment, 2nd Ed. W. B. Saunders Company, Philadelphia

Weast, R. C. 1972. CRC Handbook of Chemistry and Physics, 52nd Ed. Chemical Rubber Company, Cleveland

Zimmerman, O. T. and I. Lavine. 1953. Handbook of Material Trade Names. And Supplements I, II, III, IV. Industrial Research Service, Inc. Dover, N. H.

6. Abstracts and Indices (Periodical Literature)

Applied Science & Technology Index, 1958. (Formerly the Industrial Arts Index, 1957.) (monthly, quarterly and annual-cumulative) H. H. Wilson Company, New York

Chemical Abstracts (Toxicology, Air Pollution and Industrial Hygiene), (biweekly). The American Chemical Society, Easton, PA

Index Medicus. National Library of Medicine (monthly). U.S. Department of Health, Education, and Welfare, Public Health Service, Superintendent of Documents, U.S. Government Printing Office, Washington

Industrial Hygiene Digest (Monthly). Industrial Health Foundation, Mellon Institute, Pittsburgh, PA

INFORMATIONAL SOURCES ON THE TLVs of the
AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS
DEVELOPMENT OF REQUISITE DATA -- TLV COMMITTEE ACTIVITIES
PROBLEMS IN SETTING TLVs

Available from Dr. Trent R. Lewis
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226

1. Criteria and Procedures for Assessing the Toxic Responses to Industrial Chemicals, ACGIH, TLV Committee
2. Current Problems of Setting Occupational Exposure Standards. 1969. Arch Environ. Health 19:277
3. Development of TLVs for Fibrous Materials. 1969. Presented at the American Industrial Hygiene Association Conference. Denver
4. Documentation of the TLVs for Industrial Air, III Ed, 4th Printing. 1977. (\$20)
5. Industrial contribution to threshold limit values. 1965. Arch Environ Health 10:609
6. Modus operandi of threshold limits committee of ACGIH. 1964. Am. Ind. Hyg. Assn. J. 25:589
7. Preface to TLV Booklet (TLV Booklets \$1.50)
8. Principles and Procedures for Developing Data from Human Subjects for Industrial Air Limits. ACGIH, TLV Committee
9. Principles and Procedures for Developing Experimental Animal Data for Threshold Limit Values for Air. American Conference of Governmental Hygienists, Threshold Limit Values Committee, Cincinnati, OH
10. Standards for Safeguarding the Health of the Industrial Worker. 1955. U.S. Department of Health, Education, and Welfare, PHS Report No. 3251, Vol 70. No. 1, pp 1-11
11. Stokinger, H. E. 1972. Concepts of thresholds in standard-setting. An analysis of the concept and its application to industrial air limits (TLVs). Arch. Environ. Health 25:153
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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Technical Services
Cincinnati, Ohio 45226

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