ARCHIVES OF

ENVIRONMENTAL HEALTH

VOLUME 19

JULY THROUGH DECEMBER, 1969

American Medical Association Publication

Summary

w of the background of prob-
l in setting occupational expo-
s over the years has, hopefully,
› impression that a tremen-
of investigation, research, and
udgment has been brought to
development of our ideas as
Many problems remain to be
vith our present occupational
dards, the industrial hygienist
f a powerful tool in the con-
ational health hazards. And
physician must be continually
ossibility that an occupational
dard may not be sufficiently
ed to be completely depend-
he health hazards within the
een shown to be within the
dards, he can have much as-
is patients, the industrial em-
the benefit of a healthful
nment.

: Maximum Allowable Concentra
l Atmospheric Contaminants, *Ind*
946 (Nov) 1945.
M.W.: Research in Industrial
hemical Industry, *Brit J Industr*
) 1955.
., Jr.: Improved Communication
lards for Daily Inhalation, *Amer*
: *J* 17:129-185 (June) 1956.
Hygienic Standards for Chrysotile
nn Occup Hyg 11:47-69 (April

and Cook, W.A.: Maximum Al
tions of Atmospheric Impurities, *J*
1:51-54 (Jan) 1949.
Evaluation of Our Concepts of
nviron Health 10:5[illegible]-549 (April

H.J.: Soviet and American Stan
al Health, *Arch Environ Health*
1965.
H.J., et al: Industrial Toxicology
nion—Theoretical and Applied,
g Assoc J 25:185-197 (March

)., and Cook, W.A.: Current MAC
USA, *Proceedings of the 15th*
ress on Occupational Health, Vi
ol 3, *Hygiene, Toxicology, Occu*
Vienna: Verlag der Wiener Medi
, Sept 15-20, 1966, pp 5-8.

Current Problems of Setting Occupational Exposure Standards

Herbert E. Stokinger, PhD, Cincinnati

THIS year marks the 25th anniversary of the appearance of the first list of Threshold Limit Values (TLVs). It would seem appropriate at this quarter-century mark to evaluate not only what has been accomplished, but to define those problems that still remain, in an effort to overcome the problems and to improve the limits and make them more generally useful and effective.

Committee Activities and Related Problems.—The TLV Committee has two major activities: development of TLVs and validation of TLVs. Most, but not all, of the problems stem from these two activities. Other problems arise from the misuse and mishandling of the TLVs by government agencies (military) or by the legal profession, by company representatives (salesmen) and some industrial hygienists who have not yet got the complete message.

Composition of TLV Committee.—Because there has been some question in the minds of some physicians on the composition and fitness of the TLV Committee, it is important at the outset to identify the professional standing and activities of its members. Of the 14-man committee: physicians—five (one representing Canada); industrial hygienists, toxicologists—eight could be counted here; industrial hygiene engineers—two; analytic chemists—three; pathologists—one.

Most are individuals of national repute, several have international reputations, but probably more important, many of the committee have a background of long experience in occupational health, and still more important, several are actively engaged daily in evaluating plant situations—and note also, membership is derived from the most highly industrial states. To my mind the accumulated background and experience of this committee provides a perspective in

Submitted for publication Feb 3, 1969; accepted Feb 3.

From the Department of Health, Education, and Welfare, Consumer Protection and Environmental Health Service, Environmental Control Administration, Bureau of Occupational Safety and Health, Cincinnati.

Read before the 28th annual AMA Congress on Occupational Health, New York, Oct 1, 1968.

Reprint requests to Department of Health, Education, and Welfare, Consumer Protection and Environmental Health Service, Environmental Control Administration, Bureau of Occupational Safety and Health, 1014 Broadway, Cincinnati 45202 (Dr. Stokinger).

occupational health and animal toxicity data of which it is difficult to find the equal.

The Problem of Data Acquisition.—Thus we have the requisite group to handle the data and recommend limits, but why, in the face of several hundred *new* products placed on the market annually, is the TLV Committee able to establish annually only two dozen or so limits for *new* substances? *These relative figures point up the greatest problem facing the Committee: The acquisition of industrial hygiene data of the appropriate type to develop TLVs on new substances.*

The TLVs are industry's values. But industry generally does not develop anywhere near enough of kinds and amounts of data that can be used for establishing a TLV of a new substance. But industry has the sole responsibility to develop data on its own products; government is not in a position to develop enough facilities to handle the problem *in total,* nor should it, when reliable toxicologic consultants are now available.

The record clearly shows this.[1] I made a review of the situation in 1965 and found that in all American chemical industry only seven companies have made significant contributions to basic data for TLVs of *new* substances. Of these seven, only two made major contributions; one company made what might be considered a significant but modest contribution, and four made only minor contributions. This is a pathetic situation when one realizes the dire need. There is no question that inability to obtain industrial hygiene data is one of the greatest problems facing the committee today.

Types and Kinds of Data that Industry Can Supply.—Perhaps a glance at the procedures used to date to develop TLVs will be helpful in seeing what kinds of data industry can supply to help solve the problem of data lack.

In Table 1, I have determined the distribution of the procedures used for TLVs of 414 substances appearing in the 1968 list. It can be seen that *industrial plant experience* (medical surveillance, epidemiologic studies), led the list with 38%. Here is a place that the industrial plant physician can be of real help in supplying data through good medical records, but only if combined with *simultaneously obtained environmental data.* But note this type of plant data is most advantageous in validating a limit already set—rarely are the working conditions sufficiently stable to furnish data to initiate a limit. (A few notable exceptions are butyl alcohol, acetone, and mercury.) Here the Industrial Hygiene Foundation's Repository of Anonymous Data can be of help; it is questionable whether any TLVs will result from the AMA registry.

Human volunteer exposures (line 2, Table 1) are becoming increasingly popular of late. They are invaluable for arriving at an estimate of sensory (organoleptic) responses, irritants and narcosis-producing agents—substances for which animals just can't supply the answer. The procedure has lesser application for long-acting cumulative substances. For the fast acting substances irritants et alia, exposures may be brief, a matter of a few hours. They should be repeated, however, with sufficient frequency to determine whether tolerance of sensitivity is a feature of the exposure. It has been the experience of the committee that TLVs of irritants et alia, based on *single* human exposures, all too commonly result in *too severe limits.*

The third listed procedure, *chronic animal inhalation toxicity,* represents the crucial procedure about which this report is mainly developed. Here is the start in acquiring the basic data from which the TLV for new substances stems. This is the category from which the committee most needs data, and which is in the shortest supply. The data are in short supply because industries either do not develop long-term studies, or if they do, more often than not do not see fit to release the data in the open literature. Various reasons are given for this: legal protection of their products, lack of staff time to put data in publishable form. Whatever the reason, the data are not forthcoming.

Validation of TLVs.—Since its inception the TLV Committee has had the policy of reviewing annually the listed values; *if new* information coming to the attention of the committee indicated the need for change such changes were proposed in a separate tentative listing. Here they remain for a period of at least two years before being

placed in the recommended list. Since 1963, deeper scrutiny has been made into the suitability of the limits. The list of substances that have been given or are being given special and rather extensive scrutiny is shown in Table 2.

Procedures used by the committee take three forms: (1) The chairman and members of the appropriate subcommittee hold a meeting with industry's physicians and industrial hygienists and review their experience. This procedure is used where the data has not been assembled or published. This procedure has been used for the TLVs for the chromate industry and the nitroglycols. (2) Where the data or reports have been published, these are reviewed by the chairman and the committee and the action taken is that mutually agreed upon by industry and American Conference of Governmental Industrial Hygienists by letter correspondence. This procedure has been used for beryllium, quartz, uranium, and vanadium pentoxide. (3) Active cooperative projects with industry and toxicology and pathology section of the occupational health program (OHP) are entered into whereby industry supplies the health records or clinical data for review, or active toxicologic research investigations are made by OHP in conjunction with clinical and environmental data obtained by industry. Such is being done cooperatively with a large producer of isocyanates to determine means of detecting the hypersusceptible worker, a side bonus of which will be the validation of the TLV for the isocyanates. A similar study is being cooperatively made of carbon disulfide.

To give a clearer idea of how these validation procedures work, a most productive day's meeting was held with industrial physicians and hygienists of the chromate industry. The reason for selecting the chromate industry was that no evidence of the suitability of the TLV for chromic acid or chromates had ever been brought forth for the prevention of either nasal perforation or bronchogenic carcinoma. All environmental levels had exceeded the recommended limit of 0.1 mg/cum when large excesses (29-fold) of lung cancer and nasal perforation were found in 1950, and the health experience had not been reviewed in these terms since the industry had improved its control measures to the recommended limit. In brief, the day's discussion revealed that the limit for chromic acid mist was satisfactory in preventing nasal perforation, and in addition contained a safety factor of three or four; that the limit was probably satisfactory for the prevention of lung cancer, as no new cases have appeared since the reduction in exposure occurred, but that the ten years in which the closer controls were operative are probably too short a time to be certain of its validity in this respect.

In a similar meeting with representatives of the dynamite explosives manufacturing industry, a question of an improperly stated TLV for intermittent exposure to ethylene glycol dinitrate and nitroglycerin was resolved to the mutual satisfaction of each of the parties. Statements derived from the long experience of the medical directors of the companies that normally would never get to the attention of the committee were elicited in amicable discussions.

In regard to substances in the process of validation, I can mention three—asbestos, carbon disulfide, and isocyanates—that represent extensive, cooperative efforts by both industry and the PHS Occupational Health Program, and five substances that represent purely unsolicited efforts of industry to de-

Table 1.—*Distribution of Procedures Used to Develop or Validate ACGIH TLVs Through 1968**

Procedure	No.	% Total
Industrial (human) experience	157	38
Human volunteer experiments	45	11
Animal, inhalation-chronic	83	20
Animal, inhalation-acute	8	2
Animal, oral-chronic	18	4.5
Animal, oral-acute	2	0.5
Analogy	101	24

*For 414 substances exclusive of "inert" particulates and vapors.

Table 2.—*Substances Validated for TLV or Undergoing Validation Since 1963*

Validated*	In Process
Beryllium	Asbestos (all forms)
Carbon monoxide	Benzene
Chromates & chromic acid	Carbon disulfide
Cristobalite	Fibrous glass
Nitroglycols	Isocyanates
Quartz	Tetraethyl lead
Uranium	Tetramethyl lead
? Vanadium pentoxide ?	Petroleum distillates

*By committee action.

velop information on a valid TLV (benzene, fibrous glass, tetraethyl and tetramethyl lead and petroleum distillates).

From these cooperative ventures and the increasing number of voluntary efforts of industry itself to validate some of the more controversial limits, we see an encouraging trend. More and more, industries are developing impressive industrial medical departments. More and more, industries are either establishing their own toxicology laboratories or purchasing toxicologic studies from a rapidly expanding number of commercial toxicity testing laboratories. More than 50 of these are available, exclusive of university sources. Not more than a half-dozen are presently sufficiently well equipped to do first rate long-term inhalation studies.

Industrial associations, the American Petroleum Institute, Lead Industries Association, American Welding Association, Automobile-Manufacturers' Association, among others, now have large research programs directed toward supplying data in support of safe limits of their sponsors' products. In addition, one can discern among industry's medical departments a keener interest in solving industrial hygiene and toxicology problems.

These broadened activities of industry would seem to relieve considerably the problem of data lack mentioned earlier. But closer inspection of the type of data being developed indicates that present efforts are directed to the validation of limits already established; little progress has been made toward a freer access of the committee to information on *newly* introduced industrial chemicals. This problem the committee still has with it.

The Problem of Misinterpretation of TLVs.—Another vexing committee problem arises from the misinterpretation and misuse of the TLVs. Particularly culpable are the factory inspector and the legal profession. Their common fault lies in misinterpreting the TLVs as fine lines between safe and dangerous concentrations "either it is, or it isn't" phenomenon. Such strict interpretation is not within the intent expressed in the preface to the TLVs, and places industry in undue jeopardy. Such misinterpretation fails to take into consideration that with few exceptions, the TLV is time-weighted average value which *perm excursions above the limit provided equi lent excursions below the limit occur.* Th a single, or even several, concentratic monitored above the limit is not ipso fa evidence of injury. The reason this is so that the TLV has an inherent safety zo between the limiting value and the conc tration capable of producing injury.

Despite the fact that such principles ha been clearly stated for many years in t annually issued TLV booklet, they ha been commonly ignored. Recently, howev the development of short-term limits (Per sylvania) ceiling values, and the concept "peak" concentrations (USASI, Z37 Co mittee) introduce into the picture the c cept of variable permissiveness that is compatible with the interpretation of a li below which all values must fluctuate the prevention of injury.

Misapplication and Misuse.—Misund standing on the relationship between TL *and short-term exposures has on occas* come to the attention of the committee. attempting to arrive at a short-term comm nity exposure limit for beryllium, the Force suggested a limit of 750μg-min/c for a single exposure. This was presumal derived from Haber's Rule, C × t = K, ing the Atomic Energy Commission-reco mended *in-plant* limit of 25μg/cum periods not to exceed 30 minutes. But permissible Ct value for *community* exp sures is about 43μg-min/cum. Hence t 750μg limit is considered dangerously exc sive.

In another instance, attempts by t Navy to obtain short-term exposure lim the suggestion was made to multiply TLV by 10 "across-the-board." This is considered good practice because some s stances do not follow Haber's rule and hi concentrations for brief periods are m toxic than equivalent exposures at low c centrations, ie, Ct is not always consta

Other Misapplications.—Misuse of TLVs as a measure of comparative toxic —*frequently used by industry's salesmen* prove the virtues of their products ove competitor's gives the committee frequ headaches. Use of TLVs for comparat toxicity is permissible only when meta

lism of the compared substances is similar. In most cases, however, either the metabolisms differ, or they are unknown. In addition, the bases of TLVs for different substances differ; not all TLVs are based on toxicity. A striking example of the erroneousness of such a comparison is that of hydrogen cyanide (HCN), TLV 20 ppm, with sulfur dioxide (SO_2), TLV, 5 ppm. The TLVs indicate that SO_2 is more toxic than HCN, which is ostensibly ridiculous! The reason is of course that the TLV for SO_2 is based *not* on health effects as is HCN, but on irritation.

Future Problems—TLVs vs Community Air Limits.—Perhaps one of the problems of greatest concern in the committee's future is how to reconcile to the satisfaction of chemical labor union leaders, union workers, their wives and families, the often large discrepancies in the TLVs for those substances in industry that are to appear (and are now appearing) as community air limits. How to explain, for example, that when a community has a limit for lead in air of 5μg/cum (Pennsylvania) that it is all right for their "boys" to breathe 40 times this amount for their working lifetime in industrial plants? It is doubtful that the rational bases for the differences can be made sufficiently convincing to be generally accepted—any more that the rationale for fluoridation has met with general acceptance.

Legalization of Industrial Air Standards.—Although it is particularly difficult in these days of federal reorganizations to be a prophet of "the shape of things to come," it might be worthwhile to try to foresee what problems will exist when the Occupational Health and Safety Act (or some similar act) is made into law. As the act is now written, the Department of Labor (USDL) will set standards for industrial air upon the counsel of an advisory committee. The present Occupational Health Program in the National Center for Urban and Industrial Health will establish the criteria on which the standards will be based. Because the standards will be "consensus" standards, it is probable that neither the recommendations of the TLV Committee or those of the USASI, Z37 Committee will be given "carte blanche" acceptance. Being consensus standards, the dominant philosophy and voice of government may be less clear than in the past (the USASI Committee, dominated by industrial representatives, and whose findings are adopted now by USDL, presently attempts to attain a consensus from the *scientific* community). What the future problems will be, will be determined largely by how broad a consensus will be required, which in turn will determine the breadth of the advisory committee. Whether the presently constitued TLV and Z37 Committees will continue to function in their present capacity seems to me problematic. The old problem of data acquisition, however, could be made easier if substantial government funds are made available to the Occupational Health Program to develop industrial hygiene data on a broad basis.

Reference

1. Stokinger, H.E.: Industrial Contribution to Threshold Limit Values, *Arch Environ Health* 10:609 (April) 1965.

TEMPO HOPPING

Air transportation has highlighted the relationship of circadian rhythms to the subjective and physical well-being of travelers, especially when they rapidly traverse more than four time zones. One country is currently proposing to mend its air crew flight time limitations as follows: "In the event of there being a time zone change of four or more hours between the place of departure and the place where duty ends, the subsequent rest period should be not less than twelve hours."—Mohler, S.R.; Dille, J.R.; and Gibbons, H.L.: The Time Zone and Circadian Rhythms in Relation to Aircraft Occupants Taking Long-Distance Flights, *Amer J Public Health* 58:1404-1409 (Aug) 1968.