

A review of what toxicologists and industrial hygienists are doing to develop threshold limits for concentrations of substances in the air, corresponding biological threshold limits, pretoxicosis tests, and prophylactic and antidotal agents . . . and a discussion of recent developments in the techniques of air sampling and air analysis.

Standards for Safeguarding the Health Of the Industrial Worker

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THE EPITOMICAL STATEMENT made some years ago by Dr. James A. Sterner, now medical director of Eastman Kodak Co. and past president of the American Industrial Hygiene Association, announced a change of attitude among industrial hygienists which today is the keynote of enlightened occupational health practice: "No substance is so toxic that it cannot be used if sufficient knowledge of its action has been made available; similarly, no substance is so nontoxic that it should be used without regard to caution."

Currently, several effective means by which such a concept may be implemented are available: (a) threshold limits for concentrations of

injurious agents in the workroom air, (b) threshold limits of concentrations of injurious agents or their metabolic products in biological fluids corresponding to the threshold limits for air (biological threshold limits), (c) tests of pretoxicosis to screen persons for early signs of injury from exposure to hazardous agents, and (d) prophylactic and antidotal agents.

Occupational hygiene standards in this country have been given various names, the most familiar of which is maximal allowable concentrations. Another designation is threshold limit values, the name used by the American Conference of Governmental Industrial Hygienists. Still another term is industrial hygiene standards, a designation recently adopted by the American Standards Association. All these terms refer essentially to the same concept of permissible contamination of workroom air by dusts, fumes, mists, vapors, or gases, although the bases on which the limits for certain substances are set may differ somewhat in the different lists. The following discussion will be confined chiefly to the list of threshold limit values, with which the author is most familiar. This list is prepared by the American Conference of Governmental Industrial Hygienists' Committee on Threshold Limits, which is composed of persons work-

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ing in State and local industrial hygiene departments and in Federal industrial hygiene units, and members of the armed services in the United States and Canada.

Only the United States and Russia appear to be currently developing such lists as the threshold limits list, other countries preferring to use those already developed. Partly because of this, but more especially because the abbreviated preface to the list only briefly refers to its application, the following paragraphs discuss in some detail the nature of the list and its purpose, methods by which the values are developed, and interpretation and proper usage of the values.

Nature and Purpose of the List

The threshold limits list includes those natural minerals and oils and chemical substances, including economic poisons but excluding radioactive materials, in the form of dust, fume, mist, vapor or gas, which are in sufficiently wide use industrially to warrant control of their concentration in the breathing zone of the industrial worker. (Permissible levels of exposure to radioactive materials are independently set by various radiation protection committees throughout the world. Values for many radioactive substances may be found in the National Bureau of Standards Handbook No. 52.) Because of the rapid development and application of certain chemical substances, often a timelag occurs between the industrial use of a substance and the appearance of the threshold limit value. This interval, however, is becoming shorter as a result of increasing attention of the chemical industries to the development of data on the toxicity and hazards of their products prior to use. Limiting values assigned to each substance in the list represent the maximal atmospheric concentration to which workers may be exposed repeatedly day after day without injury to health.

The purpose of the list is to provide a limiting value of air concentration for injurious substances for use by plant engineers, industrial hygienists, and others concerned with the health and comfort of the workers. The list is intended to be a guide for the control of working atmospheres and to provide management,

labor unions, and the worker alike an assurance of healthful conditions on the job.

Development of Threshold Limits

A value for a toxic substance is assigned on the basis of data accumulated from animal inhalation toxicity studies and on the basis of industrial experience. Together, these represent, of course, ideal requirements not always fulfilled for each substance in the list but approximated as far as possible. Of the two, industrial experience is the test on which the validity of a value must ultimately rest. Because reliable information from industrial experience is frequently difficult to obtain, the Committee on Threshold Limits is often forced to rely on opinion of industrial hygienists, rather than on factual information, or sometimes, merely on animal data. Such opinions, however, are based on specific experience with various substances and come from occupational hygienists throughout the country. The current toxicological literature is also scanned continually for usable information. When the need for the assignment of a value seems urgent, a tentative value is assigned on the basis of the best information available at the time.

Originally, preventing impairment of health was virtually the only consideration in the selection of the proper limiting air concentration of an injurious substance. Now, however, with the increasing emphasis in occupational health on the "total man," more subtle effects on health, such as the effects of annoying or irritating agents, are also considered. Thus, whereas a threshold limit value of 3 or 4 p.p.m. for chlorine would insure no impairment of workers' health, this value is reduced to 1 p.p.m. in the interest of greater freedom from irritant effects. The levels of other gases and vapors with irritant or other discomforting effects on the workers have been similarly adjusted.

The rapid growth in the number and diversity of industrial substances to which workers are exposed and the increasing attention being given to occupational health in this country have given rise to a very real problem of maintaining the threshold limits list current. To meet this problem, the Committee on Threshold Limits reviews the lists annually, considering

carefully each value and any new information pertaining to a change in level. When a value is changed, it is so designated.

In the threshold limits list for 1954, a further accommodation has been made in an attempt to keep pace with the ever-increasing use of new industrial chemicals. This is the addition of a tentative list separated from the list of established values. Henceforth the tentative list will include all substances not previously listed. Because of the lesser certainty sometimes associated with these tentative values, they should provide only general guidance in the control of exposure and should carry no legal weight. The tentative list is looked upon as providing levels under trial and test, to be revised when new information justifies. Substances in the tentative list will not be incorporated in the main list until the values have been proved by experience to be acceptable. It is hoped that the tentative list will stimulate a greater number of yearly additions than in the past, as well as the critical evaluation of these values by greater numbers of industrial hygienists.

Overall Maximal Upper Limits

It is now considered desirable by a majority of the persons concerned with occupational health to assign a maximal upper limit of 1,000 p.p.m. for most, although not all, of the gases and vapors that are apparently nontoxic or nonhazardous. Such a limit has been set for certain Freons and other apparently innocuous substances, although it is known that neither health nor safety are endangered by exposure to far higher levels under ordinary conditions. In favor of this practice is the argument that it will prevent excessive or wanton exposure to air contaminants. It is recognized that all the facts needed to assure safety are seldom at hand. Physiologically inert substances, such as certain Freons and sulfur hexafluoride, in unlimited concentration may suddenly become hazardous, in the presence of welding or plumbing operations, through decomposition by heat to highly toxic products.

A similar concept is developing with respect to dusts that in the past have been considered

essentially nonhazardous or not incapacitating. Numerous reports from various countries make it all too apparent that many dusts formerly considered inert are capable of producing pulmonary changes that are oftentimes disabling (1-7). It would therefore seem that all insoluble dusts of whatever nature should be held suspect until proved otherwise (4). Unfortunately, the assignment of a specific level for each mineral dust is impossible at present. Mineral dusts are commonly of complex and inconstant composition, often varying according to locality, and thus are potentially capable of causing a variety of physiological responses. As a case in point, pulmonary carcinoma is commonly associated with the long-term inhalation of asbestos in England, but not in America (8). Assignment of specific levels is also difficult because pulmonary changes derived from the inhalation of mineral dusts commonly require years to assess, because sound information relating exposure to response is not, for the most part, available, because exposures are not uniform owing to changes in the industrial process and job changes, and because dusts from operations involving the same materials often differ in size and surface area.

Therefore, it is believed that the validity of the present standards for dust should be reviewed and consideration given to the following suggestions. In the absence of information and in view of the poor prospect of obtaining any in the near future, the conclusion seems inescapable that if protection from dusts is to be guided by hygienic standards, an overall limit value should be selected. Actually, two values appear desirable, one for dusts containing free silica, and another for nonsiliceous dusts.

For silica-bearing dusts, a limit of from 2 to 5 million particles per cubic foot (m.p.c.f.) is suggested. It would be applicable to those substances containing free silica of any appreciable percentage (10 percent or more). Such a level appears justifiable on the basis of usage and experience, as shown in table 1, and tacitly assumes no other mineral is more hazardous than silica and/or any combination of a mineral with silica. Actually, this value represents a rather low level of exposure when

expressed in terms of milligrams of substance per cubic meter of air. Depending upon particle size, 5 m.p.p.c.f. silicon dioxide (SiO₂) with a density of 2.2 might range from 0.01 or 0.02 milligram to several milligrams per cubic foot, assuming the general size distribution of industrial dusts thus far recorded by optical methods (9); with dusts differing in density from SiO₂, corresponding differences in weight concentration, of course, would occur.

The question then arises of how best to express the dustiness of an atmosphere. Although this concerns matters too involved to be entered into here, it would seem that, with an absolute method now available for the measurement of industrial dusts, the limiting concentrations should be expressed in terms of either millions of particles per cubic foot or milligrams per cubic meter, or both, but within a definite size range, this range to be 0-3 μ diameter. Otherwise, dust counts, as well as expressions based on weight per volume of air, become meaningless. Particles of the size 3 μ and below can now be sampled and measured and are believed to be the only ones of hygienic significance. Whether the value approximating 5 m.p.p.c.f. will be found to hold when the submicroscopic particles are included is a very important project for future investigation.

Table 1. Recommended permissible limits of some silica-bearing dusts¹

Industry or source	Reported percent free SiO ₂ ²	Recommended concentration m. p. c. f.
Sydney sandstone.....	90	³ 6
Silica brick.....	80	2
Gold mining (Union of South Africa).....	80	⁴ 3
Granite.....	35	9-20
Pottery.....	30	4
Gold mining (Ontario, Canada).....	25-35	⁴ 8. 5
Pyrophyllite.....	30-40	10
Anthracite (hard rock).....	30	5-10
Nonferrous mines.....	20-40	5-10
Anthracite (haulageways).....	13	10-15
Cement.....	6	20

¹ From a table prepared by Theodore F. Hatch, professor of industrial hygiene, University of Pittsburgh.

² Values are approximate.

³ Owens Counter.

⁴ Konimeter.

A practical threshold limit value for non-siliceous dusts would appear to be 5 mg./m.³ This value has been in satisfactory use for some years for controlling hematite dust and fume in at least one American plant (10). It would seem to represent a reasonable level of dustiness for all other presently considered "inert" nonsiliceous inorganic dusts.

More Specific Designations

With increasing industrial hygiene knowledge and experience, refinements in designating specific substances to which values are assigned will assuredly follow. As yet, however, only a beginning has been made in this respect. For chromium, the designation specifically refers to chromic acid or to chromates. The highly poisonous arsine gas has a threshold limit value of 0.05 p.p.m., whereas the value for arsenic and its compounds is 0.5 mg./m.³ Differences in toxic action of uranium compounds have been recognized by individualizing the soluble and insoluble compounds.

It would appear that manganese dioxide would be a desirable designation for manganese, because manganese dioxide is the most common industrial hazard of this element. Mercury at 0.1 mg./m.³ should refer to mercury vapor and its inorganic compounds and should not imply inclusion of the more toxic organic mercurials. Similarly, for fluorides the newer organic fluorides which vary widely in toxicity and hazard should be explicitly excluded, and for selenium, the threshold limit should apply only to selenium compounds which are highly toxic, not to elemental selenium dust, which is essentially nontoxic. The value of 0.1 mg./m.³ for cadmium should refer specifically to the cadmium fume, for use of this limit for most of the insoluble cadmium compounds imposes far too severe a restriction. Different levels for lead and its compounds should be specifically defined according to information accumulated in the lead industries in this country over the past 10 years. Data show that whereas there is no reason to alter the value of 0.15 mg./m.³ for lead fume or for lead dust of submicroscopic size, this value is unrealistically severe when applied to the more insoluble lead salts, and probably too lenient if applied to certain or-

ganic lead compounds. These and other desirable refinements in the list will undoubtedly be made in the near future.

Biological Threshold Limits

One new feature of occupational health standards that appears destined to play a useful role in evaluating personnel exposure in industry is what might be called biological threshold values, for want of a better term. These values refer at the present time to the greatest permissible content of an air contaminant or its metabolic derivatives in the body fluids, usually in blood or urine, although changes in other bodily constituents may in time serve also as measures of exposure. A list of biological threshold values, which correspond to the threshold limits for concentrations of the substances in air, is given in table 2. The values given for some of the substances are tentative, having been derived from limited experience; for others, such as lead and fluorine, the values are well founded. For still others, such as arsenic and mercury, there is considerable disagreement among industrial hygienists as to the usefulness of urinary determinations.

It is probable that the biological threshold limits of only a few selected substances will ultimately find an accepted place in occupational hygiene standards, since all substances are not amenable to accurate analysis in body fluids (complex organic molecules) by reason of wide individual variation in metabolism, interferences from dietary sources (arsenic), or simply the relative absence of constituents in easily obtainable body fluids (chromium, manganese, silver, and probably beryllium). For biological values to be serviceable, repeated determinations must be made on each person exposed, and preexposure control determinations are desirable. When biological threshold limits are used, they should supplement determinations of air concentrations, not replace them. In effect, these biological limits substitute diagnosis for the control or prevention of injury provided by air analysis.

Currently, in the lead industry, considerable enthusiasm is being expressed over the ap-

Table 2. Biological threshold limits¹

Substance	Blood (mg./100 ml.)	Urine (mg./l.)
Inorganic constituents		
Arsenic		1 ² (0.5 for arsine or lewisite).
Beryllium		0.002.
Cadmium		0.1.
Copper	0.1	
Chromium		Any detectable amount.
Lead	0.08	0.2.
Mercury		0.25. ³
Manganese ⁴		0.001.
Thorium		Not eliminated in chemically measurable amounts.
Vanadium		0.05. ⁵
Uranium		0.01. ⁵
Fluoride		4.
Selenium		0.07.
Tellurium		0.01.
Organic constituents		
Benzene		15 percent below normal sulfate ratio of inorganic to total sulfate.
Bromide	100	
Carbon disulfide		0.15.
Dinitro- <i>o</i> -cresol		5.
Methyl alcohol		5-7.
Methyl acetate		Analyzed as methyl alcohol.
Toluene (as hippuric acid)		3,000.
Trichloroethylene (as trichloroacetic acid)		75.

¹ Many of the values given here are found in or have been revised from *Chemistry of Industrial Toxicology* by H. B. Elkins, New York City, Wiley, 1950, and in *Analyses of Biological Materials as Indices of Exposure to Organic Solvents* by Elkins, A. M. A. Arch. Indust. Hyg. and Occup. M. 9: 212-222, March 1954.

² H. H. Schrenk, in *New Information on Arsenic Trioxide*, Ind. Eng. Chem. 45: 11A (1953), states that urinary arsenic values of 4-5 mg./l. are commonly not associated with signs of arsenic poisoning. Use of urinary values is considered of doubtful worth because of great variation in normal values. Dietary arsenic, such as that obtained from seafoods, would greatly alter the urinary arsenic picture; moreover, arsenic is excreted chiefly in the feces.

³ Urinary values may not always be reliable in long-term exposures owing to possibility of development of lower nephron nephrosis and for other reasons.

⁴ Inasmuch as manganese is eliminated chiefly via the intestine, urinary determination is not a particularly valuable indicator of exposure.

⁵ Tentative value.

parently successful use of urinary lead values with or without prior screening by urinary coproporphyrin determinations. The argument in favor of the use of urinary values is that in practice most industrial exposures are neither uniform nor simple, but are mixed, and, therefore, that the body serves as a better sampling device and indicator of this type of exposure than do air samples. Biological determinations also offer a guide in the diagnosis of illness not provided by air analysis. Whether it is a wise decision to allow the individual to serve as his own indicator of exposure is debatable: Derangement of metabolic function or excretion for various causes is not uncommon among working populations, especially in older age groups, and concomitant exposure to other substances or other stresses may deflect normal metabolic pathways. It would appear reasonable, for the present at least, that biological values should be accompanied by one other independent method of evaluating the working environment.

Interpretation and Use

After the threshold limits have been accepted, it is most important that they be properly interpreted and used. Because there is some lack of agreement among industrial hygienists as to the use of the values, it might be worthwhile to consider what is meant by threshold limit or maximal allowable concentration. Confusion appears to center on the precise meaning of the term "threshold" or what constitutes "maximal allowable." These are brief terms used to express a rather complex and abstract concept which may be explained philosophically and operationally.

Philosophically, the threshold limit represents a level to which a normal healthy worker may be exposed for 8 hours each workday without harm to his physical or mental well-being. Because, in practice, most situations involve intermittent or varying exposures, the concept of the limit is that the summation of physiological effects of such exposures shall not be greater than the effect of exposure to a constant concentration at the level of the limit.

Operationally, the word limit refers to the highest permitted averaged values of an agent

in the workroom air that have been obtained in a complete cycle of operations during the day. Proper averaging of concentrations should take into consideration the duration of exposure at each concentration; this is referred to as a "weighted average." Concentrations far above the limit for periods of 30 minutes or more and prevailing sporadically throughout the day, although possibly equaling the threshold limit, are not within the intended meaning of the term. Such levels come under the classification of acute, high exposures, and suitable measures should be taken to bring such levels in line with the accepted limit. Threshold limit values are not based on high, acute levels superimposed on a persistent lower level irrespective of what value their average is.

Threshold limit values should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations, that is, a point above which injury is bound to occur and below which complete safety may be expected for all exposed persons. Competent judgment is required here as in the interpretation of any standard.

Misuse of Limits

The threshold limit values should be used only for control of exposure atmospheres for repeated 8-hour working days. They should not be used in the following ways:

1. For brief acute exposures. (The threshold limit values have been set on the basis of chronic exposures, not on the basis of brief acute exposures.)

2. For mixtures of substances. (There is no assurance that mixtures may not have potentiated and enhanced effects greater than the summated effects of each component.)

3. As levels for community air pollution or for levels to be derived therefrom by simple extrapolation. (The threshold limits have been set on the basis of an 8-hour exposure day with the assumption that a subsequent 16-hour period of nonexposure will aid distribution and elimination of the toxic agent from the body; therefore, they cannot apply to 24-hour continuous exposures common in air pollution conditions.)

4. As levels of permissible concentrations in community water supplies or for substances in solution. (Appropriate levels have been fixed specifically for several toxic elements in potable waters.)

5. As the basis for selecting dangerous compounds for labeling. (Hazards involved in handling chemicals frequently arise from routes other than inhalation, which is the basis for threshold limits.)

6. As safe limits for flight personnel in aviation. (Higher standards of safety and performance are required, and degree and duration of exposure at flight altitude differ from the degree and duration at sea level.)

Pretoxicosis Tests

Closely related to the biological threshold values are tests of pretoxicosis, the detection of subtle metabolic changes in the body before injury of serious proportions has developed. The idea is not new, the first reported test of this sort having been applied to the hematologic reactions of presaturism by Heim de Balsac in 1908 (11). Although the determination of pretoxic reaction is unquestionably one of the highly desirable goals of the industrial toxicologist, few such tests have been developed mainly because the mechanism of action of most toxic agents on which such tests are based is not generally known.

A pretoxicosis test for carbon disulfide has been reported by Bourguignon (12). This test is based on the change in chronaxie, which, in turn, depends upon the knowledge of the vascular and neurologic changes caused by carbon disulfide during the early stages of injury. Chronaxie, by definition, is the minimal time that an electric current of standard strength is required for the excitation of the tissue. Bourguignon's report indicates that after men had been exposed to carbon disulfide for only 2 months and before any clinical signs of disease were manifest, their chronaxie changed. Accordingly, this test permitted early detection of intoxication by carbon disulfide.

Another test of pretoxicosis that is promising although it is still in the developmental stage is the lowered cystine content of fingernails of individuals exposed to vanadium. The

lowered content occurs in the absence of any objective or subjective signs or symptoms in the workers, and it has been experimentally demonstrated in the hair of animals ingesting vanadium compounds in amounts that caused no demonstrable signs of toxicity (13). When used in combination with urinary vanadium determinations, the test appears to be highly suggestive of early metabolic changes resulting from exposure to vanadium.

The well-known urinary coproporphyrin III screening test for lead poisoning might well be classed as a pretoxicosis test. Used in combination with urinary lead values, it is now considered a reliable guide to incipient damage by lead (14). At potentially harmful body levels, lead is believed (15) to convert more of the normally occurring colorless precursor to the chromogen while increasing the total coproporphyrin of the urine.

The relative paucity of such procedures attests to the extreme difficulty of their development. Investigators should be encouraged to develop this aspect of preventive medicine, however, because its value obviously transcends that of diagnostic tests of established disease.

Prophylactic and Antidotal Agents

As the realization of the importance of toxicology in the development and safe use of industrial chemicals has widened, more diversified groups of scientists have become attracted to its problems. Such attraction has resulted in the development of a metal complexing agent, the calcium salt of ethylene diamine tetraacetic acid (CaEDTA), for the treatment of lead poisoning (16). This chelating agent has been given good evidence of effectiveness in numerous clinical trials (17, 18), and it gives promise of considerable versatility. It has been found, for example, to be a satisfactory antidote in experimental vanadium poisoning (19) and to give promise in the treatment of essential hypertension (20). Further use of CaEDTA for the more rapid elimination of other toxic metals having the capacity to complex firmly with this chelating agent at body pH conditions will undoubtedly be made. Since the advent of BAL (2, 3-Dimercaptopropanol) for combating arsenic poisoning, no

other organic complexing agent has proved of such value, although others, such as aurin tri-carboxylic acid for the elimination of beryllium (21), have been suggested from time to time.

An ingenious and novel use of a complexing agent for combating cyanide poisoning has been recently reported (22). Cyanideless vitamin B₁₂ (vitamin B₁₂^a, hydroxo-cobalamin) is capable of tightly coordinating with the cyanide ion in experimentally poisoned animals and thus preventing toxic symptoms and death.

Well-known reducing agents, such as ascorbic acid, have been reported experimentally at least to be effective prophylactically against a variety of toxic agents. For example, vitamin C was shown to function as effectively as CaEDTA against vanadium poisoning in animals (19), and this vitamin is reported (23) to reduce substantially fatal pulmonary edema and hemorrhage in animals inhaling ozone or nitrogen dioxide. Essentially complete protection against fatal ozone exposures in animals was afforded by a mixture of such reducing substances as glycuronate, cystine, and other similar substances that include vitamin C.

Two-carbon fragments administered as ethanol, acetate, and propanol have been reported to be capable of combating the highly toxic fluoracetate (1080) in animals (24), and they give promise of successful therapy for this poison. Cystine, methionine, and other sulfur-containing amino acids have been suggested as more general aids to the detoxifying capacity of the liver for protecting animals against the toxicity of 1,2-dichloroethane (25) and methylchloride (26).

Within the last few years, atropine has proved an effective antidote for parathion and other closely related organic phosphorous insecticides.

Air Sampling and Analysis

The development of valid threshold limit values goes hand in hand with the development of accurate procedures for sampling and analysis of the industrial atmospheric contaminants.

The Millipore Filter

Unquestionably, the greatest boon in recent years to such a development has been the introduction into the field of industrial hygiene of the Millipore filter (27, 28), known also as the membrane filter or molecular filter. This filter has an efficiency of sampling airborne particulates approaching 100 percent for all particle sizes of hygienic significance. The 150 μ thick paper of cellulose acetates and nitrates with 80 to 85 percent voids possesses a high dielectric constant and effectively attracts even noncharged particles of infinitely small size to its surface despite a mean pore size of 0.8 μ . Thus, the paper possesses a collection efficiency independent of the particle size of the aerosol. A limitation of the paper is that oils and tars clog the filter in a very short period of time, making it useless as a sampling medium for these materials.

Valuable use may be made of the property of the membrane to become transparent upon the addition of a limited amount of solvent (acetone, acetates, alcohols). This transparency permits the collected air sample to be directly counted under the optical microscope over a circumscribed, known area of the filter, thus providing a permanent dust mount that may be quantitatively analyzed.

Further advantage has been taken of the solubility characteristics of the Millipore filter by Fraser (29), who combined the high sampling efficiency of the paper and its solubility properties with electron microscopy to develop for the first time an absolute method of sampling and analyzing solid airborne particulates. In outline, the procedure consists of (a) collecting a sample of airborne particulates on the Millipore filter, (b) effecting transfer of the particles to a prepared electron microscope specimen screen after solution of the paper, (c) photographing the particles, and (d) determining the size distribution of the particles by visual measurement from their projection on a screen.

It is strongly urged that industrial hygienists take advantage of this powerful technique to explore the heretofore unsampled and unseen particles of industrial atmospheres and use such information to aid in the determination of their

industrial health significance. The results of such a study could well revise some of our concepts of the effective number of particles required to produce pneumoconiosis.

In the light of this and other recent developments, the Engineering Section of the Occupational Health Field Headquarters, Public Health Service, has undertaken an extensive reinvestigation of the entire field of dust sampling and measurement with the objective of developing improved generally acceptable methods that incorporate the advantages of these advances. Already the investigation has led to a promising use of the transparent properties of the Millipore filter, referred to above, as a dry, permanently fixed, dust sample for on-the-site use in plant or factory.

An automatic instrument which continuously records the mass concentration of dust in the atmosphere has recently been introduced (30). This instrument is based on the photoelectric measurement of forward-scattered light from solid or liquid aerosols and has a range from 10^{-3} to 10^{+2} $\mu\text{g./l.}$ in terms of dioctyl phthalate as 0.3μ diameter droplets. A further modification of this device is being undertaken by David Sinclair of the Johns-Manville Research Center in the development of an instrument which will indicate the size of the particulates as well as their concentration by electronically computing the ratio of backward and forward scattered light from the particles.

Another development in dust analysis techniques is the use of the electron microscope as an electron diffracting instrument. This technique is capable of exploring the surface of particles to the depth of approximately 0.05μ in respect to their crystallinity or lack of it. In conjunction with X-ray diffraction techniques which determine similar properties within the core of the particle, it may provide much useful information concerning the relation between the physical structure of dust and its physiological effects. At the Occupational Health Field Headquarters, such work is being done on the various forms of diatomaceous earths, and in Scotland, on various types of silica (31). Efforts along this line are expected to go far in helping elucidate the etiology of various types of pneumoconiosis.

Developments in sampling and analysis in the highly individualized field of vapors and gases during recent years have yielded no new principle or device, but rather they have found application for many of the methods long used in other fields. The study of air pollution has given a sudden impetus in this direction. Among the recent innovations used in the air pollution field are the portable Venturi scrubber (32), which has proved satisfactory for sampling ammonia, nitrogen oxides, aldehydes and sulfur dioxide, freeze-out trains, large-capacity plastic bags, silica gel, and other solid absorbents (33).

For the analysis of organic pollutants, the infrared analyzer and the mass spectrometer are being explored rather widely. Chromatographic procedures have also aided in the confirmation of many often closely related organic substances present in the air.

Automation appears to be the only really new basic development in this field in recent years. This principle has been most successfully applied to the measurement of sulfur dioxide in the form of the Thomas Autometer (34). This instrument is especially useful in situations where round-the-clock measurements are needed, or with further attachments for signaling added, it may be used successfully for control of gaseous concentrations. Automatic analyzers have also been developed for halogen analysis, for carbon monoxide (35), and for other substances. It should be emphasized that such automatic recorders in their present state of development require careful standardization and repeated attention and maintenance to assure faithful recording of actual concentrations. Commercially available recorders vary widely in this respect. If original design has been good and the instrument carefully standardized and maintained, the saving to industry over the years far outweighs the relatively high initial cost. Increasing automation is foreseen for the coming years in this and related fields of analysis and control of air concentrations of contaminants.

It may seem unfortunate that many of the recent developments in the industrial hygiene field often involve the use of equipment that is

expensive and nonportable. Immobility, but not expense, is fast being overcome when the need demands. A mobile infrared analyzer has been designed (36) and a portable mass spectrometer as well (37). High cost, a factor necessarily associated with increased complexity and sensitivity, will be slower to be overcome.

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Copies of the American Conference of Governmental Industrial Hygienists' list of threshold limit values may be obtained from Allan L. Coleman, chairman of the Committee on Threshold Limits, Connecticut State Department of Health, Hartford 6, Conn.

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Community Health Week, March 21-27

Community Health Week programs are recommended for March 21-27, 1955, by the United States Junior Chamber of Commerce in cooperation with the National Health Council.

Chapters of the Junior Chamber of Commerce have been asked by their national officers to name program chairmen for Community Health Week and to seek the aid of local health leaders. The program theme is "Know Your Community Health Resources."

Voluntary organizations are recommending that their affiliates provide the programs with cooperation and guidance. Basic health services will figure in programs where local public health units work with interested members of the organization.

Interested chapters will obtain a kit of aids from the national office. Suggested activities include health fairs and forums, special newspaper coverage, television and radio programs, exhibits, and school health projects.

Program leaders may wish to consult *Guide to Health Organizations in the United States, 1951*, by Joseph W. Mountin and Evelyn Flook. Public Health Service Publication No. 196. Available from the Superintendent of Documents, Washington 25, D. C. 30 cents.