Transactions of the

EIGHTEENTH ANNUAL MEETING

OF THE

AMERICAN CONFERENCE

OF

GOVERNMENTAL INDUSTRIAL HYGIENISTS

PHILADELPHIA, PENNSYLVANIA

April 21-24, 1956

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Prepared by
THE AMERICAN CONFERENCE OF GOVERNMENTAL
INDUSTRIAL HYGIENISTS

June 1956

Address of Secretary-treasurer:

Mr. Charles D. Yaffe
Secretary-treasurer, ACGIH
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AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

EIGHTEENTH ANNUAL MEETING

April 21 to 24, 1956

Philadelphia, Pennsylvania

April 21, 1956: Standing committee meetings
Executive Committee dinner meeting

April 22, 1956: Round Table Discussions
Meeting of directors of State and local industrial hygiene programs only, with staff members of the Occupational Health Program, U. S. Public Health Service

April 23, 1956: Two general sessions and one business session
A.C.G.I.H. dinner

April 24, 1956: General session, business session and joint session with American Industrial Hygiene Association

ANNUAL MEETINGS AND OFFICERS

ANNUAL MEETINGS			Chairman	Secretary-treasurer
No.	Date	Place		
1	June 27-28, 1938	Washington, D.C.	Albert S. Gray, M.D.	J.J.Bloomfield
2	Apr. 26-28, 1939	Washington, D.C.	W. Scott Johnson	J.J.Bloomfield
3	Apr. 30-May 2,1940	Bethesda, Md.	M. H. Kronenberg,M.D.	J.J.Bloomfield
4	Feb. 17-18, 1941	Washington, D.C.	Charles L. Pool	J.J.Bloomfield
5	Apr. 9-10, 1942	Washington, D.C.	Carl A. Nau, M.D.	J.J.Bloomfield
6	May 24, 1943	Rochester, N.Y.	Marion F. Trice	J.J.Bloomfield
7	May 9, 1944	St. Louis, Mo.	Paul A. Brehm, M.D.	J.J.Bloomfield
8	Apr. 7-13, 1946	Chicago, Ill.	Paul A. Brehm, M.D.	J.J.Bloomfield
9	Apr. 26-29, 1947	Buffalo, N.Y.	K. M. Morse	J.J.Bloomfield
10	March 27-30,1948	Boston, Mass.	L. W. Spolyar, M.D.	J.J.Bloomfield
11	Apr. 2-5, 1949	Detroit, Mich.	H. G. Dyktor	J.J.Bloomfield
12	Apr. 22-25, 1950	Chicago, Ill.	K. E. Markuson, M.D.	L.J. Cralley
13	Apr. 21-25, 1951	Atlantic City,N.J.	J. J. Bloomfield	J.E.Flanagan,Jr.
14	Apr. 19-22, 1952	Cincinnati, Ohio	L. M. Petrie, M.D.	J.E.Flanagan,Jr.
15	Apr. 18-21, 1953	Los Angeles, Cal.	J. C. Soet	J.E.Flanagan, Jr.
16	Apr. 24-27, 1954	Chicago, Ill.	Joseph Shilen, M.D.	J.E.Flanagan, Jr.
17	Apr. 23-26, 1955	Buffalo, N.Y.	Harry B. Ashe	J.E.Flanagan, Jr.
18	Apr. 21-24, 1956	Philadelphia,Pa.	Ralph R.Sullivan,M.D.	C.D. Yaffe

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1/ Refers to year of appointment.

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Dr. Louis W. Spolyar, Ind. Board of Health
Miss Victoria Trasko, U.S.P.H.S.

GENERAL SESSION

April 23, 1956 - 9:00 a.m.

Dr. Ralph R. Sullivan, Chairman, Presiding

THE OCCUPATIONAL HEALTH PROGRAM OF THE STRATEGIC AIR COMMAND

Alvin F. Meyer, Jr., PE
Lieutenant Colonel, USAF (MSC)
Headquarters Strategic Air Command
Offutt Air Force Base, Nebraska

The Strategic Air Command, more generally known as SAC, is the long range nuclear striking force of the United States Air Force. Under control of the Joint Chiefs of Staff, SAC has the mission of being prepared to conduct long range bombardment missions in any part of the world at any time. It is a highly integrated organization of men and machines. The principal aircraft used by SAC are the six jet, swept wing B-47 (an aircraft in the six hundred miles per hour class); the B-36 bomber with six conventional and four jet engines capable of operating above 40,000 feet with a bomb lead of up to forty tons; the eight jet, swept wing B-52 stratofortress; the KC-97 aerial refueling tanker; C-124 globemaster cargo aircraft and strategic fighters. The KC-135 jet tanker will be in service in the future. In the event of actual combat operations the ultimate aim of SAC's operations is to disarm the enemy as quickly as possible and to destroy his will to fight. A brief, unclassified, comprehensive description of SAC, its aircraft, training and organization is contained in the pamphlet "Scanning SAC."(1)

The question might well be asked, "Why have an occupational health program in a combat military organization such as SAC?" As the modern weapons system has become more and more effective, necessary support and maintenance for aircraft, accessories, armaments and weapons has also become increasingly complex. The airplane and its associated components today is vastly different from those of World War II. As an example, the aircraft structural repair problems are quite different from those which existed in days during the reciprocating engine, medium performance aircraft era. The skin of a B-17 bombardment type aircraft was 2/32 inch thick aluminum. On the B-47 it is 5/8 inch (20/32 inch) thick at the wing root tapering to 3/16 inch at the tip. On the B-52 it is milled aluminum, twelve times thicker than the B-17 skin. Competent structural engineering knowledge and skill is required for the repair and maintenance of such aircraft. Virtually every aircraft component and system has become of a nature requiring specialized inspection and repair techniques, even at base level. A further example of the increasing complexity of the maintenance operations may be gathered from the fact that 19.5 man-hours of maintenance are required to produce one flying hour for the B-17. The B-47 requires 47 man-hours of maintenance (exclusive of engine overhaul and minor repair); the B-36 requires 92 hours per flying hour, and the B-52 requires 117 hours.

With the advent of atomic and thermonuclear weapons delivered by high performance jet aircraft, the importance of a single aircraft and a single weapon becomes immediately apparent. It is obvious that a high degree of base operational level inspection and maintenance is required if the weapons system is to be ready to discharge its assigned mission in an economical manner. Depot overhaul and maintenance is still a major requirement; however, maintenance activities at base level have become more detailed, requiring highly skilled personnel and equipment.

Concurrent with the development of the airplane and the increasing maintenance problems at installation level, there has developed a widening utilization of the techniques and procedures common to the aviation industries throughout the Air Force structure. Management is intensely aware of the dollars and cents aspects of all operations, both as they are related to materiel and with regard to manpower (the latter being one of our most critical assets). Operating as the USAF does within strict budgetary and personnel allocations, it is essential that maximum productive effectiveness be maintained. An example of the concern in this area is the fact that in SAC all maintenance personnel are required to maintain time cards similar to those used in industry. These time cards are used as a basic source of data for the maintenance production control system.[2] Included in the non-productive man-hour accounting are reports of absences due to illness and injury, medical out-patient treatment and physical examinations and similar procedures.

Some better idea of the scope of the occupational health problem on an average SAC base may be obtained from the following information for a typical two wing SAC base. Almost eighty percent of all SAC personnel are involved in maintenance or support activities. A typical base may have between six and seven thousand personnel assigned, of whom the majority are, of course, military. Aircrews comprise approximately ten percent of the total number. The total physical assets, including the aircraft and real property, average around $358,400,000. The average hourly wage paid maintenance workers amounts to approximately $1.25. The total monthly operating cost, including salaries, utilities and similar costs, amounts to approximately $2,922,000. The average total floor space of base shops is 356,000 square feet. In addition, line maintenance and hangar facilities provide another 160,000 square feet of work area.

A wide variety of industrial type operations are conducted within the shop and work areas involving many industrial hygiene and occupational health hazards and problems typical of the aviation industry. Because of the specialized nature of Air Force operations, there are a number of unusual type hazardous exposures. Among the problems of major concern in this area are those related to high intensity noise and the handling of large volumes of aviation fuel.

The aircraft inspection and maintenance program includes such activities as pre- and post-flight inspections, minor aircraft repairs, washing and pre-flight preparation of aircraft. In addition to the exposure to chemical hazards incident to such work, personnel must accomplish these operations frequently under extreme climatic conditions with exposures to very high or very low temperatures, high winds and glare conditions. Although a major portion of the aircraft overhaul and maintenance operations are conducted in shop areas, there is a considerable amount of work actually done within aircraft in parking areas which requires personnel to work in very confined areas, again frequently under adverse climatic conditions. There are many problems of ventilation and illumination of work areas within the airplane. It is obvious that even a small amount of solvent vapor may represent a very serious potential hazard under such conditions.

Field maintenance activities include shops for in-flight refueling equipment, hydraulic systems, electrical equipment, instrument and office machine repair, overhaul of pneumatic systems, wheel and tire build-up, fuel system repair, aircraft repair and reclamation, repair of motorized and ground equipment, battery shops, and power plant maintenance, including engine conditioning, engine change, engine build-up and tear-down, power pack repair, jet engine overhaul and propeller repair. A wide variety of materials affording potential hazards, including solvents, alcohol, lubricants, small quantities of toluene, acetone, ethyl alcohol, caustic cleaners, fuels, some exposure to lead, are present throughout these shops. There are potential exposures to carbon monoxide and many of the chemicals required in maintenance operations are possible sources of dermatitis.

In support of the aero-repair facilities there are required a number of fabrication operations. In addition, minor changes in aircraft configuration and components frequently require the preparation on a semi-production line basis of equipment for "technical order compliance." To support this function there are woodworking shops, machine shops, welding shops, doping, painting and fabricating shops, sheet metal shops, electroplating shops, trichloroethylene degreasing facilities, parachute, leather repair and textile facilities. The usual industrial hygiene problems involved in all of these operations are present. Included are mechanical injury, possibility of production of dermatitis, exposure to ultraviolet and infrared radiations in welding operations, metal fumes, exposure to benzol, acetone, ethyl alcohol, naphtha paint pigments, solvents, ethylene dichloride, methyl ethyl ketone, trichloroethylene and electroplating materials.

Another very important maintenance activity is the armament and electronics maintenance operation. In this activity the radar, radio and gunnery systems are maintained as well as camera repair, navigation and bombardment devices and associated weapons maintenance. Materials used include such solvents as trichloroethylene, with some soldering accomplished and the potential problem of exposure to microwave radiation.

In addition to concern with the occupational environment in the aircraft maintenance shops, there are a number of other activities of primary concern in the occupational health program. Each base has a large motor vehicle shop in which routine periodic maintenance is accomplished so as to keep Air Force owned vehicles in proper operating condition. These shops are typical of large automotive repair garages and involve operations such as soldering, painting, welding and engine overhaul. Operation of the fuel system for aircraft involves the handling of large volumes of aircraft fuels and associated additives. To support an activity of the magnitude of the average air base, housekeeping of the installation is accomplished through the installations engineer. He operates welding shops, sheet metal shops, degreasing shops, woodworking shops, paint shops and has plumbers and electricians and other utilities personnel working throughout the base. The insect and rodent control section operated by this division handles a wide variety of economic poisons with associated potential exposures both to the poisons and their diluents and solvents. Base fire departments handle large volumes of fire extinguishants, such as chlorobromomethane, carbon dioxide and carbon tetrachloride, with attendant potential exposures. Most bases have their own water and sewage facilities with attendant problems of protection of the operators thereof against such chemicals as chlorine gas, lime, soda ash, fluorides, methane and hydrogen sulfide.

There is also present potential hazards affecting clerical and administrative personnel, such as the handling of duplicating fluids, exposure to deficiencies of illumination and other adverse working conditions.

The occupational health problems in the Air Force working environment also include cognizance of factors in the working environment which produce a lessened ability on the part of individuals to do their job. This situation is typical of that which exists in civilian industry and may arise from physical, psychological or other factors, In many instances, such individuals frequently present themselves to the out-patient department with vague and ill-defined symptoms. Among the factors which influence the incidence of this situation are:

a. Actual repeated exposures to unsuspected low level toxicants with the resulting slow build-up within the body of harmful effects.

b. Long working hours coupled with adverse environmental conditions such as excessive heat or cold, glare, noise, irritating or aesthetically undesirable conditions.

c. Poor dietary habits.

d. Dissatisfaction with job, promotion opportunities or related conditions.

e. Adverse off duty living or recreational facilities.

f. Mild personality or emotional conflicts, either job or off duty related.

Concern for this type problem is no unusual situation peculiar to Air Force operations.(3)

There are also present all of the usual community public health considerations required for the living environment: the need for consideration of housing, food service, provision of sanitary water supply and waste disposal, insect and rodent control and the prevention of communicable diseases.

A comprehensive occupational health program is a logical extension of Air Force management's interest in the total problem of economical, effective Air Force operations. The occupational health program in SAC is designed to improve and maintain the productive effectiveness of the working force, both military and civilian employees. The aim of the program is not only to prevent or minimize time away from places of work as a result of occupational diseases and injuries, but also to reduce all lost time due to sick absenteeism. This has always been a fundamental concept of military medicine with its principles of selection of personnel to meet physical standards, preventive measures to minimize the effect of adverse conditions and early restoration of the sick and injured to duty.

The occupational health program developed to provide the required health promotion and conservation measures at SAC installations is an integral part of the base medical service. In general, it consists of two broad functional areas--those devoted to procedures for individuals and those which pertain to the environment. The functional activities of the flight surgeons are closely integrated with those of other medical personnel and the sanitary and industrial hygiene engineers of the medical service.

To a large extent the entire military medical system is concerned in one way or another and out-patient departments, laboratory, aeromedical services and administrative activities, not normally considered as part of the preventive medical effort, have major roles to play in the program. A physical classification profile is a basic part of each airman's job description and such physical profiles are assigned an individual on his entry into the military service based upon his physical examination at that time. Appropriate changes are made in event of illness or injury and if the profile does not meet that for the job concerned, the individual must be reassigned or retired under provisions of personnel procedures. Provision exists for similar procedures with regard to civilian employees under Civil Service regulations. In addition, pre-placement physical examinations programs are enforced for those jobs in which there are special physical considerations requiring either base line data or exclusion of individuals with disqualifying physical status.

Periodic physical examinations are utilized to detect the effects of exposure to the occupational environment with a view of possible initiation of corrective measures well in advance of actual onset of disease or disability. While it would be highly desirable to accomplish such examinations on all of the SAC work forces, the scarcity of physicians and medical personnel precludes this. Instead, with the exception of certain potentially serious hazardous exposures, periodic examinations are accomplished on a statistically significant portion of the exposed group within a shop or work area. The selection of individuals for the sampling group is generally based on evaluation of the work environment and operation by the industrial hygiene engineer so as to select individuals with the greatest exposure. Similarly, in work areas where environmental surveys have shown the exposure potential to be slight, random examinations are made periodically on selected individuals. The results of these examinations are carefully studied and if indicated additional personnel are examined. Workers exposed to high intensity noise are included in the group requiring detailed physical examinations on a periodic basis. Of interest also is the fact that only standard Air Force, Department of Defense and federal agency forms are used for maintenance of required records of the occupational health program. As a result, the standard military out-patient service folders are a basic component of the occupational health program records. There is a wide variety of standard federal forms which are either directly applicable or may be adapted for the purposes required in the occupational health program.

The close relationship between medical and engineering procedures required for the operation of the periodic physical examination program is carried out further with regard to investigations of suspected cases of occupational disease or dermatitis. Environmental surveys of exposure conditions are generally accomplished on all such cases.

There are many unusual environmental problems requiring the practice of a high degree of sanitary and industrial hygiene engineering skill. Advice and assistance is provided operating agencies on minimizing of the effects of environment on aircrews. Considerable emphasis is being given to the biotechnical aspects of work procedures and shop environments with a view toward improved worker effectiveness. Studies made in the past have included those on aircraft fuel cell repair, human engineering in battery shops and acoustical noise reduction design for crew positions in aircraft, among others.

To coordinate and direct a program of the broad scope covered by the occupational health program in SAC at many installations there have been appointed preventive medicine councils consisting of the senior medical officer in charge of the medical facility, the flight surgeon, the chief of professional services, the sanitary and industrial hygiene engineer officer, the veterinary officer and representatives from the directorate of materiel and office of safety and other base agencies. A major area of service to the command provided through the occupational health program is in consultations to various staff agencies at SAC headquarters and numbered Air Force headquarters. These professional consultations cover a wide variety of engineering and bio-medical subjects which include both planning for new procedures and operations in which potentially hazardous exposures to physical, chemical or biological agents of disease are present as well as solutions to current problems. Another major contributary service to other agencies is the preparation of articles on occupational health subjects for publication in various publications such as the SAC Maintenance Engineering Bulletin and the Combat Crew and Flying Safety magazines.

In order to provide required additional training for newly commissioned sanitary and industrial hygiene engineers, there has been developed a guided study program. This program is intended to be used as an aid in self study and supplements training available from other sources. A number of comprehensive reference publications in the field of occupational health have been prepared for use as guides in the command. Among these are those relating to noise, radiation exposure, planning for disaster operations, a guide to the occupational health program and an engineering data book for the preventive medical and occupational health program. Information on preventive medical and occupational health subjects of a non-directive nature has also been distributed to subordinate activities by the command surgeon's office through the means of a preventive medicine bulletin.

Biometric studies of both occupational and non-occupational disease problems are a continuing function at command headquarters and subordinate levels. The command sick absence rate for both military and civilian personnel is computed from data available from the previously referenced time cards. This data is analyzed in comparison with known rates in civilian industry and other military organizations. Review is also made of all clinical record cover sheets, DD Form 481-3, in cases of hospitalized conditions attributable to occupational exposures. Where indicated, follow-up action is taken to bring the facts of such cases to the attention of management.

In conclusion, the occupational health program in SAC can be thought of as comparable to that of the civilian aviation industry with necessary modifications to fit the special needs of a combat military organization. The future problems will undoubtedly be of a stimulating and challenging nature if the experience of the past is any indication. The mission of conservation of productive effectiveness is being met although many problem areas yet remain.

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THE RESPONSIBILITY OF OFFICIAL AGENCIES IN AGRICULTURAL INDUSTRIAL HYGIENE

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The population of the United States in 1910 was 92,000,000. Today it is 166,000,000, an increase of 80 percent. In 1910 there were 322,000,000 acres of crop-land. Today there are 350,000,000 acres of crop-land, an increase of only 9 percent. Yet, we have no difficulty producing enough food for our present needs. On the contrary, we are faced with the problem of farm surpluses. It is estimated that 310,000,000 acres will be able to supply our 1960 population. The reasons for this increase in productivity per acre are manifold. Improved farming practices, such as erosion control and the use of fertilizers and other agricultural chemicals, have contributed appreciably. Mechanization has increased the ability to harvest. Furthermore, machines have released for human food about 75,000,000 acres which were formerly required to grow feed for the horses and mules which they replaced.

This same mechanization has now made it possible to produce more than enough for our present needs through the efforts of only 6,500,000 farm workers, or 11 percent of our working population, whereas in 1910, 11,600,000 or 31 percent were employed in such pursuits.

Examining these trends further we find that the number of farms is now 5,425,000 (1954) as compared to about 6,600,000 in 1910. More important, half of our present farms produce nine-tenths of the crops. Those of us in industrial hygiene are immediately struck with the parallel with industry where a small number of large companies account for a high percentage of the total production.

And, just as large manufacturing concerns are often better able, because of the scale of their operations, to afford the latest advances in mechanization, so, and frequently to a greater degree, are large farms better able to employ mechanical equipment. The capital investment associated with many of the new mechanical devices having agricultural uses often represents an amount which cannot be spared for a small operation.

Some idea of how mechanization has progressed in farming may be obtained from U. S. Department of Agriculture statistics, which reveal that between 1941 and 1952 the number of tractors increased from 1.7 million to 4.4 million (159 percent), the number of grain combines from 225,000 to 940,000 (318 percent) and the number of mechanical corn pickers from 120,000 to 635,000 (429 percent). The over-all increase of total power on American farms during that period exceeded 70 percent. Farm output per man now has approximately doubled in the 15 years since Pearl Harbor.

Part of this increase per man-hour also results from the greater use of agricultural chemicals, which not only increase production but also reduce labor by controlling weeds, insects and other pests which formerly required hand cultivation measures.

Agriculture, thus, is seen to have undergone a change during the past generation similar in nature to the revolution in manufacturing which had an earlier start.

What effect has this change had upon the health and safety of farm workers? Farming is intrinsically hazardous. Accidents have always been frequent on farms. While statistics are not available as evidence, it is quite certain that a great many injuries have resulted from the handling of farm horses. Interestingly enough, a limited survey in one county within the past six months showed that 8 out of 29 recent accidents involved horses. Even with mechanization there seems to be a tendency to keep a few horses. Of 44 farms visited in this survey 36 had at least one horse, with a total of 182.

Other farm animals, particularly bulls, also present safety hazards to farm employees.

The danger of infections from injuries incurred on the farm must be considered much greater than that in industry. This danger is heightened by the nature of the working environment, the inaccessibility of first-aid facilities, and the absence of organized health maintenance programs stressing prompt care of minor wounds and other dermatologic conditions. The greater prevalence of the tetanus hazard on farms is well recognized, but other organisms must also be considered.

There are a number of bacterial diseases which may be contracted in connection with agricultural work. Brucellosis, or undulant fever, is generally thought to be the most common one, but reliable statistics are lacking. Incomplete reporting, as well as unrecognized cases, may account for more cases than are actually recorded. One factor contributing to the higher incidence of brucellosis is that many farmers themselves vaccinate cattle, rather than calling upon a veterinarian, and thereby risk accidental infection. Other diseases of significance include anthrax, erysipeloid, leptospirosis, tularemia, bovine tuberculosis and various forms of salmonellosis.

The farmer is also exposed to a variety of viral and rickettsial diseases, including equine encephalomyelitis, ornithosis—which is commonly called psitticosis—Q fever and Rocky Mountain spotted fever. There is a long list of mycotic diseases, of which actinomycosis and histoplasmosis are examples. A number of parasitic diseases are also potential hazards.

Moving from these biologic hazards to physical agents, we find that farm work involves exposure to extremes of temperature, both high and low. Heat exhaustion and heat stroke undoubtedly affect many farm workers. Another problem believed to be significant is skin cancer, produced by prolonged exposure to the sun's rays.

The increased use of machines has brought a whole group of hazards new to agriculture. Noise exposures, for example, may now be sufficient to affect the hearing of some individuals who operate machines for considerable periods. When more is learned about the problem of vibration, it may also be found to have adverse health effects on agricultural workers. Maintenance and repair work on farm machinery introduce further problems, such as the hazards of welding.

Accidents incurred in the use of farm machinery represent one of the major categories of farm hazards. Accident rates in agriculture are far above industry as a whole. In 1954 only the mining and construction industries had higher death rates, agriculture having 60 fatal work accidents per 100,000 (a total of 3,800) as compared with a rate of 25 per 100,000 for all industries. The injury rate, according to the National Safety Council was 4,930 per 100,000, compared to 3,240 per 100,000 for all industries.

In addition to biologic and physical hazards, the industrial hygienist who looks at present-day farming is struck forcibly by the vast number of toxic chemicals which have come into use. Although many of these are soil conditioners and fertilizers involving little hazard, the majority are insecticides, fungicides, rodenticides, nematocides and weed killers which are employed specifically because of their toxic properties. While some are comparatively safe, nearly all present some degree of danger to humans, and some must be classified as extremely hazardous. In particular, the heavy metals, such as lead, arsenic and mercury, the halogenated hydrocarbons, and the organic phosphates present serious potential dangers to the people using them and sometimes to others working or living in the vicinity.

In dealing with industrial exposure to hazardous materials, we frequently express the view that any material, regardless of toxicity, can be used safely, provided that proper control measures are employed. The same philosophy might be applied to agriculture, but assurance of proper control measures is harder to obtain, at least at the present time. The reasons for this are readily apparent. Industrial operations can usually be performed in a fixed location where exhaust ventilation or other suitable control methods are feasible. Industry has been subjected to fairly extensive and intensive educational programs on health and safety for at least a generation. Larger companies usually have full-time safety and medical departments which are on the alert for potential dangers. Furthermore, personnel of insurance carriers and official agencies make frequent visits to industrial plants to check for possible hazards.

On the other hand, agricultural workers generally have little idea of the potential hazards involved in the handling and application of dangerous chemicals. Although most chemicals of this type carry warnings on the container labels, there is a tendency to pay little or no attention to them, particularly if a material has been used previously without untoward incident.

Moreover, the methods of application are almost as varied as the materials used. Many of these methods present dangers that would not be tolerated in manufacturing establishments. For example, the application of fumigants such as carbon tetrachloride in connection with grain storage may involve techniques that would horrify an industrial hygienist. On a recent farm survey, workers were observed tying handkerchiefs over their faces to protect themselves from heavy concentrations of carbon tetrachloride.

Thus, we see that the problem of hazardous exposures on the farm is one of considerable magnitude. Let us now consider what is being done and what more needs to be done about the problem.

Occupational health programs are conducted in official agencies either because of laws specifically concerning industrial working conditions or because of broad powers regarding the protection of health. Virtually all of these programs were inaugurated to cope primarily with problems associated with manufacturing, and, sometimes, also mining. Few of them gave much thought initially to the farm worker. In recent years some of the State units have devoted some attention to specific farm problems that have come to their attention. For example, in Florida, where 46 claims for parathion poisoning were filed in 1952 and 45 in 1953, the Division of Industrial Hygiene has conducted an educational campaign among citrus grove and truck garden owners on the hazards of insecticides and the preventive measures to be taken.

Also, the high incidence of occupational disease among agricultural workers in California has led to special investigations of farm hazards in that State. In 1954, of 23,101 reports of occupational disease in California, 3,143 (13.6 percent) were in agricultural workers.

In addition to purely occupational influences, the health of many farm workers is affected by environmental factors which are much less significant among present-day urban workers. Farm labor, especially migrant workers, sometimes have to live in places where the housing and sanitation standards are far below those now considered as acceptable to the American way of life. Large numbers of workers follow the crops from one State to another, meanwhile living in places where waste disposal is primitive, where water supplies are of questionable quality, where food spoilage is difficult to prevent, and where protection against flies and other disease carriers is absent. The problem of health protection for such people extends far beyond the control of the traditional occupational diseases, encompassing, in addition to basic sanitation, knotty questions of medical care for individuals not eligible for service available to permanent citizens of the area. Under these circumstances, it is reasonable to expect such transient workers to increase the transmission of communicable disease from one area to another.

While these problems require action involving all of the available community health resources, occupational health personnel must not overlook their responsibility in this area. Industrial hygienists, in checking the working environment in factories and mines, should also be concerned with the water supply, washing facilities, waste disposal and food sanitation. Neither should they neglect these points with respect to farm work or, for that matter, in other situations where workers are housed temporarily, such as in construction camps. Since responsibilities in this field also rest upon other personnel in State and local health agencies, policies for the best utilization of resources must be developed to meet the individual situation. It is important, however, to recognize the place which these problems have in the broad field of occupational health among agricultural workers.

As stated before, a number of State occupational health units have concerned themselves, to a limited extent, with specific or selected problems involving the health of agricultural workers. To the best of our knowledge, however, no agency has ever considered the over-all problem, with the objective of ascertaining the extent and severity of health problems on the farms of its State. This approach, which has been applied effectively by the States in planning logical and sustained programs for the improvement of worker health in industry, must now be used in agriculture if we are to successfully cope with the problems facing the farm worker.

The first stirring of activity in this direction came in 1955, when the South Dakota Department of Public Health requested assistance in planning an occupational health program for that State. In response to this request, the Public Health Service suggested that the program be developed to give industry and agriculture equal consideration from the start. To help develop such a program, the Occupational Health Program of the Public Health Service assigned a veterinarian to South Dakota last September. Through this project it is hoped to evaluate the effectiveness of certain survey techniques, and to develop useful information regarding occupational health problems and methods for their attack.

Coincidentally, during 1955 the State University of Iowa Medical School established an Institute of Agricultural Health which will study similar questions in Iowa.

It is significant, we believe, that these related projects were independently conceived and started at this time. Although the existence of health and safety hazards on the farm has been recognized by public health authorities for some years, the South Dakota and Iowa programs represent the first positive steps taken toward a comprehensive approach to the problem.

While some findings from these two States may become available relatively soon, other States need not wait for them before taking stock of the adequacy of their activities with respect to this particular segment of the employed population. Indeed, because of variations in crops, climate, soil and other factors, problems will be found to differ in each locality, and all States can contribute appreciably to scientific knowledge while carrying out a public health activity of real merit.

The subjects which need exploration are numerous. Study needs to be made of the toxicology and proper application of chemicals, of the safe use of mechanized equipment, of the general health status of agricultural workers as compared to the rest of the population, of the effectiveness of educational measures, and of the availability of health resources.

This is a new and complex field confronting the industrial hygienist. The agricultural occupational health problem may not readily lend itself to solution, but in every State where agriculture is a significant industry, an earnest beginning should be made to meet this public health responsibility.

OCCUPATIONAL HEALTH STUDIES IN THE INVESTMENT CASTING INDUSTRY

Environmental Aspects

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INTRODUCTION

Industrial investment casting is a new industry and little is known about the potential health hazards associated with its operation. Kramer and Goldwater [1] reported the hazards associated with the use of mercury as a pattern material in the Mercast process. Many investigators have reported on the health hazards in the sand foundry industry. Since there is a material difference in the sand casting foundry technique and the investment casting technique, this study was undertaken to determine the nature and extent of the potential health hazards in this industry.

THE INVESTMENT CASTING INDUSTRY

HISTORY [2] -- Industrial investment casting is more commonly known as the lost wax process. Three different sources were responsible for the development of the industrial casting techniques. The fundamentals of this process came from the arts. This method of casting was used in the creation of statues and artifacts as long ago as 2,000 B.C. in Egypt and perhaps earlier in China. With the exception of a few fleeting instances little is known of the progress of this art until the 16th century. During the 16th century, Benvenuto Cellini cast many of his figures and objects of art using the lost wax process. Like others of his contemporary artistic countrymen, he kept his method secret; thus, the process was lost for several hundred years.

The process, however, was rediscovered in 1897 by a dentist, B. F. Philbrook, and further developed by Dr. W. H. Taggart. The dental profession contributed accuracy, smooth surfaces, and investment compounds to this casting process.

The third source of information and technique was supplied by the jewelry trade in the early thirties. The manufacturing jewelers' contribution to the lost wax process was the development of a permanent die as a means of producing thousands of castings as exact duplicates of the pattern.

PLANT DISTRIBUTION--Prior to World War II less than 10 percent of the existing number of manufacturers presently in this industry were in operation; about 20 percent started business between 1940 and 1945 and the balance, or 70 percent, started after World War II. In 1955, there were 189 investment casting establishments in the United States, Canada, and Europe, employing a total of 12,400 production workers. Approximately 50 percent of these workers are women. [3]

DESCRIPTION OF OPERATION--The principal steps in the production of castings by the investment casting process are as follows: preparation of wax or plastic patterns, dip coating of patterns, investing, mold burn-out, melting and casting, knockout and cleaning of castings.

To produce the patterns a split metal die is prepared from the master pattern. The die cavities are sprayed with parting compounds generally consisting of a mixture of green soap and water or non-hydrolyzable silicones. The vehicles employed with the silicones are: methylene chloride, perchlorethylene or members of the freon family of fluorocarbons.

The most common method of filling the dies is to force the wax into the cavity with air or hydraulic pressure. A wide variety of waxes are used including bees wax, carnauba and several crystalline type petroleum waxes. Trichlorethylene and carbon tetrachloride are used when necessary to clean out sticky parts of the pattern dies.

The wax patterns are generally grouped together to form a tree or cluster around the pouring sprue and it is common practice to use small electric soldering irons or hot knives to momentarily soften the wax pattern in order to attach it to the common sprue. After assembly of the wax patterns it was observed, in some plants, that each assembly was dipped into a solvent, either ethyl alcohol or benzene, in order to remove all traces of the parting lines.

Polystyrene plastic can also be used as a pattern material. A plastic cement, using benzene or carbon tetrachloride as a vehicle, is used in some plants to assemble the plastic patterns. After being grouped into clusters or trees, the plastic patterns may receive further treatment of cleaning with solvents prior to dip coating.

The tree or cluster is dipped into a slurry which contains approximately 70% silica flour and such ingredients as octyl alcohol, ethyl hexanol, sodium fluoride, chromium oxide, iron oxide, sodium silicate, gum tragacanth, wetting agent, solvent and many other materials to give desired surface properties. Spraying is another method of applying this coating. After the coating has been applied, coarse sand is sprinkled over the dip coat to provide better bonding surfaces for the main body of investment material. The coated pattern may be waterproofed by spraying or dipping with dimethyl silicon dichloride, mineral acids, monammonium phosphate, zinc chloride or ethyl silicate.

The dip coated patterns are then invested. Webster's definition of "To invest" is "To envelop or cover". Therefore, the slurry that is poured over the tree is called an investment.

In general, investment materials are mixtures of graded refractory materials such as fire clay grog, silicon dioxide, silica flour, sillimanite, cristobalite, aluminum oxide, zirconium oxide and flint. Magnesium oxide is used as an accelerator. The materials are dry mixed in cone blenders, open end mixers or mullers. The dry mix is placed in individual containers because most investment mixes segregate readily in mechanical conveying.

Binders used with these materials include Portland cement; sodium silicate and phosphoric, nitric or hydrochloric acid; ammonium or sodium phosphate; ethyl silicate and ethyl alcohol, acetone, cellosolve or iso-propanol alcohol and zirconium oxychloride.

The dry mix and binder is mixed in an open end mixer or commercial dough mixer. A flask is placed around the tree and the investment slurry poured around the tree. To remove any entrapped air the flasks are tamped, vibrated or vacuumed. The molds set up in thirty to sixty minutes.

The molds are inverted and placed in a melt-out furnace at about 350°F and the melted pattern material is allowed to run out and is collected for re-use. It is from this step in the process that the name "lost wax" is derived. The mold is further heated in a burn-out furnace at 1200-1800° F to volatilize or burn away any pattern material that has soaked into the mold or which has not run out of the cavity made by the pattern. The metal is poured into these molds immediately upon removal from the burn-out furnace. Some of SAE series of constructional and stainless steels are reactive to the mold surface, therefore, to protect the surface the mold is inoculated by squirting three to six cubic centimeters of carbon tetrachloride or trichlorethylene into the hot mold cavity.

Melting may be done in the usual types of equipment except that very small furnaces are used. High melting point alloys can be melted in carbon arc or induction furnaces. Lower melting point alloys can be melted in induction furnaces, or in oil or gas-fired stationary or tilting furnaces.

The actual casting of the molds varies greatly from shop to shop. In some cases the molds are poured statically: in other cases, centrifugal casting machines, air pressure machines, or vacuum machines are used.

When the mold is cool, the casting is knocked out of the flask by means of a pneumatic hammer. The sprue and gates are then cut off and necessary grinding operations performed. The surface of the casting is frequently treated in order to give a desired finish. This is done either by sand blasting, tumbling, or wheelabrating.

Prior to shipment the castings receive a final inspection. The castings that are used in aircraft assemblies, may require 100% x-ray inspection.

The above description reveals that the investment casting process differs in three major respects from normal sand casting techniques: the pattern of the desired part is made of an expendable material, such as wax or plastic and a new pattern is required for each casting; the molding mixture, called investment, has the consistency of thick cream or slurry and is consolidated by vibrating, tamping or vacuuming; and the metal is cast into hot molds.

OTHER INVESTMENT CASTING PROCESSES

SHAW PROCESS--This process involves the use of a mold material consisting of ethyl silicate and refractory, which passes through a pliable stage during solidification and can be stripped from the permanent pattern. These mold sections are ignited for drying. They are then assembled and clamped together. Around this assembly a quick-setting refractory slurry is poured. This is fired by igniting and is then ready for pouring.

INVESTMENT X--The wax pattern is sprayed or dip-coated a number of times in a mixture of ethyl silicate and refractory material to build a refractory shell. After formation of the shell, the wax is removed by immersion in trichlorethylene vapors at 120° F. The finished mold is packed in a canister or flask with dry refractory back-up material for pouring.

MERCURY CASTING PROCESS--A mercury pattern is made by freezing mercury which has been poured into a steel die. A ceramic shell mold is built around the frozen mercury pattern by dipping the pattern into a slurry containing refractory materials. The mercury is extracted by allowing the mercury to remain at room temperature. The shell mold is baked to insure complete removal of the solvent and then fired. The fired shell mold is placed in a flask and loose sand is poured around the shell as back-up material prior to pouring.

GLASCAST PROCESS--Glascast powder is essentially a finely crushed (minus 325 mesh) 96 percent pure silica glass, mixed with water. No binder is required. Poured into a porous plaster form, the slip builds up into a glass shell which is dried, removed from the mold, and fired. The shell is then ready for use without further treatment. The shells can be assembled with wire or cement or placed in flask with back-up material and then poured.

The silica glass powder contains approximately 2% quartz and the remainder is a non-crystalline form.

ELLIS PROCESS--This process is essentially a combination of plaster casting and investment casting technique.

ENVIRONMENTAL STUDIES

The engineering phase of the investment casting investigation included an evaluation of the environmental factors of dust, gases, and solvents and the physical conditions of noise and ventilation. The studies were extended over a period of time to include both summer and winter conditions.

The investigation was carried out in five Michigan investment casting establishments. The number of employees per establishment ranged from 22 to 452. These establishments produced castings, that were generally less than one pound, from carbon and low alloy content steel, cobalt and nickel base heat resistant alloys, and other highly alloyed stainless steels. At some plants, approximately 10 percent of the castings produced were from alloys of aluminum, copper, or magnesium. The majority of plants worked only during the day with the exception of one plant which operated three shifts. In the smaller plants, operations were of an intermittent nature.

COLLECTION AND ANALYSIS OF SAMPLES

FIELD PROCEDURE--In each establishment three or more dust samples were collected at each operation and on different days. A total of 223 samples were collected for defining levels of exposure and the physical and chemical characteristics of the silica dust. Of these, 153 were impinger samples for determining atmospheric dust concentration. An additional seventy-eight samples were collected for determinations of iron, cobalt, chromium, and nickel.

Depending on the information desired, three methods were used for collection of air-borne dust. Sampling for dust counting and particle size determination was done by the standard impinger and counting by light field technique (4). The sampling medium was 100 milliliters of triple distilled water. A gross air sampler was used for the collection of air-borne dust for chemical analysis. These samples were elutriated, and the sections thus obtained were each analyzed for free silica. Electrostatic precipitator was used to collect dust and fume samples at the melting, knockout and grinding operations for determination of iron, cobalt, chromium, and nickel. The precipitator was operated at a sampling rate of 3 cubic feet of air per minute.

The Davis Combustible Gas Indicator and Halide Meter were used to sample for combustible gases and solvents, respectively.

Three impinger samples were taken at a given plant and operation for particle-size determinations. The slides were prepared in the manner described by McCormick (5) and particle-size distribution was determined with the filar micrometer using an oil immersion objective (6).

(Laboratory procedures used were described in the original paper, but are omitted here. The authors will provide them on request.)

RESULTS OF ENVIRONMENTAL STUDIES

ATMOSPHERIC CONTAMINANTS - DUSTS

The modern investments should be divided into two classes: Those used for low temperature work, and those used for high temperature work. Low temperature investiments are used for metals which contain no iron and with pouring temperatures of 2000° F or below. High temperature investments are primarily used for metals that are poured above 2000° F, although they may also be used for low temperature work.

Two types of high temperature investments were encountered in this study: The custom formulation, developed by the individual plant, consisted of 30-60% fireclay grog, 17-24% silica sand, 21-52% silica flour and a binder of ethyl silicate and ethyl alcohol. The proprietary investment formulation, developed by commercial sources, consists of silica sand, silica flour and a water soluble binder.

The low temperature investments are a mixture of silica sand and flour and use plaster of Paris as the binder.

Analysis of 10 custom and proprietary high temperature investments showed an average free silica content of 70 percent and 82 percent respectively. An analysis of 5 proprietary low temperature investments showed an average free silica content of 28 percent.

The investment process lends itself to casting metals that have high melting temperatures and which are difficult to machine. The alloy range of these metals is 5-50 percent cobalt, 5-55 percent nickel and 1-30 percent chromium. In addition carbon and low alloy steels, stainless steels, yellow brass, bronze, beryllium-copper, aluminum and magnesium are also cast.

FREE SILICA IN AIR-BORNE DUST--The percent free silica, on a weight basis found in the air-borne dust by operation and by type of investment in five plants was as follows:

Operation	No. of Samples	Custom Investment				Proprietary Investment			
		Free silica percent by weight				Free silica percent by weight			
		Total sample		Fraction less than 5 microns		Total sample		Fraction less than 5 microns	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Dip coating	5	37-80	54	-	-	-	-	-	-
Dry mixing	9	76-98	87	44-52	47	-	-	-	-
Wet mixing	17	61-83	74	41-54	47	51-85	68	23-51	36
Knockout	13	63-90	72	56-67	63	21-70	43	11-39	25

These data show that the average free silica content in the total sample and the fraction less than 5 microns are higher in custom investments. The significant difference observed between custom and proprietary investment in the knockout operations may be attributed to the formation of silicic acid on the hydrolysis of ethyl silicate with ethyl alcohol. In all operations, for both types of investments, the average free silica content of the total sample was about 40 percent greater than the average free silica content in the fraction less than 5 microns.

FREE SILICA IN SETTLED DUST--The samples for this determination were collected from beams and overhead pipes 10-15 feet above the floor level. These samples were collected for custom and proprietary investments in the following areas: (1) dry mixing, (2) wet mixing, and (3) knockout. The results of these samples for free silica are as follows:

Operation	Number of Samples	Custom Investment		Proprietary Investment	
		Free Silica Percent by Weight		Free Silica Percent by Weight	
		Range	Mean	Range	Mean
Dry Mixing	4	52-63	57	*	*
Wet Mixing	6	50-63	58	42-46	44
Knockout	6	46-80	64	25-43	34

* This operation not necessary for proprietary investments.

A comparison of this table on settled dust with the previous one shows that the free silica content of dust less than 5 microns in size, at the knockout operation using custom investment is the same as the settled dust. In all other operations, the free silica content of dust less than 5 microns was about 20 percent less than that of the settled dust. The average free silica content of all settled dust, for proprietary investments was 25-50 percent lower than that for the custom investment.

RELATION OF PARTICLE SIZE TO WEIGHT--This was determined from the air-borne dust collected with the gross air sampler in the vicinity of the various operations. The gross air samplers were operated at breathing zone levels. The samples were elutriated as previously described and the percent by weight of the dust less than 5 microns for the various operations was found to be as follows:

Operation	Number of Samples	Percent by Weight of Air-Borne Dust LessThan 5 Microns	
		Range	Mean
Dry Mixing	3	2.4-3.4	2.9
Wet Mixing	4	6.0-21.9	12.6
Knockout	5	4.5-23.3	12.8

These values were essentially the same for the custom and proprietary investments.

PARTICLE SIZE DISTRIBUTION--This was determined for 12 custom investments and 6 proprietary investments. While these samples were not collected in all five investment establishments they were selected to be representative of all conditions encountered. A summary of the findings was as follows:

Operation	Geometric mean of total sample (microns)	Percent of total sample equal to or less than indicated size		
		3.5 microns	2.5 microns	1.5 microns
Wet mixing - Custom	2.1	75	68	35
Wet mixing - Proprietary	1.9	79	72	37
Dry mixing - Custom	1.7	88	81	47
Knockout - Custom	1.3	95	90	65
Knockout - Proprietary	1.5	93	85	56
Grinding - Custom	1.5	89	80	38

Seventy-five percent or more of all particles were 3.5 microns or less. No appreciable difference was noted in particle size distribution between the custom and proprietary investment at the wet mixing operations. At the knockout operations the size distribution for both types of investment was higher than at the wet mixing operation. Knockout operations using custom investments had the lowest geometric mean.

Dust concentrations at the major operations were found to be as follows:

Operation	No. of samples	Custom Investment — Millions of particles per cubic foot of air: Plant A	Plant B	Plant C	Proprietary Investment — Millions of particles per cubic foot of air: Plant D	Plant E	Overall median	Overall mean
Sand-coating	20	1.4-6.1	5.0-27.5	3.4-5.9	12.8-28.3	5.3-8.8	5.3	8.8
Dry mixing	17	6.3-69.2	5.1-61.0	103.0-113.6	*	*	18.5	36.2
Wet mixing	25	5.8-48.2	19.9-183.0	71.8-91.2	16.3-60.0	16.0-32.9	32.7	40.6
Knockout	27	6.3-37.9	19.1-151.0	8.5-23.4	2.3-7.5	28.1-107.8	17.5	32.2
Sand-blasting	23	3.2-14.5	198-210	27.4-47.2	1.7-5.7	14.8-19.5	9.4	28.6
Sprue and gate cut-off	15	3.2-4.2	1.5-2.2	12.9-13.7	2.9-5.5	2.0-26.7	4.3	8.3
Grinding	26	1.7-8.3	1.1-4.1	2.0-3.3	2.6-11.8	3.3-3.8	3.1	3.6

In addition to these activities there are certain functions performed on an intermittent basis. One of the operations involved unloading silica sand and flour from box cars. Two samples collected showed dust concentrations of 282 and 361 million particles per cubic foot. Four samples were collected at dip coat mixing. These showed dust concentrations ranging from 14 to 182, with an average of 75 million particles per cubic foot. Repair and rebuilding small electric arc furnaces revealed dust concentrations of 17 and 42 million particles per cubic foot.

It was observed that the proprietary investments produced a lower mean dust concentration than the custom investment. However, in each instance dust concentrations were in the same frequency distribution classification.

Frequency distribution of dust concentration according to operation was found to be as follows:

Operation	Number of samples with indicated range of million of particles per cu. ft. of air.					
	No. of samples	0.0-4.9	5.0-14.9	15.0-34.9	35.0-74.9	75.0 or over
Sand coating	20	8	8	4	0	0
Dry mixing	17	0	8	2	5	2
Wet mixing	25	0	2	12	9	2
Knockout	27	4	8	7	3	5
Sand blasting	23	7	10	2	2	2
Sprue and gate cut-off	15	9	4	2	0	0
Grinding	26	22	4	0	0	0
Percent of total		32.5	28.8	19.0	12.2	7.2

Of the 153 samples shown in the table, 112, or about 65 percent, involved silica dust. The remaining 41 samples, or about 35 percent, were on operations at which metallic dust predominated. On operations involving silica dust approximately 80 percent were greater than 4.9 million particles per cubic foot and on metal dust approximately 65 percent were less than 4.9 million particles per cubic foot.

IRON—Together with its compounds, iron was evaluated as a constituent of investment dust. Highest concentrations of iron dust were found at sprue and gate cut-off, followed by grinding and knockout operations. Results of the analysis of dust samples are as follows:

Operation	No. of samples	Iron, milligrams per cubic meter	
		Range	Mean
Grinding	10	0.43-4.4	1.7
Sprue and gate cut-off	10	0.13-50.0	13.9
Knockout	8	0.1-3.7	1.1

COBALT, NICKEL AND CHROMIUM—Concentrations of nickel, cobalt and chromium taken at similar operations in plants casting heat resistant alloys were found to be as follows:

Operation	No. of samples	Alloying element	Milligrams per cubic meter Range	Mean
Melting	2	Co	0.02-0.15	0.08
	3	Ni	0.008-0.11	0.04
	1	Cr	0.16	
Grinding	7	Co	0.04-0.49	0.22
	4	Ni	0.013-0.015	0.14
	3	Cr	0.025-0.20	0.13
Welding	2	Co	0.013-0.10	0.60
	2	Ni	0.006	
Pouring High Cr. Alloy	2	Cr	0.012-0.017	-
Cut-off High Cr. Alloy	2	Cr	0.25-1.67	-

Gross air samples in areas where metallic dust was to be expected were obtained for iron in those plants casting steel and for the alloy elements cobalt, nickel and chromium in plants casting the heat resistant alloy. Typical of the concentrations found are these results at various grinding operations in one plant: iron - 0.43 - 0.65 percent, cobalt - 0.55 - 1.06 percent, nickel - 3.00 - 4.10 percent, chromium - 0.33 - 7.7 percent.

Rafter samples of settled dust were obtained and similar information obtained for comparison. The results are as follows: iron 0.23 percent, cobalt 0.67 percent, nickel 1.7 percent and chromium 0.32 percent.

ATMOSPHERIC CONTAMINANTS - SOLVENT

The solvents used may be readily divided into three categories, alcohols, aromatic hydrocarbons and chlorinated hydrocarbons. Several types of alcohols were encountered in custom investment binders, dip coat mixtures and washing of wax patterns. Benzene was used as a diluent in the preparation of a plastic cement and washing of plastic patterns. Carbon tetrachloride and trichlorethylene were involved as mold inoculating agents, plastic cement diluents and general cleaning or degreasing solvents.

Another major compound in the binder, used with custom investments, was ethyl silicate.

ALCOHOLS—In the use of ethyl alcohol as a binder for custom investments, concentrations of solvent vapor in air were determined on five different days during the winter and summer and no appreciable difference in concentration levels were noted. In the binder preparation room, which was provided with good local ventilation, general room levels of ethyl alcohol ranged from between 25-50 parts per million. During the operation of investing, general room concentrations with no general ventilation provided were found to range between 500-1500 parts per million. Breathing zone determinations made at investing operation, with poor local ventilation, revealed concentrations of from 1000-5200 parts per million.

At one plant, pattern clusters were dipped into ethyl alcohol prior to dip-coating. Concentration of ethyl alcohol in the workers breathing zone on two different days ranged between 800-1000 parts per million. The operation was intermittent, being carried on 3-4 times daily for 10-15 minutes at a time.

Octyl and iso-propyl alcohol were found to be components of dip coats. No information is available with regard to industrial exposures of octyl alcohol although it is known that the vapors cause irritation of the mucous membranes of the eyes and upper respiratory tract.

AROMATIC HYDROCARBONS--In the one plant using benzene no air samples were taken because of the flagrant manner in which this solvent was being used. Since no local or general ventilation was provided, immediate recommendations were made to provide a less toxic solvent.

CHLORINATED HYDROCARBONS--In the mold inoculation operation 3-6 cc of carbon tetrachloride or trichlorethylene is placed into the mold cavity, by means of a pressure oil can, after removal from the furnace and immediately prior to pouring. Samples were taken during this operation for phosgene with negative results. In this particular plant adequate general ventilation was apparently controlling the hazard.

Trichloroethylene has been used as a substitute for carbon tetrachloride in mold inoculating and to clean out sticky dies. This solvent was generally kept in an oil can and was used 3-6 times a day. General room concentrations during occasional cleaning of dies ranged from 25-50 parts per million and breathing zone determinations were 100-200 parts per million. At the close of the shift the worker squirted trichlorethylene all over the die and work table and cleaned with a rag. General room concentrations during this operation were 200-300 parts per million. Breathing zone concentrations for 5-10 minutes during this period were greater than 425 parts per million.

ETHYL SILICATE--It was not possible to obtain reliable data on the exposure to ethyl silicate. Several sampling methods were attempted, however, they were not successful because of the formation of ethyl alcohol and silicic acid during the hydrolysis of ethyl silicate. Another complicating factor was the presence of silica dust in the atmosphere.

DISCUSSION OF ATMOSPHERIC CONTAMINANTS

SILICA--Slightly more than 10 percent of the employees are exposed to silica dust and fifty percent of this group are also exposed to solvents. Another twenty-five percent are exposed to solvents alone.

To produce the desired fine surface finish on investment castings, this process requires the use of silica flour. Sixty to seventy percent of the dip coat mixture is silica flour of 325 mesh and the investment mixes consist of 20-50 percent silica flour of 160 mesh.

Size distribution curves [13] of representative grades of silica flour are illustrated in Figure 9 (not reproduced). The distribution of sizes is practically the same in any of the grades but the median size decreases with increasing mesh number from 38 microns for the 120 mesh to 16 microns for 325 mesh. The percent less than 5 microns for 120, 160, 200, and 325 mesh silica flour is 5, 7, 10, and 15 percent respectively. A producer of silica flour has reported similar data. [14]

The use of silica flour, and the manner in which it is used, is primarily responsible for the high dust counts and free silica concentrations. Another factor is the space allotted to production of castings by this process. Most of the equipment required is much smaller than conventional foundry equipment and the same applies to size of castings produced. Since less space is necessary the dust producing operations are located in closer proximity to each other.

In animal experiments King [15] has demonstrated that when quartz dust has been treated with dilute mineral acids a great increase in the pathogenicity of the quartz dust was observed. Since 0.05 to 8 percent of nitric or hydrochloric acid may be used in the binders for custom investments a need is indicated for further work on acid treated quartz.

The dust concentrations at the sand blasting operations may be attributed to poor maintenance and unwise use of the ventilation provided.

METALS--Iron dust and oxide produce a non-disabling pneumonoconiosis known as siderosis. Because of the radio-opaque nature of iron in the lung this condition is frequently confused with silicosis. Suggestive, though not as yet conclusive, evidence that iron dust may cause pulmonary carcinomas has been reported. [16]

The hygienic significance of nickel in industry is its skin sensitizing ability, its production of respiratory tract carcinomas and its formation with carbon monoxide of the extremely toxic nickel carbonyl [16].

A pneumoconiosis known as chromatosis results from the inhalation of chromium compounds in the lung. Many of the chromium compounds exert a corrosive action on tissues. Skin contact and inhalation produce ulcers of the skin and nasal septum. Lung cancers are now believed to be caused by chromium compounds that are either not soluble in water or sparingly so. [17]

Cobalt induces a condition of polycythemia, or excess of red blood corpuscles, Miller et al. [18], report on three cases of an industrial pneumoconiosis which they felt was caused by cobalt. Schwartz, Markuson and Blair [19] found cobalt to be the cause of a sensitization dermatitis in the cemented carbide tool industry.

Although not encountered in this study beryllium copper and brass and bronze, containing varying contents of lead and zinc, are frequently cast by this process.

Beryllium has been the cause of a delayed chemical pneumonitis[20] in workers exposed to beryllium oxide in the manufacture of fluorescent tubes. Symptoms may appear after months or even years.

Lead presents perhaps the second greatest hazard to health in the melting and pouring of non-ferrous metals. The chief portal of entry is the respiratory tract, although the problem of ingestion may be serious where adequate washing facilities are lacking.

Zinc produces an illness known as metal fume fever. Although, the illness is temporary and workersare believed to acquire a certain degree of immunity, it is sufficiently disagreeable to seriously affect worker morale with resulting absenteeism and turn-over.

SOLVENTS--It is today generally conceded that benzene and carbon tetrachloride are altogether too toxic to be used where a suitable substitute of lesser toxicity may be employed. Because of the extremely low concentration of these solvents that cause physiological damage it is recommended that, where necessary to use them, they be used in a totally enclosed system or under adequate exhaust ventilation.

The other chlorinated hydrocarbons in use, that is trichlorethylene, methylene chloride, perchlorethylene and the Freons, are of lesser toxicity than carbon tetrachloride. However, in any discussion of the toxicity of a chlorinated solvent, it is necessary to consider not only the "raw" hazard of the solvent, but also the possible hazard from breakdown products which may be formed when the solvent passes through an open flame or across a very hot metal surface. The breakdown products of certain chlorinated hydrocarbons are phosgene, chlorine, hydrogen fluoride and hydrogen chloride with Maximum Allowable Concentration of 1, 1, 3 and 5 parts per million respectively. It is seen that these break-down products are of much greater toxicity than the parent solvent.

Smyth and Seaton [21] "found that concentrations of ethyl silicate as low as 245 parts per million gave rise to some pathology in animals after several hours of exposure. An allowable limit of 100 parts per million is suggested for prolonged exposure, but with lack of industrial experience at known concentrations, any workers subjected to an exposure approaching 100 parts per million should be under medical supervision".

It has been alleged that the operators of the melt-out and burnout furnaces contracted dermatitis from the vapors and fumes and that this difficulty was no longer encountered. It may be presumed that the thermal decomposition products of alcohols, ethyl silicate, waxes, plastics and many other compounds required for the molds would be highly irritant to nasal and mucous membranes. Thus, the practice of providing local exhaust ventilation is desirable.

RECOMMENDATIONS--A summary of recommendations for controlling dust and solvent exposures is presented. Detailed information on ventilation is given in the section that follows.

1. Local exhaust ventilation should be provided for preparation of dip coat, sand coating, dry and wet mixing and knockout.

2. Local exhaust ventilation should be provided for the standard operations of sprue and gate cut-off, grinding and polishing and abrasive blasting.

3. Local exhaust ventilation should be provided at the melt-out and burn-out furnaces.

4. Dust producing equipment, exhaust systems and dust collecting equipment should be given proper maintenance at all times.

5. The use of benzol and carbon tetrachloride should be discontinued and a less toxic solvent provided. Where this is not practical local exhaust ventilation must be provided.

6. When it is not practical to provide local exhaust ventilation at solvent operations adequate dilution ventilation should be employed.

7. The use of large quantities of silica flour requires the best possible housekeeping program which should be enforced at all times.

CONTROL OF ATMOSPHERIC CONTAMINANTS

Initial surveys of the investment casting plants indicated that dust control measures, dilution ventilation and supply air ventilation were inadequate. The results of the environmental studies bore out this observation and the findings have a direct bearing on the design of local and general ventilation. In each of the five plants studied, attempts had been made to provide ventilation control. However, in only one of these was any attempt made to control all of the dust and solvent producing operations.

It is recognized that the industrial plant should be considered as a whole in working out a satisfactory ventilation design and that local exhaust, general exhaust and so-called make up or supply air are dependent on each other for satisfactory ventilation. The dust and solvent exposures in this industry can be controlled. A series of hood designs along with basic ventilation data have been prepared for most operations. For those operations that are standard in many industries, reference is made to the Industrial Ventilation Manual (22) published by the American Conference of Governmental Industrial Hygienists. The following discussion involves operations which are most characteristic in the investment casting plant along with information on dilution ventilation and supply air.

LOCAL EXHAUST VENTILATION

SAND COATING--After the pattern has been immersed in the dip coat, sand is sifted over the surface of the pattern. Dust control at this operation can be achieved by the use of a small bench type hood as illustrated in Plate 1 (not reproduced). Exhaust volumes should be a minimum of 150 cubic foot of air per minute per square of face area. Since the bench hood is usually designed for minimum size, interior baffles should be used to provide uniform face velocity. A hood of this type was observed in one of the plants and the dust control was satisfactory.

Although the operation of mixing the dip coat was carried out once or twice per day, the high dust concentration indicates the need for ventilation control. The same type of hood as described above would also be satisfactory for this operation. Some of the dip coat mixtures contained a solvent and the ventilation will also provide control for the solvent vapors.

DRY MIXING--Mixing of the dry ingredients to prepare the investment is carried on by several different methods. The standard muller, cone blender and open end mixer are used for this operation as well as for wet mixing. A typical open end mixer, similar to a small concrete mixer, can be effectively controlled with a booth type hood as illustrated in plate 2 (not reproduced). The required exhaust volume is a minimum 150 cfm per square foot of face area. A semi-circular slot hood, Plate 3 (not reproduced) may also be used to advantage, but care must be taken to insure moderate slot velocities to minimize material losses.

Common to all dry mixing operations is the use of scales for proportioning the ingredients. The material is contained in small buckets which are used to transfer the investment to the dry and wet mixers. A typical booth enclosure for this operation is shown in Plate 4 (not reproduced).

It was found that after the dry investment bucket has been emptied into the mixer there is a considerable release of dust as the bucket is returned to the dry mix area. Control can be provided by a short length of flexible duct at the mixer location that serves as a vacuum cleaner for the buckets as shown in Plates 2 and 3. (not reproduced). In practice the end of the tube can be dropped into the bucket momentarily and the remaining fines are effectively removed. The existing ventilation at one plant was modified for this purpose and the dust control successfully achieved.

Ventilation design data for the standard muller type mixers is shown in VS-24, Mixer and Muller Hood.[22]

WET MIXING--A commercial type mixer is used for mixing the proprietary investments. Satisfactory control of this operation requires the use of the bench hood at the mixer as illustrated in Plate 5 (not reproduced). Minimum air volumes should be 150 cubic feet per minute per square foot of face. An important source of dust at this operation is the scooping of the material from the container and exhaust ventilation is required at this point. A booth type hood or a small local exhaust hood can be used for this purpose. Design data on the latter hood is contained in drawing VS-3, Barrel and Bag Loading.[22]

At all of the mixing operations care must be taken in locating duct take offs and selecting design volumes so that valuable fines will not be lost into the exhaust system. This is an important consideration in the design of any dust exhaust system since poor engineering will result in overloading and excessive wear on the ductwork, fan, and collector.

KNOCKOUT--The castings produced are small and the knockout equipment and hoods are usually bench mounted. In two of the plants, marginal exhaust ventilation was provided for this operation through the use of enclosing hoods as shown in Plate 6 (not reproduced). The basic design of the hoods in use was good; however, an insufficient volume of air was being exhausted. A minimum exhaust volume of 250 cubic feet per minute per square foot of open hood area is required. It is also necessary to exhaust the hopper under the grating to provide dust control at this point and the exhaust volume must be a minimum of 10 percent of the air exhausted from above. The exhaust take off should be located and protected so that a build up of material in the hopper will not plug the branch duct.

One of the plants produced castings larger than conventional size and therefore, used a larger floor standing knockout arrangement. Ventilation, Plate 7 (not reproduced), for the larger equipment would be similar to that used for the bench type operation.

Disposal of the waste material, from the knockout, varied from plant to plant. Since this disposal involves further exposure to dust, ventilation must be provided for adequate control. Design data for controlling bucket elevators and transfer belts is available (22).

CASTING FINISHING--These operations involve the usual abrasive blasting equipment and sand blast cabinets. Generally abrasive mills and tables are satisfactory when the ventilation has been provided and used in accordance with the manufacturer's recommendations. In the case of sand blast cabinets this is not necessarily true. Much difficulty has been experienced with these cabinets due to the lack of maintenance, inadequate exhaust and poor design which allows flying particulates to get into the exhaust system and these conditions result in rapid break down of the exhaust equipment. The most practical solution is the use of a large take off at the rear of the cabinet as shown in Plate 8 (not reproduced). The vertical baffle prevents the majority of large particules from entering into the trap while those that do get in are allowed to settle and return to the sand hopper, leaving only the fines to be carried off into the exhaust system. Minimum exhaust requirements call for a 500 feet per minute indraft velocity at all operative openings. Additional design data is given in drawing VS-1, Abrasive Blasting (22).

GRINDING AND POLISHING—The investment casting is usually ground and polished with small bench mounted grinders and abrasive belts. Silica dust has not been a problem in the grinding department and attention has been focused on the metallic dusts. It is not desirable from the standpoint of housekeeping, equipment maintenance and casting quality to have uncontrolled dust in this area.

Hoods for the various grinders and belts are designed in a manner similar to the larger foundry equipment shown in drawings VS 7, 11, and 15 (not reproduced), Buffing and Polishing, Grinders and Cut-Off Wheel and Polishing Belt (22). Wherever possible, the natural trajectory of the particulates should be considered and the hood should be located to confine as much of this as possible. Depending on individual requirements, the hood may be of minimum size enclosing the belt or wheel or it may be large enough so that a considerable part of the machine is enclosed and the workers hands are inside the face opening. Design volumes should provide a minimum of 500 feet per minute velocity at the point where the grinding wheel meets the casting. Another satisfactory method, Plate 9 (not reproduced), is the use of ventilated benches.

DILUTION VENTILATION

In most cases the control of the ethyl silicate—ethyl alcohol solvent mix can be obtained through local exhaust ventilation. However, after the molds have been invested and placed on vibrating tables, there is a considerable release of the solvent vapor into the air. It is not always possible to provide exhaust hoods at this point and dilution ventilation must be considered.

For proper design it is necessary to calculate the amount of air required to reduce the solvent vapor concentration to a level below the Maximum Allowable Concentration (MAC). The following is a typical calculation to provide dilution volumes for ethyl alcohol and ethyl silicate vapors:

<u>Ethyl Alcohol:</u>

MAC = 1000 ppm
Specific Gravity (S.G.) = 0.789
Molecular weight = 46.07

K = a constant which varies from 3 to 10 depending on toxicity of material and dilution of air flow obtained.

Pints per hour or pints per minute = The actual amount of solvent vaporized in the process. To be determined at the plant.

$$\text{Cubic Feet of Dilution Air} = \frac{403 \times S.G. \times 10^6 \times \text{pts. evap.}}{\text{Molecular weight} \times MAC} \times K$$

$$= \frac{403 \times 0.789 \times 10^6}{46.07 \times 1000} \times K/\text{pint}$$

$$= 6900\ K/\text{pint}$$

Ethyl Silicate (tetraethyl orthosilicate, Proprietary)

MAC = 100 ppm
Specific Gravity (S.G.) = 0.9356
Molecular weight = 208.30
K = constant

$$\text{Cubic feet of dilution air} = \frac{403 \times S.G. \times 10^6 \times \text{pts. evap.}}{\text{Molecular weight} \times MAC} \times K$$

$$= \frac{403 \times 0.9356 \times 10^6}{208.3 \times 100} \times K/\text{pint}$$

$$= 17{,}970 \times K/\text{pint}$$

Due to the present lack of knowledge about the combined effects of toxic materials it is necessary to combine the ventilation rates for both ethyl alcohol and ethyl silicate to arrive at the necessary dilution volume. In this case the proper dilution volume will be K x 24,870 cubic feet of air per pint of material evaporated. To complete the calculation, assume that the solvent evaporation rate is one gallon per hour, that the vapors are made up of equal parts of ethyl alcohol and ethyl silicate, and that K = 5.

$$Q = K \times 24{,}870 \frac{FT^3 \text{ of Air}}{\text{Pint}} \times 8 \frac{\text{Pints}}{\text{Hr.}} \times \frac{\text{Hr.}}{60\ \text{Min.}}$$

$$Q = 16{,}580\ \text{cfm}$$

Under these conditions the minimum dilution rate will be 16,580 cubic feet per minute.

In addition to arriving at the necessary dilution volume, the air flow in the room and the location of exhaust and supply points must also be considered.

A common error is to assume that, since the vapor density of a solvent is heavier than air, the solvent vapor will fall to the floor and the exhaust points should be located on the floor. Unfortunately this assumption does not recognize that normal air motion and human occupancy in manufacturing areas will cause a rapid mixing of the solvent vapor with air and the resulting density of the mixture will be essentially the same as that of air itself (storage rooms, stair wells, pits and other areas of litle or no air movement require additional design consideration).

The specific gravity, with reference to air, of ethyl silicate vapor is 7.2 and that of ethyl alcohol is 1.6; assuming that all of the vapors released are ethyl silicate and that the vapor air concentration would be as high as 1 percent which corresponds to 100 times the MAC of ethyl silicate, the specific gravity of the mixture can be calculated.

.99 parts of air, @ 1	=	.990
.01 parts of ethyl silicate, @ 7.2	=	.072
		1.062 = specific gravity of mixture

The specific gravity of the mixture is only 6 percent heavier than air alone instead of 700 percent as usually stated. In a similar fashion the calculated specific gravity of a mixture of air and solvent vapor equal to the MAC (100 parts per million; 0.01%) is equal to 1.00062. Obviously, the solvent mixture will have a density so close to that of air alone that, the difference is insignificant when applying general ventilation. Therefore, the location of exhaust points and air supply systems should be dictated by considerations other than the specific gravity of the material. The calculations above assume that the only vapor release is that of ethyl silicate. In actual practice ethyl alcohol vapors will also be present and the effective specific gravity of the mixture will be even closer to that of air.

SUPPLY AIR SYSTEMS

In order to insure that exhaust ventilation will operate at the designed volumes and static pressures, to relieve the workroom of uncontrolled cross draft and temperatures and to insure the proper operation of heating equipment it is necessary to provide for the introduction of outside air into the plant. Air may be supplied in a volume equal to that removed by the exhaust systems or may be tailored to provide either more air or less air to suit the needs of the plant or individual departments.

The flow of supplied air should always be from a relatively clean region of the plant toward the contaminated areas, thus preventing contamination of the entire building.

There are definite trends toward providing year round climate control (air conditioning) for industry, particularly that industry involved in the manufacture of precision tools and electronic equipment. In the investment casting industry working tolerances on finished casting may be as low as 0.003" per inch. The waxes and plastics normally used for patterns can vary from 0 to 0.3 percent of dimensional tolerance when subjected to abnormal temperatures. In the case of the investment materials, temperature fluctuations can cause a difference in setting time of up to 90 minutes. These variations in pattern dimensions and processes tend to be extremely important to the manufacturer of precision castings.

The time is rapidly approaching when the demands of quality will require a more precise control of the working environment. Two of the plants studied have already provided a localized form of air conditioning and one of the plants has found it necessary to add humidity during the winter months to provide a satisfactory dip coat for the pattern. Year round air conditioning may still be in the future for the investment casting plants. It is entirely possible and practical, however, to accomplish climate control with reasonable expense and a great deal of success through the proper design of the supply air systems. Outside air properly controlled and distributed can be a source of comfort for workers engaged in hot operations and can also provide controlled conditions throughout the entire plant.

The recommendations outlined above can be successfully applied to the investment casting plants for the control of hazardous exposures. Local exhaust, general exhaust and supply air ventilation all play a part in providing a satisfactory working environment. While the individual investment casting plant may not find itself in a position to provide year-round climate control much can be accomplished through the proper application of supply air, which will serve as make up air for the fans, desirable ventilation and as an elementary type of air conditioning.

PHYSICAL CONDITIONS - NOISE

Noise levels were taken to determine the intensity of sound produced at the various operations and to predict their influence on the hearing of employees engaged in this industry.

Leading otologists have indicated that long term exposure to noise levels above 110 decibels (re: 0.0002 microbars) will produce permanent hearing loss in most individuals. Currently, investigators are engaged in an extensive study aimed at accurate predictions of damage risk associated with the exposure to noise. Sound levels below 85 decibels are normally thought to be below this risk level.

The sound level readings were taken with the General Radio Sound Level Meter, Type 759, and the General Radio Octave Band Analyzer, Type 1550-A, using a dynamic microphone and a 25 foot extension cable. The instruments were calibrated with a H. Scott Random Noise Generator and a microphone calibrator. The readings were taken at the ear level. The damage risk criteria as presented was taken from material by Beranek.[23]

FINDINGS--The date obtained indicates that three major noise problem areas exist in investment casting plants; namely, the knockout, grinding and sprue and gate cut-off areas. The knockout operations produced an intense noise field, figure 10 (not reproduced), but only a few individuals were exposed to these levels on a continuous basis. A rather large number of workers were exposed to the high noise levels produced in the grinding operations, figure 11 (not reproduced), and the operations are nearly continuous during an 8 hour shift. The sprue and gate cut-off operations using resin wheels produced noise levels of approximately the same intensity as the grinding operations.

The sound levels determined in these areas indicate that a serious damage risk exists to the employees exposed over long periods of time and that a number of individuals will suffer permanent hearing loss. Approximately 180 or one-third of the workers are exposed on these operations.

The sand blast operations, figure 12 (not reproduced), produced moderately high noise levels and may be a problem in the plants where a number of the units are placed side by side. The noise levels in the melting furnace rooms and the injection molding areas indicate no serious noise problem. Results in other areas revealed sound levels generally below 85 decibels.

A comparison of the noise produced by electric and pneumatic hand tools, figure 13 (not reproduced), revealed a considerable difference in their overall loudness. Pneumatic tools equipped with air muffler can be made to compare favorable with electric tools.

The results of this study indicate the need for consideration of noise in the design and selection of equipment, in the construction and layout of new plants, and in the modification of existing plants to reduce the noise exposure. A number of general recommendations are included herein:

1. Knockout units should be provided with air mufflers, resilient mountings, and the enclosures should be treated with sound deadening mastics. See Plate 6 (not reproduced).

2. Personal protection in the form of ear plugs or ear muffs should be provided for knockout operators.

3. The use of electric hand grinding tools or pneumatic tools with mufflers is indicated to reduce the noise source in the grinding room.

4. The substitution of belt grinders for hand held tools is recommended where this equipment can be applied.

5. The grinding room construction should include booth arrangements for individual grinding stations with sound treatment provided in the booth construction and on the ceiling and walls of the room to reduce overall noise intensities. See Plate 9. (not reproduced).

6. The selection of equipment and tools for reducing noise sources should be carefully practiced.

7. The use of resilient mounts on the base of vibrating equipment is desirable.

8. Noise sources should be enclosed where practical.

9. The use of sound deadening mastic on enclosures and structures to reduce vibration and eliminate noise sources is recommended.

10. Exhaust fans in ventilation systems should be properly designed, mounted, and maintained to produce a minimum noise level.

11. Noisy operations should be isolated from highly populated work areas.

12. A maintenance program should be enforced to keep equipment in good repair at all times.

PHYSICAL CONDITIONS—VIBRATION

A subject of particular interest to the investment casting industry is the problem of portable vibrating tools and their relation to the possible clinical effects which they produce. Early work done by Hamilton and Rothstein (24), and others pointed out the problem of injuries to joints, injuries to muscles and nerves, and Raynauds' phenomenon which occurs in the hands. Agate, Druett, and Tombleson (25) reported injuries occurring to employees engaged in grinding small iron castings against large belt-driven grinding wheels. It is interesting to note that no vibrating tool was held in the hand, but that the casting being ground vibrated against the wheel producing the clinical results. Dart (26) reported a clinical picture from the use of high speed rotary grinding tools driven by compressed air. The symptoms reported included pain, numbness, stiffness, and swelling of the hands.

Recent studies have indicated that vibrations of large amplitudes between the frequencies of 40 and 123 cycles per second are more likely to produce Raynaud's phenomenon. High speed rotary grinding tools do not normally produce vibrations of large amplitudes in the low frequencies, but may produce the features of pain, and swelling of the fingers.

The studies conducted within the plants did not reveal the presence of clinical symptoms. It is likely that any disabilities, if they exist among the workers, are of minor nature and are such that they have not interferred with the employees' work function. The length of time to which the worker has been exposed to the vibration is a factor that must be considered in relating the incidence. Biden, Steele, and King (27) suggest a limit of nine months' exposure as the only protective measure, this being admittedly impractical. It may be that the turnover of employees and variable work schedules, which were true of a large proportion of the employees within the industries studied, meet this condition.

The disabilities produced appear to be in relation to the amplitude of the vibration transmitted to the hands and to the duration of the exposure. The use of permanently mounted tools and hand held castings will reduce the vibration amplitude and the exposure duration time. The use of belt grinders and sanders will tend to reduce both the amplitude of vibration and the duration of exposure. The use of heavy gloves, where practical, is indicated to aid in absorbing the shock and protecting the hands from cuts and burns.

SUMMARY

The engineering phase of the investment casting investigation included an evaluation of the environmental factors of dust, gases, and solvents and the physical conditions of noise and ventilation and were extended over a period of time to include both summer and winter conditions. The investigation was carried out in five Michigan investment casting establishments and

the number of employees per establishment ranged from 22 to 452.

Two types of high temperature investments were encountered. One consisted of a mixture of fireclay grog, silica sand, and silica flour and the other consisted of silica sand and silica flour. The former utilized a binder of ethyl silicate and ethyl alcohol and the latter phosphate compounds.

It was found that 75 percent or more of the air-borne dust was 3.5 microns or less in size. The amount of free silica in the air-borne dust varied with the operation. The free silica content of the total sample ranged from 43 to 87 percent and for the fraction less than 5 microns in size 25 to 63 percent. Settled dust revealed a free silica content of from 34 to 64 percent.

Eighty percent of all silica dust samples were greater than 4.9 million particles per cubic foot of air.

Ethyl alcohol vapor concentrations in the investing area ranged from 500 to 5000 parts per million and trichlorethylene vapor in the pattern area ranged from 25 to greater than 425 parts per million (limits of instrument).

The data obtained indicates that a major noise problem exists at the knockout, grinding, and sprue and gate cut-off operations.

A series of plates is presented to show how specific dust, solvent vapor and noise problems may be controlled.

Calculations and data are given to illustrate dilution ventilation techniques.

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GENERAL SESSION

April 23, 1956, 2:00 P.M.

Dr. Ralph R. Sullivan, Chairman, Presiding

MEDICAL AND ENVIRONMENTAL CONTROL OF WORK IN COMPRESSED AIR

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and
John T. Wilson, Jr., M.D.
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The medical and environmental control of health and safety hazards in compressed air work depends largely on the recognition and understanding of the hazards associated with such work. In this occupation, the individual is predisposed to a number of hazards which can be grouped under: 1) those occurring within the working environment, and 2) those due to inadequate decompression upon leaving the work area.

1. Hazards Occurring Within the Working Environment.

The following are associated with primary or secondary pressure phenomena:

a. Aero-otitis and aero-sinusitis: Pressure, per se, in the usual working range is apparently without physiological effect provided that equalization of pressure is effected without trauma in the sinal and aural spaces (1). If the air spaces in the ear and sinuses are occluded, slight pressure variations in the range of 1-2 lbs. per sq. in. may elicit a painful response and induce congestion, edema and hemorrhage in the affected tissues. Such tissue reaction creates a favorable condition for the growth of pathogenic bacteria. The terms aero-otitis and aero-sinusitis have been applied to this type of pressure trauma in the ears and sinuses.

b. Oxygen Toxicity: The increased partial pressure of O_2 in the compressed air is capable of producing pulmonary damage. Smith et al.(2) found that at a pressure of 4 atmospheres, 16 adult rats developed active hyperemia and acute pulmonary edema. The data obtained from clinical as well as experimental studies has indicated that prolonged residence in compressed air be limited to a pressure of 3 atmospheres absolute.

c. Sudden loss of air pressure: Sudden loss of air pressure within the area of operation due to an unbalanced hydrostatic head has occurred with sudden decompression and its sequellae, and in some instances drowning.

d. Miscellaneous hazards: Other hazards which are not infrequently present in the work environment and predispose the compressed air worker to injury are: a) fire and explosives, b) mechanical, c) noise, d) increased concentrations of gases such as CO_2, methane and CO, e) dust, and f) variations in temperature and humidity. These hazards have not been studied as extensively as those due to inadequate decompression.

2. Hazards Due to Inadequate Decompression upon Leaving the Working Environment.

The illness due to inadequate decompression has been studied extensively from both the clinical and experimental approach. The appropriate name, decompression sickness, has been given to the symptomatology and this is preferred to that of compressed air illness or caissons disease as it is sometimes called. Decompression sickness is a comprehensive term which encompasses the various signs and symptoms of the attacks suffered by compressed air workers after leaving the decompression chamber. These include:

a. bends (extremity and joint pain), the most common type,
b. chokes (dyspnea or substernal distress),
c. staggers (dizziness or vertigo),
d. abdominal cramps,
e. skin rash and pruritis, and
f. paresis, or paralysis of the extremities. The latter is the most serious type, but fortunately is rare today as compared to old reports.

Originally described as bends alone, this illness dates back to 1839 when compressed air was first used in the construction of a mine shaft in France(3). As far back as the 17th century, however, experiments with various diving devices in the form of helmets and bells were performed and at that time animal experimentation using rarified air supplied by a vacuum pump led Boyle to the theory of the role of bubbles in this disease(4). It is conceivable that cases of decompression sickness actually occurred at that time but were unreported. Hoppe-Seyler(5) and Bert(6), two centuries later in subsequent animal experimentation, confirmed Boyle's theories. Their work, together with that of many other investigators, has contributed considerably to our knowledge and understanding of this illness, and today the theory of nitrogen bubbles liberated in the blood vessels and tissues as a result of inadequate decompression is accepted as the cause of decompression sickness. The principles of prevention and therapy of this disorder have been based on this theory.

Recently a great deal of attention has been paid to lesions observed in the bones and joints of these workers and is looked upon by many as a specific complication of decompression sickness(7). The term "aseptic bone necrosis" has been given to this lesion. The progressive disability observed in a number of these workers resulting from this disease renders this complication a serious one.

It is important to bear in mind that the symptoms of decompression sickness may be delayed beyond 12 hours and that sudden collapse may occur without warning in an apparently well individual. Of note also is the fact that the bone complications described previously may not be associated with symptoms or be apparent roentgenologically for a period of years while working in compressed air or after retiring from this work.

Medical Survey of a Sewer Project using Compressed Air.

Recently, the Division of Industrial Hygiene had the opportunity to review the data of a sewer construction project requiring the use of compressed air. The findings will illustrate to a large extent the hazards mentioned.

This 5-mile sewer is of a reinforced concrete intercepting type. Its construction in reclaimed land and its proximity to a large body of water necessitated the use of compressed air. The pressures required ranged from 7 to 22 lbs. per sq. in. above atmospheric pressure. The stage method of decompression was employed and the decompression time varied from 12-15 minutes depending on the working pressure.

In the period covered by this survey (August 1954 to January 1956), 1157 compressed air workers were employed. Of these, 176 men or 15% had decompression sickness; in 112, the attacks were single, and in 64 they were multiple. The total number of attacks were 305. Two hundred and seventy five of these attacks occurred in an estimated total of 170,400 decompressions, giving an incidence of 0.16%. The remaining 30 attacks were experienced by 12 individuals classed as walking bosses, engineers, or survey men, whose job required their entering and leaving the compressed air environment several times a day. The total number of decompressions for this group was not obtained. The highest incidence occurred at pressures between 18 and 22 lbs. per sq. in. above atmospheric pressure but a number occurred between 15 and 18 lbs. (fig. 1). (Not reproduced).

The great majority of the attacks were bends involving primarly the knees and lower extremities. Abdominal cramps occurred in 3.95% of the cases; chokes in 1%; staggers in 3.64%, and central nervous system manifestations in the form of numbness, paresthesias, or paresis of the extremities in 1.32%. There were no fatalities, although 20 men were hospitalized as stated by the physician in charge, to insure proper rest after recompression.

The onset of the attacks varied from immediate to as long as 24 hours after leaving the decompression chamber.

In addition to decompression sickness, a not insignificant number sustained injuries related to various operations in the working environment. These included aero-otitis, aero-sinusitis, burns, fractures, and other forms of trauma. Fifty-three of these workers were hospitalized for the following injuries:

Fractures (simple and compound)	23
Lacerations, bruises and sprains	18
Burns (3rd degree)	1
Smoke poisoning - due to explosion	10

This survey clearly illustrates the need for better medical and environmental control of this type of work. It is particularly significant that in spite of the relatively low working pressure used in this operation, 15% of the group experienced decompression sickness.

Principles Underlying Control.

The prevention of decompression sickness depends upon the elimination of nitrogen absorbed during exposure to increased barometric pressure thereby inhibiting excessive bubble formation in the blood stream. About 75% of the total body nitrogen is eliminated at a comparatively rapid rate and hence does not usually contribute to the formation of bends. It is known however, that the amount of gas in the fatty tissues, especially the bone marrow, requires many hours of elimination. After long exposures, the reservoir of nitrogen in the saturated fa constitues the predisposing cause to embolism. According to Behnke, an important consideration is not mastery of a method of computing the decompression table on the basis of a ratio, but rather the acquisition of an understanding of the basic physiologic principles (1). One of the most important is the realization of the difficulty in getting excess N_2 out of fatty tissues. In line with this, one of the basic prerequisites in the adequate control of decompression sickness is the limitation of the time of exposure in compressed air. This is reflected in the various codes which progressively limit the time of exposure in compressed air as the working pressure is increased (Table 1).

Other principles underlying the prevention or control of illness in compressed air work are:

1. Proper selection of personnel. - This entails a careful pre-employment history, physical examination and the use of specific pressure tests for the selection of fit men and the exclusion of those who cannot accommodate to the increased pressure or decompression.

2. Maintenance of good physical condition and personal hygiene. - Empirical data indicate that poor cardiovascular tone renders men more susceptible to development of decompression sickness. Similarly, avoidance of fatigue, obesity, infection, hot atmospheres, excessive CO_2 in air, and alcoholic indulgence, are essential since all these factors are associated with increased incidence of decompression sickness (fig. 2).

3. Adequate decompression time. - This is based on the working pressure and the employment preferably of a modified stage of decompression (Table 2). The use of exercise in promoting a more rapid elimination of N_2 during the early part of decompression and adequate removal of CO_2 in the working environment should be encouraged.

4. Early recognition and treatment to prevent residual injury, prolonged morbidity or fatality. - Adequate recompression must take into account the degree and type of injury, the level of working pressure prior to the attack, and the individual's response to treatment. The pressure to which the individual must be recompressed and the duration of recompression will vary according to the aforementioned criteria. It is usually advisable to incorporate O_2 in the latter part of the therapy to hasten nitrogen removal.

5. Provision of good industrial hygiene engineering practices which include:

   a. Proper ventilation and elimination of noxious gases in the working environment.
   b. Proper control of temperature and humidity.
   c. Elimination of fire hazards such as the keeping of flammable material to a minimum.
   d. Adoption of automatic devices in lieu of manual operations in situations where reliance on operators introduces a calculated risk.

TABLE 1

1922

PRESSURE SHIFTS AND INTERVALS OF WORK FOR EACH TWENTY-FOUR HOUR PERIOD IN PRESENTLY EXISTING COMPRESSED AIR CODE

PRESSURE		HOURS			
Column 1 Minimum number of pounds	Column 2 Maximum number of pounds	Column 3 Maximum total	Column 4 Maximum first shift in compressed air	Column 5 Minimum rest interval in open air	Column 6 Maximum second shift in compressed air
Normal	18	8	4	1/2	4
18	26	6	3	1	3
26	33	4	2	2	2
33	38	3	1 1/2	3	1 1/2
38	43	2	1	4	1
43	48	1 1/2	3/4	5	3/4
48	50	1	1/2	6	1/2

TABLE 2

SHIFTS AND REST PERIODS WITHIN EACH TWENTY-FOUR HOURS
AS PROPOSED IN NEW COMPRESSED AIR CODE

PRESSURE		HOURS		
Column 1 Minimum number of pounds	Column 2 Maximum number of pounds	Column 3 Maximum total working time	Column 4 Maximum shift in compressed air	Column 5 Minimum rest interval
Normal	to 24	6	3	2 1/2
over 24	" 30	4	2	3 1/2
" 30	" 36	3	1 1/2	4
" 36	" 42	2	1	4 1/2
" 42	" 48	1 1/2	3/4	4 3/4
" 48	" 50	1	1/2	5

Realization of Effective Control.

The realization of effective control requires an understanding both of the basic physiologic principles underlying the hazards as well as an appreciation of the socio-economic and medico-legal factors which are intimately associated with the overall problem.

Effective control utilizing the basic physiologic principles has been obtained by the Navy in their subterranean work[8]. Unfortunately the experience in industry has been far from good. This is so as shown by sewer project survey in spite of our present level of knowledge which, if utilized, would significantly decrease the incidence of decompression sickness and the residual injuries.

Ordinarily in industry the high cost of an operation such as this, would automatically call for the implementation of effective engineering and medical control to cut down the expense. It is therefore significant that this has not been realized here. The answer may perhaps lie partially in the attitude of the worker, the carry-over experience of labor and contractor, and/or the inability to get at the facts. The attitude of the worker is exemplified by his resistance to submit to a full physical examination and x-rays. This is understandable because of his fears of job insecurity and loss of future rights under workmen's compensation. From the point of view of the man's health and safety, it is not realistic.

The carry-over of resistance on the part of labor and contractor is shown by their opposition to accept a revised code which has incorporated sound medical and engineering principles (Table 2). In the light of this, it becomes exceedingly difficult for a governmental agency to get at the facts. It is inconceivable for labor and management to wish to disregard the high cost of this type of work. Yet, could it be that industry finds it less costly to pay the excessive workmen's compensation rates ($52 per $100) than to install such equipment as, for example, two tunnel locks or other control measures which would make for a safer and healthier working environment? Is the unavailability of a better and less expensive method of tunneling without the use of compressed air another reason for maintaining the status quo? These questions have a very important bearing on the ultimate realization of effective control.

Recommendations and Conclusions.

To provide a safe and healthy environment for the compressed air worker requires not only the application of sound physiologic and industrial hygiene engineering principles but also patience, diligence, and appreciation of the socio-economic and medico-legal factors, and mutual trust among the interested parties. A persevering educational campaign by the governmental agency responsible for the health and safety of the compressed air worker is essential before the adoption of a desired code and its proper enforcement can be realized. Careful medical and environmental studies of field operations must be carried out employing an epidemiologic and statistical approach. The data obtained should be correlated with the experimental findings. With the exception of a few outstanding studies, most of the data on tunnel, caisson, and underwater construction has been poorly controlled and inadequate.

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SOME FACTS ON THE PREVALENCE OF SILICOSIS IN THE UNITED STATES

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One of the conclusions reached at the 1955 McIntyre-Saranac Conference on Occupational Chest Diseases was that statistics are needed on the incidence of pneumoconioses for the proper evaluation of progress in the control of dust. At this Conference, the Occupational Health Program of the Public Health Service presented some preliminary statistics1/ indicating that silicosis continues to be a widespread occupational health problem in the United States. This finding has been reaffirmed by an inquiry which we have recently completed on the prevalence of silicosis in the United States. The results of this study will be published in detail this year in a special bulletin which will also cover silicosis in terms of compensation costs and causes of death.

It should be stressed at the outset that our study was based on official records obtained from scattered sources. Since a uniform scheme for compulsory routine examinations of workers in dusty trades does not exist in this country, and very few studies of the incidence of dust diseases have been carried out in recent years, official records hold forth the only promise of information. When we began this inquiry, we recognized the impracticability of developing evidence of a conclusive nature. But, by accumulating data on a sufficiently large number of cases, we hoped to come up with general information on at least four questions.

1. What is the prevalence of silicosis in the United States?

2. What are the characteristics of the silicotic population?

3. Is a significant number of new cases developing among workers entering dusty trades for the first time in the past 20 years?

4. What aspects of the dust problem need further study?

Covering the five-year period 1950-1954, the study disclosed 10,362 cases of silicosis that have been compensated or reported in one form or another in 22 States. If cases processed by compensation agencies but for various reasons denied benefits are added, the total exceeds 13,000.

Of the 10,362 silicotics whose cases are on record during this period, about 20 per cent are dead; 50 per cent are totally disabled; and 30 per cent are still working, seeking work, or of an unknown status.

Sources of Information

In our search for quantitative data on silicosis, we wrote to official

1/ Doyle, H.N., Victoria M. Trasko, W.M. Gafafer, and S.E. Miller, M.D.: Accomplishments in the Epidemiologic Study of Silicosis in the United States. A.M.A. Archives of Industrial Health, July 1955, Vol. 12, pp 48-55.

health or compensation agencies in 26 States believed to have information. We asked for data on individual cases on their records from 1950 through 1954, covering age, sex, years and places of employment, diagnostic data and compensation costs when applicable.

The cooperation we received from the States was gratifying. Only one of the 26 States did not respond. Three States either had no usable data or they could not readily sort out the silicosis from other work injury cases. Two States provided their own tabulations on age and occupations, one on compensated cases, and the other on employer reports. For three States, only total number of claims processed could be obtained. Three compensation agencies sent us listings of individual claims processed, and two State health departments sent official medical reports of individual cases, containing all or some of the information requested. The sources of information in two States were cases discovered upon routine x-ray examinations of workers in dusty trades.

Several of the other ten States participating in this study wrote that the information we were requesting was available but not tabulated, and that if we wished to review and abstract the cases ourselves they would make files available. We accepted these offers and proposed this procedure for other States. In this manner, a considerable volume of data including where and when individuals worked was opened to us which otherwise would have remained buried in the files. Some of the compensation case files were so voluminous that it often took as much as half an hour to pick out the few personnel and occupational facts on a single case from the mass of transcripts of hearings; reports of referees, advisory medical boards, hospitals, physicians, and laboratories; autopsy reports; birth and death certificates; bills; employer reports of hours and wages worked; and correspondence with insurance companies and others.

As might be expected from resorting to such varied sources of information, the data collected are not qualitatively comparable. One of the major and well recognized shortcomings is the absence of uniformity in classifying stages of silicosis. For this reason the term "silicosis" is intended to cover all stages determined, both medically and legally. Not all agencies concern themselves with noting whether the person also has tuberculosis, or if deceased, of noting the date and causes of death. Occupational information could not always be considered adequate or complete. Where compensation laws require employments for the previous 10 or 15 years, usually this was all that would be recorded. Medical reports and death certificates give the most recent occupation which is not always the one responsible for causing silicosis. As a result, as analyses become more refined, the number of cases used as a basis becomes smaller.

On the other hand, many records were reviewed that contained extensive clinical, laboratory and radiographical proof of the disease, and at times reports of industrial hygiene investigations of places where the disease may have been contracted. For some individuals, serial x-ray findings were recorded. As a rule, the purpose of the record and the legal procedures involved in compensation influenced the kind and extent of data kept. However, in the absence of uniform sources of information, we accepted what was available and considered ourselves fortunate to get as much as we did.

Geographical Distribution

The geographical distribution of the States participating in the study as well as the number of cases obtained in each State is shown in Figure 1. Altogether, 7 States each contributed under 100 cases; 5 States between 100 and 500 cases and 10 States over 500. The circled figures indicate that sources of reports were primarily compensation records. The number of cases shown cannot be related to industrial populations within the States because of differing reasons for keeping records on silicosis.(Figures not reproduced).

As an example of wide differences in State prevalence figures, attention is called to the figures for Montana and the neighboring mountain States. These cases refer almost exclusively to hard-rock miners. The 81 cases for Idaho, and 40 for Utah represent compensated disabled and death cases filed with the industrial commissions. In Montana, the 588 cases represent individuals receiving silicosis benefits from the State Department of Welfare for the first time during 1950-1954, and deaths among silicotic workers, most of whom began receiving benefits prior to 1950. The requirement for eligibility for benefits in Montana, which is entirely apart from regular compensation is 10 years' residence and medical evidence of disabling silicosis. The case load of workers receiving benefits has averaged between 600 and 625 per month over the past 5 years. Thus, the figure shown for Montana, as large as it is, does not reveal the real prevalence. It was used only because it represented the number of cases on which we had detailed information.

The figure of 2,153 for Pennsylvania represents workers with silicosis and anthraco-silicosis who were awarded compensation benefits during 1949 through 1953. Statistics on deaths and employer reports of silicosis were also obtained, although not used. The differences in these 3 sources of information are illustrated in Figure 2. The first series of bars relate to the number of deaths coded to silicosis and anthraco-silicosis; the second series are compensated cases and the third are employer reports made to the Department of Labor and Industry. The black shaded areas represent deaths, and unshaded, live cases. While the Pennsylvania experience may not be typical, this figure shows strikingly how different sources of information can influence the prevalence figure for silicosis.

Prevalence

As an indication of the prevalence of silicosis in the United States, the 10,362 cases on which we gathered information are obviously an underestimate of the real situation. In the first place, not all States nor all potential sources of information within the 22 States participating were canvassed. Secondly, about three-fourths of the cases were obtained from compensation agencies, which because of numerous legal requirements seldom draw all the medically eligible. Since disability for work must usually be evident for compensation purposes, we can assume that the majority of these cases would be unemployed and disabled.

The prevalence figure, then, does not reflect accurately the number of individuals still at work who probably have some form of silicosis. This number may be larger than we suspect. Many skilled workers, such as granite cutters and molders, though they know they have silicosis, often prefer to remain at their jobs rather than seek compensation or learn a new trade. Many industries, especially the mines, continue to employ workers with roentgenographic evidence of silicosis as long as they are not seriously disabled.

Moreover, more than 10,000 workers have probably died from occupational lung diseases during 1950 to 1954. According to the National Office of Vital Statistics[2/] such deaths averaged 2,000 annually between 1949 and 1952. Of the cases accumulated for this study, only 20% were known to have died during 1950-54.

Despite the paucity and limitations of the data, one cannot deny that 10,362 cases is a sizeable number, even if spread out over a 5-year period. Since we have no previous prevalence figures to relate it to, or even an adequate estimate of the population at risk to determine rates, we will have to be satisfied with the observation that this is a "lot of silicosis" for these times.

Age

Using age as one of the characteristics, the data reveal that these cases are primarily an older group. The age distribution, based on 4,814 individuals with all stages of silicosis shows that 2.5 per cent (120) were under 35 years of age sometime during the 5-year study period; 21.3 per cent (1,025) between 35 and 49 years; 50.6 per cent (2,437) between 50 and 64 years; and 25.6 per cent (1,232) over 65 years. In other words, three-fourths were over 50 years of age. A number of individuals covered in this survey knew that they had silicosis before 1950, but in general, most of the cases were diagnosed during 1950 to 1954.

Sharp differences occurred in age distributions by States, depending upon the sources of data. In States allowing benefits for temporary or partial disability, records revealed comparatively more workers under 50 years of age with silicosis. For instance, New Jersey had 55% under 50 and West Virginia 35%. In Montana where the reports were of totally disabled individuals or of death cases, only 4 per cent were under 50 years of age. In Michigan, which supplied medical reports of occupational diseases, 20% were under 50. New York's data are not included in the above totals, but the State's own tabulations show that 15 per cent of 681 closed cases (disabled) were under 50 years of age. Pennsylvania's data are also excluded since age distribution is based on employer reports and ages for over one-half were not known.

These findings, within limitations imposed by the data, support the current opinion that most of the cases of silicosis coming to light at the present time are among older men, and represent a residue of old cases. However, these data also show that silicosis is occurring among young men with recent exposures.

Industry

The industries most likely associated with the production of 10,152 cases of silicosis in 20 States are classified broadly in Table 1. This is a frequency distribution of the cases and in no way constitutes an indication of the order of hazardousness of the industries listed. The mining industries produced 6,755, or two-thirds (66.6 per cent) of these cases. Coal mining including both soft and hard, ranked highest with 4,079 cases; metal mining followed with 1,637 cases. There were 854 cases for whom the type of mining

2/ Personal communication.

was mixed or was not specified. Drillers, muckers, shovelers and machinemen were the most commonly mentioned specific occupations. Another 185 cases were associated with the extraction and milling of nonmetallic minerals such as clay, feldspar, and mica, and in tunnelling and quarrying operations.

Manufacturing industries with silica hazards accounted for 27.6 per cent or 2,804 cases. Foundries ranked highest with 1,645 cases (16.2 per cent) about one-half of whom were molders. There were 485 cases among granite cutters and finishers; 257 among pottery workers; 150 among clay and tile workers; 165 cases among workers engaged in manufacturing abrasives, the processing of silica flour, mica, and numerous other nonmetallic mineral products, and 89 cases among silica brick furnace dismantlers and repairmen. The occupations for 593 workers (5.8%) were either not known or could not be readily classified.

Table 1 - Silicosis Cases by Type of Industry
Based on 10,152 Cases in 20 States

Industry	Number of Cases	Percent of Cases
Mining:		
Coal mining	4,079	40.2
Metal mining	1,637	16.1
Mixed and unspecified	854	8.4
Nonmetallic mining and quarrying	185	1.8
Total - Mining	6,755	66.6
Manufacturing:		
Tile and clay	150	1.5
Potteries	257	2.5
Glass	13	0.1
Stone cutting and finishing	485	4.8
Nonmetallic mineral industries	165	1.6
Foundries	1,645	16.2
Silica brick furnace work	89	0.9
Total - Manufacturing	2,804	27.6
All other and not known	593	5.8
All industries	10,152	100.0

The age distribution for industry groups was determined for 4,814 cases and is shown in Table 2. Excluding the group of 11 glass workers, silicosis was found among individuals under 35 years of age in each industry group listed. However, none exceeded 5.9 per cent of its total. The 50 to 65 year old group accounted for most cases within each industry as well as for all industries combined.

Proportionately, nonmetallic mining and quarrying and the nonmetallic mineral industries produced more silicosis among workers under 50 years of age. Numerically, more cases among workers under 35 as well as under 50 years of age were found in the mining industries and foundries.

Table 2 - Age Distribution of Silicosis Cases by Industry Based on 4,814 Cases in 17 States

Industry	Number of Cases					Percent of Cases				
	Total	Under 35	35 to 49	50 to 64	65 and over	Total	Under 35	35 to 49	50 to 64	65 and over
Mining:										
Metal mining	1637	56	278	764	539	100.0	3.4	17.0	46.7	32.9
Coal mining	1129	18	334	602	175	100.0	1.6	29.6	53.3	15.5
Mixed and not specified	67	3	12	39	13	100.0	4.5	17.9	58.2	19.4
Nonmetallic mining and quarrying	153	5	66	69	13	100.0	3.3	43.2	45.0	8.5
Manufacturing:										
Tile and clay	68	4	16	35	13	100.0	5.9	23.5	51.5	19.1
Potteries	149	1	21	63	64	100.0	.7	14.1	42.3	42.9
Glass	11	0	2	6	3	100.0	0	18.2	54.5	27.3
Stone cutting and finishing	126	1	35	53	37	100.0	.8	27.8	42.0	29.4
Nonmetallic mineral industries	119	7	30	64	18	100.0	5.9	25.2	53.8	15.1
Foundries	1119	16	187	629	287	100.0	1.4	16.7	56.2	25.7
Silica brick furnace work	67	3	8	34	22	100.0	4.5	11.9	50.8	32.8
All other, and not known	169	6	36	79	48	100.0	3.6	21.3	46.7	28.4
Total	4814	120	1025	2437	1232	100.0	2.5	21.3	50.6	25.6

From these facts, we can conclude that silicosis is still associated with a wide variety of industries. If the occurrence of silicosis among young men can be regarded as a criterion, no industry can take credit for complete dust control. However, it should be pointed out that the classified industries do not always represent the most recent place of employment. This was particularly noted in cases from Michigan, Connecticut, Missouri, Oklahoma and Montana where other than compensation records were used for the determination of prevalence. Hundreds of workers whose cases were reviewed left the dusty trades prior to 1950, and were employed at other jobs when silicosis manifested itself. To illustrate, Figure III shows the correlation between number of years worked and year last worked in mines for 250 Tri-State lead and zinc miners who were hospitalized or were out-patients at a hospital in Jasper County, Missouri. All of these cases were on record as having silicosis or silico-tuberculosis sometime during 1950-54. According to recorded data, all but 63 had left the mines before 1950; 42 had quit by 1930.

Compensation agencies, recognizing this problem of multiplicity and changes in occupations, follow the practice of assigning liability to the most recent place of employment with a silicosis risk. When the individual remains at the same place or even at the same kind of employment for his entire life, and many workers including coal miners, molders and granite workers do this, there is no problem in determining the responsible occupation or industry. But large numbers of workers found with silicosis seldom stay at one job or place, particularly when the work is dusty, or they are beginning to feel the effects of "too much dust on the lungs".

Metal miners are especially migratory and their length of employment is recorded as being "off and on". An example of the work history of a California metal miner is presented in Figure IV.

Another instance of migration was revealed by the analyses of reports submitted by Michigan. Of the total 722 cases reported during 1950-1954, 321 or 45 per cent had worked in coal mines of Pennsylvania, West Virginia, Alabama and other States where some no doubt contracted the disease before migrating to Michigan in search of other work. About 20 were working in Michigan foundries; most of the others were employed at non-dusty occupations when their conditions were reported.

Silicosis among workers receiving exposure to dust since 1935

Information on the third question—"Is a significant number of new cases developing among workers entering dustry trades for the first time in the past 20 years?"—is based on the analysis of 3,455 cases in 10 States for whom reasonably adequate employment histories were obtained. Of this number, 344 workers or 10 per cent allegedly received their entire dust exposure after 1935, or sometime during the past 20 years. Individuals who began working in the early thirties and overlapped this period were not counted in these figures.

The distribution of 344 cases by industry is shown in Table 3. The two groups with the largest proportion of cases receiving total dust exposure in the past 20 years were nonmetallic mineral industries with 32 per cent, and nonmetallic mining and quarrying with 21 per cent. It was shown earlier that these two groups had the greater proportion of younger workers. On the other hand, the number of cases in these groups is comparatively small; so it is hard to tell what significance should be placed on this finding. Tile and

Figure IV

WORK HISTORY OF A CALIFORNIA MINER

AGE 59 IN 1953 - MODERATELY ADVANCED SILICOSIS

(COMPROMISE SETTLEMENT OF $3,500)

MINNESOTA	Iron mines	1914-1917
IDAHO	Lead & zinc mines	1918-1919
UTAH	Coal mines	1920-1924
UTAH	Silver & lead mines	6 or 7 mos. in 1925
CALIFORNIA	Built house	
ARIZONA	Copper mine	1927-1929
NEVADA	Lead & zinc mines	1929-1930
ARIZONA	Copper mine	1931-1933
CALIFORNIA	Tunnelling	1941
WASHINGTON	Road blasting	1941
NEVADA	Mines	1942
CALIFORNIA	Granite quarry	1943

No work since 1943

Table 3 - Silicosis Cases Receiving Dust Exposure After 1935, Based on 3,455 Cases in 10 States

Industrial Group	Number of Cases on Record	Cases receiving dust exposure after 1935	
		Number	Percent
Mining:			
Metal mining	509	80	16.
Coal mining	1095	77	7.
Mixed or not specified	65	7	11.
Nonmetallic mining and quarrying	146	31	21.
Manufacturing:			
Tile and clay	46	9	20.
Potteries	130	3	2.
Glass	11	0	0.
Stone cutting and finishing	323	7	2.
Nonmetallic mineral industries	87	28	32.
Foundries	888	85	10.
Silica brick furnace work	65	9	14.
All other, or not known	90	8	9.
Total	3455	344	10.

clay workers with 20 per cent are also a numerically small group. The proportion for metal mining was 16, for silica brick furnace work 14, for foundries 10, and for coal mining 7.

Cases were found with less than 5 years of exposure, but in general, the exposure period averaged about 15 years. The circumstances giving rise to the occurrence of these cases will be discussed more fully in the final report.

Silicosis with tuberculosis

Preliminary tabulations of data collected on 2,746 cases in 11 States for whom tuberculosis when present was recorded, shows that 35% also had tuberculosis. It was diagnosed in 33% of the 1,763 persons who were alive at the time of the latest record. Forty-nine per cent of the 983 individuals who had died during the study period were found to have tuberculosis. No other observations can be made at this time as this aspect of the problem has not been explored.

Conclusions

Our fourth question, "What aspects of the dust problem need further study?"—cannot be answered from a study of records such as this except in a general way. Our findings indicate that silicosis continues to be an occupational disease of considerable importance. From the standpoint of dust control, the silicosis problem appears to be largely the result of exposures prior to 1935, but not completely so. Sufficient evidence was uncovered to suggest that either the application of dust control measures is not universal or other factors are involved. We know this because silicosis is developing among younger men with recent and short exposure to dust. In addition, we must consider that with less severe exposures, silicosis may take longer to develop than in the past, a possibility that can't be determined for some years.

The findings also suggest that silicosis is a serious social and economic problem. Over the past 5 years, the number of compensation claims for silicosis has been increasing. Liberalization of compensation laws, and improved diagnoses have undoubtedly influenced this situation. For instance, in West Virginia, the number of claims filed increased from 447 in 1951 to 931 in 1954; in New Jersey from 18 in 1950 to 135 in 1954; in Alabama from 117 in fiscal 1952 to 298 in fiscal 1955.

Moreover, the silicotic is living longer. Medical progress in general and the gradual adoption of preventive control measures which have minimized the severity of exposures among men continuing in dusty occupations, have probably contributed to the longevity of the silicotic. The result is that the number of older people seeking financial assistance through compensation or other means is rising.

There are unknown numbers of individuals disabled from silicosis who cannot meet the eligibility requirements for workmen's compensation, and who become community responsibilities in one way or another. Presumably the silicotic population will become stabilized as the previously exposed workers die. Our present silicotic population exemplifies the tremendous impact on society of a preventable but uncontrolled occupational disease.

This inquiry into the prevalence of silicosis has revealed, among other things, the need for better reporting of facts on diagnosed cases of silicosis, uniform classification of diagnostic terminology, criteria of disability, and standards for the supervised employment of non-disabled silicotics.

In the absence of previous prevalence data of any kind on silicosis in the United States, it is hoped that the final report will provide a base line for future evaluations of the occurrence of silicosis. There is little doubt that silicosis will continue to be a problem of industrial, social and economic significance for many years to come.

Acknowledgments

Grateful acknowledgment is made to the workmen's compensation, health and other agencies who participated by contributing so generously to this study.

REPORT OF COMMITTEE ON AIR POLLUTION

Basic committee activities for the past year concerned a model code for use on the local level and consideration of the method of using the air pollution section of the Encyclopedia on Instrumentation, copies of which have been purchased for committee use and distribution.

At the 1955 annual meeting, the Conference authorized the purchase of 500 sets of material which is part of the Encyclopedia and which is directly related to air pollution instrumentation. This material has not yet been released by the printer but it should be available within a few weeks. The Air Pollution Committee intends to edit the material, bring it up to date and issue revised editions periodically. Due to a mid-year change in the chairmanship of the committee made necessary by the resignation of Mr. J. S. Sharrah, who accepted employment in private industry, there has been an unavoidable lull in activities.

Projected for the coming year is the manual preparation as mentioned. This will include the addition to the Air Pollution Instrumentation Section of instruments and related equipment not described in the original edition of the Encyclopedia.

The committee is also planning to review the two new Russian texts on air pollution if translations can be obtained.

Bernard D. Bloomfield, Chairman
William G. Fredrick, D.Sc.
H.N. Doyle
Arthur Stern
Leonard Greenburg, M.D.
Thomas F. Mancuso, M.D.

REPORT OF THE COMMITTEE
ON INDUSTRIAL HYGIENE CODES AND REGULATIONS

The work of this Committee was generally outlined in the report of the previous year (1955) which stated in part---"its (the Committee) program is now at a point where it should consider what has been done and determine whether to develop new supplements or to review the material already prepared to decide whether revisions are indicated."

In review, the Committee over the past years prepared "A Guide for Uniform Industrial Hygiene Codes or Regulations" which was issued in April, 1949. This was followed by three supplements: (I) "A Guide for Uniform Industrial Hygiene Codes or Regulations for Dry Cleaning Operations," April 1951, (2) "A Guide for Uniform Industrial Hygiene Codes or Regulations for the Use of Fluoroscopic Shoe Fitting Devices," July 1951, and (3) "A Guide for Uniform Industrial Hygiene Codes or Regulations for the Use of Radioactive Static Eliminators," January 1953.

Mr. Yaffe has informed our Committee that there is still a demand for the general "Guide for Uniform Industrial Hygiene Codes or Regulations" and that the supply of mimeographed copies is practically depleted. Mr. Yaffe has further requested recommendation from this Committee for reissuing this code in its present form.

Although we do not think that a comprehensive revision of the general guide is indicated at this time, we do believe that an abbreviated review should be made before it is reissued. In this review, comments from State and local programs would be most useful.

We feel that the greatest use can be made of the Committee's time through developing supplements to the general guide. In this respect, we recommend that the Conference endorse as a supplement to the general guide the ASA Z4.1-1955 American Standard Minimum Requirements for Sanitation in Places of Employment. This standard was sponsored by the U. S. Public Health Service. Our Conference was represented on the Committee which developed the revision by Mr. Joseph E. Flanagan and Mr. Charles D. Yaffe.

Other areas which have been mentioned to us as suggested subjects for supplements include: (1) Use of radioactive materials, (2) Spray painting, (3) Working in areas of excessive temperature and humidity, and (4) Proper and safe use of ultra-violet lights. Here again, we believe that an expression by the Conference membership would be most useful in determining the areas most urgently in need of supplemental guides. This Committee recommends that such a canvass be made for purposes of long term planning. In the interim, the Committee plans to meet during the conference to discuss immediate areas on which supplemental guides can be started.

Dr. L. J. Cralley, Chairman
Mr. B. R. Hubbard
Mr. D. A. Holaday
Mr. A. L. Coleman
Mr. C. E. Couchman

REPORT OF COMMITTEE ON INDUSTRIAL HYGIENE RECORDS AND REPORTS

The Committee on Industrial Hygiene Records and Reports wishes to report that time and staff shortages did not permit further work on the proposed manual of record and report forms for use of State and local industrial hygiene agencies which the Committee hoped to have ready for preliminary review by the membership of the Conference. It is the feeling of the Committee that the inclusion of already selected forms will need to be reconsidered in view of the changing content of programs of State and local agencies. This project will be continued as an urgent need exists for this type of manual, especially in view of the large number of newly recruited individuals in State and local programs.

The Sub-Committee on Plant Medical Records and Reports, of which Mrs. Alice Weldy was Chairman, completed a draft of a manual containing suggested in-plant medical record and report forms for use in small plants. Mrs. Weldy resigned her position with the Milwaukee Health Department last fall, but the draft is to be presented for comments in the near future.

The Committee proposes to sponsor the collection of annual reports of industrial hygiene activities this coming year, and it is hoped that all State and local agencies will cooperate by sending a copy of their activity report to the Chairman of this Committee. The reports are summarized in order to determine what the current accomplishments of State and local agencies are, trends in programs, volume of services and needs.

Miss Victoria M. Trasko, Chairman
D. D. Huffman
Hugh L. Parker
Miss Heide L. Henriksen
Dr. Christine Einert

REPORT OF THE COMMITTEE ON INDUSTRIAL VENTILATION

Your Committee is pleased to report a hard working year in which a new revised fourth edition of the Ventilation Manual has been prepared and printed.

The fourth edition includes much new material. The section on duct design has been completely rewritten with a more understandable and simpler approach to this important problem. All of the basic design data has been reviewed and revised where necessary. The section on air cleaning devices is enlarged and includes practical tables for selection of air cleaning equipment. New material has been added in sections II, IV, and in the appendix. A number of errors have been corrected.

The cost of printing and binding the fourth edition has increased materially. This price increase is due to increased printing costs, additional pages and a heavier and more expensive binding necessitated by the increased size. A slight leveling off of sales has reduced the revenue of the committee. A careful accounting of costs connected with preparation, printing, handling, sales and mailing of the manual indicates that at the price of $3.00 per copy ($1.00 of which goes to the ACGIH) the manual would be sold at a loss. To continue on a sound financial basis the committee has felt the need to increase the price to $4.00. It will continue to be the policy of this committee, however, to sell the manual at the lowest price possible to get the good practice recommendations into the hands of the largest number of users, and at the same time retain sufficient funds to allow for the publication of future editions.

Your committee intends to increase sales by a modest amount of paid advertising and intensive word-of-mouth publicity by committee members.

Your committee would like to point out that the present favorable financial status of the ACGIH is largely due to the sale of Ventilation Manuals. If this is to continue, Ventilation Manuals must be sold. Your committee requests that the various governmental agencies actively assist in promotion of sales. Your committee believes that the fourth edition is sufficiently changed and improved so that replacement copies should be ordered for staff members of governmental agencies. Previous users of the manual in your State or municipality should be recanvassed for new orders. Advertising literature suitable for mailing is available from your committee.

The financial report of this committee will be presented at the annual meeting in April.*

George Hama, Chairman
Jack Baliff
Ronald Bales
James C. Barrett
Benjamin Feiner
E. Lynn Schall
John C. Soet

* ANNUAL FINANCIAL STATEMENT
COMMITTEE ON INDUSTRIAL VENTILATION
4-1-56

Assets		Liabilities	
Inventory		Accounts Payable	
Manuals	$ 315.70	Income Tax & FICA	$ 80.26
Calc. Sheets	53.92	Conference	870.00
VS-Prints	30.00	Uncollectable Accounts	8.25
Office Equipment	1.00	Losses	14.00
Cash Balance	3829.57		
Accounts Receivable	887.69		
			972.51
		Balance	4145.37
	$5117.88		$5117.88

The 4th Edition of the manual "Industrial Ventilation" will be printed and ready for distribution at Conference time. Due to the increase in printing cost (approximately $ .35 per copy), the price of the new edition has been raised to $4.00. The Committee feels that the increased price will not be reflected in the sale of the manual.

In the past year the Committee on Industrial Ventilation has paid a total of $1153.50 to the Conference, including the check we are presenting at the meeting. The manual continues to have excellent acceptance and sale.

REPORT OF COMMITTEE ON RECOMMENDED ANALYTICAL METHODS

During the past year substantial progress has been made in the development and testing of several methods. A colorimetric method for arsenic, based upon the reaction of arsine with a solution of silver diethyldithiocarbamate, has been developed and tested and the first draft of the final report has been submitted to the Committee for review. A dithizone method for cadmium has been developed, tested and is being written up for submission to the Committee. Polarographic and colorimetric methods for sulfur dioxide have been subjected to preliminary testing and modification; a complete report on these methods is expected within a few weeks.

Satisfactory progress has been reported by the respective referees for the following methods: antimony, beryllium, organic solvents, ozone, selenium and silica. The alkaline iodide method for ozone (modification of Byers, Saltzman and Hyslop) has been reported by the referee to be the least subject to interference by nitrogen dioxide of 8 methods tested.

A referee has been appointed recently to complete the work on the fluorine method.

Previous difficulties encountered in the method for methanol are being eliminated and the procedure should be available for testing by collaborators in the near future.

In the past, distribution of the methods approved by this Committee has been limited to members of the Conference. In recent years, however, industrial hygienists outside the Conference have expressed their interest in securing copies of these methods. The Committee has given this matter serious consideration and wishes to make the following recommendations:

1. That the Conference consider the preparation of a manual of the analytical methods recommended by this Committee. To keep the cost of the manual at a minimum and to facilitate the addition of future methods, the Committee suggests that these methods be reproduced in mimeographed form (8½" x 11") in a standard size, three-ring, looseleaf type of binder with the following title printed on the outside cover:

> "Methods for Analysis of Atmospheric Contaminants
> Committee on Recommended Analytical Methods
> American Conference of Governmental Industrial Hygienists"

2. That a price level be established for the sale of this manual to non-conference members, the price to be based upon the cost of the binder, the cost of reproduction of a specific number of copies and the mailing charge.

3. That a decision be rendered as to whether or not Conference members may receive a copy of the manual free of charge, with or without a limit of one copy to each laboratory represented. As Conference members are eligible

to receive mimeographed copies of all current and future methods approved by this Committee, this recommendation involves only the proposed binder collection of current methods.

4. That the Conference consider running an advertisement in one or more appropriate journals (after cost estimates of the initial binder collection in lots of 1,000 have been made) to determine the approximate sales volume from the response to the advertisement.

5. That future methods (in mimeographed form) be offered for sale at a price based upon costs of reproduction and mailing of each method as it becomes available.

The above recommendations are presented in this report by the Committee to obtain the opinions of the Executive Committee and the Conference membership in this matter. The recommendations are offered primarily in the spirit of sharing with all industrial hygienists the analytical methods which have been developed and tested by Conference members who, indeed, have been assisted markedly by non-conference chemists serving as collaborators.

Robert G. Keenan, Chairman
D. E. Van Farowe
D. E. Rushing
W. J. Roberts
H. L. Parker
J. L. Monkman
W. L. Lea

REPORT OF THE COMMITTEE ON STANDARD LABELING PROCEDURES

With some trepidation the Committee has undertaken the task of preparing a model set of regulations for the labeling of harmful substances.

Preliminary plans were drawn up at a meeting held in Pittsburgh in November, 1955, and attended by four members of the Committee. It was the consensus of those present that the model regulations should be based on the system worked out by the Manufacturing Chemists' Association. This system, with minor changes, has been incorporated in laws or regulations in the States of California, Illinois, New Jersey, New York and Oregon, and in the Territory of Hawaii. Emphasis would be placed on strengthening what appeared to members of the Committee to be weaknesses in these regulations.

A preliminary draft of a model act has been drawn up and has undergone two revisions. It is hoped that further progress will be made during the course of the Philadelphia meeting and thereafter and that a detailed report will be available for circulation before the 1957 meeting.

Hervey B. Elkins, Chairman
William G. Fredrick
Samuel Moskowitz
Hugh L. Parker
Jack C. Rogers
Herbert E. Stokinger

REPORT OF THE COMMITTEE ON STANDARDIZATION OF AIR SAMPLING INSTRUMENTS

Committee activity during the past year dealt principally with the Encyclopedia of Industrial Hygiene Instrumentation about to be issued by the University of Michigan. Several committee members have devoted a great deal of time and effort to the terminal stages of the production of this volume, which included proofreading, indexing, and composing of material for appendices. This part of the report is therefore brief inasmuch as the work referred to will be adequate evidence of accomplishment. It should, of course, be stressed that committee members were only participants in the whole venture, the great bulk of the work having been done by U. S. Public Health Service and University of Michigan personnel.

The comparative study of mercury vapor indicators, which had been planned as an outgrowth of last year's survey of these instruments, was not carried out due to time limitations on the part of committee members. In view of the anticipated future work load of the committee, it is not at present planned to accomplish this study.

The primary goal of the committee during the coming year is to construct the manual of air sampling instruments, using that chapter of the previously mentioned Encyclopedia which deals with this subject. The detail of this task need not be given here, but in summary form, it will be necessary to edit the existing material to conform to our requirements, modernize it as needed, and add such other sections as are necessary to make it a useful and wanted publication.

The committee wishes to suggest that its current title is perhaps inappropriate to its past and projected activities. To date there has been little or no "standardization" of air sampling instruments accomplished, but rather an appraisal of them. The matter might well be discussed by the membership-at-large, but the simple title, "Committee on Air Sampling Instruments", would seem to be entirely adequate.

The retiring chairman expresses his thanks to all members who have contributed to the committee's accomplishments during the past several years.

Ralph G. Smith, Chairman
Irving H. Davis
Edwin C. Hyatt
H. H. Jones
A. D. Hosey
Paul F. Urone
Alfred Setterlind

1956

REPORT OF THE COMMITTEE ON THRESHOLD LIMITS

More than 3000 reprints of the 1955 List of Threshold Limit Values were distributed to various organizations and individuals in this country and abroad. Copies of the proposed 1956 list were sent to A.C.G.I.H. members for review. Values for 250 materials, including the 23 new tentative items are now listed. Preliminary data for another 12 materials are under consideration by your committee.

In the proposed 1956 List, you have noted that changes have been made in the introduction, and in the format in addition to the transfer of 48 tentative values to the body of the table. Your committee recommends that the Conference approve these changes, more specifically as follows:

1. The change in wording of the introduction which it is hoped will clarify the meaning and purpose of threshold limit values.

2. The expression of concentration of gases and vapors in terms of approximate milligrams per cubic meter of air as well as parts per million by volume. This addition was made in response to many requests that the additional information be included.

3. The acceptance of the 48 values, previously designated as tentative, for inclusion in the 1956 List.

During the past year, in addition to the usual reviewing of literature and suggesting the indicated changes and revisions in the published table, your committee felt it desirable to determine the manner in which threshold limit values are being used by governmental industrial hygienists.

Accordingly, letters requesting such information and welcoming any suggestions for changes or additions to the table were sent to 56 State, county and city industrial hygiene units. A total of 41 replies were received. Of these, 28 indicated that the values were being used as guides in the evaluation and control of industrial health hazards, while in 13 units the values were used in the formulation of codes or regulations. Of the 28 using them as guides, 21 use the values as published, 4 revise the list every 2 years, and 3 revise their published lists every 3, or more, years. Of the 13 units using the values in codes or regulations, 2 make annual revisions, 4 every two years and 9 have made revisions after 3, or more, years.

Suggestions for additions to the present table included the following items:

Economic poisons	Epoxy resins
Noise levels	Systox
Sanitation standards in industry	Teflon
Boron trifluoride	Alpha - emitting daughters of radon
Mineral oil	
Diatomaceous earth	Ompa

The committee will consider these items during the coming year.

It is of interest to note that in these cases where Threshold Limit Values are used as codes or regulations, there is a tendency toward less frequent revision of data. This lack of uniformity in values used by various units has led to some confusion, especially in cases where companies operate plants in several States or communities where different values are used. Again, the committee would like to encourage the use of threshold limit values as guides rather than having them incorporated into laws.

Mention should be made here of the fact that recommendations have come to the attention of the committee, through literature and correspondence, for changes in values rather long standing and for which there is considerable substantiating data and experience. Changes recommended by various individuals in the recent literature and by personal communication include the reduction of the Threshold Limit Value of:

Carbon monoxide	---	from 100 to 50 p.p.m.
Ethylene oxide	---	from 100 to 50 p.p.m.
Sulfur dioxide	---	from 10 to 5 p.p.m.
Toluene	---	from 200 to 100 p.p.m.
Carbon disulfide	---	from 20 to 10 p.p.m.
Trichloroethylene	---	from 200 to 100 p.p.m.
Styrene	---	from 200 to 100 p.p.m.
Stoddard solvent	---	from 500 to 200 p.p.m.
Petroleum naphtha	---	from 500 to 200 p.p.m.
Ethylene dichloride	---	from 100 to 50 p.p.m.

Recommendation of new values for these familiar materials suggests the need for collection and reevaluation of toxicity data by your committee. Many industrial hygiene units have been studying exposures to most of the above materials under actual working conditions in industry for a considerable number of years, during which time much information has been collected, but not necessarily published. With this in mind, we should like to ask for the full cooperation of our membership in supplying information which will be requested in the near future. While animal experimentation provides valuable data and a background of knowledge, only human experience can decide whether exposures previously reported for animals, can be applied to human workers. Because of this, the valuable experience gained by State industrial hygiene units is the type of information upon which such values have been or should be based. The American Conference of Governmental Industrial Hygienists is in a unique position to bring forth the data accumulated over years of experience to give expression to these human values as different from animal values. Your obligation in this phase of industrial hygiene work is great. You may rest assured that the committee will give fullest consideration to all material which you supply.

Meanwhile, your committee plans to continue the listing of properly substantiated values for new materials reported in the literature.

Allan L. Coleman, Chairman
William L. Ball
L. T. Fairhall
H. E. Stokinger
Ralph S. Smith
W. H. Reinhart
S. D. Silver
A. J. Vorwald

PROPOSED THRESHOLD LIMIT VALUES FOR 1956

Values are given in the following tabulation for the maximum average atmospheric concentration of contaminants to which workers may be exposed for an eight-hour working day without injury to health.

These values are based on the best available information from industrial experience, from experimental studies, and, when possible, from a combination of the two. They are not fixed values but are reviewed annually by the Committee on Threshold Limits for changes, revisions, or additions as further information becomes available. Threshold Limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations. They represent only conditions under which it is felt workers may be repeatedly exposed, day after day, without adverse effect on their health. The figures listed refer to average concentrations of an eight-hour working shift rather than a maximum which is not to be exceeded even momentarily. The amount by which these figures may be exceeded for short periods during the work day 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 results are cumulative, the frequency with which high values occur and for what periods of time. All must be taken into consideration in arriving at a decision as to whether a hazardous situation is deemed to exist.

These values are not intended for use, or for modification for use, in the evaluation or control of community air pollution or air pollution nuisances.

GASES AND VAPORS

Substance	PPM*	APPROX. MG. PER CU. M.**
Acetaldehyde	200	360
Acetic acid	10	25
Acetic anhydride	5	20
Acetone	1,000	2,400
Acrolein	0.5	1.2
Acrylonitrile	20	45
(x) Allyl alcohol	5	12
(x) Allyl propyl disulfide	2	12
Ammonia	100	70
Amyl acetate	200	1,050
Amyl alcohol (isoamyl alcohol)	100	360
Aniline	5	19
Arsine	0.05	0.2
Benzene (benzol)	35	110
(x) Benzyl chloride	1	5
Bromine	1	7
Butadiene (1,3-butadiene)	1,000	2,200
Butanone (methyl ethyl ketone)	250	740
Butyl acetate (n-butyl acetate)	200	950
Butyl alcohol (n-butanol)	100	300
(x) Butyl amine	5	15
Butyl cellosolve (2-butoxy-ethanol)	200	970
Carbon dioxide	5,000	9,000
Carbon disulfide	20	60

* - Parts of vapor or gas per million parts of air by volume.
** - Approximate milligrams of dust, fume, or mist per cubic meter of air.
(x)- These values appeared on the tentative list last year.

Gases and Vapors
(Cont.)

	Substance	PPM*	APPROX. MG. PER CU. M.**
	Carbon monoxide	100	110
	Carbon tetrachloride	25	160
	Cellosolve (2-ethoxyethanol)	200	740
	Cellosolve acetate (hydroxyethyl acetate)	100	540
	Chlorine	1	3
(x)	Chlorine trifluoride	0.1	0.4
	Chlorobenzene (monochlorobenzene)	75	350
	Chloroform (trichloromethane)	100	490
	1-Chloro-1-nitropropane	20	100
	Chloroprene (2-chlorobutadiene)	25	90
	Cresol (all isomers)	5	22
	Cyclohexane	400	1,400
	Cyclohexanol	100	410
	Cyclohexanone	100	400
	Cyclohexene	400	1,350
	Cyclopropane	400	690
(x)	Diacetone alcohol (4-hydroxy-4-methyl pentanone-2)	50	240
(x)	Diborane	0.1	0.1
	o-Dichlorobenzene	50	300
	Dichlorodifluoromethane	1,000	4,950
	1,1-Dichloroethane	100	400
	1,2-Dichloroethylene	200	790
	Dichloroethyl ether	15	90
	Dichloromonofluoromethane	1,000	4,200
	1,1-Dichloro-1-nitroethane	10	60
	Dichlorotetrafluoroethane	1,000	7,000
	Diethylamine	25	75
(x)	Difluorodibromomethane	100	860
(x)	Diisobutyl ketone	50	290
	Dimethylaniline (N-dimethylaniline)	5	25
	Dimethylsulfate	1	5
	Dioxane (diethylene dioxide)	100	360
	Ethyl acetate	400	1,400
	Ethyl alcohol (ethanol)	1,000	1,900
	Ethylamine	25	45
	Ethyl benzene	200	870
	Ethyl bromide	200	890
	Ethyl chloride	1,000	2,600
	Ethyl ether	400	1,200
	Ethyl formate	100	300
	Ethyl silicate	100	850
	Ethylene chlorohydrin	5	16
(x)	Ethylene diamine	10	30
	Ethylene dibromide (1,2-dibromoethane)	25	190
	Ethylene dichloride (1,2-dichloroethane)	100	400
(x)	Ethylene imine	5	9
	Ethylene oxide	100	180
	Fluorine	0.1	0.2
	Fluorothrichloromethane	1,000	5,600

Gases and Vapors
(Cont.)

	Substance	PPM*	APPROX. MG. PER CU. M.**
	Formaldehyde	5	6
	Gasoline	500	2,000
	Heptane (n-heptane)	500	2,000
	Hexane (n-hexane)	500	1,800
	Hexanone (methyl butyl ketone)	100	410
	Hexone (methyl isobutyl ketone)	100	410
(x)	Hydrazine	1	1.3
(x)	Hydrogen bromide	5	17
	Hydrogen chloride	5	7
	Hydrogen cyanide	10	11
	Hydrogen fluoride	3	2
(x)	Hydrogen peroxide, 90%	1	1.4
	Hydrogen selenide	0.05	0.2
	Hydrogen sulfide	20	30
	Iodine	0.1	1
	Isophorone	25	140
(x)	Isopropylamine	5	12
	Mesityl oxide	50	200
	Methyl acetate	200	610
(x)	Methyl acetylene	1,000	1,650
	Methyl alcohol (methanol)	200	260
	Methyl bromide	20	80
	Methyl cellosolve (methoxyethanol)	25	80
	Methyl cellosolve acetate (ethylene glycol monomethyl ether acetate)	25	120
	Methyl chloride	100	210
	Methylal (dimethoxymethane)	1,000	3,100
	Methyl chloroform (1,1,1-trichloroethane)	500	2,700
	Methylcyclohexane	500	2,000
	Methylcyclohexanol	100	470
	Methylcyclohexanone	100	460
	Methyl formate	100	250
(x)	Methyl isobutyl carbinol (methyl amyl alcohol)	25	100
	Methylene chloride (dichloromethane)	500	1,750
	Naphtha (coal tar)	200	800
	Naphtha (petroleum)	500	2,000
	Nickel carbonyl	0.001	0.007
(x)	p-Nitroaniline	1	6
	Nitrobenzene	1	5
	Nitroethane	100	310
	Nitrogen dioxide	5	9
	Nitroglycerin	0.5	5
	Nitromethane	100	250
	2-Nitropropane	50	180
	Nitrotoluene	5	30
	Octane	500	2,350
	Ozone	0.1	0.2
	Pentane	1,000	2,950
	Pentanone (methyl propyl ketone)	200	700

Gases and Vapors
(Cont.)

Substance	PPM*	APPROX. MG. PER CU. M.**
Perchlorethylene (tetrachloroethylene)	200	1,350
Phenol	5	19
(x) Phenylhydrazine.	5	22
Phosgene (carbonyl chloride)	1	4
Phosphine.	0.05	0.07
Phosphorus trichloride	0.5	3
Propyl acetate	200	840
Propyl alcohol (isopropyl alcohol) . . .	400	980
Propyl ether (isopropyl ether).	500	2,100
Propylene dichloride (1,2-dichloropropane)	75	350
(x) Propylene imine	25	60
(x) Pyridine	10	30
(x) Quinone.	0.1	0.4
Stibine.	0.1	0.5
Stoddard solvent	500	2,900
Styrene monomer (phenyl ethylene).	200	850
Sulfur dioxide	10	25
(x) Sulfur hexafluoride	1,000	6,000
Sulfur monochloride.	1	6
(x) Sulfur pentafluoride	0.025	0.25
(x) p-Tertiary butyl toluene	10	60
1,1,2,2-Tetrachloroethane.	5	35
(x) Tetranitromethane	1	8
Toluene (toluol)	200	750
o-Toluidine.	5	22
Trichloroethylene.	200	1,050
(x) Trifluoromonobromomethane.	1,000	6,100
Turpentine	100	560
Vinyl chloride (chloroethene).	500	1,300
Xylene (xylol)	200	870

TOXIC DUSTS, FUMES, AND MISTS

Substance	MG. PER CU. M.**
(x) Aldrin (1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene)	0.25
(x) Ammate (ammonium amidosulfate)	15
Antimony	0.5
Arsenic.	0.5
Barium (soluble compounds)	0.5
Cadmium oxide fume	0.1
(x) Chlordane (1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane).	2
(x) Chlorinated diphenyl oxide	0.5
Chlorodiphenyl (42 per cent chlorine). .	1
Chromic acid and chromates (as CrO_3) . .	0.1

** - Milligrams of dust, fume, or mist per cubic meter of air.

Toxic Dusts, Fumes, and Mists (Cont.)

Substance	MG. PER CU. M.**
(x) Crag Herbicide (sodium-2,4,dichlorophenoxy-ethyl sulfate)	15
Cyanide (as CN)	5
(x) 2,4-D(2,4-dichlorophenoxyacetic acid)	10
(x) Dieldrin (1,2,3,4,10,10-hexachloro-6,7, epoxy-1, 4,4a,5,6,7,8,8a-octahydro-1,4,5,8-dimethano-naphthalene)	0.25
Dinitrotoluene	1.5
Dinitro-o-cresol	0.2
(x) EPN (ethyl-p-nitrophenyl thionobenzenephosphonate)	0.5
(x) Ferrovanadium dust	1
Fluoride	2.5
(x) Hydroquinione	2
Iron oxide fume	15
Lead	0.15
(x) Lindane (hexachlorocyclohexane, gamma isomer)	0.5
Magnesium oxide fume	15
(x) Malathon (O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate)	15
Manganese	6
Mercury	0.1
(x) Mercury (organic compounds)	0.01
(x) Methoxychlor (2,2,diparamethoxyphenyl-1,1,1, trichloroethane)	15
(x) Molybdenum	
(soluble compounds)	5
(insoluble compounds)	15
Parathion (0,0-diethyl-0-p-nitrophenyl thiophosphate)	0.1
Pentachloronaphthalene	0.5
Pentachlorophenol	0.5
Phosphorus (yellow)	0.1
Phosphorus pentachloride	1
Phosphorus pentasulfide	1
(x) Picric acid	0.1
Selenium compounds (as Se)	0.1
(x) Sodium hydroxide	2
Sulfuric acid	1
(x) TEDP (tetraethyl dithionopyrophosphate)	0.2
(x) TEPP (tetraethyl pyrophosphate)	0.05
Tellurium	0.1
Tetryl (2,4,6-trinitrophenylmethylnitramine)	1.5
(x) Titanium dioxide	15
Trichloronaphthalene	5
Trinitrotoluene	1.5
Uranium (soluble compounds)	0.05
Uranium (insoluble compounds)	0.25
(x) Vanadium	
(V_2O_5 dust)	0.5
(V_2O_5 fume)	0.1

Toxic Dusts, Fumes, and Mists (Cont.)

Substance	MG. PER CU. M.**
Zinc oxide fumes	15

Radioactivity: For permissible concentrations of radioisotopes in air see "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water", Handbook 52, U.S. Department of Commerce, National Bureau of Standards, March, 1953. In addition, see "Permissible Dose from External Sources of Ionizing Radiation", Handbook 59, Department of Commerce, National Bureau of Standards, Sept. 24, 1954.

MINERAL DUSTS

Substance	MPPCF +	Substance	MPPCF +
Aluminum oxide	50	Silica	
Asbestos	5	high (above 50% free SiO_2)	5
Dust (nuisance, no free silica)	50	medium (5 to 50% free SiO_2)	20
Mica (below 5% free silica)	20	low (below 5% free SiO_2). .	50
Portland cement	50	Silicon carbide	50
Talc	20	Slate (below 5% free SiO_2). .	50
		Soapstone (below 5% free SiO_2)	20
		Total dust (below 5% free SiO_2)	50

+ - Millions of particles per cubic foot of air.

TENTATIVE VALUES

	Substance	PPM*	APPROX. MG. PER CU. M.**
	Allyl chloride	5	15
	ANTU (alpha-naphthylthiourea).		0.3
(x)	Butyl mercaptan	10	35
(x)	Calcuim arsenate		0.10
	Chlorinated camphene, 60%		0.5
	Chlorobromomethane (Cl Br CH_2) . . .	400	2,100
	Chlorodiphenyl (54% chlorine) . . .		0.5
	Chloropicrin	1	7
(x)	DDT (2,2-bis-(p-chlorophenyl)-1, 1,1-trichloroethane)		1
	Decaborane ($B_{10}H_{14}$)	0.05	0.3
	2,4-Diisocyanotoluene.	0.1	0.7
	Dinitrobenzene		1
	Ethyl acrylate	25	100
(x)	Ethyl mercaptan.	250	640

Tentative Values
(Cont.)

	Substance	PPM*	APPROX. MG. PER CU. M.**
	Ferbam (ferrous dimethyl dithiocarbamate)		15
	Fluoroacetates		0.1
(x)	Furfural	5	20
(x)	Furfuryl alcohol	50	200
	HETP (hexaethyltetraphosphate)		0.1
(x)	Lead arsenate.		0.15
	Methyl acrylate.	10	35
(x)	Methyl mercaptan	50	100
	Nicotine		0.5
	Nitric acid.	10	25
	Pentaborane (B_5H_9)	0.01	0.03
(x)	Perchloromethyl mercaptan.	0.1	0.8
	Pyrethrum		2
	Rotenone		5
	Strychnine		0.15
	Tetrahydrofuran.	200	590
	Thiram (tetramethyl thiuram disulfide)		5
	Thallium (soluble compounds)		0.15
	Warfarin (a-acetoxybenzyl) 4 hydroxy coumarin		0.5
(x)	Zirconium Compounds (as Zr).		5

Beryllium: During the past few years, several papers have appeared in the literature which report a limit of 2 micrograms per cubic meter of air for beryllium. Among these is the paper by Van Ordstrand, H. S.: Berylliosis, A.M.A. ARCH. INDUST. HYG. 10: 232-234 (Sept.) 1954, and one by Sterner, J. H., and Eisenbud, M.: Epidemiology of Beryllium Intoxication, A.M.A. ARCH INDUST. HYG. 4: 123-151 (Aug.) 1951. Conflicting data from industrial experience has caused the Committee to postpone the suggestion of a Threshold Limit for this material. It is apparent that more epidemiologic work is needed for the establishment of a definite value.

Allan L. Coleman, Chairman
William L. Ball
L. T. Fairhall
H. E. Stokinger
Ralph S. Smith
W. H. Reinhart
S. D. Silver
A. J. Vorwald

REPORT OF THE COMMITTEE ON WORKER HEALTH INFORMATION

In a letter to the Secretary from the Chairman, Dr. Miriam Sachs, she said:

"This year there is no formal report from the Committee on Worker Health Information. I am convinced that this Committee should be maintained as one of the active committees of the American Conference of Governmental Industrial Hygienists. It is said but true that health education efforts and worker health information are intangible and difficult to organize and initiate.

"There are several ideas and plans which might be put into effect during the next two or three years. For example, some coordinating activities should be attempted with our counterpart in the occupational health section of A.P.H.A. I am attaching a copy of the report of the Committee on scope of that section pertaining to that matter."

(The report referred to above is as follows.)

REPORT OF COMMITTEE ON SCOPE OCCUPATIONAL HEALTH SECTION - A.P.H.A.

I. Education

The American public is woefully unaware of even rudimentary facts about occupational health and the professions working in this field. A program concerned with two objectives should afford almost unlimited opportunity for development:

(1) To make available for the working public essential information on occupational diseases and personal health maintenance as related to work and to their part in avoiding injury to health as a result of working condition.

(2) To introduce the general public to the science of occupational health and to the variety of skills needed in it.

GENERAL SESSION

April 24, 1956, 9:00 A.M.

Dr. Ralph R. Sullivan, Chairman, Presiding

A STATISTICAL STUDY OF 1470 CASES OF SILICOSIS

Miss Esther W. Kilmer
and
Dr. William G. Fredrick
Detroit Department of Health

Silicosis is a preventable disease. It is caused by the inhalation of silica dust in excessive amounts. Hence its prevention is accomplished by not inhaling silica dust in excessive amounts. This is of course a simple statement of basic industrial hygiene philosophy. The application of this philosophy is fraught with a formidable dilemma involving on one hand the problem of how to measure the concentrations of silicon dioxide in the air to be respired and on the other hand how much of the dust so measured constitutes an excessive amount. Some 25 years have elapsed since the development of the Greenberg-Smith Impinger and the "light-field" counting technique and nearly 20 years since the establishment of the so-called limits of air dustiness based upon this counting procedure and the silica content of the air. Without question use of these counting procedures and exposure limits have reduced the incidence and severity of silicosis. But are they good enough to prevent the occurrence of the disease in the workers employed in the dusty trades? There is no quick answer to this question when the period from start of exposure to diagnosis of the disease may cover a span of 3 to 4 decades.

In 1936 the Bureau of Industrial Hygiene of the Detroit Department of Health began a vigorous program of dust control in ferrous and non-ferrous foundries in Detroit. By 1946, levels of dustiness substantially conformed with acceptable limits of exposure. However, cases of silicosis continued to appear with distressing regularity. The probability was high that these cases were the result of excessive exposures which occurred prior to 1936. Using this assumption, one would expect that cases resulting from exposures started after 1936 could not reasonably be expected in substantial numbers before 1965-70, and if the dust exposure was not excessive, cases should never appear. But if by 1965, cases continued to appear, reduction of the limits of dust exposure to lower values would come too late to protect at least a generation of foundry workers. A possible way to verify the preventive effectiveness of silica dust standards presently in use in foundries would involve collecting detailed occupational histories of exposure of as many cases of foundry silicosis diagnosed in Detroit as possible. Usually, accurate diagnosis and accurate occupational histories are not easily obtainable for any occupational disease, and especially for silicosis. The Bureau of Industrial Hygiene, of the Detroit Health Department found itself in a uniquely advantageous position. It offices are located in the Health Department's Herman-Kiefer Hospital, which is primarily concerned with pulmonary tuberculosis and all other pulmonary disease. All cases of tuberculosis and most cases of silicosis in the City of Detroit pass through its clinics or the Tuberculosis Control Division of the Health Department which is housed therein.

It was because of the speaker's past experience in working in the Tuberculosis Division that there was an awareness of this valuable source of information for our Bureau of Industrial Hygiene. In 1946 the authors arranged a cooperative program with these groups whereby accurate diagnosis and complete occupational histories are obtained on all cases of silicosis and pneumoconiosis, regardless of the occupation or work place in which they were acquired. These histories are obtained by either public health nurses or personnel with special training. All silicosis cases are reported monthly to the authors and when indicated, additional studies are made of Detroit workplaces in which suspected exposure occurred and data obtained which we are now presenting. Filesof environmental dust exposure levels dating back to 1936 are maintained for all Detroit foundries and all other Detroit industries known to present a silica exposure. It is hoped that through this machinery, possible failure of present day dust control standards for silica and all other dusts capable of causing lung disease can be detected at the earliest possible date. The files of the Tuberculosis Division and the hospital have been studied for the period prior to 1940, but few accurate records were available. Through the utilization of the highly accurate tuberculosis register, calling in of silicosis patients to the clinic, and Detroit death certificates reporting tuberculosis, silicosis or pneumoconiosis as a contributing cause of death, followup is achieved on a substantial number of our known cases. All chest x-rays are read by physicians highly specialized in recognizing diseases of the lung. Autopsy reports have also been available to us which have confirmed the silicosis diagnosis and sometimes have shown silicosis diagnosed for the first time.

It is too early for this continuing project to yield the data for which it was inaugurated, but a consideration of this large group of well studied cases provides data which may be of value to many workers interested in the prevention of silicosis, especially when it is considered in conjunction with unpublished or confidential information already in their hands. The current summary of the statistical information is presented for this purpose only.

The authors are reluctant to draw many positive conclusions or too many inferences from the data and the reader is similarly warned to use it with caution. For example, the leading cause of silicosis in this series of cases is mining, but the only mine in Detroit (or within three hundred miles of Detroit) is a silica free salt mine. So the data mean that many miners who are eventually destined to develop silicosis migrate to Detroit and work many years, usually in non-dusty occupations, before the disease is diagnosed. Of this group, many are at work and in apparent good health at the time of diagnosis. The low number of sand blasters developing silicosis need not reflect a low hazard at this work but rather a very small number of workers engaged in this occupation. The low number of silicotic ceramic workers reflects the near absence of this industry in the Detroit area and the probable failure of any appreciable number of this occupational group to migrate to Detroit. The authors regret that although information is available to them in official records concerning the number of workers in the several dusty trades in Detroit, sufficient staff time has not been available to get it out. The reader is also cautioned to consider that these data have been obtained primarily through a machinery designed to discover cases of tuberculosis and may be biased in this respect. Also that since 1950, an extensive tuberculosis case finding program has been in force utilizing mobile chest x-ray units as its primary tool. Further, that Detroit is a great and expanding industrial city. In 1945, 700,000 workers were employed in 40,000 workplaces. In 1955, 836,000 workers were employed in 42,000 workplaces. The increase of worker population has been obtained largely by immigration. Until the recent advent of seniority and pensions, workers tended to shift frequently from job to job, not necessarily in the same trade.

Some results of this study to date, given in summary form, follows:

1. The study includes 1470 individuals who have been diagnosed as having silicosis. Over 50% of these have been so diagnosed within the past ten years, which makes it apparent that silicosis is still an important occupational disease in Detroit.

2. Mining and foundry work has provided the silica exposure in most of the cases, 44.5% arising out of mining, 31.7% from foundries and 5.2% from a combined exposure in these occupations. The remaining 19.6% of cases were distributed among some 20 occupations or industries.

3. Of the total cases studied, 556 or 37.8% have had superimposed tuberculosis which developed well before the normal retirement age.

4. The average age at diagnosis of both silicosis and silicosis with tuberculosis was approximately the same—56.3 years and 56.6 years respectively. The average length of exposure to dusty jobs was approximately the same in each group. Those with silicosis averaged 21.4 years of exposure; those with silicosis and tuberculosis averaged 20.8 years of exposure.

5. The diagnosis of both silicosis and silicosis with tuberculosis occurred later in life for white workers than for negro workers. The average age at diagnosis was 58.0 and 51.0 years respectively, a difference of seven years.

6. Of the 556 workers diagnosed as having silicosis with tuberculosis, 65.6% died of tuberculosis. This death rate is higher than is experienced for cases of uncomplicated tuberculosis. Prior to 1950, the average age at death of cases with the combined disease was 56.8 years. For the past 5 years, this average age has increased to 61.5 years, which suggests that present day chemotherapy and tuberculosis control programs are exhibiting a beneficial effect.

7. Silicosis does not appear to be disappearing at a very rapid rate in Detroit, especially among those who have received their exposure in the foundry or mining industry. Although those exposed in mines have migrated to Detroit, most of those exposed in foundries have worked in Detroit area foundries. This problem may be made more serious by the fact that negroes in increasing numbers are entering the foundry trade.

8. Another 5 years of study will be required to definitely establish the effectiveness of silicosis control programs in Detroit's foundries, but it now appears that our present industrial hygiene dust standards may be inadequate for this group of workers.

A PROGRAM OF PUBLIC HEALTH NURSING IN SMALL WORK PLACES

Heide L. Henriksen
Minnesota Department of Health

This discussion of public health nursing services to workers in small plants will relate to the Minnesota situation, since that is the only one in which I have had personal experience. Reference to public Health nurses will be to those functioning in generalized community health programs.

According to national statistics, the small plant problem in Minnesota is similar to that in other States, although it is only in recent years, comparatively speaking, that Minnesota has become industrialized to the extent that income from industry exceeds that of agriculture. Here is a picture of our firms according to numbers of employees:

Distribution of Plants in Minnesota According to Numbers of Employees

Size of Firm	Employers		Employment		Weekly Payroll
Employees	Number	Percent	Number	Percent	Percent
0 - 7	23,551	68.6	59,647	9.7	7.9
8 - 19	6,272	18.3	75,353	12.2	10.7
20 - 49	2,796	8.1	84,218	13.6	13.1
50 - 99	926	2.7	63,754	10.3	10.5
100 - 499	657	1.9	128,298	20.8	21.2
500 - 599	58	0.2	39,628	6.4	6.6
1000 -	59	0.2	166,355	27.0	30.0
All Firms	34,319	100.0	617,233	100.0	100.0

Prepared by the Minnesota Division of Employment and Security, March 1953.

45.8 percent of wage earners in nonagricultural employment were in plants employing less than one hundred workers.

Accident and Health Problems Associated with Small Work Places

All of you are familiar with the accident and health problems associated with the small plant. The president of a small firm may also be its treasurer and secretary, its foreman, production manager and personnel manager.1/ The demands on his time are tremendous. As a result, he often overlooks accident and health problems. He may feel he has fulfilled his safety obligations when he buys workmen's compensation insurance, as prescribed by law. He may even feel that the financial cost of remaining an insurance pool risk is less costly than the time, money and energy required to install a safety program. His accident frequency rate is high. Nation-wide, in 1952, the accident frequency rate in the small plant was two and a half times higher than that in

1/ Small Plant Health and Medical Programs, Publication No. 215, Federal Security Agency, Public Health Service, 1952.

the large plants, and this ratio still maintains in Minnesota today. For 1955, the accident frequency rate in the small plant was 20.0 against 9.1 for the large plant.[1]

The Industrial Health Section and Services to Small Plants

In order to tell you what led to small firms in Minnesota opening their doors to public health nurses, it is pertinent to review some of the past endeavors that have been made by industrial health personnel of the Minnesota Department of Health in behalf of the small plant. These activities centered mainly on industrial hygiene problems and occupational disabilities.

1. One frequently made suggestion was the establishment of a central health unit placed so as to be accessible to several small firms in close proximity to each other. Theoretically, this still seems like a good idea, particularly where several firms are under the same roof; but for many reasons, it did not find general acceptance. Today, there is one case where two plants share the services of the same nurse and, to the best of our knowledge, that is our achievement to date in this effort.

2. Another proposal related to first aid training and the assignment of responsibility for emergency care to selected employees with valid first aid certificates. In larger urban areas, American Red Cross classes were generously offered and well attended, but there was no way to follow through to the plants to see that appropriate facilities and equipment were provided. In the small towns, there were other problems. Who was to pay time for worker's attendance at classes, particularly when none could be obtained locally and the employee had to go to a larger center? In one instance, an employer paid time and a half and expenses for two employees who enrolled in a class in a town twelve miles away. The men subsequently found employment in that town and their former employer was still without a trained first aider.

3. Still another effort in behalf of the small plant was the promotion of part-time nursing service in voluntary public health associations. The staff in one agency received carefully planned in-service education in occupational health nursing. Promotional material was prepared. Two plants bought nursing service from this agency and, for at least ten years, have expressed satisfaction over the service they have continued to buy. At the present time, this program is obviously not an expanding one since progress still is measured by the experience in those two plants.

4. Consistent effort was made to provide industry with information about the benefits of basic industrial health services. It would seem that our information was not convincing, that management officials were too busy to read what was given them or that the seeds are still lying dormant.

5. Engineering surveys were made on an industry-wide basis in plants with special hazards. Cooperative activities were also carried on with personnel in the Labor Department, with safety engineers in insurance companies and with safety councils and voluntary health associations. There is evidence that activities in this category have been productive.

1/ Minnesota Industrial Commission, 1955.

For example, our engineers report that in the majority of air analyses in dusty trades the silica count is well below the amount considered hazardous to health. Machines can be guarded, vents and exhausts installed, warning signals provided, lighting made adequate and toxic exposures controlled. At least there is the know-how in creating a safe working environment, and that is progress.

Emergence of a New Type of Problem

In the midst of continued effort to work with management in small work places on health protection relating to occupational disabilities, and to help them provide a measure of service comparable to that found in the large plants, there appeared to be a new trend in problems referred to the Section of Industrial Health. These problems centered not around occupational disabilities, but on absenteeism due to sickness. And now what to suggest, particularly to plants in rural areas where the ratio of physician to population was in no sense optimum. Our problem had been and still is that any work with small firms to be effective needs to be carried on at the local level and, as yet, there is not even one member of the industrial health team in the district health offices, to say nothing of the county health administrations.

Calling Public Health Nurses

When requests came in that could not be answered from the State level, we tried to explain that the tremendous medical-economic problem of sickness among workers was a matter of great concern to many important persons in many important places, including the President of the United States, and that we did not have any good answers yet. However, we soon became aware that it does not relieve an ache to know that someone some place else is struggling with a solution; and rather than do nothing, we came up with an idea which involved the public health nurse in the generalized community health program where the emphasis was on family-centered care. The wage earner is also a member of the family.

Minnesota has 87 counties which are grouped under the health jurisdiction of eight districts of the Minnesota Department of Health. There are 262 generalized public health nurses in the State. The ratio of public health nurse to population served by her ranges from one nurse to 5,000 to one nurse to approximately 40,000.

Public health nurses have full and busy programs, and our first goal was to find a practical and economical method for extending preventive services to wage earners on an exploratory basis. There was recognized a certain similarity between the school as a focus for school health services, and the plant for adult health services; and this concept seemed to hold promise.

With the encouragement and support of the Chief, Section of Public Health Nursing, traditional public health services were studied with a view to their usefulness to employed adults and the possibilities of carrying them on through plant visits. Activities under scrutiny included control of communicable diseases (chest surveys and follow-up of anomalies whether of the chest or heart, immunization information); health education (nutrition, personal hygiene, individual responsibility in health maintenance and safe practices); geriatrics and chronic diseases (heart disease, diabetes, hypertension, arthritis); rehabilitation; mental health.

Preparation for Including Plant Visits in a Generalized Public Health Program

Before the public health nurse was ready to start knocking on doors of plants in her community, there were a certain number of other doors that had to be opened for her. There was also preparation relating to in-service education and the development of printed materials, since what was wanted was not available.

First, adult health services through plant visits were discussed at the general nursing consultant meetings. Then industrial health personnel met with the staffs of the respective district health offices to talk through local situations. There were meetings with Nursing Boards of specific nursing services to tell them about the proposed plant visits, the purpose for going into plants, and to get authorization from them for the inclusion of this activity in the nursing program. In-service education sessions with staff nurses was an important part of preparation and in this connection we used "Opportunities Unlimited", a booklet prepared for the purpose of extending the nurses understanding of the services she might offer through plant visits. We used selected materials relating to long term diseases because service in this area is a primary goal. We also used source material relating specifically to occupational health, such as Workmen's Compensation Law of Minnesota,1/ the biennial report of the Minnesota Industrial Commission, which reports occupational disabilities by counties, Safety Standards for All Places of Employment2/ and statements of functions of occupational health nurses. We thought it important that public health nurses have an orientation to occupational health programs and problems in order that they might clearly distinguish between their own responsibilities as public health nurses from those of the occupational health nurse, for which they could assume no responsibility.

By way of administrative preparation, a section for recording plants was placed on the "Local Community Survey Form" which is the basis for planning the public health program in a given community. To help get information about plants each district office was provided with a Minnesota Directory of Manufacturers3/ which lists firms by geographical location, and gives the approximate number of employees in each plant. On the public health nurse's Monthly Report Form, one section is for recording plant visits.

Materials were also prepared for the nurse to give to management in connection with her visit. One was "Public Health Nursing Services Available to Industry"; another "Guide to Minimum First Aid Facilities" for help in improving emergency care facilities in small plants; "In Case of Emergency" cards supplied by the Minnesota Safety Council and "Emergency Treatment in Industry" compiled jointly with the Minnesota State Medical Association and printed as a public service by Minnesota Blue Shield-Blue Cross. Health information materials were suggested for their appropriateness to the industrial pamphlet rack. This preliminary work was not as much a formal program as it was an exploration of possibilities, and following through on such preparation as seemed needed. Staff nurses never gave the impression of having another activity added to an over-load program but accepted it as an opportunity to do something in the adult health field.

1/ Workmen's Compensation Law of Minn. 1953

2/ Safety Standards for All Places of Employment in Minn. Department of Labor and Industry. 1950.

3/ Minnesota Directory of Manufacturers 1955, Minnesota Department of Business Development.

The Plant Visit

Before the initial visit, an appointment was made with the president or top officer of the firm on the principle that he should be the first to know of proposed activity within his establishment and either give or withhold his blessing.

The sequence of the initial visit was quite consistently as follows: We would introduce ourselves and say: "We have come to see if there are any services offered in your community health program that could be useful to your employees if they knew about them." One did not need to be a mind reader to follow our host's mental processes. His mind's eye saw his foreman who could still handle any man on his crew; his truck driver; the man on the electric drill; his employees en masse—self-reliant, a little taciturn and fiercely resentful of anything that smacked of charity. So we hastened to add: "We are particularly interested in the employee with long-term illness or one who keeps losing time because of being sick himself or has sickness in his family." Again, his thought processes are written for all to read. He would relax, close the desk drawer where he had put his checkbook and lay down his pen. Then we would talk about the nursing services the public health nurse offered in a family-centered care program.

Next, mindful of our obligation to "diffuse proper information," as stated in the public law under which we operate, we would show some carefully selected health information materials which either could be posted on the bulletin board or placed in a pamphlet rack. I will digress to relate just one incident in this connection which happened in a foundry where no women were employed. "If you had women employees, we would suggest pamphlets like these," showing some material on child care, behavior problems in children and the like. The answer we got was: "Why do you nurses assume that only women are interested in children? I have a year-old son at home and I would like to read those pamphlets. What's more, I will pass them on to a couple of other fathers here when I get through with them."

The topic we saved for the last was emergency care because now we were coming to the part of the house where the dust was swept under the rug. We would offer to take a look at their facilities. Often there were none. One firm permitted us to take a photograph of its first aid station. One nurse, with the permission of management, carried out a half bushel of bottles without labels, drug samples, proprietary medicines, antiseptics characterized by pungent odors, burn salves, dermatitis ointment, contaminated dressings, unwound bandages, old adhesive. Actually, much thought was given to the question of first aid before deciding to include this activity among the proffered services. The reason, of course, was that we wanted no confusion in the mind of the employer as to whether we were offering public health nursing services to his employees or occupational health nursing to him such as he could buy from organized voluntary public health nursing agencies, if there were such an agency in his community. In making a decision, we went back to the precedent set in school health services where the public health nurse cooperates in supervising first aid equipment and supplies. A good emergency care program unquestionably is reflected in reduced severity rates of injuries. It is a good preventive measure; and in view of the high incidence of injuries, not at the plant alone but in the community as a whole, the concensus was that we would include services on emergency care. The man who was injured, not his employer, would be the primary benefactor; and, hopefully, principles of safe emergency care would be carried over to home safety practices. With reference to first aid, we had four recommendations for the employer: (1) minimum facilities as defined in "Safety Standards for All Places of Employment in Minnesota," (2) establishment of defined medical direction, (3) assignment of responsibility for emergency care to a person with a current first aid certificate, and (4) a simple record system.

Illustrations of Public Health Nursing Activities Through Plant Visits

Five incidents have been selected to illustrate the kinds of services that occurred in actual practice.

One had to do with an employee whose recovery from an injury was discouragingly slow. The nurse called at the home to see if she could be helpful in home nursing problems. Flexion contractures were developing from long bed rest. The status of understanding of basic principles of nutrition was indicated by the fact that a carbonated orange drink was being substituted for the fresh orange juice ordered by the doctor. Oranges were too expensive. The nurse was able to give the physician a good picture of what was going on and to help the family carry out his directions in relation both to keeping joints functioning and to nutrition.

One nurse told that, when she was at a plant, an employee approached her to ask if she carried with her the "blue medicine for cold sores they used in schools." He had a cold sore which did not heal. She convinced the man that his cold sore needed a diagnosis. The surgeon told her later it was gratifying to get a cancer of the lip at that early stage of development.

In a turkey processing plant, there was a persistent dermatitis problem. The insurance carrier was threatening to cancel the policy. No chemicals were being used, and apparently the only adverse contact was with the wet birds on the conveyor line. We nurses had one advantage not available to the other members of the health team. We went into the washroom with the girls. These women knew there was a Newcastle Disease. They also knew there was a "turkey itch" and they developed their own preventive measures--first a vigorous scrubbing of the hands and arms with a stiff brush, reminiscent of old-time operating room "scrubbing up," then a liberal application of rubbing alcohol. One woman dashed cupped handfuls of alcohol on her neck and chest. They could not have been more effective if they had set out to cause dermatitis. A few lessons in hand washing and the use of hand creams took care of that problem.

In one firm, the secretary-bookkeeper whose mother was a paraplegic had to stay home every time outside help failed to show up because her mother could not be left alone. Intensive rehabilitation nursing through the motivation and guidance of the nurse brought the mother to the point where she could take care of her own personal needs. The employer, in this instance, said it was the most important service the nurse had given in her whole community program; and, in his eyes, it was.

The last is an excerpt from a public health nurse's record. There were a good many long-time employees in the plant she visited and many of them had progressive impairments. The problem was to motivate them to do their part in taking care of themselves, to follow their physician's directions and particularly to work at weight control. This is the nurse's remarks: "Between May 16 and October 20, there were eighteen visits made to the company by the nurse during which time forty-nine employees of the plant were given health counsel. A chest x-ray was obtained for the child of an employee who is a tuberculosis contact; one employee was given care and help with home nursing for an acute condition; and conferences on family health problems were held with wives of three employees on several occasions."

Problems and Limitations Associated with Plant Visits in a Community Health Program

The first issue that might well come to mind is the implication for socialized medicine inherent in this activity. Does the utilization of plants as a focal point for preventive health services open the door to practices or policies which are contrary to our philosophy of medical care? "Who pays for what" is an important issue today. The legal responsibilities of the employer for occupa tional disabilities are well defined. Less well defined, because of the tremendous range in fringe benefits, is the treatment of ills that have their origin in things that happen during the sixteen hours a day when the worker is away from the plant; but, nevertheless, there are recognizable policies here. It is in the area of prevention where there is greatest need for both policies and integrated program as differentiated from the "drives" against this disease or that.

"Who pays for what" is an important issue today, and out of the contentions between management, labor and medicine will eventually come plans which will take into consideration the needs for preventive services and real health maintenance. When such plans are agreed upon, it seems highly probable that the public health nurse will still be carrying on her traditional functions. Nurses by the nature of their professional preparation and job assignment will be helping families to use health resources purposefully and to take personal responsibility for overcoming physical handicaps and keeping physically fit.

There is a sense of urgency in doing something because none will deny that the cost of disabilities among workers is staggeringly extravagant, for the individual and for the community. In Minnesota, for example, the net wages lost to workers because of occupational disabilities for the year ending June 30, 1954, was $3,765,844.1/ What ratio do you want to use for nonoccupational disabilities? The figures I most frequently found in analyses of sickness absenteeism were ten percent due to occupational disabilities; and ninety percent due to nonoccupational disabilities. On this basis and presupposing there were sick benefits comparable to workmen's compensation, the net loss of wages to Minnesota workers for nonoccupational disabilities would be $33,892,596 or a total loss of buying power of $37,658,440. Of course, this takes no account of such hidden costs as relief and welfare, loss of taxes and loss of production. Nor does it reduce the cost to take children out of school at the age of sixteen to try to find work. A 1953 study of manpower showed that only a little over nineteen percent of jobs are open to unskilled workers.2/ The conviction grows that the most effective of all public health programs is a full pay check. Thirty-seven and a half million dollars will buy a lot of groceries, medical and dental care, housing, education and other items that are important in maintaining a reasonable degree of health.

Administrative Problems

Other problems are administrative in nature. There is a matter of budget

1/ Minnesota Industrial Commission 1954.
2/ Manpower Blueprint for a Free Economy, Committee Report, Subcommittee on Labor and Labor-Management Relations, GPO, 1953.

and dedicated funds. The objectives of a nursing agency have to be taken into consideration. The ratio of the numbers of nurses employed to the population she serves affects the extent of what the nurse can add to her program. This item has to do with program planning and the establishment of priorities. Those of us with a special interest in health maintenance of the labor force might argue that the time has come to give priority to the able wage earner in that many public health and welfare problems might never occur if the wage earner maintained his earning capacity.

There has to be planned staff education and orientation of nurses to plant visits. It is only recently that essentials of occupational health are being included in the professional preparation of nurses. It is important that the public health nurses understand the role of management in employee health services, the functions of the occupational health nurse and organized labor's interest in health programs. She must be able to distinguish between the functions of the occupational health nurse and her own authorized and established activities.

Changing Health Problems

In the United States, we are obviously in transition, from the period when communicable diseases were the major threat to life to an era in which we have to learn to live with technological products and processes and an increased life span. Among the current ten leading causes of death in Minnesota, only one, the pneumonia-influenza classification, is due to communicable diseases. Sociological changes are having their impact on health programs, too. For example, in Minnesota in October 1955, 35.7 percent of the labor force were women. The life span of our population is increasing. As a matter of fact, the Federal government is still paying a Civil War pension to a 109 year old veteran of that war who is still with us. It may be in the interest of economical provision of an adult health program that natural groupings of adults be used for preventive and constructive health services.

Appraisal of Public Health Nursing Experiences in Plant Visits

Our experience in making plant visits in a generalized public health program has indicated that there are many opportunities here for finding health problems while they are still amenable to treatment, for helping control progressive impairments so that the individual may remain employable, and for getting appropriate health information to a very important segment of our population. The wage earner is an influential member in the policy making team at home; and if he thinks immunizations are something the doctors have thought up for their own profit and that coffee is as good as milk for the children, that is pretty likely to be the way it is at home. Health services through plant visits can be especially advantageous in reaching working mothers. Actually, because of the shifting picture in public health problems in the area of nursing service, the use of plants as a focus for adult health services may be less an innovation than a practical adjustment to changing times.

In our experience, public health nursing services have been well accepted by both management and the workers. We have been making small plant visits since 1951 and have yet to have our first rebuff. When one plant celebrated "Founders Day," the local public health nurse was invited to sit at the head table; and along with the major and other important guests, she was introduced because she had come to their plant to see if their employees needed services being offered in the community health program.

Obviously, the public health nurse is not the whole answer to the small plant health problem. Even if adult health services through plant visits became an established part of every community health program, there are not, at the present time, enough public health nurses to do what there is to be done. In other areas of health work, such as, for example, in tuberculosis case finding and follow-up, maternal and child health and health of the school child, the public health nurse has made an important contribution. In the total preventive program, she is an indispensable member; and in my opinion, it would seem that the possibilities inherent in the cooperation of management and workers at places of employment are worth further exploration.

JOINT SESSION WITH AMERICAN INDUSTRIAL HYGIENE ASSOCIATION

April 24, 1956 - 2:00 P.M.

Co-chairmen - Mr. E. P. Wheeler, Monsanto Chemical Company, St. Louis, Mo., and Dr. R. R. Sullivan, Occupational Health Section, Oregon Board of Health, Portland, Oregon.

RECENT INDUSTRIAL HYGIENE DEVELOPMENTS IN THE FIELD OF AIR POLLUTION

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Probably the most significant development in the past year in air pollution as it may affect industrial hygiene or any of the health-related sciences is the passage of Public Law 159. Public Law 159, which was signed by the President on July 14, 1955, authorized a comprehensive program of community air pollution research and technical assistance to the States, communities, and other organizations. The act declares "the policy of Congress to preserve and protect the primary responsibilities and rights of States and local governments in controlling air pollution, to support and aid technical research, to devise and develop methods of abating such pollution, and to provide Federal technical services and financial aid to State and local government air pollution control agencies and other public or private agencies and institutions in the formulation and execution of their air pollution abatement research programs." The law authorizes the expenditure of funds not to exceed $5 million per year for a period of five years. In 1956, $1,722,000 was appropriated. For fiscal year 1957, $3,000,000 has been requested.

The community air pollution program within the Public Health Service is carried out by the Divisions of Sanitary Engineering Services and Special Health Services. The technical work of the Division of Sanitary Engineering Services consists of technical assistance, training, and demonstrations related to engineering and is carried out at the Robert A. Taft Sanitary Engineering Center. The Division of Special Health Services has the responsibility for the determination of the health effects of air pollution. The technical studies, particularly as they relate to toxicology and medical effects, are being performed at the Occupational Health Field Headquarters. The primary objective of the toxicologic studies is determination of the toxic effects of such air pollutants as ozone, nitrogen oxide, and sulfur derivative hydrocarbons on test animals. Much of the medical research is being carried out through contractual arrangements with universities and private organizations. These relate primarily to studies of the biologic effects of air pollution on health. Included are studies of the feasibility of using tissue culture and tissue enzymes to evaluate the toxicity of different air pollutants. A third project at the National Institutes of Health involves the statistical determination of geographic variations in the leading causes of death. This information, when correlated with environmental findings, will provide leads for community epidemiologic studies of air pollution.

Because of the diverse interest of many federal agencies in air pollution, an inter-departmental committee on community air pollution has been organized. The Departments of Agriculture; Commerce; Defense; Health, Education, and Welfare; and Interior; and the Atomic Energy Commission and National

Science Foundation are represented on the committee. This committee will provide liaison between and coordination of Federal activities relating to air pollution. It will review from time to time the policies and programs related to community air pollution of the federal agencies, the general status of technical knowledge concerning air pollution, particularly with regard to the area and scope of needed research and other technical activities and advise the Surgeon General thereon. At the first formal meeting of the committee, held in November 1955, the areas of interest and responsibility of each of the participating agencies were determined. Public Law 159 vests the primary authority for air pollution studies in the Public Health Service but authorizes it to cooperate with and finance studies of other federal departments.

In addition to research--both through direct operation and contracts--another important activity has been technical consultation to the States and communities. Personnel were assigned to the California State Department of Public Health to aid in a special study of the Los Angeles problem and to assist in the development of a State-wide program. Other personnel have been assigned by the Sanitary Engineering Center to the Los Angeles Air Pollution Control District to assist in the conduct of a specialized aerometric survey and oil refinery studies. Another cooperative effort involving special studies of air pollution in the Louisville, Kentucky area has been initiated to study the source and character of air pollutants in that area. This study, which is expected to be completed in two years, was initiated in January 1956.

Direct research operations at the Sanitary Engineering Center included extension of the national air sampling network to a total of 45 cities and 74 sampling stations. Analysis of the material being collected includes determination of the weight of material collected, identification of 17 metals, certain anione and organic fractions as well as the radioactivity levels. Twenty-six research projects are under way at the Sanitary Engineering Center. These include research to establish the relationship between atmospheric pollution and meteorologic variables, studies of the performance and design factors involved in controlling air pollution from incinerators, and development of control devices utilizing fabric filters. Eight studies are under way to develop methods for determining the composition of air pollutants and for the development of instruments for air pollution measurement. Work also includes a detailed examination of certain air samples, studies of economic costs of air pollution, and studies of control in several industries.

In addition to its directly conducted research activities, the Public Health Service is supporting air pollution studies in other federal agencies. The U. S. Weather Bureau, U. S. Bureau of Mines, and National Bureau of Standards are all undertaking important studies. The Weather Bureau, for instance, is studying the meteorologic parameters contributing to the severity of air pollution. The Bureau of Mines is investigating the incineration of combustible wastes, evaluating sulfur dioxide removal processes, and studying the effluents from automobile exhausts. The Bureau of Standards is developing methods for sampling and analysis of air pollutants and is studying the interreactions of the air pollutants at the source and in the atmosphere. Negotiations have also been completed with the Library of Congress to provide a continuous abstracting service and to compile an annotated bibliography covering all phases of the air pollution literature.

Utilising the grants mechanism of the National Institutes of Health, to date, 20 air pollution research grants, totaling $481,359 have been awarded. Of these, 6 are in the field of physical science and engineering and the remaining 14 are concerned with the health effects of air pollutants.

Training will be eventually another major activity under Public Law 159. To date, the Sanitary Engineering Center has held several seminars for State and local personnel. The fact that 95 people from 31 States, 14 cities, and 5 countries attended the September 1955 seminar indicates the widespread interest in air pollution. Another technical seminar was held in 1956 which concerned itself with atmospheric sampling, analytic procedures, sampling theory and techniques, and air pollution meteorology. A third seminar is planned for May 1956.

These developments, all related to the passage of federal legislation in the air pollution field, will probably stimulate expanded research activities in air pollution, not only by federal agencies but by private organizations as well. In passing this legislation Congress recognized that the Federal Government had a responsibility in research and development but it left the control of air pollution in the hands of local authorities and private enterprise. The research being stimulated by this law promises to have the same beneficial effect in the air pollution area that stream pollution investigations had in the correction of inter-State waste problems.

RECENT INDUSTRIAL HYGIENE DEVELOPMENTS IN THE FIELD OF CHEMISTRY

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The past year has produced a number of papers relating to the chemistry of industrial hygiene which serve to indicate that the field is an active one, and one in which a tremendous amount of work remains yet to be done. A complete review of all published work would be prohibitively long; instead, the present effort seeks to present some of the more pertinent accomplishments noted in the past year's literature.

Classic problems associated with such well-studied substances as lead and silica continue to be studied, as well as entirely new problems related to materials only recently used by industry. Jephcott and Wall (4), for example, reviewed existing methods for determining free silica by means of phosphoric acid, and concluded that several modifications of such methods improved the accuracy of the determination. Particular attention was paid to the errors which arise when the size of particles being analyzed was neglected, and data are presented to substantiate their conclusions.

A new dithizone procedure for determining lead in urine was described by McCord and Zemp (7), in which lead, as the iodide, is extracted from methyl isopropyl ketone, then removed with sodium hydroxide prior to its estimation as the dithizonate.

In the continuing attempt to fully utilize the speed and ease of spectrographic methods, Kumler and Schreiber (6) have published a method for lead in blood which is shown to be more rapid than chemical methods for large numbers of samples, and which is as accurate and sensitive as needed for this determination. Whole blood samples are partially wet-ashed, bismuth is added as an internal standard, and a small portion of the resulting homogenous liquid is then introduced in carefully controlled fashion to the electrode.

The spectrograph was also used by Keenan and Kopp (5) to determine trace quantities of cobalt in animal tissues. For many purposes, direct analysis of tissues is possible by their method, and when extreme sensitivity is required, the samples may be chemically treated in such fashion that the cobalt is greatly concentrated.

Mercury was the subject of two papers published by different groups, both choosing to use dithizone as the color-forming reagent. Polley and Miller (9) devised a micro-procedure suitable for either biological or mineral materials, and Campbell and Head (1) produced a single-extraction method for urinary mercury which utilizes the chelating agent Versene to complex interfering metals. The various ashing procedures used to destroy the organic matter of urine were studied, and the sulphuric acid — permanganate ashing was considered superior to the others.

An unpublished work of Shepherd (13) at the National Bureau of Standards appeared posthumously, and dealt with the N.B.S. indicating gels for carbon monoxide. Using the procedures outlined by the authors, the sensitivity of the gels may be greatly increased, so much so that as little as 0.1 PPM CO may be determined. The obvious use of this great sensitivity is the analysis of air in conjunction with air pollution studies, a field in which existing methods of carbon monoxide estimation have been largely inadequate.

Smith and Gardner (15) studied the determination of fluoride in urine and recommended a method similar to that generally in use. Samples are heated with calcium oxide, distilled and colorimetrically evaluated with Alizarin Red S and thorium.

A needed specific method for acrolein in the presence of other aldehydes was devised by Van Sandt, et al. (16). Analysis is performed polarographically after samples have been collected on silica gel. Care must be exercised throughout the analysis to exclude air from the prepared sample.

Hydrazine in both air and blood plasma was investigated by McKennis and Witkin (9), and Prescott, et al. (11), respectively. In the air determination, which is also suitable for ammonia vapors, samples are collected in sulphuric acid, ammonia is removed by aeration after suitable treatment, then nesslerized, and hydrazine is reacted with p-dimethylaminobenzaldehyde. For the plasma estimation, 4-pyridylpyridinium dichloride is used to develop a color with as little as 0.1 microgram of free hydrozine.

A rapid method of detecting aniline vapors in air was reported by Riehl and Hoger (12), in which paper strips impregnated with furfuralacetic acid mixture turn pink to red when exposed to aniline vapors.

Hill and Johnston (2) and Hill, et al.(3), published further studies relating to boron, describing both a rapid iodometric method for boron-containing atmospheres, and a direct ultra-violet procedure for decaborane which does not require conversion to boric acid.

A rapid technique for evaluating industrial benzidine exposure was described by Sciarini and Mahew (13), in which a simple urine test is performed. The specimen is rendered alkaline, an extraction with ethyl acetate-acetone is performed, and the yellow color developed with Chloramine T is measured spectrophotometrically.

Kusnetz (7) devised a rapid field method for measuring the concentration of radon daughters in mine atmospheres. After collection of samples on filter paper, the alpha activity is measured, and results are converted directly to fractions of tolerance level by graphical means.

Certainly, the great diversity of chemical problems in industrial hygiene is well exemplified by the subjects treated in this brief review, and the constant effort to improve existing methods and devise new, more rapid, and more specific methods should be a source of inspiration to our engineering associates who chronically lament the inadequacy of the information usually given them.

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RECENT INDUSTRIAL HYGIENE ENGINEERING DEVELOPMENTS

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It is difficult to cover the field of industrial hygiene engineering developments in recent years without the possibility of conflicts with developments in related fields such as air pollution control. In the limited time provided, however, I am restricting my discussion to items which may be considered logically as problems of the industrial hygiene engineer.

Industrial hygiene engineering developments are not apt to be startling in considering a short period since they are usually based on long time process evaluations and critical studies of new manufacturing operations or methods of production.

It is true that, in general, industrial hygiene engineering developments must keep pace with engineering developments in order to anticipate, prevent, or minimize hazards. In many instances the anticipation approach is neglected or greatly delayed. The process is often placed in operation without prior discussion or consideration by individuals who could recognize potential contamination of the working environment or spot an unusual hazard from radiation, inhalation or skin effects.

Welding Studies

The development of new welding techniques such as the inert gas shielded arc is a recent example of a problem where conventional control methods did not apply because the conditions of contamination are unique. In welding aluminum with argon or helium as the shield gas it is possible to control the fume at the source and yet not eliminate exposure to ozone completely. This is because the ozone is created by ultra-violet radiation from the aluminum spectrum. We (1) have studied this in detail and so have others such as Ferry (2). However, when the process involves the use of the inert-shielded arc on mild or stainless steels the radiant energy produced does not create as much ozone, so conventional methods appear to give nearly complete control. From our experience, the only reasonable approach to the high ozone levels created close to the breathing zone is to provide an air supplied helmet to the worker or supply sufficient general ventilation to dilute the concentration below permissible values. General ventilation may be only partially satisfactory, is likely to be an economic burden and will cause a drafty condition. It therefore appears to be the less desirable choice.

The recent use of carbon dioxide as an inert shield gas for mild steel welding is increasing and studies of engineering control for its use are lacking. The question of carbonyl formation is unanswered; however, theoretical and practical considerations of the temperatures and radiation involved make the probability it can be present appear unlikely. The use of conventional local exhaust ventilation, if maintained at a distance which does not disturb the inert shield gas flow, has not created any problems in practice for CO_2 welding gas operations.

Gas Cleaning

Work on the development of fibrous media and filters in recent years has proceeded at a fairly rapid pace. The application of these developments to control contamination in working environments is becoming increasingly important. Studies such as those reported by Fitzgerald and Detwiler [3]; Kramer [4]; Silverman, Conners, and Anderson [5] have indicated that new techniques may be applied to aerosol filtration so that efficiencies beyond 99.99% (penetrations of less than 0.01%) can be obtained on aerosols of submicron particles. Of particular interest in this area is the further delineation of forces in filtration mechanisms. The work cited above has contributed to our knowledge of electrostatic forces present in fibrous filters.

In the field of electrostatic precipitation the recent work by Thompson, Myron and Davis [6] has indicated important factors to consider in operating on open hearth steel furnaces. These authors have shown that, using pipe type units, it is possible to clean open hearth fume to 98 to 99% with retention times of 0.58 to 0.88 seconds; to 96 to 98% with periods of 0.44 to 0.58; and to 92 to 96% with 0.35 to 0.44 periods. Water injection was not of material assistance in improving efficiency. Dry plate precipitators showed less effective results since efficiencies obtained ranged from 83 to 97%.

A new approach to high temperature gas cleaning has been developed in our laboratory and is presented in three recent papers [7,8,9]. This method involves the use of refractory slag wool fibers made from by-product blast furnace slag. These fibers are formed into a slurry which is dried in a continuous filter, passed through the contaminated gas stream, and returned to the slurry for washing and reuse. Laboratory studies and early pilot plant investigations appear promising. Efficiencies above 90% have been obtained in both cases on 0.03 μ fume at resistances of 2 to 6 inches of water. The important factor is that the filtration velocities used for this performance have exceeded 100 feet per minute which considerably reduces the size of equipment necessary for large gas volumes. Typical 300 ton open hearth furnaces involve 40 to 50,000 cubic feet of gas at temperatures above 1000°F.

A recent description of the application of precipitators to ferromanganese blast furnace cleaning has been given by Good [10]. Many technical difficulties were encountered and overcome before the present satisfactory engineering control of pollution was obtained. Other precipitator studies on fly ash collection have been reported by Flodin and Haaland [11] and White [12].

The mechanism of separation on louver-type dust separators has been studied at length by Smith and Goglia [13]. Their data showed that the per cent of initial dust separated was essentially independent of initial air velocities and dust concentrations. Particles as small as 10 μ were separated although the device is more effective on particles above 40 μ.

Engineering Control of Working Environments

New studies in this area are limited. A recent study by Venable [14] is of interest in that it shows many aspects of handling engineering improvement of an aromatic solvent exposure. Venable reports on methods of reducing or controlling losses at the source.

Control of general exposures to uranium by limiting the deg tamination of steel scrap is discussed at length by McAlduff (15). article focuses attention on the need for evaluation of the many a the atomic energy industry which are beginning to pervade other in A recent article by Kramer and Goldwater (16) describes the contro hazards during its use as a casting material. The fact that the a tions could be maintained within safe values when using large amou mercury even though at low temperature in most exposures is a trib engineering ventilation design.

At last year's (1955) engineering session of the AIHA we pr the results of a study of resistance losses in various types of fl These data permit more accurate selection of hose, blowers and exh other air moving equipment. The effect of spiraling flow and its on resistance was observed. This caused the friction factor to in increasing diameter.

New Books

In the past year new books have appeared which will be of a value to industrial hygiene engineers. One is the recent revision and Hatch (18). The new edition is thorough and includes the late in industrial hygiene engineering.

Hemeon's recent book (19) on plant and process ventilation excellent coverage of the field and presents some novel treatment problems. Also appearing in the past year in book form (20) are t of the first international congress on air pollution. A number of papers on engineering control of air pollution are included in thi

Another recent book of interest to industrial hygiene engin new handbook on electroplating engineering (21). Two chapters in cover industrial hygiene engineering approaches and a number of ot chapters are of interest.

Some of the papers included in the recent proceedings of the Conference on the Peaceful Uses of Atomic Energy, which just appeare 1956) cover many aspects of industrial hygiene engineering as applie energy problems. Those wishing to become acquainted with recent dev in this field of activity should consult the pertinent volumes.

General

In making this review I was impressed with how little reall work could be strictly claimed as solely industrial hygiene engine lishments. Perhaps this is because many aspects of industrial hyg ing can be performed by people with specific basic training such a ventilation or chemical engineers. It may also be attributed, at tially, to modesty of industrial hygiene engineers. Problems once viewed as a finished project and they are too concerned in solving than in reporting success on old items. More reporting of success ing control of exposures and the features which are uniquely those trial hygiene should be encouraged.

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RECENT INDUSTRIAL HYGIENE DEVELOPMENTS IN THE FIELD OF RADIATION

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Many of the developments have been primarily "administrative," that is to say that they deal with the development of regulations, codes and standards and the matter of agency jurisdiction over health and safety.

In June of 1955 a conference was held on the subject of health physics, and as a result of that conference, a preliminary organization of professional health physicists was formed.

In July of 1955 the AEC published its proposed standards for protection against radiation as part of Article 10 of the Code of Federal Regulation. Although other parts of the same Title may also be based upon a need to consider the hazardous aspects of atomic energy, Part 20 will be among the first Federal occupational health codes to be enforced by a Federal agency. Many interesting new concepts in radiation protection are included in the AEC's proposed code. It is expected that a revised draft will be forthcoming shortly.

Many papers on radiation protection were submitted to the International Conference on the Peaceful Uses of Atomic Energy held in Geneva in August 1955. The legal and administrative aspects of the problem received a great deal of interest.

In December of 1955 the American Standards Association called a National Conference on Standardization in the Field of Nuclear Energy to review its program in this area and to obtain the thinking of a large cross-section of industry, government, labor and others on the need for additional American Standards Association activities. As a result of this meeting, a Planning Committee was established to review the present status of standards and recommend appropriate action. This Committee met in full session on February 15, 1956, and was followed by meetings of the various subcommittees. Reports of these subcommittees were analyzed on March 15, 1956, at a meeting attended by the subcommittee chairmen and the Chairman of the Planning Committee. The major recommendation was for the American Standards Association to establish a nuclear standards board.

Also in December of 1955, the National Bureau of Standards issued Handbook No. 61 on the regulation of radiation exposure by legislative means, which contained the recommendations of the National Committee on Radiation Protection concerning the development of acts and regulations on the part of State government. Many of you are familiar with the earlier work by the Committee.

In March of 1956 the New York State Health Department and the New York State Labor Department radiation protection regulations became effective.

This same month, the United Nations Radiation Committee had its first meeting and elected officers. The next meeting will be in about five months.

This Committee was established in December 1955 by the United Nations as a committee of specialists from 15 nations to collect information on radiation levels and radiation effects on man and his environment from 85 nations. Working groups were set up on genetics, internal and external radiation effects, natural radiation background, exposure during medical procedures and occupational exposure. It is not clear at this moment what the relationship is between this special committee and the World Health Organization which published in July 1955 a summary of national laws and regulations on radiation protection.

Early this month the International Commission on Radiological Protection and the International Commission on Radiological Units met in Geneva. As a result of this meeting, some revisions are to be made in airborne concentration limits for radioisotopes and a new edition of the National Bureau of Standards Handbook No. 52 may be prepared.

These activities indicate diversified attempts to evaluate the importance of radiation protection. In some industries and areas the problem is considered negligible and in others it is paramount. The increase in legislative activity points to the need for precise legal definitions of such terms as "radiation hazards," "radiation installations," and "qualified expert." These definitions, however, relate to the philosophy of the agency or the organization toward the importance of radiation protection in its scope of activity.

The problem of preventing injury to human beings from radiation is not new. Many of you have been studying it for some time, even prior to the development of a sustaining chain reaction. The recent developments above, however, indicate the need for careful technical scrutiny of all concepts concerning the achievement of a "safe" radiation environment before these concepts are placed into laws which subject someone to fine or imprisonment if they are ignored. Skilled radiation hygienists may agree on the few basic laws of nature which have been discovered concerning the effects of a given dose of radiation upon a given individual or group of individuals; there may be some differences as to which laws of nature must be considered in each case.

Conclusion

There exists a continuing need to have a coordinated, objective appraisal of radiation hazards to develop a definition satisfactory to health officers in government and industry and to legal authorities. Having defined a "hazard," appropriate controls can be more clearly spelled out on the degree of competency of the supervising personnel.

ADVANCES IN INDUSTRIAL TOXICOLOGY FOR THE YEAR 1955

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In the brief space allotted to review recent findings in the field of industrial toxicology, I have selected those subjects that have appeared to be of interest, either because of their novelty, their basic value or their indications of future importance to industrial health. From the vast field from which to choose it is obvious that other selections might equally well have been made.

New Compounds Presenting Serious Hazards. Acrylamide, $CH_2=CH-CONH_2$, a chemical intermediate of great potential usefulness for the formation of polymers and copolymers, plasticizers, dispersants and other purposes, has the unusual property of being insidiously neurotoxic at relatively low levels of intake, while at the same time showing unremarkable toxicity from acute doses (oral LD_{50}, 170 mg/kg) [1]. Acrylamide is toxicologically remarkable in other ways. 1. It shows practically no species variation; effective doses for the cat, dog, and rat were essentially the same. 2. Its physiologic effects are produced by any route, oral, skin or eye. 3. A definite quantity of acrylamide will produce the characteristic central nervous system syndrome of disturbed gait, postural tremors, visual and auditory halucinations and muscular atrophy irrespective of the dosage schedule used. 4. There is an anamnestic response, in that following cure, lesser amounts of acrylamide recalls the syndrome. Apparently the effects are reversible, although in severe cases this may amount to a matter of years (in man).

Acrylamide represents an interesting demonstration of our current inability to predict the grave physiologic consequences from chemical structure; the closely related amine, propionamide ($CH_3CH_2CONH_2$), is used as an animal feed supplement. Here, again is another striking case of the addition of a second double bond in the molecule to form a conjugated system with conference of remarkable toxicity. Another well-known example is the 44-fold greater toxicity of crotonaldehyde compared with its saturated analogue butyraldehyde (Skog, Acta Pharm. Tox. 6,299, 1950). Less well known, but equally striking is the highly lacrimatory power of conjugated unsaturated nitrocompounds such as 1 nitroisobutylene compared with the unsatured but not conjugated isomer, 1-nitroisobutyl-2-ene which has no marked lacrimatory powers. The potent irritating capacity of the diisocyanates discussed below are other examples of the effects of conjugated unsaturated compounds. Examples could be multiplied almost endlessly.

Diisocyanates. As a new group of nonomeric substances used in foam rubber, lacquers and for other purposes, the aromatic diisocyanates, especially 2, 4-diisocyanotoluene, 1,5-diisocyanonaphthylene, and 1,4-diisocyanobenzene present interesting toxicologic properties. Although extremely inert in polymeric forms, and possessing a very low oral toxicity 1-8 g/kg, [2] these aromatic isocyanates, particularly the naphthalene derivative, are exceedingly irritating to the upper respiratory tract, producing histologic changes in animals at 0.09 ppm and death at 1 ppm upon repeated inhalation exposures. Man also responds at exceedingly low concentrations with evidences of sensitivity such as asthma at air levels well below 1 ppm. Peculiarly sensitive individuals may show sensitivity responses below 0.1 ppm, which is below the odor threshold of toluene diisocyanate for many individuals. A level of 0.5 ppm of TDI produces throat irritation. The tentative threshold limit has been set for TDI at 0.1 ppm. In our present state of knowledge it is believed that the upper respiratory tract is first involved following inhalation of low concentration of the isocyanates, pulmonary edema occurring only at far higher concentrations (TDI). Also, all evidence to date indicates no other type of systemic involvement from the isocyanates if the respiratory tract itself is free of involvement. Moisture greatly reduces the toxicity of 1, 4 diisocyanobenzene presumably by hydrolysis and destruction of the unsaturated conjugated system.

Boranes. Three boron hydrides, diborane, pentaborane and decaborane have received considerable toxicologic and pharmacologic study [3-6]. Used as high-energy fuels these boranes are highly hazardous by all practical routes of entry into the body. Diborane, a gas at room temperature (b.p. 92.5C) differs from the others in toxicologic action in possessing no neurotoxic properties presumably because of its ease of hydrolysis; it is however, acutely, subacutely and chronically injurious to the lungs, producing congestion, edema and hemorrhage in higher doses and in the kidneys it leads to the production of tubular casts. The threshold limit of exposure has been tentatively set at 0.1 ppm; this is considerably below its odor threshold of from 2-4 ppm.

Pentaborane (B_5H_9) is the most hazardous of the 3 boranes. A liquid (b.p. 58C) whose vapor in a 2-hour exposure at 14 ppm results in immediate death of mice at lower concentrations, produces symptoms of weakness and tremors indicative of central nervous system involvement but without the lung involvement seen with diborane. Cumulative effects are seen with low repeated doses. Skin absorption is a possible contribution to the over-all toxicity. On the basis of hazard from the vapor and its severely toxic effects, a tentative threshold limit has been set for this compound of 0.01 ppm. No medical preventive or therapeutic effective agent for this compound has yet been developed; complete protection is afforded by airline gas-masks or a mask cartridge layered with soda lime, silica gel and activated carbon [7].

Decaborane. ($B_{10}H_{14}$) presents a toxicity picture similar to, but slightly less than that of pentaborane but as it is a solid, it presents less of a hazard than pentaborane; accordingly its tentative threshold limit has been set at 0.05 ppm. The cardiovascular actions of decaborane in animals have been reported [8].

It is recognized that the boranes are but additional examples of non-metal hydrides such as phosphine, arsine, stibine, hydrogen sulfide, etc., which are characterized by their exquisite toxicity.

A LOOK AT NEW INDUSTRIAL CANCERIGENS

There would seem to be small solace in attempting escape by the common argument that, if a compound is carcinogenic in animals, this does not necessarily prove its carcinogenicity in man; a more proper argument is that all animal carcinogens should at least be considered potentially carcinogenic in man.

Beryllium. Sufficient work seems now to have been done in one laboratory (Saranac), at least, by Vorwald, Schepers and Scheel [9] to establish beryllium as a carcinogen in the rat. Inhalation of beryllium sulfate for several months produced what was interpreted as an adenocarcinoma of the lung. The cancer has been successfully transplanted subcutaneously in rats, whence it metastasized to the lung and the lymph nodes of the mediastinum. Inhalation of beryllium phosphor (13% Be) produced in 3 to 6 months lesions in the lungs which appear to be squamous cell carcinoma. The beryllium cancer has not been produced by other workers although it is not rat-strain dependent in the hands of the Saranac workers. Alkaline phosphatase inhibition appears to be the first step in the physiologic process leading to tissue changes. It is believed that the $Be(OH)^+$, a form through which all beryllium compounds pass in the fluids of the body, initiates the reaction. The lack of success of other workers elsewhere to reproduce beryllium cancer opens the intriguing question of locality-dependent cancer.

Asbestos. Doll[10] has found that the incidence of lung cancer among 105 English asbestos workers employed more than 20 years was tenfold that in the normal population. Cartier[11] studying over a 9-year period 4000 asbestos miners in Canada, involving 128 cases of asbestosis, 40 of them with autopsies, found 6 of these have bronchogenic carcinoma. One might be inclined therefore to associate lung cancer with asbestosis were it not for the fact that 7 cases of lung cancer were found among asbestos miners with no asbestosis. If one inclines to the view that asbestos may produce lung cancer, one might admit the occurrence of this disease from asbestos inhalation without the production of asbestosis. On the other hand one might equally well question whether the ten-fold increase in incidence of lung cancer among asbestos workers is statistically significant in view of the small number of cases involved. According to Lanza[12] investigators both here and abroad are now less certain than formerly that lung cancer is associated with asbestosis. It is most difficult to determine the causative agent of a disease whose time of onset may be delayed two decades or more from the start of exposure. Before a final decision is reached it would seem well to wait until a more impressive number of cases have been documented. Moreover it seems to this author that the question of the nature of the asbestos in different localities and the associated minerals such as chromium and nickel seem to have been too little considered. Asbestos is a fibrous form of several different species of minerals, a point commonly disregarded.

Hydrocarbon Products of Incomplete Combustion. Carcinogenic hydrocarbons have now been shown to be present amont the exhaust products of Diesel and gasoline engines [13], and in the air of English [14] and American cities [15]. These products have been shown furthermore to produce skin tumors in mice. Although these findings were made in connection with air pollution studies, it is pointed out that the diesel and gasoline engine is becoming a significant factor in many industrial operations. Efficient and innocuous operation of a diesel engine from an atmospheric pollution view has been pointed out as possible, moreover, without costly engine redesign[13]. The fact that human lung cancer has not yet been proven to arise from the inhalation of these hydrocarbon products should not act as a deterrent to an active program to reduce the air contamination of working areas from this source.

Bladder Cancer from Aromatic Amines. 4-Amino diphenyl has now been repeatedly found to produce carcinoma of the urinary bladder of dogs fed this substance (16-18), the last of these confirming reports being that of Deichmann in 1956. The cancer was predominantly squamous in type and was produced from total doses ranging from 30g (English workers) to 113g, 3 to 10 g/kg (American workers). The British investigators consider 4-Amino diphenyl as a more effective bladder carcinogen than either benzidine or 2-acetyl amino fluorene, and at least as potent as beta naphthylamine.

A resurvey of the British chemical dye industry (19) produced statistical evidence that bladder tumors are associated with the manufacture of the dyes auramine or magenta, (amino diphenyl-and aminotriphenylmethane dyes) but do not necessarily arise from contact with the finished dyes themselves. Aniline, however, has been definitely excluded as a causative agent in bladder tumors, at least in the British chemical industry over the years 1910-1952.

Skin Cancer from Cutting Oils. Straight-run distillates (20) and higher boiling point fractions of catalytically cracked petroleum (21) may contain numerous carcinogenic hydrocarbons. A relationship between exposure to these substances and high incidence of occupational skin diseases other than cancer has been reported (22) and tests in animals with cutting oils have implicated them as possible carcinogenic agents. More recently cutting oils with a sulfonated mineral-oil base have been connected definitely with squamous cell carcinoma of the skin among Canadian metal cutters (23). 6 cases of skin cancer and one papilloma case have been reported among workers with an average exposure period of about 20 years. Although most of the lesions appeared on the forearms, one case involved the scrotum of a worker on whom oil splashed continually in the region of his lower abdomen, giving a clear definition to the relation between exposure and response from this type of oil. On the other hand, no skin cancer or precancerous manifestations have appeared to date among a group of 60 shale-oil workers in this country studied over a period of the past 6 years (24). The group will remain under continued observation, however.

TOXIC THERMAL DECOMPOSITION PRODUCTS

The toxicity of the degradation products of a large number and variety of plastics, synthetic hydraulic and lubricating fluids and fire extinguishants has been determined chiefly by Treon and associates (25). The importance of the studies is the finding that the over-all toxicity of the thermally degraded products from each substance was more toxic by a large factor than the substances from which they originated. The substances studied thus far include Teflon, Kel-F, Fluorolube FS, (all fluoro or fluorochloro-organic polymers), silicones, Gafite, (a chlorinated methacrylate), a paraffinic hydrocarbon lubricating oil, Skydrol, Pydraul F-9, Arochlor 1248, tricresyl phosphate, adipate and sebacate esters and Freon F13B1. In a few instances the toxic factors have been partly identified. As might be expected, the amount, nature and toxicity of the products was dependent upon the temperature of decomposition; in general, greater toxicity was experienced with increasing decomposition temperatures until a maximum was reached at a temperature characteristic of the substance. Temperatures above 500°F generally produced the more important amounts of toxic products from most polymers. Another interesting finding was a marked decrease in toxicity of the thermal decomposition products of Freon F13B1 in the presence of moisture. The mechanism by which this is brought about is being studied.

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BUSINESS SESSION

Monday, April 23, 1956
11:30 a.m.

Dr. Ralph R. Sullivan, Chairman, Presiding

DR. SULLIVAN: We would like to bring the business meeting of this session to order.

I would like, first, to announce the Resolutions Committee appointments, since the resolutions have to be considered by the Executive Committee at its second business meeting tomorrow morning at breakfast -- in order to have them ready.

The Resolutions Committee chairman is Dr. Seward Miller, and the other members are Dr. I. R. Tabershaw and Mr. Lou Garber. Will you please give your resolutions to one of those individuals as quickly as possible.

As apparently is the custom here, I would like to read Article XI from our Constitution dealing with resolutions, so there will be no question about how we operate with respect to them:

"Section 1. All resolutions shall be brought before the Conference and may be made at any time during the annual or other meetings, but they shall be referred to the executive committee for consideration and recommendation prior to being voted upon by the Conference. The executive committee is required to present a statement supporting its recommendation and is also required to present minority opinions of members of the executive committee along with the supporting evidence for such minority opinions. A majority vote of the membership present is required to pass a resolution. The membership present may vote a rewording of resolutions without resubmitting them to the executive committee."

Be sure to get them in because we will have to consider them tomorrow morning at the breakfast meeting of the Executive Committee. The deadline for resolutions, then, is today.

The next item of business is the report of the Secretary-treasurer.

MR. YAFFE: The activities of the American Conference of Governmental Industrial Hygienists during the past 12 months give ample evidence of a definite vitality. From a membership standpoint, there was an increase of 26 during the year and in addition, 17 applications were acted upon favorably by the Executive Committee at its meeting here April 21. Including these, we now have 301 full members and 47 associate members for a total of 348. 43 members have not paid dues thus far this year. To satisfy my curiosity, I dug back through the records and tabulated the total membership of our organization for each year since 1939. Although the first meeting was held in 1938, I could find no information as to the number of members at that time. These figures plotted graphically show a fairly steady growth over the past 17 years. There was a substantial drop in membership between 1944 and 1946 when the total went down from 281 to 225. This was to be expected because of changes which took place at the conclusion of World War II. At the 1946 meeting, as I recall, the Conference gave itself a rather careful appraisal, drastically shook up its entire committee structure and took steps to revise the Constitution. The wisdom of these actions is borne out by the developments of the past ten years, which have not only seen our membership reach what is now an all time high, but has seen the emergence of the organization as one which commands great respect throughout the country. This reputation is due in a large measure to the contributions which have been made by its various standing committees.

My predecessor in office, Joe Flanagan, warned me a year ago that I would be faced with a great variety of duties as Secretary-treasurer and I wish to state that he was completely correct. I also want to take this opportunity to say that the job has been far easier because of the assistance and guidance which he provided not only at the time that I took office, but throughout the year whenever I felt the need of help.

Routine activities during the past 12 months including the preparation of dues notices, mailing of membership cards, preparation and mailing of the Transactions of the 1955 meeting, distribution of resolutions, notification of Conference membership of the composition of the Nominating Committee and preparation of ballots, mailing and tallying results for the election of the coming year's Conference officers. Form 990 was filed with the Collector of Internal Revenue as required. The reports of the following committees were received and mailed to the Conference membership for study prior to the annual meeting:

1. Recommended Analytical Methods
2. Industrial Hygiene Records and Reports
3. Industrial Hygiene Codes and Regulations
4. Standard Labeling Procedures
5. Standardization of Air Sampling Instruments
6. Industrial Ventilation
7. Threshold Limits

In addition, in accordance with instructions from the Executive Committee, a membership booklet was printed and distributed to the members. This was the first new listing since 1952. It is planned to issue a new booklet annually from now on. Another publication of considerable significance during the year was the printing of the new edition of the Trade Names Index, for which a charge was made for the first time. A great deal of correspondence and bookkeeping have had to be done in connection with the sale of this publication because of the necessity of interpreting the rules for eligibility for the Trade Names Index and the mechanics connected with billing and collecting, particularly since most of the purchasers were official agencies, each of which has a different system of red tape which must be dealt with. (In a tabulation of information which Mr. Flanagan provided me at the time that he turned the office over to me, he concluded with the following statement: "Secretary to the Secretary-treasurer. Be sure and get a good one or you will be lost." I assure all of you that any success I have had has been due to my ability to follow that advice.)

Another activity of the year was to purchase and distribute to all of our Past-chairmen or their widows, suitably engraved gavels. This has been done with one exception. I have been unable to locate Mr. Charles L. Pool, who was Chairman at the 1941 Conference. Extensive search brought forth an address in Spain, but a letter to him at that location was returned unopened last week.

One new activity was undertaken voluntarily. This was the issuance of the Bulletin Board, a sort of newsletter, which was sent out intermittenly, usually together with other material being mailed to the members. A number of the members have expressed their approval of the Bulletin Board and urged its continuance. The extent to which this is done, however, and its successfulness will depend upon the cooperation of the membership in providing material to be included. Your Secretary-treasurer looks on the Bulletin Board, not as a medium for the expression of his views, but one to facilitate communication between Conference members.

Before presenting the Treasurer's report, this is an appropriate point to present the results of the election of officers. The Nominating Committee did a remarkable job of selecting candidates who were equally capable of attracting votes. Two of the races for office were so close that a shift of a few votes in each case would have altered the final results. In connection with this, there were at least a dozen invalid ballots received. These were not counted because the sender failed to put his or her name on the outer envelope as instructed. This is necessary, because the name has to be checked against the records to see that dues have been paid in accordance with requirements of the Constitution. Members who are behind in their dues are entitled to vote if they send payment for back dues with their ballots. That is why there was a place on the voting instructions on which we indicated the amount of dues owed, if any. I believe the instructions were clear, since about 95% of those who voted, did so properly. Many of the invalid ballots were in official letterhead envelopes but did not show the voter's name on the outside. Having your name on the outer envelope does not destroy the secrecy of your vote, since the outer envelope is destroyed after checking and the inner envelopes, containing the ballots, are mixed together before opening.

The new Chairman-elect is Dr. Thomas Mancuso, of Ohio. The new Member of the Executive Committee is Mr. Jack Baliff of New York. The Secretary-treasurer was re-elected.

The following is the financial statement:

Balance on hand April 15, 1955			$6440.75	
Income:				
Dues		$ 605.00		
Share of 1955 Conference		283.50		
Sale of Ind. Vent. Manual		761.50		
Sale of Threshold Limits		312.41		
Sale of Trade Names Index		990.00		
Refund - J. E. Flanagan		20.00		
Total income			2972.41	
				$9413.16
Expenses:				
Travel Expense-Labelling & Ad Hoc. Comm.		$ 202.55		
Meeting expenses - Buffalo meeting		242.46		
Postage		322.69		
Transportation to Phila., Sec-treasurer		71.17		
Printing expenses:				
Trade Names Index	$1865.85			
Threshold Limits	92.43			
Stationary & Envelopes & Membership Cards	105.25			
Constitution Booklets	200.00			
Transactions	364.84			
Addressograph	14.45			
Committee Reports	10.00			
Total for printing		2652.82		
Reporting Service - Buffalo Meeting		58.75		
Typing Services - Transactions		95.00		
Typing Services - Trade Names Index		25.00		
Bond for Secretary-treasurer		25.00		
Purchase of File Cabinet & Safe		69.50		
Purchase of Reprints from AMA		85.00		
Purchase - Rubber Stamps		7.99		
Purchase - Gavels & Engraving		187.10		
Copyright - Trade Names Index		4.00		
Notary Fees - Trade Names Index		1.00		
Total expenses				4050.03
Balance on hand April 19, 1956				$5363.13

Thus, our balance during the year dropped from $6440.75 to $5363.13. Our finances are such that I think some discussion is indicated at this point. Expenses for 1952-53 were $963. During 1953-54, they were $1229. During 1954-55, they were $21[illegible], as much as in the two previous years combined. Expenses during 1955-56 were $4050.03, which is almost double last year's, and in addition, we are committed to an additional expenditure of $1500 for 500 sets each of two sections of the Encyclopedia of Instrumentation for Industrial Hygiene for use by the Committee on Standardization of Air Sampling Instruments and the Committee on Air Pollution, in accordance with action taken at the 1955 meeting in Buffalo. This material is being purchased for use by these committees in their proposed projects of keeping these particular sections up to date. These revised editions are to be sold and it is anticipated that the $1500 will eventually be gotten back through sales. Since this money has not actually been paid out yet, it doesn't appear under the expenses and our actual bank balance after this obligation is met will drop to about

$4,000.

Income this past year from the sale of the Ventilation Manual was considerably less than last year, dropping from $2161 to $761. On the other hand, income from the sale of the Trade Names Index has amounted to $990. and receipts from the sale of the Threshold Limits have jumped from $16 to $312. Consequently, our income was about $900 above last year, despite the decline in revenue from sale of the Ventilation Manual.

Our biggest single expenditure during this past year was the Trade Names Index. 500 copies were printed at a cost of $1865, half of which has been recovered to date through the sale of approximately 90 copies. Restrictions on distribution of the Trade Names Index will keep it from being sold too rapidly, but it would appear that the total cost of printing should be recovered within another couple of years. Another major expenditure was the printing of the Transactions, an item which tends to get larger each year as the number of pages increases and labor and printing costs go up. The total expenses including postage for shipment was around $500. The membership booklets were $200, and as previously stated, this will probably be an annual expense. One unusual expenditure was $185 for the purchase of 18 gavels for presentation to all of our past chairmen. It will only be necessary to purchase one a year from now on, so this custom will not represent a financial burden in the future. Another significant item was the travelling expenses paid in connection with special meetings of the Labelling Committee and Ad Hoc Committee on the Trade Names Index. These expenses were authorized by the Executive Committee.

I have presented this discussion of our financial transactions in order to point out the expenses involved in connection with conducting the many types of activities in which our organization is engaged. These activities are worthwhile and should be continued and even increased if the resources of the Conference permit. I would remind you, however, that we operated on a very small budget until the income provided by the sale of the Ventilation Manual suddenly provided us with a comparatively substantial amount of money. We cannot expect revenue from this source to continue in the future at the same level. On the other hand, we have other undertakings which may more than pay their own way and enable us to continue with activities which are worthwhile, but not capable of being carried on without financial support. The important point is that we shall have to plan and execute our various activities with considerable care if we are to continue solvent.

MR. SOET: May I ask one question? I didn't get the figure on the cost of the Trade Names Index.

MR. YAFFE: $1,865. We've gotten back $990. Of course, if you add the shipping costs, and we haven't dared to add those at $15 a copy, -- with the shipping costs, the total cost will run about $2,000.

MR. SOET: How many copies do you have now?

MR. YAFFE: We printed 500 and we have sold about 90. If we wanted to make them available to the general public, we could sell the other 400 in a week.

MR. HAMA: I may be a little premature in mentioning this, but we have a sizeable check to present to you from the Ventilation Committee. We've been in the throes of printing a new edition, consequently the delay, but we do have a sizeable check, and I will present it this afternoon.

MR. YAFFE: We are expecting that check.

(Laughter)

I reported the figures for income received during the fiscal year. Anything you give me now is for next year, so it can't go into this statement. During the past year, the amount was $1400 less from the Ventilation Committee than the year before.

MR. HAMA: There is a reason for that too. The previous Chairman indicated to the membership that the Committee would retain $2.00 per copy from retail sales this year in order to give us enough money to publish the new edition. I don't know if you recall that or not.

FROM THE FLOOR: I was wondering, when ballots are mailed for the election of officers, whether biographical notes on the candidates could be included. It would enable some of us who don't know the candidates personally to vote a little more intelligently.

MR. YAFFE: That is an excellent suggestion. Our organization has been small enough in the past, where we all knew each other fairly well. But in recent years, because of the increase in membership, I think that is a fine suggestion and we will try to follow it. It will require that the Nominating Committee furnish us with the names in sufficient time so that we can get that information. That's another problem the Secretary has to cope with.

DR. SULLIVAN: May we have the reaction of the membership on this report?

(It was moved and seconded that the report of the Secretary-treasurer be accepted.)

DR. SULLIVAN: The next item of business is the report of the Executive Committee, which Mr. Yaffe will also present.

MR. YAFFE: The regular annual meeting of the Executive Committee was held at the Penn-Sherwood Hotel in Philadelphia on April 21, 1956. All members of the Committee except Miss Catherine Chambers were present. They included Dr. Sullivan, Dr. Fredrick, Dr. Miller, Mr. Ashe, Mr. Coleman and Mr. Yaffe. The new Chairman-elect, Dr. Mancuso, was also present at the meeting in accordance with a policy adopted last year. Your Chairman, Dr. Ralph Sullivan, presided over the meeting.

As a result of the deliberations, the following actions were taken and are presented for your comments, discussion, and approval:

1. The Secretary-treasurer's report (which you have just heard) was presented and discussed, particularly with respect to the basic policies being followed in the use of Conference funds. It was the concensus that these policies are appropriate and are enabling the Conference to fulfill its duties and responsibilities and to be of effective usefulness to its members and the general public.

2. Seventeen applications for full membership were reviewed and accepted.

3. In view of the fact that the present Constitution has been in effect approximately ten years, it was deemed advisable to subject it to a careful review to determine whether any changes might now be appropriate. For this purpose, a special Constitution Review Committee was appointed, consisting of Mr. John Soet, Chairman, Dr. L. M. Petrie, Mr. Harry Ashe, and Mr. C. D. Yaffe, Secretary. The Committee is instructed to report its recommendations to the Executive Committee prior to the next Annual Meeting.

4. The Secretary-treasurer was instructed to again prepare a new membership booklet and that this be done annually until further notice.

5. The Executive Committee approved the recommendation contained in the report of the Committee on Recommended Analytical Methods that a manual of recommended methods be prepared and sold. Detailed recommendations of the Executive Committee concerning this project will be presented in the course of discussion when the Committee report is presented this afternoon.

6. The Executive Committee reviewed the general policies and procedures being employed in connection with the development of the annual list of threshold limits. It was agreed that the Committee on Threshold Limits has performed its very difficult task very well. It is felt that greater assistance, particularly by ACGIH members, would enable them to do an even better job. It is felt that virtually all of the official industrial hygiene agencies have information on file concerning in-plant concentrations of materials which would be most helpful to the Committee, which otherwise often has only very limited data upon which to try to make decisions. The Executive Committee urges the Conference members to review their records and to let the Committee on Threshold Limits know what information they have available. While the Committee also seeks and obtains considerable assistance and information from individuals and groups outside of ACGIH, the extent to which this is done is not fully recognized because of the informal methods of communication employed. While these methods will continue to be used, the Executive Committee instructed its Chairman to write to the heads of other national organizations having committees interested in the subject of threshold limits inviting them to work out arrangements whereby they will be able to offer comments on changes or additions to the list of threshold limits which are under consideration.

7. At the suggestion of the Committee on Standardization of Air Sampling Instruments, its name was changed to Committee on Air Sampling Instruments.

8. The following individuals were appointed to standing committees: (For list of standing committees, see pages 5, 6, 7 and 8.)

9. The Program Committee for the 1957 Annual Meeting consists of the following individuals:

   Dr. Thomas F. Mancuso, Chairman
   Dr. Miriam Sachs
   Mrs. Mabelle Markee
   Mr. John Soet
   Dr. Lewis Cralley
   Mr. J. L. Monkman

10. The Chairman for Arrangements for the 1957 Annual Meeting is Mr. Jerome Molos.

11. Resolutions Committee

    Dr. S. E. Miller, Chairman
    Dr. Irving R. Tabershaw
    Mr. Louis Garber

12. The Executive Committee reviewed and approved the policies for sale of the Trade Names Index as revised by the Ad Hoc Committee.

13. The problem of advertising in which erroneous or improper use of ACGIH threshold limits is made was discussed. It was decided to call upon the Federal Trade Commission where appropriate. The problem will also be publicized in the Bulletin Board.

I would like to add one further comment. These companies give the implication that this organization has tested their material and has established a threshold limit for it, which is a very high figure, indicating it is quite safe. Now, maybe their stuff is made up of gasoline -- but they don't say it's gasoline; they just say the M.A.C. value for it is -- whatever it is.

FROM THE FLOOR: You don't have any objection to their advertising, giving information about threshold limits, do you?

MR. YAFFE: We have no objection to their advertising where they are calling it by the technical name, but this organization has not established a limit for "XYZ" or any other solvent under its trade name.

FROM THE FLOOR: Suppose you had included this "XYZ" solvent in your list of threshold limits?

MR. YAFFE: Then it would be all right, but it isn't in there. There is no objection to their publicizing or reprinting any in there as is.

Well, that is the report of the meeting of the Executive Committee, which adjourned at 12:30 a.m.

DR. SULLIVAN: Do you want to take action on the report? Actually, it depends on how much controversy may have been created by the many items covered by the Executive Committee. I suppose that we might try to go for the ultimate end, which would be the approval of the entire report -- which would mean that you approve the actions of the Committee. That would shorten our meeting, and if we can attain that objective, maybe that's the way it should be done.

(Whereupon it was moved and seconded that the report of the Executive Committee be accepted.)

DR. SULLIVAN: The next item is new business. Are there any items of new business to be brought before this meeting by any of the members?

MR. YAFFE: There was a suggestion made this morning, which I think should be followed through. I would like to get some opinions on the subject, and that is that we set up a committee to explore the problem of agricultural health. As to what the specific bill of particulars should be for the committee, we would have to study that. Most of you now present were here and heard that suggestion. I think it would be worthwhile getting some discussion from the group as to whether that would be a useful activity.

DR. SULLIVAN: Would any member like to discuss that item of new business?

MR. LINDSAY: Would it be the purpose of that committee to investigate the potentials in agricultural materials and come up with a manual or something like that, of projected hazards and control measures, or such things as that?

DR. SULLIVAN: It would be difficult to say what this committee might encompass, but it would be initially a study group, and perhaps that would be one of the accomplishments. There might be many angles.

MR. LINDSAY: Do you have in mind a manual on ventilation or such as that, which might be valuable as far as agriculture is concerned?

MR. YAFFE: I think it would be wise to point out that before the manual on ventilation was developed, we had a number of years' experience in the field. I think the same thing will apply here if we get some experience in it.

MR. DOYLE: Mr. Chairman, I think that we are in the stages of agricultural health similar to the situation we were in 20 or 25 years ago with respect to lead poisoning and many other topics. At that time, of course, the Conference wasn't organized, but committees of other organizations functioned in these fields. Early in our history we appointed committees of this type.

As far as a manual is concerned, I think it is much too early for a committee to attempt to formulate one. We don't know what the problems are, really. Some of these points need to be explored.

So, I would move that the Chairman appoint a committee entitled "The Committee on Agricultural Health" to explore and investigate the problems in agricultural health, and come up with recommendations which official agencies can follow in pursuing an agricultural health program.

DR. SULLIVAN: Is there a second to that motion?

MR. WUKASCH: I think Mr. Doyle's suggestion is an excellent one; I second the motion.

DR. SULLIVAN: It has been moved and seconded that the Chairman appoint a Committee on Agricultural Health problems. Is there any discussion on that motion?

(The motion was put to a vote and duly carried.)

Are there any other items of new business? Hearing none, I will entertain a motion for adjournment.

(Such a motion was made, seconded and carried and the meeting adjourned at 12:15 p.m.)

BUSINESS SESSION

Tuesday, April 24, 1956

11:30 a.m.

Dr. Ralph R. Sullivan, Presiding

DR. SULLIVAN: May I call the second business meeting of this annual session to order?

I would like to make a couple of very quick announcements. One, that the Agricultural Health Committee which you voted on and approved yesterday, has been appointed by the Executive Committee at this morning's meeting. Its members are: Dr. William Clark, of California, Chairman; Mr. Emil Chanlett, North Carolina; Mr. Wilson Applegate, Oregon; Mr. George Raschka, Minnesota; and Dr. Lewis Cralley, Public Health Service. (Subsequently, at his own suggestion, Dr. Cralley was replaced by Dr. Harold J. Paulus, Public Health Service). A letter of appointment and a bill of particulars for the functioning of this new standing committee will be sent out to the individual members of that committee by the Secretary.

The Executive Committee also approved the Program Committee:

Dr. Mancuso is automatically Chairman; Dr. Miriam Sachs, Mrs. Mabelle Markee, Mr. John Soet, Mr. John Monkman and Dr. Lewis Cralley are the members of the Program Committee for the next year's session at St. Louis.

The next item of business is the report of the Resolutions Committee, whose Chairman is Dr. Seward Miller.

DR. MILLER: We have a number of resolutions. I hate to delay your lunch, but these have been suggested, and we have developed them for your approval:

WHEREAS, Mr. Steve Marsh passed away in early June, 1955, a long standing member and colleague in governmental industrial hygiene work; and

WHEREAS, Steve Marsh, late Chief of Industrial Hygiene Engineering Services of the North Carolina State Board of Health, was a devoted servant of the people of his native State, was a conscientious investigator, who never considered his learning or his teaching job completed, and was a sturdy proponent of occupational health activities on a broad cooperative base among State and local agencies, under the leadership of the North Carolina State Board of Health; therefore

BE IT RESOLVED that the Eighteenth Meeting of the American Conference of Governmental Industrial Hygienists express its deep regret on the untimely death of Steve Marsh, and extend its sincere sympathy to his widow and children, and that the Secretary be instructed to transmit this resolution to Mrs. Steve Marsh at Marshville, North Carolina.

MR. DOYLE: I move the resolution be adopted.

FROM THE FLOOR: Second.

DR. SULLIVAN: All those in favor say "aye."

(The motion was put to a vote and duly carried.)

DR. MILLER: The next resolution:

WHEREAS, the American Conference of Governmental Industrial Hygienists is most happy with its participation in this annual joint Industrial Health Conference; and

WHEREAS, the Local Arrangements Committee has done an outstanding job in the execution and development of facilities necessary for a successful meeting; therefore

BE IT RESOLVED that the American Conference of Governmental Industrial Hygienists commend and express its sincere thanks to our hard working A.C.G.I.H. Local Arrangements Committee, and to the Industrial Health Program Planning Committee.

MR. CHANLETT: I move the adoption of that resolution.

FROM THE FLOOR: Second the motion.

DR. SULLIVAN: All those in favor say "aye".

(The motion was put to a vote and duly carried.)

DR. MILLER: Next resolution.

WHEREAS, the American Conference of Governmental Industrial Hygienists has a growing number of members in South America; and

WHEREAS, it is most difficult for these members to attend the annual Conference; and

WHEREAS, several South American members have written our Secretary, expressing a desire to form a South American section of the American Conference of Governmental Industrial Hygienists; and

WHEREAS, it is important for them in maintaining their professional growth to have the opportunity of participating in industrial hygiene conferences; therefore

BE IT RESOLVED that the newly appointed Constitutional Review Committee consider developing such amendment to our Constitution as may be necessary to provide for the establishment of affiliated sections.

DR. MOSKOWITZ: I suggest that the entire matter of affiliated sections and foreign membership be considered by the Constitutional Review Committee and a report on all of these matters be presented at our next annual meeting, rather than adopt a resolution on the subject now, more or less binding the Committee to that action.

I think it best that this present resolution be tabled for a year, or else defeated completely.

DR. MILLER: Did you understand what I read thoroughly?

DR. MOSKOWITZ: I believe so.

MR. YAFFE: There is considerable interest on the part of people of South America in the field of occupational health. We have a fairly large number of members there, and few of them can get up to the meetings very often. I think we can anticipate that, as industrial hygiene develops in South America, they are going to organize.

They have expressed a desire to organize as part of A.C.G.I.H. because most of them are governmental people and have interests similar to ours.

This resolution is merely an attempt to make it possible for them to do it the way they would like to. It is entirely possible that they will organize in a separate way which will not be compatible with our interests, and this is nothing except calling the attention of the Committee on Constitutional Review to the fact that they can't do what they would like to do under the present situation.

As far as other parts of the world are concerned, we have no members except for the one in Europe I told you about this morning. So actually, from a practical standpoint, there is no other place to form an organization.

FROM THE FLOOR: Would this be binding?

DR. PETRIE: Even if the Constitution Committee takes action, the only action it could take would be to submit it back to the Conference for vote.

DR. MOSKOWITZ: In which case I withdraw my objection.

DR. MILLER: You see, the resolution calls upon the Committee to consider this among other things. I think it is a good idea for this to appear in the minutes so that the folks in South America who get the proceedings of this Conference know we are trying to do something for them.

BE IT RESOLVED, that the newly appointed Constitutional Committee consider developing such amendments to our Constitution as may be necessary to provide for the establishment of affiliated sections.

DR. MOSKOWITZ: I withdraw my objection.

DR. PETRIE: I move the adoption of the resolution.

(The motion was seconded, put to a vote and duly carried.)

DR. MILLER:

WHEREAS, there is great deficiency in the teaching of occupational diseases in medical schools; and

WHEREAS, the need for such instruction is great; and

WHEREAS, most cases of industrial illness are cared for by private physicians; and

WHEREAS, the proper treatment depends upon the correct diagnosis of an occupational disease; and

WHEREAS, the recognition of occupational disease frequently is essential to the detection of health hazards in the working environment and their correction; therefore

BE IT RESOLVED that the American Conference of Governmental Industrial Hygienists urge the U. S. Public Health Service to develop a coordinated program for the teaching of occupational diseases in medical schools.

DR. MILLER: Discussion?

DR. PETRIE: I move the adoption.

FROM THE FLOOR: I second it.

(The motion was put to a vote and duly carried.)

DR. MILLER: This, incidentally, is in accordance with pretty well-established customs in other fields and other activities in developing teaching aid for medical schools.

WHEREAS, additional facilities for training young physicians in the newly-created specialty of occupational medicine are needed, and WHEREAS, under Item 3 of Special Requirements for Certification, in this specialty a period of not less than three years of special training after interneship is required; and

WHEREAS, many official industrial hygiene agencies have excellent resources and material affording opportunities for rich experience in the field of occupational medicine; therefore

BE IT RESOLVED, that the Secretary of American Conference of Governmental Industrial Hygienists transmit this resolution to the Secretary of the American Board of Preventive Medicine; and

FURTHER BE IT RESOLVED that the respective official agencies who believe they could adequately supply such training and facilities apply directly to the American Board of Preventive Medicine for approval of their facilities for such training.

DR. MILLER: Discussion?

MR. DOYLE: I didn't understand the last part of that.

DR. MILLER: There were two parts. One is that the Secretary transmit this resolution to the Secretary of the Board of Preventive Medicine, which paves the way for the industrial hygiene agencies to apply directly to the Board for examination of their facilities for approval. I will re-read it.

BE IT RESOLVED, that the Secretary of American Conference of Governmental Industrial Hygienists transmit this resolution to the Secretary of the American Board of Preventive Medicine; and

FURTHER BE IT RESOLVED that the respective official agencies who believe they could adequately supply such training apply directly to the American Board of Preventive Medicine for approval of their facilities for such training.

FROM THE FLOOR: Does that apply to training young physicians in occupational health and certifying them?

DR. MILLER: Not certifying. Enabling them to take the examination for certification.

DR. PETRIE: That's right. It's directed toward training young physicians.

DR. MILLER: In public health, as you know, many local health departments are certified training facilities as part of the training for physicians for their boards in public health.

We felt that there are many official agencies who could supply similar training for physicians interested in occupational medicine.

DR. FREDRICK: Do you think it might lead, actually, to perhaps a setting up of a certification of suitability of industrial hygiene agencies to function, just as there is a program developed for the certification of industrial medical departments?

DR. MILLER: I doubt it. This is an official agency. Who is going to certify an official agency? I don't think so, and I hope that time never comes. I couldn't understand such a thing happening.

FROM THE FLOOR: Is there a slight anomaly here? We, as a group of members of this Conference are resolving something for official agencies. Isn't there an anomaly or incongruity there? It seems to me that the Conference is resolving official agencies to do something.

DR. MILLER: I think your comment is quite right.

RESOLVED that the respective members who believe their agency .....

That would be right. I might add that on. I am sorry Dr. Sachs is not here. I think the idea is that a portion of the individual's time might be spent in certain health departments that have adequate facilities set up, so that such individuals would gain broader experience in occupational health.

In other words, what Dr. Sachs thought on Sunday was that the individuals were getting their experience in plants in industrial medicine, but they were not getting enough experience in preventive medicine, which they needed and that perhaps, if Dr. Sachs, for example, or some other agency could induce that trainee to spend one year in the health department setup, and that was approved, such experience might go toward the time necessary to satisfy certification requirements.

It wasn't intended, as I recall, that the person seeking ultimately to be certified would spend his entire training time in the health department.

DR. MOSKOWITZ: Will Dr. Sullivan amend his remarks to include "and labor" after "health?"

DR. SULLIVAN: Yes.

DR. MILLER: There is nothing about health in the resolution. It says, "official agencies."

MR. DOYLE: Doesn't that amount to informal certification by some of the Boards, even where it might not be a formal certification? Because an agency has to be approved before you can send the residents there for training.

DR. MILLER: I don't think I understand your question.

MR. DOYLE: The discussion a few minutes ago was that this might amount to certification of official agencies by some organization.

DR. MILLER: No, this has nothing to do with that.

MR. DOYLE: But doesn't the latter part of the resolution lead into that? It does amount to an informal certification.

DR. MILLER: I repeat; I don't understand your question. It says here:

"FURTHER BE IT RESOLVED that the respective members who believe their official agencies could adequately supply such training, apply directly to the American Board of Preventive Medicine for approval of their facilities for such training."

That is all.

DR. SULLIVAN: Would you regard that any more, Henry, as approval for the American Board of Preventive Medicine, which is already doing it? In other words, this Board of Occupational Medicine is a sub-board of the Board of Preventive Medicine, and, as Dr. Miller said, this machinery already exists. Now, would this be any more?

MR. DOYLE: I probably don't know enough about the approval system to be talking, but one point that concerned me is that if the State indicates that they have the facilities and asks for approval, State-wide, and they don't meet the approval, then doesn't this amount to an informal certification on the part of the Board. State "X" can have these; but State "Y" can't?

DR. MILLER: No, it doesn't indicate anything to do with the quality of service being rendered. It concerns whether the opportunity exists for training of physicians only. It doesn't have anything to do with the quality of service rendered.

You see, right at the moment the condition exists in public health. I am not certain of this, but I think Philadelphia has applied for and received approval for the interneship type of training for young physicians in public health as part of their experience, which will allow them to take the Boards.

Well, say Harrisburg has applied, but they have been turned down. It just means that the setting is not appropriate for training purposes; it has nothing to do with the quality of service being given the people. That exists all over today.

DR. FREDRICK: I cannot help feeling, however, the resolution would amount to this, in effect; once it was implemented, certain industrial hygiene agencies and health departments, both State and local, would appear on the list approved for the training of Board members; others would not appear on the list, either because their suitability for training were not acceptable, or they had never applied for it. But such lists would not go behind the reasons why certain names appear and certain names do not, and I am afraid that in due time those agencies who do not appear on the list might be criticized adversely, at least at the local political levels, because you can't tell what folks like to dig up to use in the political and propoganda purposes.

It seems we are laying ourselves open to difficulties, at least on a State or local level, and I would hope that the resolution might be rephrased, simply to call to the attention of the American Board group that facilities for training might be considered, or something like that, or are available.

DR. MILLER: For the life of me, what you suggested seems to be exactly what we have got down here. Let me re-read it and see if you see any objection to it:

BE IT RESOLVED, that the Secretary of American Conference of Governmental Industrial Hygienists transmit this resolution to the Secretary of the American Board of Preventive Medicine; and

FURTHER BE IT RESOLVED that respective members who believe their official agencies could adequately supply such training, apply directly to the American Board of Preventive Medicine for approval of their facilities for such training.

DR. PETRIE: Read the "whereas".

DR. MILLER:

WHEREAS, additional facilities for training of young physicians in the newly created specialty of occupational medicine are needed; and

WHEREAS, under Item 3 of Special Requirements for Certification in this specialty, a period of not less than three years of special training after internship is required; and

WHEREAS, many official industrial hygiene agencies have excellent resources and material affording opportunities for rich experience in the field of occupational medicine; therefore -

BE IT RESOLVED . . . . .

DR. PETRIE: I think we can get around the difficulties by leaving out, in the second "resolved," the getting in touch with the American Board for approval. If we leave out that "for approval," I think the function of this thing would be answered all right. We are just trying to call the attention of the American Board to the institutions and resources which we have which are available for training purposes. We are not asking them to approve these things.

DR. SULLIVAN: Would that be calling attention to the availability of such services?

DR. MILLER: What part do you want re-read?

DR. PETRIE: The second "resolved."

DR. MILLER: (Reading):

FURTHER BE IT RESOLVED that the respective members who believe their official agencies could adequately supply training apply directly to the Board of Preventive Medicine for approval of their facilities for such training.

You see, if they don't do that, and get them approved, no physician can be trained there. A facility has to be inspected and approved, just like a hospital has to be inspected and approved for residency training, or internship training. If it is not, then it is not accepted by the Board.

We have one State already which has made such overtures, informally, and has been in the process of investigating this matter. I don't know specifically how far they have gone with it, but other States should know about it. Otherwise all the training of physicians in occupational medicine will have to be done in approved schools and industrial plants.

DR. CLARK: I wonder whether maybe part of the confusion doesn't exist in that I believe that it is probably the case that an agency which might ask for approval of their occupational health training facilities would already be in the position of being approved for training for public health residence to begin with. What we are really asking is for health departments to consider extending their exploration in this field to cover the new sub-specialty of occupational health. It does not add anything different.

Our own State Health Department is already in the residence training program for the parent Board of American Preventive Medicine, and we are planning to ask for an extension of this consideration to the field of occupational health.

DR. MILLER: You are already ware of this, but many departments may not be.

DR. CLARK: That is true.

DR. MILLER: Is there further discussion before we come to a vote?

DR. FREDRICK: Perhaps the resolution is a little too pointed. Instead of referring specifically to industrial hygiene agencies, if you referred generally to public health departments and labor departments, then you would avoid the difficulty, because the industrial hygiene activities are, after all, one of many public health functions within the health department, or labor department, as the case may be.

DR. MILLER: It says: "Official agencies" not "industrial hygiene agencies" in the resolution. The third "whereas" is perhaps what you are referring to. The third "whereas" reads:

WHEREAS, many official industrial hygiene agencies have excellent resources and material affording opportunities for rich experience in the field of occupational medicine; therefore,

BE IT RESOLVED. . . .

Your idea was to change that "industrial hygiene" wording to what? To "official agencies" ad we did in the final one?

DR. FREDRICK: Well, refer it to the health departments.

DR. MILLER: You can't do that. We have labor departments, too.

DR. FREDRICK: I suggested health and labor departments.

DR. MILLER: Why can't we say: "Whereas many official agencies have excellent resources . . .?"

DR. FREDRICK: Say "official health agencies" because if a labor department does not contain an official health agency .....

DR. MILLER: Let me cross out "industrial hygiene", and re-read it.

WHEREAS, many official agencies have excellent resources and material affording opportunities for rich experience in the field of occupational medicine; therefore

BE IT RESOLVED . . . .

DR. GREENBURG: Dr. Miller, I think this is a great help and it should be a great help to young physicians who want to be certificated and want to know where to go to get some training. I can't see anything wrong in it, no matter whether you change a word here or there. The intent is clear.

Some places will be certificated at once and some will be certificated later on, and I'd like to move the adoption of this resolution.

DR. PETRIE: I second the motion.

(The motion was put to a vote and duly carried.)

DR. MILLER: Let me assure you that I think this is a significant thing you ladies and gentlemen have just voted, because otherwise, under the present circumstances, the only opportunity for training of physicians in occupational medicine is confined to industrial plants and possibly graduate training in schools and universities. I think you folks all have a rich experience to offer them.

DR. PETRIE: How about Cincinnati? Is it approved now?

DR. MILLER: Yes.

(Reading.)

WHEREAS, official industrial hygiene agencies meet a great variety of occupational health problems affording excellent opportunities for research; and

WHEREAS, it is recognized that there is great need to utilize these opportunities for research; and

WHEREAS, official agencies are in position to secure the cooperation of universities and schools; and

WHEREAS, such research usually can be financed by appropriate research grants; therefore

BE IT RESOLVED, that American Conference of Governmental Industrial Hygienists encourage official industrial hygiene agencies to develop and actively engage in such research.

DR. MILLER: Discussion?

DR. CLARK: As a matter of resolution, I wonder whether the business of financing by grants should be brought in? The "whereases" all fit no matter how you finance it, and it would be kind of helpful in our State if we could get money out of our own people instead of having to go to grants.

DR. MILLER: Is there further discussion on that point? The Committee put it in there with a feeling that it might be more acceptable to the majority of State health officers who perhaps might review this.

We were attempting to indicate that if the State did not have the resources, or could not get them from their appropriating bodies, that abundant opportunity exists among the various foundations and research grants, such as the Army, Navy, AEC, Public Health Service, to finance any project that might be developed.

Now, if it is going to hamper anybody, perhaps, as you say, we should remove it.

DR. CLARK: It would not hamper us; I merely brought it up.

DR. MILLER: Is there other discussion on that point, or other discussion on the entire resolution?

DR. CLARK: I move it be adopted.

FROM THE FLOOR: I second it.

(The motion was put to a vote and duly carried.)

DR. MILLER: (Reading)

WHEREAS, the work of our Threshold Limits Committee is essential in the operation of official industrial hygiene programs; and

WHEREAS, many threshold limit values are presently based largely on animal experimental work; and

WHEREAS, sufficient human exposure data are not presently available; and

WHEREAS, in many workplaces throughout the States, conditions of human exposure to toxic substances exist; and

WHEREAS, official agencies frequently are aware of these conditions and do studies, this information often is not being correlated and transmitted to our Threshold Limits Committee; therefore

BE IT RESOLVED, that the American Conference of Governmental Industrial Hygienists strongly urge its members to sieze these opportunities for careful evaluation of the clinical, environmental and toxicological effects on human health and to supply this information to our hardworking Committee on Threshhold Limits.

DR. MILLER: Is there a discussion?

(No response.)

MR. COLEMAN: I move it be adopted.

FROM THE FLOOR: Second it.

(The motion was put to a vote and duly carried.)

DR. MILLER: That completes the report of the Resolutions Committee.

DR. SULLIVAN: I'd like to thank the Committee, Dr. Miller, and his co-workers, for an excellent set of resolutions and for having safely carried them through to adoption.

Is there any other business to come before this business meeting? Hearing nothing, I'd simply like to offer a very few concluding remarks of my own.

FROM THE FLOOR: I'd like to ask a question. Does the interim Committee on the Trade Names Index still exist?

MR. YAFFE: You mean the Ad Hoc Committee on Trade Names Index. At last year's meeting the Ad Hoc Committee submitted a report to the Executive Committee. One of its recommendations was that it be continued in existence.

There has been no action taken to abolish it, so it is still in existence and available.

DR. GREENBURG: Would you like to tell us about the status of the Index at the moment?

MR. YAFFE: Well, that was reported in our report yesterday. I'll be glad to tell you that the Index has been out for some time, that we have sold enough copies to have recovered about half of the initial cost of investment. We are glad to sell them to eligible parties.

Due to the restrictions on the sale, we can't sell them too fast.

DR. GREENBURG: Have those restrictions been lifted?

MR. YAFFE: They have been modified. There was a special meeting of the Ad Hoc Committee in January, at which time we got our most knotty problems taken care of, and we have been able to satisfy most of the people who were complaining, including your Secretary-treasurer. If you have any specific question on it ...

DR. GREENBURG: The question I'd like to ask, that I had in mind was, I was talking to aMedical Examiner in New York the other day, and I think he would be interested in getting a copy. Is it legitimate for him to get a copy?

MR. YAFFE: That is a situation we have not run up against. However, in most inquiries, we refer them to the official agency who have one, such as the New York Department of Labor, in this case. They have a copy and could certainly make it available to him.

DR. GREENBURG: He asked me about it. He asked if he could get a copy. I said, "I don't know, but will try to find out."

MR. YAFFE: There will be certain questionable cases that will have to be decided on their merits. We will be glad to receive a letter from him.

DR. SULLIVAN: I will resume where I left off.

I have enjoyed serving as your Chairman for the past year. I hope that in attempting to get this business meeting under way I wasn't too rough on the last speaker. I began to think, as the time went on, that maybe I had been.

The program was in error. The paper should have concluded at 11:30 and our business meeting should have gotten under way. We were ten minutes late and I feel that most members of the Conference are very anxious to have business meetings start and get over with as quickly as possible.

So, I was, perhaps, guilty of too great an enthusiasm to carry out what I thought were the wishes of the members of this Conference, in trying to get under way.

I'd like to call on the new Chairman for the coming year, Dr. Fredrick, to take over at this point and make such remarks as he would like to make, and adjourn the meeting.

DR. FREDRICK: My remarks will be very brief. I only hope that the American Conference of Governmental Industrial Hygienists can make as much progress in the coming year as we have in the past year under the very excellent chairmanship of Dr. Sullivan.

I would like to make a dual motion that I think will be reasonably acceptable. The motion is one of thanks to the outgoing chairman, and adjournment, simultaneously.

(The meeting adjourned at 1:00 p.m.)