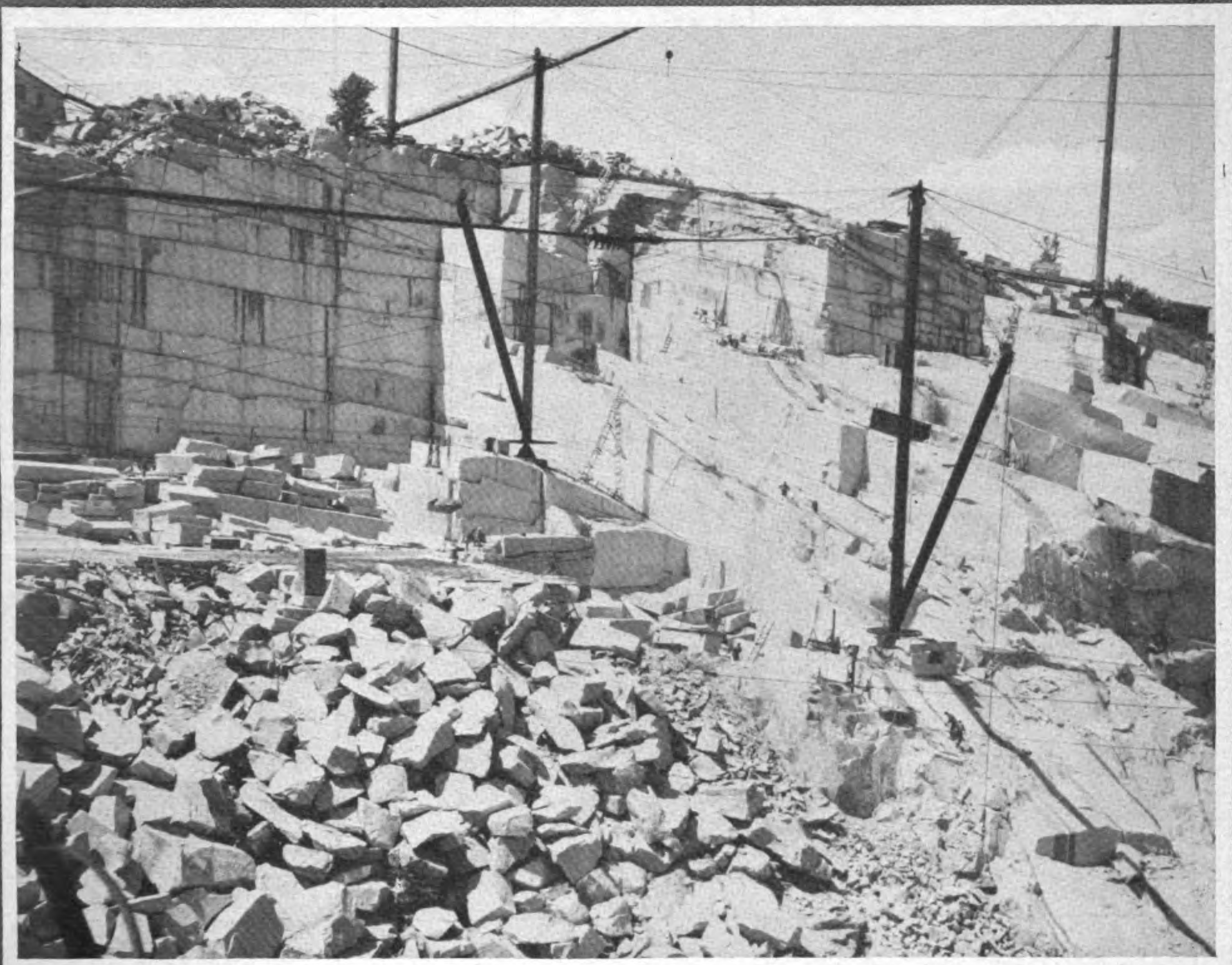
The Industrial Hygiene newsletter



Vermont Granite Quarries **DECEMBER 1950**

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INDUSTRIAL HYGIENE NEWSLETTER

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FEATURES

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Advisory Committee Urges PHS to Study Human Relations Phase Of Industrial Health

INVESTIGATION in the field of human relations as it relates to industrial health was given top priority among the recommendations made by the National Advisory Committee on Industrial Hygiene to the Public Health Service at its annual meeting recently. The committee met in Cincinnati the day following open house for the new field headquarters of the Division of Industrial Hygiene, PHS.

Deep interest in the subject of human relations as it affects the health of the worker in industry was expressed in the formal recommendation asserting that the Surgeon General be informed that the Advisory Committee is particularly disappointed because of the fact that no appropriations have been set aside for the investigation of mental hygiene or human relations in industry. "We further urge him, as we did last year," the recommendation said, "to formulate a program of investigation. That we think it is much more important at this particular time than we did a year ago. That the Advisory Committee suggests that this undertaking be carried on by the National Institute of Mental Health in cooperation with the Division of Industrial Hygiene with special reference to human relations."

The committee also discussed at length the number of nurses needed for serving essential industries, their working hours and salaries, and necessary training. It was recommended that a sub-committee of three be appointed from the committee to make a special study of the nursing situation.

Concern for the agreement between the Public Health Service and the Department of Labor was expressed in a recommendation that the committee urge the Surgeon General to come to

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COVER PICTURE—One of Vermont's largest granite quarries. Owners of quarries and sheds, labor union representatives and State and Federal industrial hygiene teams have been working together for a quarter of a century to safeguard the workers from silicosis. All quarry pictures in this issue are by courtesy of the Rock of Ages Corp.

Vermont Granite Quarries Find Wet Drilling Feasible to Control Dust—Sheds Use Local Exhaust *

By Harry B. Ashe

THE quarrying of granite involves the use of large, medium sized and small pneumatic drills known as leyners, jackhammers and plug drills, respectively. The control of dust generated by these machines has always been a problem, but not until 1937 was any type of dust control practiced. At that time a suction box or oversized vacuum cleaner was designed and perfected for the larger leyner drills and this method of dust control has been used by all quarries up to the present year on that particular size of machine.

While not 100 percent effective, the majority of granite dust generated by the leyners was taken care of by this collector. Jackhammers and plug drills have always operated without the benefit of dust control. One exception was a dry dust control system for two-plug drills which has been in operation for a number of years at one of the quarries. While suction boxes for each quarry operation appeared practically impossible, the use of water to control the dust generated at each machine appeared worthy of consideration.

*From the annual report (fiscal year ending July 1950) of the Division of Industrial Hygiene, Vermont Department of Health. Mr. Ashe is director of the division.

During the past winter, one granite quarry was convinced of the feasibility of wet dust control on a limited scale. A water heater was installed, piping was laid and several drills, large, medium and small, were converted to wet drilling late in January and continued in one small location for the duration of the winter. Although at times this method of operation seemed hopeless, all obstacles were overcome and by warm weather the quarry operators called the experiment a success and the method of dust control practicable.

At this writing, wet dust control in granite quarrying has spread to all five quarries with one quarry operating 100 percent wet; 75 percent of the dust boxes on the large leyner drills have been replaced with wet dust control; 51 percent of the jackhammers are now operating with water to control the dust; and 73 percent of the plug drills are being controlled with water. This project has required miles of water pipe, installation of pumps, procurement of thousands of feet of water hose and hundreds of water tubes and parts for the machines themselves.

These factors, plus the amount of time required to educate machine operators in a new method of drilling, prevented some of the quarries from operating on a 100 percent dust control by July 1. However, parts on hand or on order indicate that four of the five quarries in operation will have complete wet dust control very soon and plan to adapt equipment for continued wet dust control during the winter months. This will mean that for the first time in the history of granite quarrying in the State of Vermont all quarrymen regardless of the machines they operate will be working under virtually complete protection from silica dust.

GRANITE SHED DUST CONTROL

The granite manufacturing industry has in the past been a chief concern of the Industrial Hygiene Division and will always be a major interest to any agency within the State concerned with occupational disease. It is in this industry that great human suffering has resulted from exposure to granite dust, the free silica content of which is the etiological agent responsible for silicosis.

For the first time in several years a complete study was made of every granite shed in the State during the

Miles of hose and pipe are used to carry the compressed air which operates dozens of pneumatic drills. The jack hammer, shown operating without dust control, drills 2-inch holes 11 inches per minute in hard granite. Wet drilling eliminates this dust exposure.

In this concentrated area five pneumatic drills operate in the wet drilling process to completely control dust. The large 25-ton rough blocks on the flat cars are unloaded to be shaped into granite squares and shipped to the finishing plants.

summer and fall of 1949 and again 6 months later during the spring of 1950. The first round of inspections found 1,665 employees (of whom 155 were apprentices) using 916 local exhaust units, 39 percent of which were below our standard and rated poor.

The second inspection found 1,698 employees (of whom 115 were apprentices) using 871 individual local exhaust units, 26 percent of which were below standard and rated poor. Ninety-four granite sheds were found to be in operation on both tours. The reduction of 39 percent to 26 percent in the number of substandard exhaust units indicates a voluntary effort on the part of manufacturers to improve the protection afforded granite cutters. Following the second round of inspections, however, it appeared necessary to follow-up vigorously our recommendations in those sheds with substandard exhaust systems.

At this writing, all sheds in the district have either made repairs to their equipment required to meet our approval or have placed orders with the suppliers to make whatever alterations necessary to bring their systems up to standard. Not only have we continued to consult with the individual manufacturer in this program but we have also checked on

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The maze of cranes and booms in this deep pit indicates the tremendous size of the task of removing the blocks of granite. Not until electric power was invented and hard-steel cutting tools were made was it possible to drill into this extremely hard stone.

Bloomfield Assigned Industrial Hygiene Consultant for Latin America

JOHN J. BLOOMFIELD, long-time assistant chief of the Division of Industrial Hygiene of the Public Health Service, and one of the best known figures in the field of industrial hygiene in the United States, this month began work in his new assignment with the Institute of Inter-American Affairs as consultant on industrial hygiene for Latin America.

Mr. Bloomfield will operate in 14 Latin American countries, with which the Institute works, and review the progress of countries which already have industrial hygiene programs and also proceed to make plans for the establishment of programs in the other countries.

Observing the problems of industrial health below the equator will not be new to Mr. Bloomfield, since he has made three previous trips to Latin America to serve as consultant for the Institute on a short-term basis. In the latter part of 1947, he spent 5 months in Peru and Chile, to make comprehensive studies of the hazards to workers in all industries. Early in 1947, he also spent 3 months in Bolivia, where he assisted in strengthening the industrial hygiene program, which was organized as a part of the labor program set up in that country with the help of the Institute.

At the invitation of the Brazilian Government and the Institute, Mr. Bloomfield returned to Latin America in 1949 to give a series of lectures to a class of physicians and engineers. At that time, he surveyed the health conditions of workers in typical plants, mines, and mills, and made recommendations for improving the current industrial hygiene program.

Many other countries in Latin America, frankly acknowledging their need for improvement, have requested assistance from the United States. Mr. Bloomfield plans to make surveys of the needs in the industrial hygiene field in such countries as Colombia, Venezuela, Mexico, and Uruguay. Eight of the 14 countries in which the Institute of Inter-American Affairs operates are fairly well industrialized and present a real need for industrial health programs to safeguard the health of the workers.

Professional personnel from the various countries now come to the United States for specialized training in industrial medicine, engineering, and chemistry, but plans are being made to establish a training center in South America where specialists from the United States can be sent to lecture on specific subjects of serious concern to Latin American personnel.

Mr. Bloomfield's pioneering work and long experience in the field of industrial health will enable him to be of great value to the Latin American countries. His first governmental position was with the United States Bureau of Mines as a research engineer at the Pittsburgh Experiment Station. For 3 years he did research on protection against poisonous gases and fumes as well as research on ventilation in mines and on protective equipment.

In 1923, he entered the Public Health Service to do broad basic industrial hygiene studies with emphasis on the environmental aspects, an almost unexplored area up to that time.

For the next 13 years, Mr. Bloomfield was engaged in many field studies pertaining to the health of industrial workers. His work included studies of dust hazards in all types of industry, the pneumonia problem in the steel industry, and numerous other health problems in industrial plants. Following these studies, he wrote comprehensive reports which were widely distributed. Many practices in use today are based on these early investigations.

In 1936, when the Social Security Act was made a law, only four States employed industrial health personnel. With funds made available by this law, States were encouraged to initiate industrial hygiene programs, and Mr. Bloomfield was given the responsibility of helping to organize these State units. Today there are 44 State and 14 Local units in the United States helping to protect the health of millions of workers.

Mr. Bloomfield will also be missed in this country at the annual meetings of the American Conference of Governmental Industrial Hygienists, of which he was the secretary-treasurer for 11 years, and of which he is the chairman this year. Many members of that organization and others in industrial health circles in this country wished him well in his new job before he left in November.

SMALL INDUSTRIES IN GEORGIA ADVOCATE COOPERATIVE INDUSTRIAL HEALTH CENTERS*

By L. M. Petrie, M. D., and J. W. Lemon

An estimate of the national annual *financial losses* from disability due to accidents and illness is 30 billion dollars. *The businessman* can readily translate these costs into individual company *terms by figuring* the cost to his business of disability insurance—compensation, *liability*, *sickness*, accident, and hospitalization—and the extra payroll he has to support to supply replacements for absentees; he can estimate the losses in production and efficiency resulting from labor turn-over. These and other factors, run up his company's bill for human disability. Thus it is relatively easy to take the financial measure of his problem.

The Problem

The application of remedial measures is not so easy. The tools, skills, and knowledge necessary to effect an enormous improvement in our industrial health and accident record are available today, but resources are not being widely exploited by business. Nearly all establishments of more than 1,000 workers have some type of medical and safety program to control disability, but only 2 percent of all businesses in Georgia employ even as many as 100 workers, and half the places of business in our State employ 3 or fewer employees.

Small establishments employ the vast majority of our working population, but medical and safety programs are almost unknown in businesses of this most prevalent size. This dearth of health programs in small enterprise is reflected in higher accident, compensation, absenteeism, and labor turn-over rates. The coverage is poorest where the need is greatest.

Can Something Be Done?

Is small business inherently more hazardous than large? Is the small proprietor more callous toward human suffering and financial loss than his counterpart in larger enterprises? Although the answers are no, there is ample evidence that even a minimum specialized industrial health and safety program is usually beyond the financial and professional reach of the individual small firm. The expenditure per worker would be prohibitive. Many firms have investigated such programs only to have their interest quickly quenched by cold economic fact. This problem of reducing disability from illness and accident resolves itself into the necessity of making available to small private enterprises the requisite specialized medical and engineering knowledge, skills, and techniques at a cost which is not disproportionate to other business expenses.

Plans That Have Worked

Plans are in operation today which have proved themselves over a period of years to be eminently satisfactory in widely diverse circumstances. They have been successfully operating in small towns and large cities, in northern and southern communities, including two in Georgia, and in both unionized and unorganized industries. They have found favor with management, labor and the medical profession—no mean tribute! The one common factor in all these plans is the simple and familiar principle of cooperation: the banding together of small businesses to do for themselves what they could not individually afford. A cooperative Industrial Health Center plan is the solution.

How the Plan Works

Under this plan, several small businesses, individually unable to afford good medical and safety programs, may jointly agree to establish and support a cooperative health center adequately staffed and equipped, and conveniently located. The cost to each participating firm is proportionate to the number of workers employed and the services offered. Control of the center is generally invested in a board of directors representing one or more of the following: management, labor, any nearby professional schools, medical societies, and public and private health agencies.

The minimum number of workers which a fully staffed center can serve economically appears to be about 1,000, regardless of the number of establishments. It appears that irreducible overhead expenses make the cost of adequate full-time service prohibitively high for smaller groups in a competitive business world.

The number and kind of professional employees of the center may be varied to suit the local situation and the size of the population served, but the recommended minimum personnel includes at least one full-time physician or the equivalent services of part-time physicians, 1 nurse for each 300 employees up to 1,000, and 1 additional nurse for each additional 1,000, a trained first aid worker or nurse in each participating plant, and clerical help as needed.

Technical specialists, such as safety and industrial hygiene engineers, may be added to the staff as the center develops. Local professional schools help in securing a highly qualified professional staff; they provide laboratories and research; and they use the center for training physicians, nurses, engineers, chemists, and physicists.

Property and Equipment

The staff would require the following property and equipment to realize its full potential: a health center building conveniently located in the business community, general furnishings, special diagnostic equipment, instruments and supplies; in addition, each place of business must have its own first-aid room and supplies. The addition of a station wagon to this list may be required to facilitate emergency treatment and routine transportation, and the use of a mobile clinic, which has proved so successful in public health work, could be considered in future expansion plans.

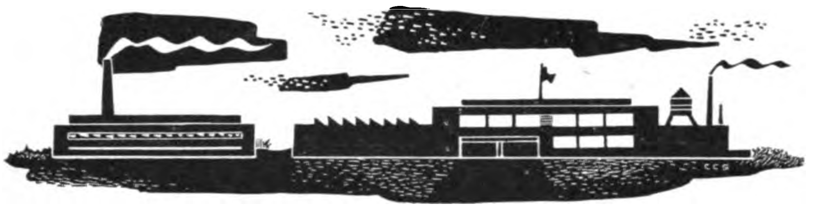
Services to Expect

Having provided a staff, quarters and equipment, the participating establishments could reasonably expect in return these services:

(1) Industrial health examinations of all members of the establishment—

Dr. Petrie is Director of the Division of Industrial Hygiene, Georgia Department of Public Health, and Mr. Lemon is the Assistant Chief Engineer of the Fulton County Health Department.

*Reprinted from *TRUX*, March 1950.



preplacement, periodic, and special.

(2) Selective placement of workers—matching the abilities of the worker to the demands of the job.

(3) Prompt emergency treatment of on-the-job accidents and illnesses, other illnesses being referred to the private physician.

(4) Professional nursing services for ill employees, health education, home visiting, and the execution of the attending physician's instructions.

(5) Other technical services such as engineering studies of environmental health and safety hazards of the business.

(6) Adequate records (including confidential personal health records) which will be the basis for analyses of absenteeism, turnover, types of disability, defense against fraudulent disability claims, and honest evidence of just claims.

(7) Coordination with, and full utilization of the social and health services of private and governmental agencies and resources.

What Will it Cost?

Capital and operating costs will necessarily vary with locality and the scope of the program, but the accompanying table will serve as a reasonable basis for estimating the expenditure necessary to operate the minimum program outlined above, almost anywhere in Georgia. The businessman will notice in this table the repetition of a common experience: The unit cost declines as volume increases. This fact points up the desirability of establishing a center which has the capacity to grow and to attract increased participation.

What Can We Gain?

The outstanding advantage of the scheme is that it makes possible the invaluable service of decreasing human disability with its attendant cost and misery to a segment of business which has usually found such a service otherwise unobtainable. The plan does not require a participating business to surrender any of its prerogatives, and although advisory services are available from governmental agencies, governmental regulation and interference are avoided.

The flexibility of the plan can also be placed to its credit. It can be expanded to provide new services or to serve more workers as the community grows, and as its patronage increases, either per capita costs may be expected to diminish or increasing services may be rendered. Taking cognizance of the fact that a large part of the lost time in industry is due to nonoccupational illness, the program undertakes to extend the influence of the plan through home visiting and instruction in personal health and nutritional problems.

Space has permitted but a brief and cursory outline of the application and organization of this plan which is capable of many variations to accommodate local needs, but your health department will welcome any request for information or help in extending the benefits of this plan to additional communities.

Annual cost estimate, to be prorated among industries on a per capita basis

1,000 employees		2,000 employees		5,000 employees	
Physician, half time	$4.000	Physician, full time	$8.000	Physician, 1 full time, 1 half time	$12.000
Nurses, 2	5.000	Nurses, 4	10.000	Nurses, 7	17,500
Clerks, 1	1.800	Clerks, 1	1.800	Clerks, 2	3.600
Supplies	1,200	Supplies	2.400	Supplies	6.000
Rent, heat, light	2.400	Rent, heat, light	2.400	Rent, heat, light	4.800
Total	14,400	Total	24.600	Total	43,900
Per capita	14.40	Per capita	12.30	Per capita	8.78

Cost of construction of building: 2,000 square feet for 2,000 employees at $10 per square foot, $20,000.

Property: Health center building, general furnishings, special diagnostic equipment, instruments and supplies, and first-aid rooms in industrial plants. A mobile clinic (truck-trailer) could be considered.

MANUAL ON LABORATORY PROCEDURES AVAILABLE

A MANUAL entitled *Laboratory Procedures in Industrial Hygiene*, compiled by Dr. F. H. Goldman, has been mimeographed by the Georgia Department of Public Health and made available to industrial hygienists who need it.

Until his recent assignment to the District of Columbia Health Department, Dr. Goldman served in the Division of Industrial Hygiene, PHS, and it was during that service that he, with the cooperation of other chemists, compiled this valuable collection of laboratory procedures. He used this material as a part of his teaching at the Georgia School of Technology when the Public Health Service, the Georgia Department of Public Health and Georgia Tech cooperated in offering graduate courses to engineers and chemists. As a courtesy, it was duplicated by the Georgia Department of Public Health and a limited number of copies made available to industrial hygienists.

Single copies may be secured without charge from Dr. F. H. Goldman, Bureau of Public Health Engineering, District of Columbia Health Department, 300 Indiana Avenue NW., Washington 1, D. C.

Harvard Plans Two Months Course In Industrial Health

From February 5 to March 31, 1950, Harvard University School of Public Health will give postgraduate training in industrial health to industrial physicians, industrial engineers, and other specially qualified personnel.

Courses and instructors are as follows: Basic Problems in Industrial Hygiene, Prof. Philip Drinker; Industrial Medicine, Dr. Robert B. O'Connor; Personnel Administration, Prof. B. A. Lindberg; Human Problems of Adjustment in Industry, Dr. Ross A. McFarland; Industrial Medical Clinics, Dr. Albert O. Seeler and Dr. Harriet L. Hardy.

Further information may be obtained by writing to: Mrs. Margaret G. Barnaby, Harvard School of Public Health, 55 Shattuck St., Boston 15, Mass.

Annual Census of Industrial Nurses Shows Illinois Top With 1300

By Winifred Devlin*

THERE were 10,796 professional nurses employed full time by industry in the United States, including the District of Columbia and Hawaii, as of January 1950, according to the annual compilation of nursing figures recently completed by the Public Health Service in cooperation with the State and Territorial health departments. Figures on industrial nursing were not available for Alaska, Puerto Rico, the Virgin Islands, or the State of Maryland.

Number of nurses by State and Territory.—The number of employed industrial nurses ranges from one in Montana to 1300 in Illinois. The largest number of industrial nurses was employed in Illinois, Pennsylvania, Michigan, and New Jersey. These four States account for 36.3 percent of the total.

The following table shows the number of industrial nurses employed in each State. These data were supplied by the health departments of 47 States and 1 Territory, and 2 State departments of labor. This material is not comparable with data published in the 1949 *Inventory of Professional Registered Nurses* by the American Nurses' Association because the dates of collection were not the same and compilation methods were different.

Data for the 5-year period 1946–50 show a slight upward trend in the reported employment of nurses in industry, an increase of 1,889 nurses. Whether or not this is an actual increase in the employment of nurses in industry, or due to more complete reporting is not known.

Percent of nurses reporting data.—There is considerable variation in the percent of nurses supplying information on type of service engaged in, general and professional education, and nursing experience, respectively. Approximately two-thirds or 70.6 percent of employed industrial nurses have reported "type of service" while a little over one-half have reported "general education" and "nursing experience" and only 15.7 percent reported "postgraduate education."

Type of service in which nurses are employed.—Of the 70.6 percent of nurses supplying information on type of services in which they are engaged, 90.6 percent are assigned to in-plant health service, 5.6 percent to hospital work, 2.7 percent to home visiting and 1.0 percent to the personnel department.

General education.—The data on general education supplied by 5,674 or 52.6 percent of the total number of industrial nurses reveal that 6.7 percent have had less than a high school education, 67.7 percent are high school graduates, while 22.3 percent have taken some college work and 3.2 have acquired one or more academic degrees.

When data are compared for 1949 and 1950 on the general educational background of the industrial nurse there appears a slight *decrease* in the number of nurses without a high school education, and a slight *increase* in the number of nurses with some college preparation, and one or more academic degrees.

Professional education, postgraduate courses.—Data on the number of postgraduate courses completed by industrial nurses were supplied by 1,695 or 15.7 of the total number of nurses reported employed in industry. Of these 1,695 nurses, 36.3 percent have taken clinical courses, 41 percent have completed courses in industrial hygiene, and 23.2 percent have taken courses in public health nursing. These data remain substantially the same when compared with corresponding data for 1949.

Years of professional nursing experience.—Data pertaining to years of professional nursing experience were received from 5,675 or 52.6 of the total

FULL TIME INDUSTRIAL NURSES, 1950 (BY STATES AND TERRITORIES)

State or Territory	Number of nurses	State or Territory	Number of nurses
United States	[1] 10,796	Montana	1
		Nebraska	43
Alabama	134	Nevada	11
Alaska	[2] NR	New Hampshire	36
Arizona	35	New Jersey	750
Arkansas	19	New Mexico	11
California	618	New York	685
Colorado	46	North Carolina	121
Connecticut	441	North Dakota	0
Delaware	45	Ohio	487
District of Columbia	258	Oklahoma	46
Florida	56	Oregon	57
Georgia	145	Pennsylvania	1,034
Hawaii	92	Puerto Rico	[2] NR
Idaho	3	Rhode Island	83
Illinois	1,300	South Carolina	130
Indiana	439	South Dakota	3
Iowa	99	Tennessee	241
Kansas	71	Texas	154
Kentucky	90	Utah	34
Louisiana	102	Vermont	22
Maine	55	Virginia	89
Maryland	[2] NR	Virgin Islands	[2] NR
Massachusetts	634	Washington	107
Michigan	838	West Virginia	171
Minnesota	172	Wisconsin	429
Mississippi	44	Wyoming	5
Missouri	271		

[1] Includes 39 nursing consultants employed by insurance companies assigned to 2 or more States.
[2] NR indicates that no report was received.

*Miss Devlin is Industrial Nursing Consultant with the Division of Industrial Hygiene, Public Health Service.

number of employed industrial nurses. Of this number 9.4 percent have had less than 1 year of experience in industry; 38.5 percent have had 1 to 5 years of experience and 51.2 percent have had more than 5 years of experience in industry.

In this group of 5,675 nurses, 3.8 percent had less than 1 year of experience in public health nursing; 5.9 percent had 1 to 5 years; and 3.3 percent reported more than 5 years of experience in public health nursing.

The data also show that 19.4 percent had less than 3 years of experience in other fields of nursing, while 54.9 percent have had more than 3 years in fields of nursing other than industry and public health.

Conclusions.—While this census of industrial nurses is incomplete it would seem to indicate certain conclusions among which are the following:

1. A slight increase in the employment of nurses in industry.
2. A trend toward collegiate preparation with an increase in the number of industrial nurses now holding academic degrees.
3. Less turnover in the employment of nurses in industry reflected by the fact that more than one half have had five or more years of industrial experience while the number employed in industry for less than a year has decreased.

Note.—The schedule used in the collection of data on the Census of Industrial Nurses appears in "1948 Census of Industrial Nurses in the United States," *Industrial Nursing*, for November 1948, pages 7–10.

Baltimore Industries Study Air Pollution

THE undertaking of an industry-sponsored survey of air pollution in Baltimore, especially the Curtis Bay-Fairfield area, has been announced by the Association of Commerce Air Pollution Committee. Employed to make the studies are the Kettering Laboratory of Cincinnati and Weather Services, Inc., of Boston.

Dr. H. C. Willet, of the Massachusetts Institute of Technology, will be in charge of the meteorological research, while J. Cholak of the University of Cincinnati, will direct the air sampling and chemical aspects of the work.

Dentists, Employers, Workers Approve Dental Program

By Dr. E. R. Aston*

After 7 years of operation, the dental section of the Bureau of Industrial Hygiene, Pennsylvania Department of Health, is reviewing its program in industry and evaluating its accomplishments.

The objectives of the program have been to furnish industries and their employees with a free diagnostic service consisting of complete oral examination, including the use of X-ray, recommendations for correction or treatment where indicated, and referral of the employee to the dentist of his choice.

No greater cooperation or appreciation could be desired from management than that experienced in rendering these services to Pennsylvania industries. Expressions of the employee, the individuals to whom we should really look for acceptance of the program, are divided into two groups: Those who received the service and those who did not. Experience has indicated that the first group has been fully appreciative. Those who did not participate in the program regretted that they had not availed themselves of this opportunity. Participation in some 30 surveys has ranged from 30 to 100 percent, the average being approximately 70 percent.

Participation is voluntary, and all findings are confidential, the entire program being on an impersonal examiner-employee basis. No individual findings are reported other than to the employee himself. This procedure has been followed strictly and the results have been very favorable. Management receives a report which covers the entire group but not as individuals. The X-ray films remain the property of the bureau, but in cases where the employee's dentist requests to see them they are lent with the provision that they be returned when the case is completed.

Many letters expressing gratitude for the service have been sent to the secretary of health and to the bureau's director. The following is a typical example:

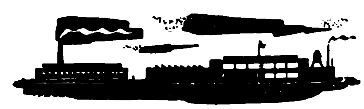
"We want to thank the Department of Health for the detailed report of the dental survey made in our plant. It is very gratifying to our management to have been made familiar with this phase of the physical condition of our employees and it will help us in future personnel relations.

"We have heard only favorable comments from our employees and union officials regarding the survey, and the Pennsylvania Department of Health is to be congratulated on creating a favorable impression with our employees regarding their State government's interest in them."

The attitude of dentists in areas where surveys have been conducted is varied. There are those who are not familiar with the objectives of this program through reading the current professional literature. As a result, these dentists offer objections. Upon questioning they are of the opinion that corrective work is being done for the employee at State expense. However, they become aware of the value of such a program when its objectives are explained and when those employees who have participated seek their services. The dentists who are familiar with the program wholeheartedly support it.

A good industrial health program will do much to improve industrial relations and, of course, dentistry must necessarily be included. The favorable acceptance of the dental section's activities by management, employees, and the dental profession indicates that its objectives are being fulfilled.

*Dr. Aston is Dental Consultant with the Bureau of Industrial Hygiene, Pennsylvania Department of Health.



VERMONT GRANITE—

(Continued from page 4)

contractors to make sure this work is done as soon as possible and in an approved manner. When this work is completed the granite sheds will for the first time be operating local exhaust units which meet minimum standards. Good maintenance on the part of the manufacturer, plus cooperation on the part of the employee in using and caring for the equipment provided him, will reduce to a negligible quantity the dangerous silica exposures experienced in the past.

MASSACHUSETTS PLANTS COLLABORATE TO CONTROL DUSTY OPERATIONS

By Harold Bavley and Richard I. Chamberlin [1]

THE engineers of the Massachusetts Division of Occupational Hygiene have been instrumental in effecting liaison between plants for control of dusty conditions in similar manufacturing operations. This liaison involved working with the engineering staffs of the various companies to control a specific dust hazard encountered during several identical operations common to each plant.

Upon completion of the technical aspects of the design and specifications, the selected plans were placed in operation by the actual construction and testing of the control equipment. The most effective of the designed controls for a given operation were selected from each plant and photographed. These photographs and design specifications were then interchanged by the Division engineers between plants having similar uncontrolled operations.

A preliminary survey of the panning and depanning operations at two wire-covering plants revealed a definite hazard due to the high talc dust concentrations in the working atmosphere. The panning operation involves the loose coiling of the rubber-covered wire in a circular metal pan prior to vulcanization. The talc dust is applied liberally by means of a hand scoop to the rubber-covered wire, while the coiling operation is being performed, to prevent adhesion during the vulcanizing process. After vulcanization, the wire is removed from the pans by uncoiling, and is then tested and rewound. Formerly, the remaining surplus talc in the pans was removed by dumping this material onto the floor, to be handshoveled into a storage bin or barrel containers.

Considerable talc dust was dispersed into the working atmosphere during these operations. The average dust concentration found was noted to be approximately 150 million particles per cubic foot of air, while individual dust concentrations of well over 300 million particles per cubic foot of air were found during the pan pumping and handshoveling operations.

After careful study and planning, a satisfactory ventilating system was designed and erected for the panning operation at one of the plants, as is shown in figure 1.

The wire-panning ventilation system consists of a circular slot-type hood exhausted through two 7-inch round ducts. There is a ½-inch slot at the upper inside edge of the hood and a 1-inch slot at the lower inside edge. A total of 2,700 cubic feet per minute is used to exhaust this system. To protect the exhaust ducts from moving trucks, belts, and the like, a 1/16-inch steel duct has been installed about the regular duct work.

The most effective control for the depanning and pan-cleaning operations was designed and installed at another wire-covering plant, as is shown in figure 2.

The ventilating system for the depanning unit consists of a movable cone-shaped canopy type hood which is fitted over the circular metal pan. The hood is exhausted at the rate of 800 c. f. m. through a flexible duct 6 inches in diameter. A smaller hood is located about the wire outlet at the top of the canopy hood, and this is exhausted by a 2-inch duct connected to the 6-inch metal coupling. A control velocity of 200 linear feet per minute is maintained through all hood openings. A duct velocity of at least 4,000 l. f. m. should be maintained.

The pan cleaning unit consists of a rotating table on which the pan is placed, and an exhausted scoop for removing the surplus talc from the pan. The talc is pneumatically conveyed to an enclosed bin for storage until needed.

CONCLUSIONS

The effective control provided for these operations has resulted in reducing the concentrations of talc dust in the working atmosphere to well below the Massachusetts allowable concentration of 20 million particles per cubic foot of air.

This illustrates how a governmental agency interested in the prevention of occupational diseases can assist management in the control of specific health hazards, by arranging for the exchange of ideas and newly developed designs among plants having similar problems.

The cooperation extended to the authors by the covered-wire and cable manufacturing concerns is greatly appreciated.

[1] Engineers, Division of Occupational Hygiene, Massachusetts Department of Labor and Industries.

BELOW–1. Ventilated wire panning unit.
CENTER–2. Ventilated depanning unit.
RIGHT–3. Rotating table and exhausted scoop for pan cleaning.

MENTAL HEALTH IN INDUSTRIAL RELATIONS

By Robert L. Sutherland *

BOTTLENECKS in business and industry were for many years technological. Advances in tool construction and plant layout are still to be made, but management is now turning its attention to a more serious slowdown factor—the variability of human behavior.

At one time, business and industry tended to govern the human material by a rough-and-ready personnel policy of "take it or leave it," but wartime labor shortages, the power of unions, and the enlightenment of management have all contrived to make this policy outmoded.

The newer approach calls for an understanding of worker attitudes, for a knowledge of group morale, and even for psychological insight about top management itself.

When the desire to understand human variability first entered the minds of business and industrial leaders, it was accompanied by the hope that quick and certain explanations about human behavior would be forthcoming. Aptitude and other vocational tests looked like the sure way of weeding out the unfit and of properly placing those who were accepted. Personality tests were the new way of measuring qualities of leadership among supervisors and top management. Technological problems had been solved scientifically, so why could not problems of human nature yield to exact methods as well?

Uncooperatively, human nature failed to respond, or to be encompassed by these "scientific methods." The approaches named had value, but were only a partial answer. They did not account for enough human variables. * * * They forgot that while people can be organized on a chart, the intangibles of how they feel about their job, as well as how they are adjusted in their off-the-job relationships, will determine their performance. Disillusioned by the failure of these early methods to give the full answer, business and industry are in a welcoming mood. They are anxious to accept ideas and help from any discipline that has insight about human behavior. Mental hygiene is proving to be one of these sources.

* * * * *

The mental hygienists' understanding of the emotional needs of people, the causes of frustration and discontent, the reasons for antagonistic and rebellious attitudes, and the ingredients of positive satisfactions and high morale are proving to be applicable to a work group as well as to any other. These principles help foremen understand that their own reactions and those of their workers are not what they seem on the surface, but reflect patterns that have developed over a period of years, and that change slowly because they serve the individual emotionally.

The mental hygiene point of view also has been that business and industry themselves have a responsibility in creating better opportunities for good housing, recreation, improved family relations, and greater social satisfactions on the job; that people who grow up in such a positive environment are much freer of antagonisms and compensatory forms of behavior.

At one time, a factory superintendent thought that high absenteeism and low morale were caused by general states of mobility and unrest in the community. He expected schools, churches, and welfare agencies to stabilize families in order that business might have a dependable work group, but now he sees that management is in the partnership. Dr. Elton Mayo, of Harvard, has shown that social satisfaction on the job, the dynamics of group interaction, the role of the foreman as a group leader—that these become a new concern and a challenge to management.[1]

The training of supervisors in an understanding of these matters is a joint undertaking. Contributions are made by clinical psychology and psychiatry, but also by cultural anthropology and sociology, as well as by religion and education. Research studies set up by industry itself utilize all of these approaches in understanding "why people work." This team approach is slower, but less likely to omit important factors.

* * * * *

Many companies are finding that a consultative relationship with the community mental hygiene clinic is valuable. Others have found it worth while to add a psychiatrist or a clinical psychologist to their own staff. Still others advise that the greatest value comes in a broad educational effort to improve the insight of all supervisors into the emotional needs of people and the various manifestations of that need. Such education of supervisors is carried on by a psychiatrist or a clinical psychologist, and the preventive work with individuals and groups is done under the guidance of such an expert.

The third contribution of the mental hygiene point of view is to management itself. Self-discipline and high-pressure output are responsible for the arrival of many superintendents at the top rung. This very drive may have made the individual blind to his own intolerances. Harmony does not always exist among top-bracket supervisors any more than it prevails between management and labor. Supervisory wheels can be skidded because of unnecessary jealousies, short tempers, high fatigue, poor placement, or a sense of inadequacy for the job. Top management is now realizing the need of psychological consultation help. It is provided by a staff expert, or by an outside consultation group of psychologists or psychiatrists, or by experts located in a nearby clinic or university center.

No utopia has been found; the more we know of human nature, the more complex it becomes. Nevertheless, mental hygiene, accustomed as it has been over the years to a team approach to any problem of human behavior, does have a distinctive contribution to make in this new and most important field.—

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* **Mr. Sutherland is director of the Hogg Foundation, Austin, Tex.**

[1] See *The Social Problems of an Industrial Civilization*, by Elton Mayo. Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1945.

BALTIMORE, MD.

Personnel.—Dr. Royd R. Sayers, retired medical director of the Public Health Service and former chief of the Division of Industrial Hygiene, has accepted a part-time position with the Baltimore City Health Department. Since the resignation of Dr. John M. McDonald, the Health Department has been unable to get a qualified physician for occupational disease prevention and control.

LOS ANGELES (CITY), CALIF.

Radiant Energy.—In a local industry, plans for a new assembly line operation were fairly well developed before the plant nurse learned, by chance, that it would involve radioactive material. The engineering department was satisfied that there should be no real hazard, on the basis of scanty information furnished by the supplier of the radioactive material, but the nurse insisted that this division be consulted before the operations were begun.

Preliminary tests proved that the hazard would be a real one, if appreciable quantities of the radioactive material were handled at one time, or the finished parts allowed to accumulate. Through the Atomic Energy Project at U. C. L. A. we have been offered assistance in a test setup to determine how the operations should be conducted, in order to provide maximum protection for the workers.

If the result of this effort is a safe operation, the credit goes to the alertness of the plant nurse.

Student Nurses.—An announcement and description of this division's teaching program for student nurses was sent to those hospitals in the city which have training schools. Favorable replies were received from three, expressing an interest in this program and requesting further information. As a result two of these hospitals will incorporate the program within the curriculum for their senior students, beginning in January. The third is considering the program for a later date.

The White Memorial Hospital is activating the program now. The industrial nurse consultant has talked to the senior students, and has arranged plant visits for them. Within this field of work, plant visits are being conducted for public health nurse affiliates and new members on the city health department nursing staff.

Ceramics.—A large ceramics firm, with southern California headquarters in their Los Angeles plant, has shown a sustained interest in learning which health hazards are dominant, as a guide for improving the engineering controls of harmful in-plant air contaminants.

Impressed with the value of dust determinations and other tests made by the Division of Industrial Health in a series of previous studies, they have established their own industrial hygiene program. After acquiring the necessary air sampling and dust counting equipment, they have assigned an engineer, whose work includes the design of dust control equipment, to make periodic checks of all their southern California plants for siliceous dusts and airborne lead.

At the request of the safety director, we helped the engineer learn the fundamentals of air sampling techniques and dust counting, and will make side-by-side tests in the plant for comparison of results.

Poster.—Many cases of industrial dermatitis, especially in machine shops and machining operations, have been traced to the cutting oil (coolant) and to inadequate programs of personal cleanliness.

The medical department of the General Petroleum Corp. has prepared an excellent safety poster outlining the chief steps to be taken by those working with cutting oils, to prevent skin effects.

Noise.—During the summer the division was flooded with complaints of noise from a variety of sources.

A retired judge complained that a retired neighbor, who uses a power saw for his woodworking hobby (during the day) was creating a noise nuisance. The judge was "against hobbies."

An author in the Hollywood hills was unable to concentrate on his work because musicians in a nearby home were practicing on horns.

A spokesman for a residential community complained of noise from the warm air blower on an automobile wash rack.

A housewife objected to the loud music of an ice cream vendor, which interfered with the children's nap.

KANSAS

X-ray Shoe Fitting Machines.—The Kansas State Board of Health at its regular quarterly meeting, January 1950, adopted a regulation requiring the placarding of all fluoroscopic shoe-fitting machines in the State. For the convenience of the owners of such equipment, complimentary placards were distributed by personnel from the industrial hygiene section who also gathered data on each machine to determine the magnitude of this hazard throughout the State. Measurements were made of exposures from direct and scatter X-radiation as they apply to both the customer and operator. In addition, certain protective features and control devices were evaluated for each machine. As a result the characteristics of 108 installations in all sections of the State have been checked and reasonable and proper recommendations made through individual reports to each owner. It is of interest to note that in only two instances were recommendations unnecessary.

A comprehensive report of this survey has been prepared and is available upon request from the Kansas State Board of Health.

Personnel.—Mr. Richard T. Page has been appointed assistant professor of civil engineering in charge of sanitary engineering curriculum at the University of Kansas. Prior to this appointment, Mr. Page had been employed as principal sanitary engineer with the Kansas State Board of Health.

MONTANA

Administration.—The Montana Industrial Accident Board and the State Board of Health have issued a joint statement in which they define their areas of responsibility and their plans for implementation. The Industrial Accident Board is responsible for inspectional services and law enforcement. The State Board of Health has the responsibility of administering an overall preventive medical program for the industrial worker and for promoting in industry the many specialized services of the Board affecting the public health.

Arsine Poisoning.—Four fatal cases from arsine poisoning occurred in a zinc electrolytic refinery in the department where the filter press cake from the purified solution for the zinc electrolytic cells is leached. In the process, the cake, which also contains arsenic and antimony, is mixed with acid to recover zinc, cadmium, and copper. The cake is "ponded" for periods of from 6 to 9 weeks to oxidize the metals in it, in order to reduce the possibility of liberating hydrogen which could react with the arsenic in the mixture.

Nevertheless, on the particular day of the poisonings, large enough concentrations of arsine were liberated to cause these fatalities with exposures of from not more than 25 to 45 minutes. It is interesting to note that, although articles in the literature on arsine poisoning state that the symptoms occur from 6 to 36 hours after exposure, in these cases definite symptoms occurred in less than an hour. The hemoglobin in some of these four cases went down to 60 percent in less than 2 hours from the time of the beginning of exposure.

Henry N. Doyle, chief, and D. E. Rushing, chemist, of the Industrial Hygiene Field Station of the United States Public Health Service, and the director of the Montana Industrial Hygiene Division made a complete review and study of the operations at the site of the arsine poisonings. A complete report of the investigation is now being prepared.

Conference.—The Division of Industrial Hygiene, for the third consecutive year, was given the responsibility of arranging the industrial health phase of the program for the annual meeting of the Montana Safety Conference.

The program consisted of a panel on "Dermatitis in Industry." Participating was a dermatologist who spoke on medical aspects, a representative from management who spoke on how an industry controls potential dermatitis problems, and the director of the division on the role of the State health agency.

The panel was led by the new executive health officer of the State Board of Health, Dr. G. D. Carlyle Thompson.

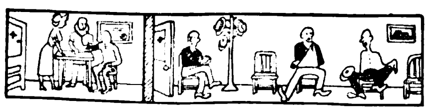
ST. LOUIS, MO.

Personnel.—Mrs. Alice C. Devers, R. N., is at present a student at Yale University School of Medicine, Department of Public Health, New Haven, Conn. Dr. B. W. Lewis is replacing her on the roster of State editors for the *Industrial Hygiene Newsletter*.

TEXAS

Defense.—The industrial hygiene section has proposed a six-point outline for radiological activities of the Department of Health in connection with the Governor's civilian defense program. Pending receipt or development of additional instruments and suitable training aids, necessary for an expanded educational and training program, members of the industrial hygiene staff have already made plans for initiation of educational programs which probably will be increased into a radiation monitoring training program for key members in 15 of the Texas civilian defense districts.

It is hoped that funds may be procured for the establishment of one or more film badge laboratories, preferably mobile, for this program. Such facilities would have continued peacetime application in regular health hazard evaluations concerning ionizing radiations. Unless additional personnel or outside assistance is obtained, it is anticipated that civilian defense activities will consume an increased part of the time allocated to the entire industrial hygiene program.



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CULPRITS *in Industry*

HYDROGEN SULFIDE CAUSES DEATH OF THREE MEN IN WELL

THE XYZ CO., was getting its plant ready to start packing green beans, lettuce, and celery from the nearby Okeechobee truck farms. Because a large supply of water is needed to wash the vegetables, the plant superintendent made a special inspection of the well which supplies this wash water.

The well was about 6 feet square and had been sunk some 18 to 20 feet in the muck. It was boarded in with heavy plank and fitted with a plank cover. The superintendent had the well pumped out and then he climbed down a ladder to inspect the bottom of the well. He found that a good deal of muck had accumulated and decided that the well should be cleaned out.

A colored laborer went down into the well and started to shovel muck into the bucket. He worked for a few minutes and then suddenly collapsed. The superintendent who was standing at the top of the well saw the laborer fall. He immediately went to the rescue but after a brief effort, he, too, collapsed. The crew foreman was a witness of the superintendent's fall. He gave the alarm and climbed down the ladder into the rising water to assist the two unconscious men. In a minute or two he also became unconscious and fell forward into the water. The local fire brigade was summoned and came at once to assist in pumping out the well.

A local diver, lowered with a rope around his waist, recovered the bodies of the three men. In the meantime, some 20 or 30 minutes had gone by and, although the three victims were given prolonged artificial respiration, they did not recover.

Some days later an inspector from the Florida Industrial Commission and an industrial hygiene engineer from the State Board of Health made a study of the well. Conditions were made as near as possible to those which had prevailed at the time of the accident. The water was pumped out to a depth of 18 feet. At this level the air in the well contained 250 p. p. m. of hydrogen sulfide; even at 1 foot below the surface of the ground the concentration was 220 p. p. m. Later, analysis of air samples confirmed these reports and also disclosed that the oxygen content in the well was 19.8 percent.

It is realized, of course, that accurate reproduction of conditions of exposure is difficult. Meteorological conditions, especially wind velocity, may have a marked effect on gaseous conditions. The stirring of the mud at the bottom of the well may have accelerated the escape of hydrogen sulfide from the ground water. Heavy breathing of the laborer at work may have reduced the oxygen content of the air. Concentrations of hydrogen sulfide prevailing at the time of the accident may well have exceeded those at the time of investigation. Even so, it is clear that hydrogen sulfide was present in extremely dangerous concentrations. It appears probable that these men were first asphyxiated and later drowned.

In the course of this investigation it developed that there had been several previous occurrences where well cleaners had been overcome by hydrogen sulfide gas, but had been rescued in time. The following preventive measures were adopted:

(1) After the well has been pumped out for cleaning, the discharge tube of a power ventilator is to be lowered to within 3 feet of the bottom. Air is to be pumped into the well for 15 minutes before anyone enters it. This ventilator is to be kept running as long as anyone is in the well.

(2) Every person entering a well should be provided with a safe life line firmly secured at the upper end.

(3) The winch should be of sufficient capacity to lift a full-size man.

(4) If a person working in the well notices any dizziness or difficulty in breathing, he should immediately be brought to the surface.—**Industrial Hygiene Division, Florida State Board of Health.**

MICHIGAN WANTS I. H. ENGINEER

The Division of Industrial Health, Michigan Department of Health, has an opening for an experienced industrial health engineer. Requirements for position include engineering degree. Those interested should submit outline of experience and qualifications. Address Chief of the Division, Dewitt Road, Lansing 4, Mich.

FILTRATION METHODS FOR THE COLLECTION OF ATMOSPHERIC IMPURITIES

Sidney Laskin, Paul B. Frank, and Robert H. Wilson, Univ. of Rochester*

Available information on sampling atmospheric impurities by filter paper methods has indicated that numerous intimately related variables affect efficiency of collection. These include such factors as the type of paper, sampling velocity, relative humidity, particle size and physical properties of the contaminant and possibly atmospheric concentrations.

To elucidate this problem, studies using a filter paper sampling train followed by a flame photometer were made to evaluate end losses. Sodium chloride aerosols at an average relative humidity of 82 percent were selected to permit simple analysis with the flame photometer. Particle-size measurements obtained from electron micrographs of samples collected with a thermal precipitator showed a mass median diameter of 0.30 micron and a geometric standard deviation of 1.74. Under these conditions, experimental data showed that the penetration losses to the flame photometer remained constant irrespective of the amount collected on the filter paper up to a 2.5 mg sample. The flame photometer was found to have a limit of sensitivity equivalent to 30 micrograms NaCl/m³ and a standard error determined from known solutions of 2.2 percent.

The studies thus far have been limited to the effects of sampling velocity and concentration on the efficiency of Whatman #41 filter paper. Aerosol penetration of progressive numbers of elements of a filter paper train were measured by the flame photometer at a sampling velocity of 39.2 cm/sec from a concentration of 43 mg/m³. The concentration passing the first paper decreased from 2.84 to 0.03 mg/m³ passing the sixth paper, which represented the limit of sensitivity of the flame photometer and only one percent of the amount passing the first element. A plot of the cumulative total efficiency of the train showed a value of 99.93 percent for six papers.

The curve rises rapidly from 93.4 percent, and above four elements approaches the 100 percent value asymptotically. To permit analysis of samples collected by filter paper trains only, the concentrations collected on each of the elements in these studies were expressed as the cumulative percentage increase above the value of the first paper. A plot similarly shows the increase in efficiency with increasing number of elements of the filter paper train, approaching a limiting value of 7.1 percent asymptotically. The efficiency of a single paper obtained from this value, of 93.3 percent, is in excellent agreement with that obtained from the flame photometer results.

Detailed analysis of samples collected with the multiple filter paper train only was made at an average concentration of 29.8 mg/m³. Sampling velocities at 8 points from 7.2 to 140.8 cm/sec were explored using trains of from 5–10 filter papers. Plotting the concentrations collected on each element, as above, a family of curves were obtained each of which approach a limiting value asymptotically. These results led to the use of this limiting value to determine the efficiency of the initial element. The number of elements required to sample the atmosphere completely was found to be directly related to the sampling velocity. Thus at 140.8 cm/sec, the initial paper showed an efficiency of 99.6 percent and a minimum of two papers was required for significant results, whereas at 7.2 cm/sec the initial paper showed an efficiency of 71.3 percent and a minimum of eight papers was required.

A range of sampling velocities from 7.2 to 142 cm/sec was explored with over 140 determinations made at 15 sampling velocities in order to obtain statistically significant results. Typical data of 9 samples at 38.1 cm/sec showed a range of velocities maintained from 37.0–41.0 cm/sec with efficiencies of from 93.2–96.9 percent. The mean results show a rapid increase in efficiency with increase in sampling rate from 7.2 cm/sec up to 36 cm/sec with efficiencies of 73.3 and 94.5 percent being found, respectively. With further increase in sampling velocities, the efficiency increased more slowly, gradually approaching 100 percent with the highest recorded value being 99.6 percent at 142.4 cm/sec.

Concentration studies to date on the effect of sampling velocity on efficiency at levels of 31.0 and 10.8 mg/m³ do not show that efficiency varies with concentration.

*Drs. Laskin, Frank, and Wilson who are associated with the Atomic Energy project, University of Rochester School of Medicine, presented this paper at the American Industrial Hygiene Association meeting in Chicago, April 1950.

HIGH EFFICIENCY COLLECTION OF RADIOACTIVE DUST*

By Knowlton J. Caplan[1]

Dust collectors used on radioactive dust must meet some rather stringent and unusual requirements, over and above the usual application. Such requirements are:

(a) The dusts handled are valuable, and are subject to very low "tolerance" figures from the air pollution standpoint. Furthermore, many of the materials are "accountable" in the security sense. These factors make a high cleaning efficiency necessary. Efficiency requirements are 99.99 percent or better.

(b) The radioactive nature of the collected dust restricts the allowable time which a man may spend at or in the collector. Thus minimum maintenance requirements are essential. Speed and ease of maintenance is also important.

(c) Regulations prevent the free disposal of solid or liquid material if it is contaminated with radioactivity. A minimum of liquid or solid waste requiring special disposal is important.

Dust collectors are tested by sampling the clean side of the collector with isokinetic samplers. Data are presented illustrating the magnitude of the errors involved if dust samples are taken with conventional room-air sampling equipment.

The type of collector which has so far best met our requirements is based on the Hersey reverse-jet principle. Such collectors are operating on dust loads from 0.07 to 32 grains per cubic foot, at air-to-bag ratios of 16 to 27 cfm/sq. ft., with pressure drops of 3.5 to 6.5 inches w. g. Under these conditions collection efficiencies range from 99.95 to 99.99% percent. These collectors also have the advantage of low material hold-up, and quick, easy maintenance.

*Speech presented at the Industrial Health Conference, Chicago, April 1950. An abstract is presented here.

[1] Mallinckrodt Chemical Works, St. Louis, Mo.

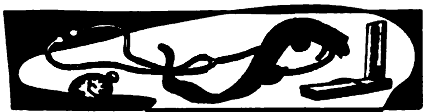
Occupational Hazards in Sewage Handling Plants*

A GREAT deal of time and effort has been spent to insure the health and safety of miners who work underground, but very little attempt has been made to insure the health and safety of the thousands of workers engaged in underground work in our city streets. Deaths and other accidents from toxic gases occur too frequently among men working in sewer manholes.

To determine the major sources of dangerous gases and what logical control measures would be necessary to maintain a safe working environment underground, a joint study was undertaken in early 1949 by representatives of this Bureau and the Division of Industrial Safety, in cooperation with the Orange County Health Department. Operations were studied in 50 sewage-pumping and 7 sewage-treatment plants in Orange County.

Atmospheric samples were collected in a large number of these locations, and were analyzed for hydrogen sulfide, oxygen, combustible gases, and carbon dioxide. Sampling equipment included the M. S. A. hydrogen sulfide detector, equipped with sensitive tubes to detect concentrations of hydrogen sulfide as low as 1 part per million parts of air, by volume; the M. S. A. Explosimeter, combustible gas indicator; and Orsat sampling bottles to determine oxygen and carbon dioxide percentages. In addition to the analysis of the atmosphere of the pumping pits, measurements of the quantities of air being circulated by mechanical exhaust ventilation were made with the Alnor velometer.

In any sewage pit, where raw domestic sewage has been retained for more than a few hours, the likelihood of hazardous conditions developing is great. Hydrogen sulfide and methane production and oxygen deficiency may result as sewage becomes septic. In addition to the primary hazard of oxygen deficiency and hydrogen sulfide contamination, these areas are exposed to the possibility of underground natural gas infiltration, which may cause fire or explosion. In some vicinities, where gaso-



line has been transported in underground pipes, leaks in these pipes might produce explosive concentrations by infiltration into the sewers. Moreover, there is the possibility that industrial wastes, which may contain petroleum naphtha, gasoline, or other volatile solvents will be capable of producing combustible atmospheres in the sewers.

In addition to the hazard of exposure to toxic gases, workers are exposed also to the possibility of infection, disease, and physical hazards, such as unguarded machinery, pump shafting, unsafe ladders, and substandard electrical equipment and wiring. Clarifiers and aeration tanks in treatment plants often are unguarded by hand railings.

Oxygen Deficiency and Hydrogen Sulfide

After considerable study of the conditions by sampling the atmospheres in the manholes and in other points of the sewage system, it appears that the most probable health hazards are oxygen deficiency and the presence of hydrogen sulfide. Only a very few of the pumping pits had been provided with ventilation facilities, and even these in general were ineffective. Our tests and observations in both wet wells and dry wells showed that hydrogen sulfide was the only noxious material regularly encountered in any of these pits. Concentrations varied from 0 to 300 parts per million.

At no time were oxygen deficiencies or detectable concentrations of combustible gases encountered. This does not imply that such conditions never exist, for there is good evidence that they do. The many reports of explosions in sewer systems is ample evidence that explosive concentrations do develop on occasions. The observations of excessive corrosion to the pipes and spalling of the concrete walls indicated high maintenance and repair costs. These conditions existed especially in those locations where no mechanical exhaust ventilation was provided and where sewage flow was extremely sluggish.

Adequate Ventilation Essential

As a result of our observations and tests, we have concluded that all pumping pits, but especially those which are more than 6 feet deep, should be provided with adequate ventilation. We base this conclusion on the following:

1. Any health hazard that might exist due to noxious gases present in the atmosphere or from a decrease in atmospheric oxygen should be minimized or eliminated.
2. All combustible or explosive gases should be removed so that fire or explosion will not occur within these structures.
3. Condensation of moisture which causes corrosion of machinery, electrical conduits, wire connections and fixtures, as well as the concrete structures itself, should be prevented. This corrosive action seems characteristic of sewer condensates.
4. Obnoxious odors that may come from sewage pumping stations should be prevented by maintaining sufficient ventilation to keep the atmosphere in the station below the odor threshold. This means removing odors in low concentration immediately upon their production.

We have found that when continuous ventilation is used, all of these objectives can be accomplished if at least 10 air changes per hour are provided in the dry wells and at least 25 air changes per hour are provided in the wet wells. It should be pointed out, however, that the characteristics of the sewage should be considered when designing ventilation for wet wells. It appears logical that if all pumping stations along the line are provided with continuous ventilation in wet wells, no odor problem will result from the discharge of this air into the atmosphere, even in residential communities, provided that the amount of air circulation is sufficient to maintain the concentration of gas below its odor threshold at all times.

In some locations, a satisfactory job of ventilation was accomplished by

*Investigation Report No. 5, *Occupational Health Bulletin*, May 1950, California Department of Public Health.

blowers that were operated only at the time when persons had to enter the dry or wet wells. In these stations, 60 to 70 air changes per hour were provided. The starting switch for the ventilation system was located on the outside of the structure, so that the ventilation system could be turned on about 15 minutes before entering the pit. This seemed to provide satisfactory protection for the health of the operator. The other objectives mentioned were not so well accomplished. Intermittent ventilation, particularly of the type connected to the pumps, or flow control, should be avoided because in all cases this gives rise to greater odor nuisance. Odor problems are best eliminated by continuous ventilation.

The criterion of "air changes per hour" apparently works satisfactorily in practically all sewage pumping stations, which are built as small as possible to accommodate the equipment and machinery. In sewage treatment plants, however, it may not be valid to use the basis of "air changes per hour" without considering the size of the structure. In cases where sewage treatment plants are covered and the housing is kept at a minimum, the same figures for ventilation of sewage pumping stations might be applied; but in treatment plants where the structures are large, the figures should be modified. We think, however, at the present time, that the magnitude would be much the same, particularly when odor problems are involved.

In the sewage pumping plants and treatment plants, permanent installations of exhaust blowers can be made easily, since electricity is available in practically all cases. In maintenance work, in underground sewers, and in manholes, it may be necessary to have other equipment to provide a safe working environment for the operators. It is suggested that a portable exhaust blower of 1,000 c. f. m. capacity, operated by a small internal combustion engine, be secured and made part of the maintenance crew equipment. Flexible canvas duct with spiral wire reinforcement is available for use on the suction side of the blower without collapsing. On the discharge side of the blower, a canvas sock can be used without reinforcement.

Consideration should be given to location of exhaust ducts. We believe that the air should be taken out near the bottom of the pit, and the fresh air should be introduced near the top. This is desirable for two reasons: (1) If any contamination occurs during the pumping, it will be near the liquid, which is always near the bottom of the pit. If the entrance to the exhaust system is located near the bottom of the pit, the gases will be collected in a much higher concentration and will be removed before they permeate the entire structure. On the other hand, if the fresh air is blown into the pit and allowed to exhaust through the manhole, the contamination is diluted and persists throughout the entire structure. (2) In deep pits, as the blower is turned on, with the air blowing in at the bottom, the contaminated air is blown up past the operator as he starts down into the structure. Thus, he may be overcome, fall, and suffer accidental injury in addition to the systemic effects of the gas. If the pattern of ventilation is reversed, he will descend into the pit in an atmosphere of fresh air. When the area is ventilated continuously, however, the consideration of direction of flow is not so important.

Safety Equipment

In addition to the air-moving equipment, a safety lamp for indicating oxygen deficiency should be a part of the equipment of every crew, and every crew member should know how this instrument works. This lamp, if kept burning, would be an immediate indicator of oxygen deficiency. If an emergency situation arises, which requires immediate entry to a manhole, and if the test lamp indicates that it is not safe for occupancy without respiratory equipment, an oxygen breathing apparatus or air supplied respirator is recommended. The new Chemox equipment, which was developed during the war, seems to be a satisfactory piece of equipment for this type of work. Such respiratory equipment also should be a regular part of the gear for any crew that is doing underground work in manholes. Other suggested pieces of equipment are a hydrogen sulfide detector, a small combustible gas indicator for use in areas where these gases frequently are encountered and a life line with harness.

The investigation of the conditions which instituted this study leads to the conclusion that a good deal more should be done in the study of working conditions in sewers and sewage handling works to make them safe for workmen.

Recommended Safe Practices

There are several safe practices, however, which can and should be inaugurated as soon as possible. These may be stated in the form of the following recommendations:

1. Open clarifiers, aeration, and other tanks should be provided with hand railings around the entire tank and walkways.
2. Machinery, such as exposed shafting, gears, and other moving parts should be guarded.
3. Pumping stations and parts of disposal plants are considered as class B-1 hazardous locations in the State Electrical Safety Orders, and as such, require vapor-proof fixtures and explosive-proof motors.
4. Access ladders to pits and manholes should be maintained in good repair, with the openings of adequate size.
5. All pumping pits, especially if over 6 feet deep, should be provided with adequate ventilation.
6. If continuous ventilation is used, at least 10 air changes per hour should be provided for dry wells, and 25 air changes per hour for wet wells.
7. If intermittent ventilation (used only at time of entry) is employed, the system should be turned on at least 15 minutes before anyone enters the pit, and should be operated at a rate of 60 to 70 air changes per hour. Intermittent ventilation should be avoided, however, if at all possible, in favor of continuous ventilation.
8. The exhaust duct location for the pits should be located so that contaminated air is removed near the bottom of the pit.
9. Safety equipment, including approved breathing apparatus, and a life line and harness, and testing equipment, including a flame safety lamp, a hydrogen sulfide detector and a small combustible gas indicator should be provided for each manhole, pumping pit, or other underground crew.
10. Each crew should be composed of at least two workers. No employee should be required or permitted to enter a manhole unless a watcher remains at the surface.

Study of Philippine Workers Exposed to Lead Shows High Rate of Absorption

DR. G. D. Dizon, Chief Industrial Hygienist, and his staff* of the *Bureau of Health*, Manila, Philippine Islands, made a study of the effect of lead among workers engaged in the manufacture of batteries, washers, lead bars, and lead seals in four Manila plants. His report follows:

Operations and Materials Used

In the process of battery manufacture, the first operation consists of casting battery plates. The casters stand near the melting pot for old battery plates, heated and maintained at a temperature of 1,000° F., and by hand operation the molten lead is taken from the melting pot by ladle and poured into the battery plate casting apparatus.

The next principal operation is the mixing of the paste. Red lead and litharge in powder are placed in mixing tubs to which water and sulfuric acid are added to make the paste. Then the interstices of the plates are filled with paste by the use of a trowel by hand and the wet plates are transferred to racks for drying. The various parts are then assembled by group burning, attaching lead connectors. The subsequent operations are the electric charging, casing, and attaching covers.

In the manufacture of washers, lead bars, and lead seals, the operation consists in melting scraps of lead in melting pots, heated and maintained at temperatures ranging from 620° to 900° F. with the workers located around or near the melting pots, and by hand operation the molten lead is taken by ladles from the melting pots and poured into the molds for washers, lead bars and seals. After a while the finished products are removed.

Workers Examined

The study involved 20 workers: 3 battery plate casting, 5 battery plate pasting, 4 lead washer moulding, 4 lead bar moulding with 2 helpers, 1 lead seal moulding, and 1 lead stumper. The length of service in each particular job ranged from 1 to 18 years. Air samples were taken from the working environment of the four industrial establishments for lead content determination. Physical examinations of the workers were performed including urine samples for porphyrin test, determination of lead values and routine examination; and blood samples for hemoglobin and red cell count, stippling, Kahn and Kolmer tests, and determination of blood lead values.

*V. J. Luciano, M. D.; Jose Y. Navarro, M. D.; J. E. Anselmo, M. D.; and E. E. Penigan, Chemist.

Findings and Observations

Air samples were taken in four industrial establishments by big impinger and electrostatic precipitator. They were taken at the breathing level of the workers and examined in the laboratory for lead.

The concentration of lead in the battery casting department ranged from 0.23 to 1.16 mg. per cubic meter of air; in the battery pasting department from 1.71 to 2.48 mg. per cubic meter; in the washer manufacturing shop from 0.14 to 0.56 mg. and from the lead seal manufacture, concentration of 0.25 and 0.38 mg. per cubic meter.

The maximum allowable concentration of lead in the air (*1*) is 0.15 mg. per cubic meter. The above findings are thus very much higher than the maximum concentration of lead allowable in the air except in the manufacture of lead bars where the result of examination of air samples gave a concentration lower than the maximum allowable concentration of lead in the air. An important observation in this connection is: the higher the temperature in the melting of lead, the higher the concentration of lead in the air.

Physical Examinations

Of the eight battery workers, only one with 1 year of service had no complaints. The common complaints were occasional weakness, headache, neuralgia, intermittent abdominal pain, metallic taste, vertigo, and pain at the joints at times. The other complaints were anorexia, nervousness, pallor, and loss of weight. Lead line was found in only one with poor oral hygiene. Of the four washer moulders, only one with 4 years of service complained of weakness, anorexia, intermittent abdominal pain and pallor. The others, with 1 or 2 years of service, had no complaints.

Of the four lead bar moulders, one complained of anorexia, metallic taste, headache, insomnia, neuralgia and muscle cramps, and two complained of vertigo. The lead bar helpers had no complaints of importance. The lead moulder complained of intermittent abdominal pain, loss of weight, insomnia, neuralgia,' joint tenderness, and muscle cramps. The lead stumper complained of anorexia, headache, and vertigo at times.

Urine Tests

Urine samples of the workers were collected in lead-free bottles with lead-free stoppers and examined in our laboratory for porphyrin and lead content.

According to C. D. de Langen and J. A. G. ten Berg, the presence of porphyrin in the urine is the first sign of lead poisoning (*2*). It is regarded as a regular diagnostic sign. The excretion of porphyrin appears earlier and more regularly than any other sign, much earlier than the basophilic granulation of red cells considered as the first sign of lead poisoning in the literature.

Porphyrin has the property to fluoresce red on radiation with ultraviolet rays led through a Wood's filter. In normal urine, porphyrin occurs only in traces and demonstration is only possible when one concentrates large quantities. Increased excretion of porphyrin in the urine is an important indication of lead poisoning when other causes as pernicious anemia, hemolytic icterus, cachexia, idiopathic porphyrinuria, some feverish diseases and poisoning by various barbiturates are excluded. The presence of porphyrin is indicated by red fluorescence varying from just observable to strong red depending upon the amount of porphyrin present.

Waldman and Seideman (*3*), in the test for porphyrin, used the modified test of Meek, Mooney, and Harrold by the addition of hydrogen peroxide to the original test of de Langen and ten Berg which consisted in adding glacial acetic acid and ether to urine before passing it on radiation to ultraviolet light. Hydrogen peroxide eliminates doubtful reactions and increases the intensity. They found that the amount of porphyrin is not exactly parallel with that of lead in urine, probably due to the more prompt changes in urinary lead concentration, and concluded that all urine specimens with more than 0.15 mg. of lead per liter gave positive porphyrin while those with less than 0.15 mg. and positive porphyrin may indicate early sign of lead absorption.

The porphyrin test on urine was carried on extensively by the Connecticut State Department of Health in 1949–50 among workers exposed to lead fumes and dust in certain industries and has shown to be a very useful test for beginning lead poisoning (*4*).

The eight battery workers, two of the four washer moulders and two of the four lead bar moulders showed positive porphyrin ranging from 1 to 3 plus. The others gave negative porphyrin or became negative after repeated examinations. In this connection, urine samples of a control group of 12 persons, without any exposure to lead, were also examined for porphyrin and all gave negative results.

Six samples containing 0.15 mg. or more of lead per liter of urine all gave positive porphyrin. Five with less than 0.15 mg. and one with negative lead also gave positive porphyrin, which may indicate an early sign of lead absorption.

Shiel's dithizone method was employed in the isolation of the lead of the urine samples. Five battery workers gave high lead values in the first examination of their urine, ranging from 0.15 to 0.60 mg. of lead per liter. One of the four washer moulders gave, in the last examination of his urine, 0.25 mg. of lead per liter. The rest of the workers gave negative or normal lead values in their urine samples. The control group of 12 persons all gave normal lead values.

The normal lead values average 0.03 mg. per liter of urine with ranges of 0.01 to 0.08 mg. per liter or from 0.005 to 0.12 mg. per liter, depending on the size of the samples analyzed (*5*). It can be seen that the lead values of the urine samples of five battery workers and one washer moulder are very much higher than the normal. Urine samples of the workers were taken and examined two or three times in order to obtain more accurate results and for verification.

The analysis of urine, if carried out carefully for the determination of its lead content, is a reliable index of the degree of lead poisoning. It is more valuable than blood lead estimation, because the change in the rate of excretion of lead in urine in response to lead absorption is proportionately greater than the change in blood lead concentration. Concentration below 0.15 mg. per liter of urine has doubtful significance, while hazardous lead exposure causes excretion of lead in urine at levels of about 0.15 mg. per liter. The majority of cases of lead poisoning examined during the stage of intoxication revealed lead concentrations of 0.15 to 0.30 mg. per liter. Concentrations above 0.50 mg. per liter are not frequent, requiring further verification.

Blood Tests

Seventeen blood samples were taken and examined for hemoglobin content, red cell count and lead value, besides Kahn and Kolmer tests, basophilic stippling and differential count.

In a normal person with a red cell count of 5 million, the average hemoglobin content is 15.43 grams per 100 cc. of blood. An average of 14 to 17 grams of hemoglobin is taken as an accurate estimation in healthy men and women. In men, however, the normal average of red cells and hemoglobin is higher than in women. Normally, in adult male, there are 5 to 6 million red cells, while in the adult female, there are 4½ to 5 million per cubic millimeter of blood (*7*).

In lead poisoning, there usually occurs a reduction in the red cells and hemoglobin. There is also a change in size and shape of the red cells. A routine procedure among physicians in the diagnosis of lead poisoning is the estimation of the stippled cells. Warning is being given that basophilic stippling which is present in the acute stage, is not pathognomonic of lead poisoning for they are found as well in many other toxic states, in various types of anemia and as a reaction to high altitudes. Anemia, which is not usually severe, is always present.

In the peripheral circulation, lead acts on the surface of the red cells, making them brittle and altering their size and shape. The red cells become easily destroyed by trauma due to brittleness. The lead concentration in the blood varies little from hour to hour except in response to brief intense lead exposure. The normal lead concentrations in the blood range from 0.01 to 0.06 mg. per 100 grams of whole blood. Lead concentration in excess of 0.07 mg. indicates recent lead exposure while concentration in excess of 0.10 mg. per 100 grams of whole blood shows that there has been a considerable exposure. Concentration of about 0.50 mg. may occur when the industrial exposure is quite severe, but is unusual (*6*).

Of the 17 blood samples, 15 gave lower hemoglobin values and 11 gave lower red cell counts than the normal which is mentioned elsewhere. Eight gave high lead values ranging from 0.08 to 1.07 mg. per 100 grams of blood. Basophilic stippling was present in only one.

Summary and Conclusions

The examination of air samples taken from the working environment of the manufacture of batteries, washers and lead seals gave concentrations of lead ranging from 0.23 to 2.48 mg. of lead per cubic meter of air, which are very much higher than the maximum allowable concentration of lead in the air which is 0.15 mg. per cubic meter, showing that the workers in the above-mentioned industries are subjected to a considerable exposure to lead dust and fumes.

The laboratory examinations of the workers' urine and blood tend to strengthen the suspicion of early lead poisoning. Of the 20 urine samples, 12 or 60 percent showed positive porphyrin and the rest gave negative results or became negative after repeated porphyrin tests. Porphyrin in urine, as already mentioned elsewhere, is regarded as a regular diagnostic sign pointing to the development of lead poisoning. Six or 30 percent gave high lead values in their urine ranging from 0.15 to 0.60 mg. per liter of urine, which are much higher than the normal lead value of 0.03 mg. with ranges of 0.01 to 0.08 mg. per liter for samples of one liter or more and 0.12 mg. as upper limit of normal lead concentration for spot samples of about 100 ml. in volume. These high lead values

(Continued on page 19)

GEORGIA RESIDENTS RECEIVE DECISION IN AIR POLLUTION CASE

SEVENTEEN of the 66 residents of Columbus, Ga., who brought suit against the owners of a fertilizer plant and an animal food manufacturing plant for polluting the air in the vicinity of their homes, have been awarded $100 each by the judge of a district court of the United States.

Having added improvements to the fertilizer plant recently, the defendants were permitted to continue operating it, but in the case of the food plant, they were given 12 months to install certain improvements to control or eliminate the gases coming from the plant.

The residents told the court that "in the manufacture of the fertilizer and the animal food ingredients there were discharged and released in the atmosphere in the locality wherein they lived, fumes, gases and vapor, that were sickening, offensive, toxic and suffocating and, when inhaled, affected the respiratory organs, caused burning of the throat and nose, and otherwise produced and caused discomfort."

In the manufacturing carried on at these plants, the process is initiated by mixing phosphate rock with sulfuric acid in proportion of approximately 8 parts rock to 10 parts acid. When the phosphate rock and the acid are being mixed after the mixture is put in bins and while curing, gases are evolved, principally hydrogen fluoride.

During the course of preparation of the case, the Division of Industrial Hygiene, Georgia Department of Public Health, was called in to make atmospheric determinations with the principle mission of establishing the fact that sulfur dioxide and fluorine from the stack effluent were actually present in the air in the vicinity.

These gases are controlled now by a scrubber system recently installed. However, the judge, in his decision called attention to the fact although all objectionable gases could be controlled, according to the experts, the expense is economically prohibitive. The judge also reminded the plaintiffs that they are residing in a manufacturing and industrial area, and they cannot expect to get the same fine, fresh air they would in the mountains or countryside; and on the other hand, the defendant must realize that, notwithstanding its isolated condition 30 or 40 years ago, it now operates in the vicinity of a very, very thickly populated section, and that it must use every possible means, which are not prohibitive economically, to control, eliminate and remove the objectionable gases originating from its operation.

LEAD POISONING—

(Continued from page 18)

in the urine indicate hazardous lead exposure and abnormal lead absorption.

The blood examination showed that of the seventeen samples, fifteen or 88 percent have lower hemoglobin content, eleven or 64.7 percent with lower red cell counts and eight or 4 percent have high lead values tending to show that there has been an abnormal absorption of lead from considerable exposure. The above findings with the common complaints of the workers, mostly in the manufacture of batteries, of weakness and anorexia at times, intermittent abdominal pain, metallic taste, headache, vertigo, and neuralgia tend to strengthen the suspicion that some of the lead workers under study are affected by lead to a certain degree indicating a lead hazard in those industries investigated.

For the protection of the workers in lead industries, control measures are necessary, consisting of medical and engineering controls.

The medical control consists in preemployment and periodical physical examination, treatment and follow-up of cases, personal hygiene, sanitary maintenance of the working environment, provision of separate lunchrooms, individual lockers, safe drinking supply, and others.

The treatment of cases is the concern of the factory physician. However, the following treatments may be mentioned: for acute poisoning—calcium gluconate intravenously; opiates for pain, and milk and eggs for diet; and for chronic poisoning—deleading by diet which contains very little calcium, by dilute phosphoric acid, ammonium chloride, and sodium bicarbonate; magnesium sulfate, pressure, and heat on the abdomen for colic; calcium gluconate intravenously for palsy and for lead paralysis, massage, electrotherapy and salicylates.

Johnstone (*6*) mentions the following regime: removal of patient from exposure, hospitalization, calcium gluconate intravenously for intestinal colic, magnesium sulfate for constipation, iron for anemia, no morphine or atropine for abdominal discomfort and barbiturates for nervousness. In his experience, deleading is not necessary and of questionable efficacy.

The engineering control of atmospheric contamination by lead dust and fumes at their point of origin is by the installation of local exhaust ventilation consisting of hoods or enclosures at the source of contamination connected by air ducts or piping to the collector and exhauster by which the contaminated air is conveyed to the collector or to the outside.

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(*1*) Threshold Limit Values Adopted by the American Conference of Governmental Industrial Hygienists in Boston, Massachusetts in April 1948.

(*2*) *Acta Medica Scandinavica*, Vol. 130, fasc. 1, 1948.

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(*6*) Johnstone, R. T.: Occupational Medicine and Industrial Hygiene. C. V. Mosby Co., St. Louis, 1948.

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MODIFICATIONS OF THE ELECTROSTATIC PRECIPITATOR*

FOR several years various laboratories have developed minor modifications of the precipitator, the major one being the substitution of an oil immersed coil. This coil is reported to give much less trouble than the coil built in the instrument. The two modifications to be discussed, however, involve greater changes than this.

Illinois-Indiana Modification

This modification involves substituting a commercial high voltage power pack for the coil, rectifier, and transformer. The PS–10 power supply will deliver 13,000 volts at 115-volt input. The cost of this modification is approximately $75. The major parts are a PS–10 power supply and a Variac No. 200–B.

The units can be fitted in the present case without too great an increase in weight. The sampling efficiency of this modified precipitator compares favorably with that of the new unit. The power pack gives a nice corona and has been very trouble free.

Michigan Modification

The Michigan Division of Industrial Hygiene has modified the old precipitator to give it a portable head with included fan. This eliminates the motor-blower in the case. A list of the component parts is as follows:

(*a*) Housing containing 24-volt, direct-current miniature motor, 1½ by 1 by 2 inches.

(*b*) Fan housing made of stainless steel containing Torrington wheel No. 116–020, 1½ inches diameter and ⅝ inch wide. Complete fans, including plastic housing and wheel, are now available.

(*c*) Standard M. S. A. sampling head housing.

(*d*) Polystyrene electrode extension tube permanently secured in head. High voltage cable terminates at brass collar on outer end which receives the electrode tip.

(*e*) Electrode and approximately 1¼ inches of the old M. S. A. electrode tube fitted to screw into electrode extension.

(*f*) Sample collecting tube.

(*g*) Orifice taps-orifice permanently assembled in sampling head. Purpose of orifice is to calibrate fan for sampling rate.

(*h*) High voltage coaxial cable Phelps Dodge R68–4, 12 feet long.

(*i*) Small, 24-volt, direct-current wire leads to fan motor.

To calibrate this instrument an external source of air moving at 3 c. f. m. is connected to the sampling tube. A micromanometer is connected to the orifice tap and the reading taken. The external source is removed and the motor-blower turned on. The rheostat is adjusted to give the same micromanometer reading. The motor voltage is read off the voltmeter, which thereafter acts as a flowmeter.

The power pack contains the following:

(*a*) 24-volt, direct-current voltmeter.

(*b*) Ventilator.

(*c*) Rheostats to control fan motor and sampling rate.

(*d*) Rheostat to control voltage.

(*e*) High-voltage switch.

(*f*) Fan motor switch.

(*g*) Plug-in for 110-volt line.

The high-voltage circuit is essentially the same as that in the old M. S. A. instrument except that the coil has been replaced by an oil immersed coil and a 6-volt, direct-current plug-in type vibrator. An additional rectifier circuit is included to supply the 24 volts needed for the fan motor.

Any further information may be obtained from the Division of Industrial Hygiene, Michigan State Board of Health.

Proposed Methods of Calibration

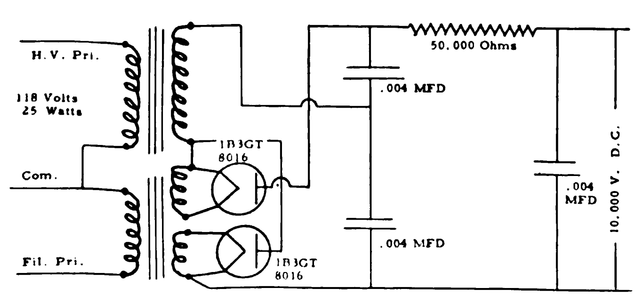
The M. S. A. *system for the new electrostatic precipitator:*

Since the characteristics of the fan are such that any resistance greatly decreases the air flow, it was necessary to design an extremely accurate pitot tube with an electronic thermal anemometer. The design consists essentially of a small aluminum block machined to fit over the inlet end of a sampling tube. The pitot tube connects with a 0.25 inch channel drilled in the aluminum block. The air from the pitot tube is conducted through the channel to the detector unit.

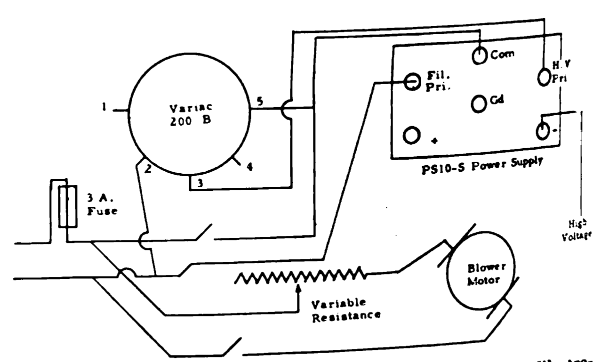
The air inlet is extended four inches with 1½ inch diameter tubing terminated by a flared bell having a radius of ¾ inch to provide more even air distribution at the pitot tube. The electronic thermal anemometer is a simple Wheatstone bridge type of electrical circuit.

The response to the rate of air flow is not linear; the response at air flows near 3 c. f. m. being much greater than at lower rates.

*Part of the report of the Committee on Standardization of Air Sampling Instruments, made at the 1950 meeting of the American Conference of Governmental Industrial Hygienists. Chairman of the committee was Mr. H. E. Bumsted, Division of Industrial Hygiene, Indiana State Board of Health.



PS–10 Power Supply Circuit.



Illinois-Indiana Modification of the Old M. S. A. Electrostatic Precipitator.

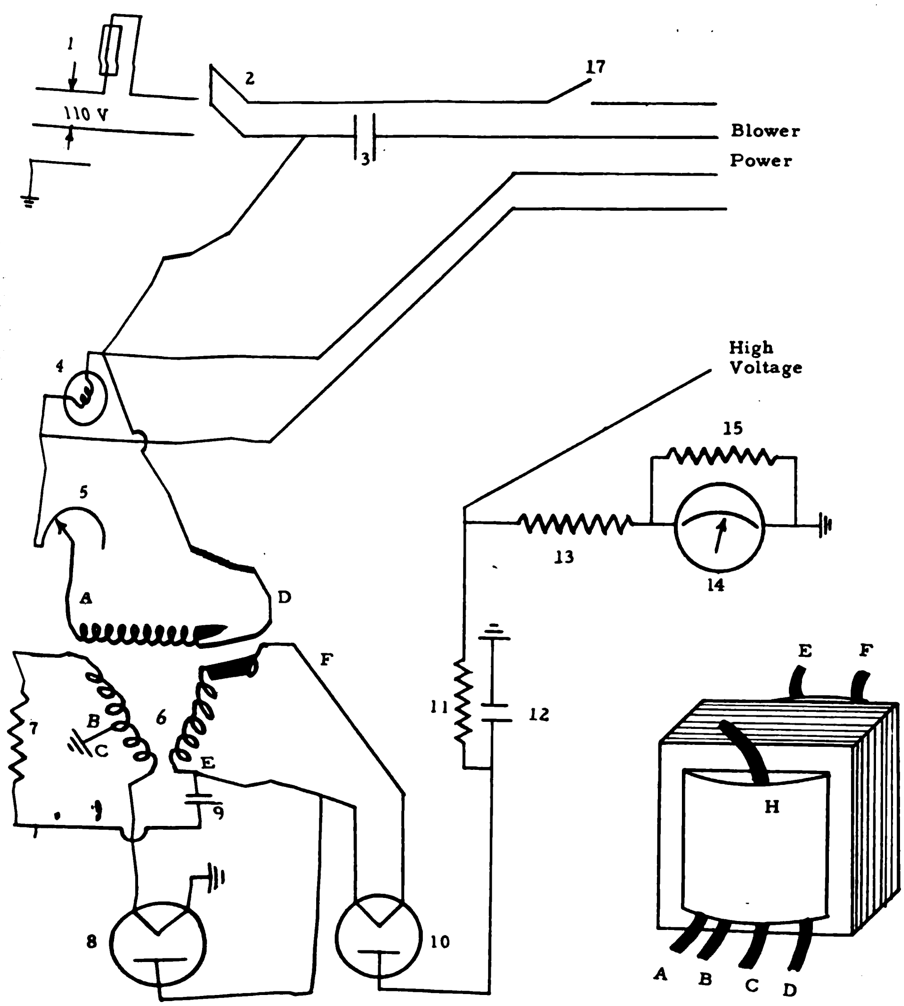
Indiana Method of Calibration

We found that we were able to get fair results calibrating the air flow in the electrostatic precipitator tubes by means of a standard Willson thermal anemometer. This was accomplished by using two standard sampling tubes sealed together with scotch tape and then covered with asbestos. In the middle of the first tube two holes are drilled 90° apart, one about 1 inch from the other. The unheated thermometer is placed in the first hole, the heated thermometer in the second one.

This assembly is then connected to a dry test meter and a source of suction. The temperature difference is determined for various air flows around 3 c. f. m. The tubes are then placed in the electrostatic precipitator head with the electrode in place and the air flow calibrated for the precipitator. Fairly good reproducibility was obtained in this manner. In fact, better results were obtained than could be got using the "Alnor" velometer. The asbestos covering apparently eliminated some variations in temperature and gave better results.

PARTS FOR POWER PACK OF ELECTROSTATIC PRECIPITATOR

No.	*Description*
1	Fuse holder and 2 ampere fuse.
2–17	Toggle switches.
3	Condenser—300 v., d. c. cap. 0.1 mfd., No. 7870639, test voltage 600 v., d. c.
4	Lamp—Westinghouse NE 20.
5	High voltage control—No. K6531, 1,500 ohms, Clarostat Manufacturing Co., Brooklyn, N. Y.
6	Transformer—No. T 3403, Electricoil Transformer Co., New York, N. Y.
7	Resistor—Type BBF, 0.1 meg. 15 percent, Resistance Products Co., Harrisburg, Pa.
8–10	Tubes—Kenrad IB3GT.
9	Condenser—No. ASG43, 0.005 mfd., 10,000 w., v., d. c., Condenser Products, Chicago, Ill.
11	Resistor—Type BBM, 1.25 meg. 15 percent, Resistance Products Co., Harrisburg, Pa.
12	Condenser—Plasticon AOG20M0016, 0.016 mfd., 20,000 w., v., d. c., Condensor Products Co., Chicago, Ill.
13	Resistor—120 meg. ± 10 percent, manufacturers unknown.
14	Voltmeter—Model 506, Weston Electric Instrument Co., Newark, N. J.
15	Resistor—6,500 BC x 2, manufacturer unknown.



Wiring Diagram M. S. A. Electrostatic Sampler.

A. M. A. Establishes Committee on Pesticides

A COMMITTEE on pesticides was recently established at the headquarters of the American Medical Association to study the health problems associated with the use of pesticides (insecticides, rodenticides, fungicides, herbicides and similar types of economic poisons). As part of its study on the safety and effectiveness of these chemicals, the Committee is undertaking an intensive educational program to assist physicians and other health practitioners in recognizing and overcoming the difficulties which certain of the newer compounds present.

The first of a series of committee reports on the medical aspects of pesticides has been published in the *Journal of the American Medical Association* for September 9, 1950. Reprints of this report, entitled, "The Pharmacology and Toxicology of Certain Organic Phosphorus Insecticides," are available from the American Medical Association, 535 North Dearborn Street, Chicago 10, Ill.

Studies of Health Hazards in Industry

By J. J. Bloomfield

This article is one of a group of lectures which Mr. Bloomfield gave to a class of physicians in Rio de Janeiro, Brazil. In view of the constant demand for basic material on industrial hygiene techniques and for practical help in this field, a number of these lectures are being printed in the Industrial Hygiene Newsletter.

This is the fourth in the series. In the first article, which appeared in the September issue, Mr. Bloomfield discussed types of plant surveys, illustrating with the Public Health Service study of mercurialism in the hatters' fur-cutting industry. The second article covered the classification of environmental exposures. The third one dealt with metallic poisons, particularly lead.

CHEMICAL HAZARDS

Solids Producing Pneumoconiosis

THE dust problem in industry is one of the most important we have to deal with for several reasons. To begin with, many dusts are known to exert a deleterious effect on health. Furthermore, there are probably more persons exposed to dust hazards in industry than to any other single occupational hazard. For example, in the United States alone there are close to 4,000,000 persons exposed to dusts. It has been estimated that more than 1 million of these persons are exposed to silica dusts, which under certain conditions are capable of producing serious lung damage. It is also known that certain dusts greatly increase the tuberculosis mortality rates and respiratory disease rates.

While dusts exist everywhere in the atmosphere, it has been known for centuries that workers in certain dusty operations are less healthy than those not so exposed. It is therefore important to classify dusts into those which are harmful and those which are not.

There are various classifications, some based on the physical properties, some on physiological, and others on pathological. A simple classification is one based on the effect of dust on the human organism. Dusts may therefore be classified as follows: (1) Dusts, such as lead, which can produce systemic poisoning. This subject has already been discussed in a previous lecture. (2) Dusts which may produce allergy, such as hay fever, asthma, and dermatitis. Castor bean pumice is a good example of a dust which can produce asthma. (3) Dusts, such as organic materials (starch), which can cause explosions. (4) Dusts which can cause fibrosis of the lungs, such as silica. (5) There are also dusts, such as the chromates, which have an irritating effect on the lungs and can cause cancer. (6) And, finally, there are dusts which cause minimal pulmonary fibrosis or no fibrosis. Among these are certain inorganic dusts, such as carbon, iron, and barium.

For the purposes of the present discussion, the subject will be limited to those dusts which are capable of producing fibrosis of the lungs of an incapacitating character. However, before discussing this subject and presenting certain findings from the author's own experience, it may be well to review the important factors to be considered in dust inhalation.

Properties of Dusts

We must first consider the properties of a given dust which determine its capacity to produce pulmonary pathology. These properties are: (1) The chemical and mineralogical composition of the dust, (2) its size, (3) its concentration in the air, and (4) the duration of exposure.

Composition of Dust.—Research on the problem of industrial dust inhalation has indicated that, insofar as their fibrosis-producing qualities are concerned, dusts may be divided into three groups: (1) Those composed completely of combined silica, that is, silicates, such as pure asbestos; (2) those containing free silica in the crystalline form known as quartz (granite contains approximately 35 percent of quartz); and, lastly, (3) dusts containing free silica in a noncrystalline form, such as diatomaceous earth. It has also been observed that the harmfulness of a quartz-containing dust is in direct proportion to its quartz content.

However, even today, we find the terms quartz, silica and free silica used interchangeably. Perhaps it may not be amiss to define these terms briefly at this time. Silica is the name given to the oxide of silicon (SiO_2). A distinction is made between free silica and combined silica. Free silica is the term used when the silica occurs in the form of a definite compound having the formula SiO_2.

Generally, free silica, when thus used, means quartz, but as a matter of fact there are several minerals that are composed of free silica. For example, in addition to quartz, there are other free silicas now finding industrial use, such as tripoli (used as a facing powder for molds in foundries), opal, an amorphous hydrated variety of silica occurring abundantly in diatomaceous earth, and other forms not quite as abundant in nature as quartz.

Combined silica is the term given to silica that occurs in minerals in chemically combined form, being united with certain bases, such as soda (Na_2O), lime (CaO), and a number of others; in short, it is the silica in silicates. According to long established convention, the chemist reports the silicon present in rocks and minerals as silica; he makes no distinction between free silica and combined silica, even though both be present.

These principles may be illustrated by means of granite. The average granite is an aggregate made up chiefly of three minerals in the following proportions: Feldspar, 60 percent; quartz, 25 percent; and mica, 15 percent. Chemical analysis shows that this average granite contains 70 percent of silica. Of this 70 percent, 30 percent is present as quartz (free silica), and the other 40 percent is present as combined silica, locked up in chemical combination in the other minerals that make up the granite.

From this illustration it is apparent that we should be more explicit in our terminology when referring to the nature of the dust. If a dust contains quartz, and we are referring to this mineral, then we should call it quartz and not just silica or free silica. There are other free silicas in existence that are of industrial use today. These other free silicas differ from quartz in their physical properties and also possibly in their action on the lungs of workers exposed to inhalation of these dusts.

In the study of health of workers in a cement plant the United States Public Health Service found it necessary to conduct mineralogical analyses of the dusts in the various departments of the plant because of the physical and chemical changes undergone by the various raw materials used in cement manufacture. Clay, one of these raw materials, was found to contain about 7 percent quartz, and the dust in all the departments preceding the calcining of the materials contained about this amount of quartz. However, in the kilns, the quartz combined with the other elements in the materials that go into cement manufacture to form complex silicates, and our dust samples obtained in the departments following the kilns showed less than 1 percent of quartz. We had to bear in mind this dissimilarity of quartz dust exposure in analyzing our clinical and other data on the health of the cement worker.

One more example of the errors one may make in not resorting to a careful mineralogical analysis of dusts encountered in the various processes of manufacture of a single article may be of interest. In 1926 Heffernan reported a study in the *Journal of Industrial Hygiene* on the "Exposure to Silica Dust Without the Occurrence of Silicosis." This occurred among brickmakers in Derbyshire, England. The raw materials used in brickmaking, according to Heffernan, contained 85 to 89 percent silica, mostly in the form of gannister sand. The finished brick was found, on a rational analysis, to contain about 83 percent silica. In the departments preceding the kilns, there is apparently very little dust generated, due to the wet methods of working the materials. On the other hand, considerable quantities of dust are given off in the trimming and polishing of the bricks, following the firing of the molded bricks in the kilns. Now, it is a well-known fact that, when quartz or other free silica is subjected to high temperatures, such as obtained in a brick kiln, in the presence of other compounds, the quartz will combine to form silicates or at least will become inverted and change its properties. Heffernan's paper does not state whether the silica in the finished brick was free or combined, but merely states the silica content as 83 percent.

It may be inferred that the reason no silicosis occurred among the gannister sand brickmakers in Derbyshire was probably that the dust exposure was negligible in the departments where quartz was present, as stated by Heffernan, and that in those departments where considerable dust was generated, the workers were no longer exposed to a dust containing quartz. A careful mineralogical analysis of the dust in each department, similar to the analyses conducted in our cement study, would have thrown considerable light on this puzzling situation presented by Dr. Heffernan.

Since no two dusts offer the same problem, it is difficult to lay down general rules for such an analysis. Suffice it to say that each sample must first undergo a careful examination under the petrographic microscope, and then be further subjected to a complete chemical analysis with frequent petrographic examinations and X-ray diffraction studies throughout the entire process. For example, only by such analysis have we found it possible to determine accurately the percentage of quartz present in quartz-containing dusts.

Size of Dust Particles.—It is well known from many studies that the dusts of pathological significance which are found in the air are less than 5 microns in size and, at the most, less than 10. The number of such particles greater than 10 microns in size present in industrial air is comparatively small, and, due to gravity and the protective action of the mucous surfaces of the upper respiratory tract, these larger particles do not penetrate to the terminal portions of the respiratory tract. Hence, in studying the size of dusts, we need only concern ourselves, as a rule, with those dust particles that are less than 10 microns in longest dimension and usually only with those less than 5.

Samples of dust in the air for particle-size determination may be obtained from the same sample which is used for counting the dust—a technique which will be described later. The dust which is suspended in a liquid medium, such as water, is placed on a microscope slide with an appropriate cover glass to prevent extraneous dust from settling on that portion of the slide to be studied. Under a magnification of 1,000 diameters (oil immersion objective), the horizontal diameter of a representative number of particles is measured by means of a calibrated filar ocular micrometer. With this magnification it is possible to measure particles as small as 0.5 micron in diameter, while smaller particles are easily distinguished and their presence recorded.

It is apparent that, when the dust concentration is high, the exposed person will inhale a greater quantity in a given period of time than he will when the dust concentration of the atmosphere is relatively low. Since the rate of production of the fibrosis is partially dependent upon the rate at which the dust is inhaled, this latter item plays an important part in predicting the relative danger of different environments. Hence, the need for the evaluation of the quantity of dust in the industrial atmosphere is obvious.

From the practical hygienic viewpoint, we feel that the particle count is at present the best quantitative index of the degree of atmospheric pollution. The decision as to the size range of the particles which should be included in the dust count will be somewhat dependent on the size of the dust particles actually found present in the industrial atmosphere. It is obvious that the size of the smallest visible particle will depend on the magnification and type of illumination used in the microscope, the refractive properties of the dust, and, to some extent, on the visual acuity of the observer.

We must bear in mind that our chief interest in this problem is the industrial hygienic aspect. Primarily we are interested in differentiating between the dust content in ordinary normal atmospheres, not known to be harmful, and in industrial atmospheres where certain dusts are known to be associated with lung damage.

As will be shown presently, this difference is sharply marked insofar as the dust particles between approximately ½ and 5 microns in diameter are concerned; but the difference between such normal and abnormal air is masked and lost when we include in our determination the particles of ultramicroscopic size which are present in vast numbers in all air.

As pointed out earlier, we need not concern ourselves with those particles greater than 10 microns in longest dimension, since the number of such particles present in most industrial air is small, as compared with the lower sizes. Let us examine what available data we have on the lower limit of particle sizes of industrial dusts. In South Africa, Moir examined microscopically 120 dust particles obtained from 2 specimens of silicotic lung and found that only 13 percent of the particles were less than 0.5 micron and about 36 percent of the particles were less than 1 micron in diameter. The majority of the particles (60 percent) were between 1 and 3 microns in size. The median size of the dust was found to be 1.2 microns in diameter.

Practically the same results were obtained by Watkins-Pitchford, who examined and measured the silica particles in sections of silicotic lungs illuminated by polarized light. Drinker, in comparing the size-frequency of the particles found by Moir with the particles found by him in the sputum of men employed in ore mills, found a close correspondence. The findings of Moir and Watkins-Pitchford have also been corroborated by Mavrogordato, who examined dust, both with light and darkground illumination, in sections of human and animal silicotic lungs as well as the dust recovered from these lungs.

The best answer to the question of the particle-size distribution of industrial dust would be data of actual measurements of such dust. Let us see what the available data on this question show. In 1929, Fehnel reported some particle-size dust measurements in connection with a dust study of hard rock drillers in New York City. As a result of this study, Fehnel reported the findings on three samples, which showed the dust which was less than 1 micron in size to vary from 1 to 15 percent. Most of the dust in these hard rock drilling operations was, according to Fehnel, between 2 and 5 microns in size.

Badham, in studying the dust hazard among sandstone workers in Sydney, measured some 16,000 particles of dust in the air of workplaces and found that 67 percent of these particles were about 1 micron in size. From his study Badham states: "It would appear that below 10 microns there is no selective action by the dust cells of the lung and that the particles found in the lung have the same size-frequency as those in the air breathed. * * *"

(Due to the length of this article, it will be continued in the January number.)

MORE PHS PUBLICATIONS AVAILABLE FREE

STOCKS of the publications listed below have been received by the Division of Industrial Hygiene, PHS, and are available upon request as long as the supply lasts. To request copies of any of the publications, address the Information Section, Division of Industrial Hygiene, Public Health Service, FSA, Washington 25, D. C. The abbreviations used below are PHR, *Public Health Reports*, and PHB, *Public Health Bulletin*.

Health Hazards in Chromium Plating. PHR Reprint No. 1245, September 1928.

Common Industrial Solvents and their Systemic Effects. *Connecticut M. J.*, August 1944.

Observations on Certain Inorganic Industrial Hazards. *Connecticut M. J.*, February 1945.

A New Technique for Performing Quantitative Contact (Patch) Skin Tests. *J. Invest. Dermat.*, December 1945.

The Toxicology and Potential Dangers of DDT to Humans and Warm Blooded Animals. *Med. Ann. District of Columbia*, January 1946.

Occupational Disease in Government-owned Ordnance Explosives Plants. Reprinted with additions from *Occup. Med.* June 1946.

Toxicity of DDT—A Report on Experimental Studies. *Soap & Sanitary Chemicals*, July 1946.

The Toxicology of Antimony. PHR Supplement No. 195, 1947.

Toxicology of 1,2-Dichloropropane (Propylene Dichloride). *J. Ind. Hyg. & Toxicol.*, May 1948.

Health Physics. *Nucleonics*, September 1948.

Toxicity and Potential Dangers of Cyclotrimethylenetrinitramine (RDX). *J. Ind. Hyg. & Toxicol.* January 194

Toxic and Pathologic Effects of Xylidine in the Fasting and Nonfasting States. *J. Pharmacol. & Exper. Therap.* February 1949.

ADVISORY COMMITTEE

(Continued from page 2)

some understanding on this importa issue.

Among the current projects whi were reported on by professional personnel of the Division were air pollutio studies, the occupational disease reporting program, morbidity studies, industrial nurses' surveys, industrial medica care plans, studies of the uranium mines and mills, and the chromate study. Progress in long-term activities was also included in the discussion.

Members of the committee present at the meeting were: Vincent P. Ahearn, executive secretary of the National Sand and Gravel Association, Washington, D. C.; Nelson H. Cruikshank, director of social insurance activities, America Federation of Labor, Washington, D. C. Harry Read, executive assistant to the secretary-treasurer, Congress of Industrial Organizations, Washington, D. C. Theodore F. Hatch, professor of industrial health engineering, University of Pittsburgh; Dr. R. H. Hutcheson, commissioner of public health for the State of Tennessee; Harold A. Vonachen, medical director of the Caterpillar Tractor Co., Peoria, Ill.; Dr. Leo Price, director of the Union Health Center of the International Ladies' Garment Workers' Union, New York, N. Y.; and Mrs. Margaret Lucal, of the Ohio Rubber Co., Willoughby, Ohio, former president of the American Association of Industrial Nurses.

Mr. William L. Connolly, chief of the United States Bureau of Labor Standards, was a guest as was Dr. Raymo Hussey, representing the A. M. A Council on Industrial Health. The only absent committee member was Mr. Andrew Fletcher, President of the St. Joseph Lead Co.

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