FILE NAME: National Safety Council (NSC)

DATE: 1940 Oct 8

DOC#: NSC067

DOCUMENT DESCRIPTION: NSC - 29th National Safety Congress - Presentation - Governmental Safety Service in Industry - Many Articles

Governmental Safety Service in Industry

TUESDAY MORNING SESSION

October 8, 1940

The session was called to order by the Chairman, Voyta Wrabetz, Chairman, Wisconsin Industrial Commission, Madison, Wis., who presided. In his opening remarks the Chairman discussed briefly the scope and importance of the service which government is capable of rendering the various industries in the prevention of accidents, and particularly in assisting in the organization of standard safety measures. He then introduced the speakers in order, as follows:

Safeguarding Manpower for Greater Production

By V. A. ZIMMER

Director Division of Labor Standards, U. S. Department of Labor, Washington, D. C.

We are today engaged in the greatest safety campaign in the history of the world, a 10-billion-dollar campaign. Upon its success depends the security and the welfare of every man, woman and child in the western hemisphere.

In comparison with this colossal undertaking for the safety of civilization, any effort to save the lives and limbs of a few thousand human beings may to the superficial mind, seem trivial. In reality the reverse is true. Never has there been more urgent need for safety action than now. Wars today are won or lost in the factories. Planes, tanks and guns are factory products. Lost man-hours in the factory may mean lost battles in the field. Aircraft on order cannot repel enemy bombers. Unfinished tanks are no protection against a mechanized invading force. They are effective only when actually on hand and ready for action.

These vital implements for defense are fashioned out of raw materials by human hands skilled in craftsmanship and trained in production methods. Here in this country we have raw materials aplenty; a supply practically inexhaustible. Too, we have ample manpower to operate our war implements, even against the rest of the world, if necessary. But our supply of trained mechanics is certainly not limitless, and indeed may not be ample if we are negligent in safeguarding against accidents and health exposures under a vastly accelerated pace of production.

Accidents and other employment hazards under ordinary operation of American industry annually cause about 16,000 deaths and one and a half million disabling injuries. These disabilities result in a billion and a half lost man-hours of production. Moreover, thousands of these disabled workmen suffer permanently crippling injuries which not only make them ineffective for any future skilled production work, but also render them unacceptable for any active military duty. No country can afford this labor wastage when preparedness production is working against a deadline.

As it stands today under plans and appropriations already made, this defense program will involve the employment of an estimated 4,500,000 men, over a period of four to five years. Of these, 3,000,000 will

PLAINTIFF'S EXHIBIT NSC-61

be skilled or semiskilled workers, and only 1,500,000 will be classified as unskilled. How to get and how to keep this vast army of trained men in continuous, uninterrupted production is the essence of the whole defense problem.

It is imperative, of course, that we immediately speed up our processes for training more mechanics to keep pace with the demand for more output. Fortunately plans to this end are already well advanced, plans which are sufficiently broad in scope to insure a continuous source of supply upon which industry may draw. The United States Department of Labor has its particular part in the concerted drive to develop more resources of sound craftsmanship so essential to the production of needed implements of defense.

It has already, under the sanction of the Congress, expanded its apprenticeship promotion functions and is devoting its full facilities to the development of apprenticeship programs in industry. The Office of Education, the CCC, the Youth Administration, and the WPA are all engaged in building up a reservoir of trained production manpower. But while we are setting in motion the machinery to augment our skilled labor supply, we must concurrently make every effort to avid the unnecessary loss of men who are already skilled, and who are now engaged in important productive work. Mechanics are not made overnight. It may sharpen this point to keep in mind that four years' time is needed to turn out the full-fledged machinist, which incidentally is exactly the time required to produce a junior army officer in our greatest military school.

And incidentally, just as the officer is the key man in his unit of the Army, so is the skilled mechanic the key man in the production unit. Replacement of either is too costly to be lightly regarded.

Fortunately there is no reason why industrial accident and health hazards should continue to sap our supply of skilled workers. Every experienced safety man in the country knows by experience what are the prevailing causes of accidents. They know that every work accident has a definite cause, and that usually it is one that can be easily remedied or corrected. Those men know well that the old adage "Accidents will happen" is true only if there has been failure of management to provide safe conditions, or failure of workmen to observe safe work practices. The substantial truth of this statement has been proved by the experience of scores of our leading industrial enterprises. Many of them have almost completely eliminated lost-time injuries incident to work operations simply by diagnosing the accident causes and then removing the causes.

These results were not obtained through the use of secret formula, patented processes or highly technical procedure, but through a practical common-sense application of knowledge acquired through experience and intelligent observation. The only kinship to genius about these successful programs lies in the fact that safety, like genius, consists of infinite attention to detail.

There would probably be no reason for the present concern about the conservation of manpower in industry IF the safety lessons learned and applied by some of our largest concerns had inspired the majority of our industrial enterprises, including the large number of relatively small units, to follow suit. Unfortunately this is not the case, as shown by reference to the annual toll of deaths and injuries. These heavy casualties plainly are occurring in the many operations wherein management, for one reason or another, has failed to adopt sound accident prevention methods.

We have already entered the first phase of a vast preparedness program which probably will not reach its peak for another year. Contracts for goods and supplies are being widely distributed among relatively small industrial units; new workers are being brought in; older and more experienced mechanics are being recalled after a long period of idleness or intermittent employment. Thus we have the "green" and the "rusty" worker facing new and unfamiliar hazards, often brought about by changes in processes and methods.

Records have shown clearly that work accidents and injuries occur most frequently among newly employed workers. The recent report of the Bureau of Labor Statistics shows that industrial employment in this country increased approximately one-half million in the month of August, an increase larger than in any similar period since 1929. Along with the increased accident hazard incident due to this great influx of new workers, it can be expected that as the tempo of production increases, a substantial increase in accidents may be expected, even among the seasoned plant personnel.

In the main, labor wastage through work injuries is largely a small plant problem. If we can prevail upon these smaller enterprises to adopt and apply preventive methods, so successfully used by leading industrialists, we will be able to reduce materially, or even eliminate the multitude of disabling injuries which fashion a dragline on production.

With this thought in mind, the Secretary of Labor recently developed and announced a plan whereby any industrial unit in the United States, no matter how small, that is engaged upon Government contracts, can, without cost, have the advice, the counsel, and the technical services of leading American experts in the field of accident prevention. Under this plan these experts will not be supplied from Washington. They will be supplied by industry itself.

From some of the foremost industries in different sections of the country the Department of Labor has secured the voluntary service of a group of highly trained, thoroughly experienced safety engineers, who stand ready to serve the Government and the Defense Program. These experts have placed their services at the disposal of any plant management producing goods or materials for the Federal Government. They stand ready to go into the shops and factories, and upon request, to appraise existing health and safety exposures, to analyze the conditions, and to give to management detailed advice on the correction or control of these exposures. They will aid in setting up and instructing plant safety committees; they will advise about methods of educating employees in safe work practices; they will suggest means for gaining the workers' cooperation in accident programs.

In short, these safety specialists from within industry itself, will bring to small operators everywhere exactly the same talent and technique with which large industry successfully combats these human losses.

I should like to make clear that this is not a policing project. Our voluntary safety experts are not enforcement officers; they are not factory inspectors. The plan does not supplant the regulatory authority of the States as applied to all work places. It is expected that plants operating on Government contracts will continue to comply with all of the requirements of the States in which they operate. Neither does the plan add any irksome or restrictive regulations to any existing Federal standard. It simply brings into play along our entire defense production line the highly specialized engineering and educational facilities which can be expected to wipe out that persistent enemy to the smooth flow of production, namely disabling injuries of our trained workers.

Perhaps it would not be an overstatement of the situation to term this project an all-profit pool, in which the Government, management and labor participate and share equally in the benefits. Management profits through uninterrupted and less costly production. Labor profits by uninterrupted wages and earnings. Government profits by an assurance of on-time delivery of urgently needed defense materials.

As part of this plan there has been set up a National Committee for Manpower Conservation, composed of widely known industrial safety promotion experts, together with representatives of labor, having a primary interest and concern in accident control. Aided by this committee, the Department of Labor has already prepared and issued a special bulletin outlining the major factors in the elimination of work injuries, as well as important information in respect to methods for controlling health exposures through the application of relatively simple engineering devices and techniques. This bulletin is largely directed to the attention of the employer, who alone can bring about the proper physical conditions requisite for control of work hazards.

Special Bulletin No. 2 will be off the press in a few days, and it is directed definitely to workers in defense industries and will attempt to show concisely what the worker can contribute to accident prevention programs. In this latter undertaking we have had the full cooperation of advisers from labor organizations, who will actively assist in arousing keener interest of labor in the safety-for-defense movement. These bulletins will be followed by a series of others dealing in greater detail with various specific exposures and information about acceptable and practicable methods of control. To summarize in a single sentence what I have said in this talk: If we are to be assured of prompt and continuous delivery of essential weapons of defense we must not only train new workers and retrain older workers, but we must restrain accidents, which fritter away our supply of skilled hands producing these weapons.

Maximum Allowable Concentrations of Dangerous Industrial Dusts and Gases

By ALICE HAMILTON, M.D.

Medical Consultant to the U. S. Division of Labor Standards, Washington, D. C.

I have been asked to make a brief summary of our present-day knowledge with regard to dangerous degrees of air pollution from gases, vapors, dusts and fumes, and the data which have been secured so far as to the maximum allowable concentration which can be assumed to be within safe limits, below the danger point. A few of the dangerous dusts and vapors have been studied intensively enough to afford us fairly full data on which to establish such standards, but only a few, and even with regard to them our knowledge is not complete, and it would be a great mistake to embody in legal regulations the standards which we are at present tentatively recommending, for it is certain that, as our knowledge increases through investigations in this field, we shall have to change our figures. I believe that the State departments of labor or of health which have adopted standards of allowable concentrations regard them as advisory only, and that is right.

The first attempt at the establishment of a maximum figure of air contamination by an industrial poison was made in England in 1910 by Duckering and Legge, who used the procedure since generally adopted; that is, they determined the amount of lead in the air of a workroom and matched it up with the record of lead poisoning in that room. In this way they were able to state that, if the amount of lead were kept under 0.5 mg. per cubic meter of air, there would be no serious plumbism, no palsy or encephalopathy and only rarely colic. This amount, you see, was not to be taken as safe, only as free from serious danger. In 1933 our own Public Health Service concluded that the amount of lead dust or fumes in the air should be kept 0.15 mg. per cubic meter for safety. This was on the basis of an investigation of a storage battery plant, and a sickness study of 2,303 men employed there. For "prolonged exposure," the figure must, it seems, be still lower, for some cases were found which had developed even at 1.2 mg.

I believe the next important contribution in this field was made by the Benzol Committee of the National Safety Council, which, as you all remember, established 100 parts per million as the maximum allowable concentration for benzol. That figure still stands, though we have a good deal of evidence that it is too high. You are probably familiar with two remarkable reports on industrial benzol poisoning which appeared in 1939; one from the Massachusetts State Department of Labor on benzol in the manufacture of shoes; the other from the New York State Department, on benzol in rotogravure printing. In both studies cases were discovered that had developed after exposure to concentrations below 100 ppm. As a result, Dr. Francis Hunter of Boston declared that, "It is doubtful whether any concentration of benzene greater than zero is safe over a long period of time."

The American Standards Association has had for some years a committee on this sub-

American Standards Association Committee

Substance	Parts per Million	Length of exposure
Carbon monoxide	100 400	Not over 8 hours daily " " 1 " "
Benzol	100	" " 8 " "
Carbon disulphide	20	" " " " "
Hydrogen sulphide	20	" " " " "

Suggested Standards for Illinois and Massachusetts

Substance	Parts per Million Illinois	Parts per Million Mass.	Milligrams per Cubic Meter Illinois	Milligrams per Cubic Meter Mass.
Ammonia	50	100		
Aniline	5	5		
Benzol	75 (and derivatives)	75		
Carbon tetrachloride	100	100		
Chlorine	0.35	1.0		
Chloronaphthalenes			5	1 to 5
Chlorodiphenyls			5	1.0
Chromic acid			1.0	0.1
Gasoline	1000	1000		
Glycols	25			
Hydrochloric acid		10		
Hydrocyanic acid	10	10		
Hydrofluoric acid	3	3		
Lead			1.5	1.5
Mercury			1.5	1.5
Methyl alcohol	100	200		
Nitrogen oxides	10	10		
Nitrobenzol		5		
Ozone		1		
Phosgene		1		
Phosphine		2		
Sulphur dioxide	10	10		
Tetrachlorethane	100	200		
Tetrachlorethylene	100	200		
Trichlorethylene	100	200		
Toluol	75	200		
Turpentine	500	200		
Xylol	100	200		
Zinc oxide	150			15

ject, composed of industrial physicians, ventilation engineers, industrial insurance carriers and toxicologists, who are trying to set up standards for use in industry.

So far we have dealt conclusively only with two gases and two volatile solvents, carbon monoxide and hydrogen sulphide, benzol and carbon disulphide. The limits adopted for the present are shown on the accompanying chart. Benzol stands at 100 ppm., chiefly because of the insistence of our insurance members that this is an ideal that can be realized practically while a more rigid standard would be rejected, and we should be left with no standard at all. Myself, I am always willing to accept half a loaf rather than no bread, but Manfred Bowditch, of the Massachusetts Bureau of Occupational Hygiene, is unwilling to go higher than 75 ppm., and Yandell Henderson, of Yale, enters an emphatic protest against 100 ppm., saying that if 20 ppm. is feasible for hydrogen sulphide and carbon disulphide, he can see no reason why it is

Tentative Standards Adopted By Public Authorities For Maximum Allowable Concentration Of Silica Containing Dusts

Authority	Millions of Particles per Cu. Ft. of Air — Free Silica Content: High	Medium	Low
National Silicosis Conference. 1936. Medical Committee.	5	10 to 20	
Ditto. Engineering Committee.	5	10 to 30	
U.S. Labor Department 1936 Division of Labor Standards	5	15	
New York Department of Labor. 1940	5 Foundry [illegible] 15 Abrasives Blast Cleaning [illegible]	10	100
Connecticut Department of Public Health. 1936.	5		
California Industrial Accident Commission. 1936.	5		50
Wisconsin Industrial Commission. 1932.	5	15	
Massachusetts Department of Labor & Industries 1940	5	10 (granite)	100 25 Foundry Nuisance Dusts

impossible for benzol. Certainly it is to be hoped that ventilation engineering will progress to the point where a lower figure than 100 ppm. may be reasonably demanded for benzol users.

The standard for carbon monoxide does not need to be defended. This gas has been exhaustively studied by the Public Health Service, by State bodies, by industry and by toxicologists in many universities. Carbon disulphide and hydrogen sulphide are the two dangerous gases which must be dealt with in the manufacture of viscose rayon, and the maximum allowable concentrations given in the chart were established through careful studies made by the American Viscose Corporation, the du Pont Company and the Tubize-Chatillon Company.

When it comes to the other toxic substances I have listed here, we can say only that the figures given represent our best judgment at the present moment, but we admit that that judgment is often based on something not far from guess work. Take the one on which I happen to be engaged at the present time, tetrachlorethane. We know it is the most dangerous of the chlorinated hydrocarbons used in industry, and we have known since the first world war what its action is on the human body, for it was used by both the Germans and the British in airplane dope, and in both countries gave rise to cases of acute yellow atrophy of the liver; but, in spite of a voluminous literature and an impressive number of clinical cases, we find no instance in which the amount of poison in the air was determined. Therefore, the standard, ten parts per million, is based on Zangger's statement that this solvent belongs with aniline and nitrobenzene in the most toxic group. We have little data with regard to the other chlorinated hydrocarbons, except CCl_4, about which we do know somewhat more. As to the others, our knowledge comes chiefly from the studies made by pharmacologists who sought a relatively non-toxic agent for cases of hookworm infection which is not the same thing as industrial poisoning from fumes.

To pass over to that very controversial field, silicosis, I need hardly emphasize the fact, so evident in the accompanying charts, that there is still much confusion and little agreement among the authorities as to the amount of dust containing varying proportions of free silica that may be permitted in a workshop. This is to be expected. Poisoning from gases and fumes, even if slow, does not take fifteen years to make itself evident; silicosis may. Moreover, other factors, aside from the actual proportion of free silica, affect the dangerous character of a given dust.

Take foundry dust. It may be rich in silica, running as high as the notoriously dangerous granite, yet, while consumption has for centuries been the occupational disease of stone cutters, this has not been true of foundry workers. Recent brilliant studies of this particular dust, notably the one by Hatch and Moke, have provided an explanation for the difference between foundry dust and other silicious dusts, for it has been shown the silica content of the former is chiefly in the large dust particles, and as the particle size decreases, the free silica falls, till it may reach, for particles under 2 microns, only one-fifth or even one twenty-fifth of the percentage in particles over 10 microns. This is, however, not true of the foundry dust caused by sandblasting and by chipping, jobs which everyone familiar with the industry knows to be dangerous. Steel foundries are the worst, probably because more chipping is needed on steel castings.

If our knowledge of the minimum dose required to produce poisoning needs amplifying, this is still truer of our knowledge of what constitutes dangerous dust concentrations. Here the Public Health Service is doing much valuable work. Their two monumental investigations, of the Vermont granite industry and of Pennsylvania anthracite mining, have carried us a long way forward, and, in cooperation with the experts of the Saranac Laboratory, they have found it possible to establish certain fundamental facts. For instance, the Laboratory is able to state that the percentage of tuberculosis to be expected among workers in an establishment where there is no special dust hazard, is 4.79 per cent. If the rate is higher, there is something wrong; of course, not necessarily dust in the air; perhaps low wages.

Donald Cummings, of Saranac, urges the adoption of two limiting concentrations of free silica; first, the "primary threshold," a concentration of dust in which a healthy man may be employed throughout his working life without a disabling injury; second, the "secondary threshold," a concentration in which a healthy man will "inevitably contract silicosis if regularly employed for several years." General experience shows that the first is at about five million particles less than ten microns in diameter; the second is probably at a level not higher than 100 million.

At the National Silicosis Conference held in Washington in 1938, this formula was suggested for determining the maximum permissible concentration of free silica in the air breathed. Multiply the percentage of free silica by the total small particle dust count by impinger. If the result is under 5 million, the condition may be looked on as permissible. If it is over 5 million, the condition is to be looked on as poor. For example, 10 per cent free silica with an average total dust count of 30 million particles would mean 0.1 times 30 million, or 3 million, good practice; while 30 per cent free silica and 50 million particles would mean 15 million, too much. This formula cannot be applied to a dust with less than 5 per cent silica.

Both New York and Massachusetts have made fairly recent studies of the foundry industry and of work with granite, such as quarrying and stone cutting, tunnel and foundation excavating. New York recommends for dust containing less than 10 per cent free silica, 100 million particles; for 10 to 70 per cent, 10 million; for 70 per cent and over, 5 million. Foundry dust, averaging 20 per cent free silica, should be kept down to 25 per cent; the dust from abrasive blast cleaning, averaging 70 per cent down to 10 million. Massachusetts allows 25 million for foundries, 10 million for granite stone mills and 5 million for pure silica dust.

Source of Dust	Percent of Quartz (Free Silica)	Suggested Standard in Million Particles (Below 10 Microns) per Cubic Foot of Air.
Gold Mines, South Africa	86 to 95	3 to 4.5 million.
Metal Mines, Broken Hill, Australia	10 to 17	14 ″
Tunneling, Sydney, Australia	90	Under 6 ″
Gold Mines, Ontario	5 to 10 (2 Mines) 25 to 35 (″ ″)	8.5 ″
Iron Mines, Canada	50	5 ″
Granite Cutting, Barre, Vermont	(Rock, 26.5) Dust, Average 35	9 to 20 ″
Metal Mines, Tri-State Area	90	5 ″
Potteries, West Virginia	20 to 30	
Anthracite Mines, Pennsylvania.	(Rock 43% Coal 6% Dust 90% Coal 2-4% quartz) Rock Workers dust average 35	5 to 10 ″
Subway and Foundation Drilling, New York City	Less than 1 to 84.	10 ″

We must not forget that the adoption of any of these standards does not mean that there will be no silicosis among the workers. In the South African gold mines, the free silica in the air was brought down to 3 to 4.6 million particles per cubic foot by 1933, but cases have continued to develop, taking 14 years now, on an average as against an earlier average of 9½ years. In Barre, Vermont, the Public Health Service found cases appearing after only ten years at 6-9 million particles and after 9 years, at 20 million. They have placed the maximum allowable number of particles at 9 to 20 million, which is certainly not extreme.

I need not say anything more about the great need of careful studies of actual conditions under which damage from poisons and dusts occurs in industry. It is in our country that these studies must be made. The day is past when we could look to Germany as the source of knowledge of industrial toxicology. Now that authoritative position has passed to us. And this particular method of determining safety limits by means of a combination of experts in several fields, chemists, ventilation engineers, and physicians is peculiarly American. No other country has made anything like the contributions to this branch of industrial hygiene that we have. But we need a great deal more.

Standardizing State Industrial Safety Requirements

By W. T. CAMERON

Chief Safety Adviser, Division of Labor Standards, U. S. Department of Labor, Washington, D. C.

The title of this address might well have been "Democracy in Action", for I know of no other place in our National life where democracy has gone to work in more typical fashion than in the field of developing State industrial safety requirements. I imagine everyone promoting the art of safety has at one time or another visualized himself in the role of Safety Dictator of the United States and, as such, has "laid down the law" to abolish all the conditions, which, year after year are responsible for identical accidents happening in the same old way—over and over again.

By one stroke of the pen you unified automobile hand signals and standardized the method of making a left turn. You outlawed the make-shift ladder, and you made it a prison offense to sell an unguarded machine. But then you came to a safety meeting like this and realized that about 10,000 other people also have some good ideas and that, while perhaps slower, the Democratic way was, after all, best.

"Democracy in Action" in the field of industrial safety regulation is a slow educational process of "give and take," of trial and error. It means consulting the victim before invoking the penalty, consulting the industry which has to make the standard fit its process, the industry which has to foot the bill, and the worker who has to use the device and still get out the production.

There is no need to argue here the cause of uniformity in State safety codes, rules and regulations. Resolutions of recent conventions of the International Association of Governmental Labor Officials, committees of the American Society of Safety Engineers, statements of machine builders, guard manufacturers, the American Standards Association and the National Safety Council, all stress the need for uniformity and the need for ironing out the discrepancies which already exist between individual State requirements. It is rather my duty to point out what progress has been made and the methods which have proved successful in speeding up our democratic processes to keep pace with modern industrial needs.

There are still those, of course, who say that State Governments have no business in the field of industrial safety—that, given enough time, industry itself will carry their methods and self-developed standards to every nook and corner of industrial America. To these let me suggest that they trade places with the State Workmen's Compensation Commissioner who is daily confronted with an ever-increasing line-up of victims of accidents and see, if under these circumstances, he could refrain from "doing something about it"—from trying to speed up the spread of the Safety Movement. The States are now definitely "in the swim" and have, as has already been demonstrated in a number of jurisdictions, an accepted place in the fight to prevent industrial accidents and occupational disabilities.

The problem now is not whether the States *should be* promulgating enforceable safety codes, but rather that those codes which are developed shall follow a logical National pattern—free from conflicts and discrepancies; in other words, that they shall be consistent with regulations being put through by other States and now in use as self-applied standards by a large segment of industry.

As we look over the methods employed by the 48 States we find a variety of approaches. All are presumed to lead to the same end—to protect the worker from the mechanical and environmental hazards of his job.

Some States write the technical details into the basic statutes where, I'm sorry to say, they stand frozen and unmolested while industrial progress rushes by.

Others have laws setting forth the principle that the employer is duty-bound to provide a safe and sanitary place to work. Under this set-up each inspector decides what is safe or unsafe with administrative guidance in the interpretation and application of the law varying with each change of administration.

Some depend solely upon recommendations having no force and effect of law and hope that, if given enough time, all workers will be assured equal protection from similar job hazards, whether the plant is large or small.

But, I am glad to say, an ever-increasing number of States are putting "democracy to work" on a plan which keeps pace with the modern tempo of industry—a plan where safety engineers, workers, regulatory bodies, compensation commissions and the public sit around the table and adapt and fit a set of National safety standards to meet the requirements of the individual State and the industry within that State.

The legislators of 28 States have realized that they cannot know all about the safe limits of pressure vessels, the requirements of a punch press guard or the intricacies of construction safety, and they have delegated to an administrative board or commissioner the responsibility and power to work out the details. And what is equally important, they have, to a greater or lesser degree, written into the law delegating the rule-making power the democratic procedure by which the standards are to be developed. Not all of these 28 States have made use of this authority and in a few cases the legislature unwittingly did the job twice, and we find States with perhaps the labor department and the workmen's compensation agency both with the necessary authority.

The Sixth National Conference on Labor Legislation, which met in Washington in November 1939, summed up the State's obligation in safety and the modern democratic approach to this end, thus:

"Adequate authority should be provided for the prevention of industrial accidents and diseases. The provision for reporting all disabling injuries and occupational diseases should be compulsory.

(a) "Every State should adopt a basic safety and health law which should:

(1) "Require all employers to provide reasonable protection of the lives, health, and safety of persons employed in the States;

(2) "Vest in the labor department or industrial commission the power to establish minimum standards of safety and health by the promulgation of industrial health and safety codes;

(3) "Set forth the right of the enforcing agency to enter places of employment;

(4) "Invest the agency with power to tag or seal dangerous machinery and unsafe or unhealthful places of employment; and

(5) "Provide for a penalty or penalties that may be applied in case of violation of the industrial health and safety codes.

"The language of delegation of power must be specific and the law should provide for (1) public hearings in formulating the codes; (2) publication of the codes after promulgation; (3) administrative and court review; (4) the enforcement by the agency of the minimum standards; and (5) power, by the department or commission head only, to make variations or exceptions from the standards (if strict compliance would work an unnecessary hardship or injustice)."

Right here let me emphasize that, while the long-range program of every State should be toward a revision of administrative set-up along the above lines, much can be accomplished with the use of present machinery if the will is there.

This can be illustrated by a situation which existed in one of our northwestern States, where two State agencies have some inspection and regulatory powers, but in each case the lack of clear definition as to how far each could go had prevented either from taking action. When these two agencies got together and expressed a mutual willingness to cooperate in establishing a single code program, it was found to their surprise that, operating jointly, they had all the authority needed. Of course, this is unwieldy and cumbersome, but much history, tradition and political consideration is involved which may take years to change. In the meantime, however, the work is going forward and the accident situation in that State is being improved.

From the standpoint of National standardization, I am pleased to report that recent studies and field trips have revealed very little of the old attitude that conditions in a particular State were "vastly different" from those found in another. In past years this has been one of the chief stumbling blocks in getting governmental officials in particular jurisdictions to cooperate with other groups, on a nation-wide basis, in establishing rules and regulations. We are at last on the way toward building a single group of rules and regulations which will be adopted and enforced uniformly throughout the country.

I know of no greater safety service that can be rendered by State agencies to the cause of universal safety than the adoption by all States of, first, the democratic process of code building, and second, the use of proven mechanical safety standards, as developed through the American Standards Association procedure as the foundation for State action on safety.

WEDNESDAY MORNING SESSION

October 9, 1940

The session, which was planned as a panel discussion of State Industrial Safety Services, was called to order by the Chairman, Harvey Saul, Director of Labor, Rhode Island Department of Labor, Providence, R. I., who presided.

Chairman Saul outlined the objectives and procedure of the meeting, and then introduced the members of the Panel, as follows:

J. T. Faust, Chief Deputy, Division of Factory Inspection, Illinois Department of Labor, Chicago.

H. D. Immel, Director, Bureau of Inspection, Pennsylvania Department of Labor and Industry, Harrisburg, Pa.

S. D. Kelley, Chief Factory Inspector, Colorado Industrial Commission, Denver, Colo.

R. McA. Keown, Engineer, Industrial Commission of Wisconsin, Madison, Wis.

E. J. McCrossin, Chief, Division of Safety and Inspection, Alabama Department of Industrial Relations, Birmingham, Ala.

Harry Sain, Assistant Superintendent, Division of Safety and Hygiene, Industrial Commission of Ohio, Columbus, O.

The program plan presented a number of service problems for discussion by the panel members, as follows:

1. Building Safe Machinery.
2. Using Accident Records to Guide Inspection Activities.
3. Safety Contests.
4. State-Wide Vs. Regional Safety Conferences.
5. Educational Techniques — Exhibits, Films, Posters, and Radio.

(Unfortunately, since no record of the discussions was taken, no detailed report can be presented in these Transactions.)

ADJOURNMENT

this ventilating current be interrupted for a period of 24 hours and with the same amount of methane being liberated, there would be 5,760,000 cu. ft. of explosive mixture. Should this be contained in an entry 10 ft. square, the length of the entry would be approximately 11 miles.

Methane detectors are now available which will automatically indicate and record percentages of methane. One type may be located in working sections on cutting and loading machines, in the last breakthrough and along haulage roads. This can be adjusted to give a warning by a signal light or other means at any predetermined methane concentration. For example, at 1 per cent or any specified percentage between .5 per cent and 3 per cent, it will operate special electrical circuits through suitable relays to cut off the power in a section or give warnings in other parts of the mine or to the outside. Methane recorders for continuously indicating and recording methane in main returns particularly have been perfected recently and are designed to be located in fan houses or other convenient places.

There is no relation between the volume of methane given off in a coal mine and the chemical composition of the coal, as both bituminous and anthracite mines produce methane, and methane has been found in metal and other mines when tunneling through carbonaceous shales. The common occurrence and explosibility of methane are responsible for numerous mine disasters and every precaution should be taken to keep it within safe limits. This can best be done by the use and guidance of methane detectors.

Pulmonary Diseases in the Mining Industry

By DR. R. R. SAYERS

Director, United States Bureau of Mines, Washington, D. C.

Although the attention of those interested in diseases peculiar to mining has been focused recently on one dust disease—silicosis—other respiratory diseases may cause more suffering and economic loss. The increased incidence of these diseases usually is attributed to exposure to abnormal air conditions underground, such as sudden changes from high to low temperatures, excessive dust, and noxious gases. The principal respiratory diseases to which the miner is subject are bronchitis, influenza and pneumonia, pulmonary tuberculosis, anthracosilicosis, and silicosis. Although the mortality statistics in some of the tables included in this paper are old they have been corroborated by later, less complete data.

Bronchitis

Bronchitis is an inflammation of the bronchial tubes due, among other causes, to the inhalation of irritants such as dusts (organic and inorganic). Occupations that entail exposure to atmospheres polluted by irritating gases carry with them the risk of bronchitis. According to Collis,[1] it cannot be distinguished clinically from bronchitis occurring among the general population and its association with the inhalation of dust or gases usually is unrecognized.

During middle life bronchitis causes much recurrent invalidity and incapacity. Mortality records compiled by Collis indicate that it is of a chronic traumatic origin associated with irritating atmospheric conditions, rather than of an infectious origin.

Statistics for bronchitis for the general population and for workers exposed to dusts in Great Britain[2] for 1921-23 show the role played by dusts in the increased incidence of the disease in certain industries. The comparative mortality per thousand (ages 26 to 65) for those in occupations exposed to siliceous dust was 214, for those exposed to nonsiliceous dust 59.5, and for the general population 49.6. (See Table 1.)

In this connection it is interesting to note the mortality statistics per thousand (ages 20 to 65) for coal miners of counties of Wales (in which most of the coal mined is anthracite) compared with those for two other groups in England and Wales.[3] The figures for coal miners are 112 for all underground workers and 139 for hewers and getters compared with 46 for males in the same social class and 50 for all occupied and retired males. (See Table 2.)

In a study by the United States Public Health Service[4] 35 cases of chronic bron-

Table 1.—Mortality per 1,000 from Bronchitis in Dusty Occupations and in the General Population, by Age Groups

	Ages at Death					Comparative Mortality Figure
	20—	25—	35—	45—	55—	20—65
Occupations exposed to						
Siliceous dust	1.1	1.0	13.7	44.6	153.7	214.0
Nonsiliceous dust	....	....	4.9	12.8	41.8	59.5
General population	0.5	1.7	5.4	13.3	28.8	49.6

chitis were found among 344 employees of two anthracite mining companies examined.

In the study conducted by the Bureau of Mines and the Public Health Service at Picher, Okla.,[8] the highest incidence of silicosis or tuberculosis, or both, was found among men who reported having had bronchitis, pleurisy, and asthma.

Table 2.—Comparative Mortality Figures for Bronchitis per 1,000 of Certain Groups in England and Wales

	Bronchitis
Coal miners[1]	
All underground workers	112
Hewers and getters	139
Males in same social class	46
All occupied and retired males	50
Ratio of rate for hewers and getters to rate for same social class	302

[1] In three counties in Wales.

Table 3.—Influenza-Pneumonia Mortality among Bituminous Coal Miners—October to December 1918

Age Period	Annual Death Rate per 1,000	
	Bituminous Coal Miners	All Industrial White Males
All Ages[1]	50.1	22.3
15-25	29.5	17.5
25-45	62.1	32.6
45-65	44.4	11.7

[1] Fifteen years and over.

Influenza and Pneumonia

Figures of mortality available for 4,700 miners insured in the group department of the Metropolitan Life Insurance Company[9] show that in the last quarter of 1918 during the influenza epidemic 64 of these miners died of influenza or pneumonia. This is equivalent to an annual death rate of 50 per 1,000. Among all occupied males aged 15 years and over, the rate from influenza-pneumonia in the same 3 months was 22 per 1,000 or less than half as high. In the age period 45 to 65 years the rate among bituminous coal miners was about four times as high as among all occupied males in the same age group. (See Table 3.)

Influenza and pneumonia, as reported, were responsible, in the years under study, for 31 per cent of the mortality in the group of bituminous coal miners at ages 16 to 70 in Indiana, Missouri, and Wyoming compared with 19 per cent among both farmers and "all other males" at these ages in the same counties. (See Table 4.)

In 1918, the year of the great epidemic, influenza and pneumonia deaths constituted 55 per cent of total mortality exclusive of accidents among the bituminous miners in contrast with 27 per cent among the farmers and 34 per cent among all other males. These percentages were not as high as the figures for Wilkes-Barre. The fact that the soft-coal counties under consideration are largely rural areas may have made some difference.

In the epidemic year 1920, the proportion of deaths from influenza and pneumonia was smaller than in 1918, but, as was found for the anthracite miners, the bituminous group showed a wider difference in the pro-

Table 4.—Percentage of Deaths from Influenza and Pneumonia (After Deducting Accidents) Among Bituminous Coal Miners Compared with Farmers, and With Other Males in the Same Areas of Several Soft-Coal Producing States[1]

Male Groups Under Comparison	Ages					
	16-70	16-30	31-40	41-50	51-60	61-70
Bituminous coal miners	31.1	49.4	44.7	25.1	19.7	10.4
Farmers	18.7	38.4	32.4	19.7	12.4	10.8
All other males	18.6	30.0	29.0	16.0	11.3	10.8

[1] The death records for soft-coal miners were obtained from 15 coal-producing counties of Indiana, 1916-20, inclusive, 8 coal counties of Missouri, 1917-21, inclusive, and the 6 principal coal-producing counties of Wyoming, 1919-23, inclusive. The record for farmers and for "all other males" was obtained from the above-mentioned coal-mining counties, and also from 3 agricultural counties of Wyoming, 1919-23.

portion of deaths from this cause compared with "all other males" than in 1918. The percentages in 1920 were 29 for the soft-coal miners and 16 for "all other males." In this epidemic the bituminous miners at ages 40 to 60 suffered heavy excess mortality from influenza-pneumonia, but the differential mortality was not quite so great as at ages 16 to 30.

Among hewers and getters of soft coal in England and Wales, the death rate from influenza and pneumonia, 1921-23, was about 12 per cent greater than among males of comparable social status (social class 3). The difference was found to be 5.8 times the probable error of the difference which is certainly a significant variation. Thus, an abnormal mortality from influenza and pneumonia is consistently indicated among miners of coal—both anthracite and bituminous—in England as well as in America.

The pneumonia mortality figures in 1921-23 for occupations in Great Britain exposed to siliceous and nonsiliceous dust compared with those for the general population were given by Collis[8] as 134.3, 76.0, and 85.3, respectively; similar figures for influenza were 47.1, 49.6, and 36.5, respectively. (See Table 5.)

According to Brundage,[5] an outstanding feature of the statistics of death for hard-coal miners in the United States is their extraordinary mortality from influenza and pneumonia not only during influenza epidemics but at other times as well. In a study by the Public Health Service at Wilkes-Barre, Pa., in 1915-23 and 1906-25[6] it was found that influenza and pneumonia were responsible for 40 per cent of the total deaths, compared with 25 per cent among males at ages 15 to 65 who had been engaged in pursuits other than coal mining in Wilkes-Barre and vicinity. The percentage of deaths from influenza and pneumonia for these two groups by ages for the years mentioned was 19.3 for anthracite miners compared with 13.3 for males in other industries. (See Table 6.)

Tuberculosis

In 1925 Collis[8] said that for coal miners generally the tuberculosis rate apparently is low although miners at the coal face suffer from the disease more than other coal miners underground and workers above ground. Results of more recent investigations seem to contradict the assumption that tuberculosis does not occur among coal miners. An investigation by the Welsh School of Medicine, reported in 1937,[9] indicates that this supposed exemption of coal miners from tuberculosis may be due to a mis- or partial diagnosis. This investigation revealed a high incidence of tuberculosis (35 per cent if the "probable" cases are included) among the pneumoconiotics of the South Wales coal fields and supports the theory that coal dust modifies the tuberculosis, leading to failure to recognize the disease or to the mistaken diagnosis of "bronchitis."

Studies by the United States Public Health Service[10] revealed that 6 per cent of hard-coal miners examined had clinical pulmonary tuberculosis. The average prevalence in the adult male population of the United States is about 2 per cent. The prevalence of pulmonary tuberculosis among hard-coal mining employees at ages below 35 was slightly less than that found through studies among male adults in the general population. In the age group 35 to 44, however, the prevalence of tuberculosis was

Table 5.—Mortality per 1,000 from Pneumonia and Influenza in Dusty Occupations and in the General Population

	Pneumonia					
	Ages at Death					Comparative Mortality Figure
	20-	25-	35-	45-	55-	20-65
Occupations exposed to						
Siliceous dust	3.3	14.4	30.6	47.2	38.7	134.3
Nonsiliceous dust	[illegible]	9.6	13.7	28.7	23.9	76.0
General population	4.3	11.5	19.6	24.2	25.7	85.5
	Influenza					
Occupations exposed to						
Siliceous dust	1.1	7.7	11.3	8.7	18.3	47.1
Nonsiliceous dust	5.4	4.8	13.7	10.6	14.9	49.6
General population	2.0	5.2	7.7	9.7	12.0	36.5

about twice, at ages 45 to 54 about 5 times, and for ages above 55 it was about 10 times the rate found in the general population. The highest prevalence of clinical pulmonary tuberculosis occurred among the rock workers (men who had been employed in rock loading or rock extraction for more than 2 or 3 years). After 20 years' service, of which more than 2 or 3 years were in rock work, 37 per cent presented evidence of pulmonary tuberculosis. In a group of 135 completely disabled former anthracite workers, which did not include any known cases of tuberculosis, 10 per cent proved positive for pulmonary tuberculosis. These findings would appear to corroborate those of the Welsh National School of Medicine that indicate that the supposed exemption from tuberculosis of coal miners is erroneous due to incorrect diagnosis. There is evidence that the above increased incidence of tuberculosis is associated with exposure to silica dust.

The incidence of tuberculosis is much higher in metal mines than in coal mines, due no doubt to exposure to dust containing a higher concentration of silica. An investigation in 1914 by the Bureau of Mines in cooperation with the Public Health Service of pulmonary disease among the zinc miners of the Joplin, Mo., district, revealed a high death rate from pulmonary tuberculosis. The mortality rate for tuberculosis for Jasper County was 200.8 per 100,000 for 1911 and 1912 and 229.7 for 1913, according to statistics of the State Board of Health.[11] On the other hand, according to the Jasper County Antituberculosis Society, during the calendar year 1912 there were 720 deaths among miners who had worked 2 years or more underground in Jasper County. Not all

Table 6.—Percentage of Deaths from Influenza and Pneumonia among Anthracite Miners and among Males in Occupations Other Than Mining in Wilkes-Barre and Vicinity

Groups Under Comparison	Ages					
	15-64	15-24	25-34	35-44	45-54	55-64
Antharacite miners	39.8	45.2	67.9	42.9	31.8	19.3
Males in other industries	25.3	28.7	46.2	31.0	16.8	13.3

Table 7.—Mortality per 1,000 from Pulmonary Tuberculosis in Dusty Occupations and in the General Population

	Ages at Death					
	20-	25-	35-	45-	55-	20-65
Occupations exposed to						
Siliceous dust	25.6	63.4	141.0	211.6	150.6	592.2
Nonsiliceous dust	13.6	26.3	46.1	56.4	29.9	172.4
General population	20.6	37.6	43.6	39.0	22.7	163.5

of these 720 deaths occurred in that county but they had contracted the disease there and some of them had moved away. Of 93 miners in the Joplin District examined by Lanza in 1914,[11] 64 showed definite symptoms of pulmonary disease and 39 of the 64 had the classical symptoms of pulmonary tuberculosis.

In a study by the Bureau of Mines and the Public Health Service[12] in Butte, Mont., during 1916 to 1920 the death records of the State Board of Health were examined. These showed that during 1915, 122, during 1916, 126, and during 1917, 169 Butte miners died of tuberculosis. The significance of the death from tuberculosis of 169 miners in 1917 is indicated by comparison with the records of other regions. In 1917 approximately 14,000 men were employed underground in Butte mines; with 169 deaths from tuberculosis for the year the rate per 100,000 was 1,207. The tuberculosis death rate of Michigan for the 10-year period 1910 to 1920 was 97.4 per 100,000; hence the tuberculosis death rate of Butte miners was nearly 13 times as great as that of Michigan.

The part played by dust, especially dust containing silica, in the production of pulmonary tuberculosis is shown clearly by figures for Great Britain for 1921-23.[8] The death rate per 1,000 for ages 20 to 65 was 592.2 for those exposed to siliceous dust, 172.4 for those exposed to nonsiliceous dust, and 163.5 for the general population; for ages 35 to 44 the figures were 141.0, 46.1, and 43.6, respectively; for ages 45-54 the figures were 211.6, 56.4, and 39.0, respectively; and for ages 55 and over the figures were 150.6, 29.9, and 22.7, respectively. (See Table 7.)

According to Collin[7] the prevalence of bronchitis, pneumonia, and tuberculosis is high among those exposed to silica dust but the incidence of these diseases is not always the same under other conditions such as exposure to other dusts, heat and fumes, or working indoors. (See Table 8.)

Anthracosilicosis

From 1931 to 1937, 87 per cent of the total deaths in Great Britain due to silicosis occurred among the coal miners of South Wales; two-thirds of the deaths and disease occurred in the Swansea Division; and 89 per cent of the medical certificates granted in the Swansea Division related to anthracite collieries.[13]

In the United States the chronic disease among miners due to breathing air containing dust generated in the various processes involved in the mining and preparation of anthracite is called anthracosilicosis. This is a descriptive title for the form of pneumoconiosis commonly called miners' asthma. The disease was found in about 23 per cent of 2,711 employees of three anthracite mining companies studied by the United States Public Health Service in 1933. About 63 per cent of those having anthracosilicosis showed evidence of disability, compared with less than 10 per cent in the control group. Moderate and marked degrees of disability handicapped aproximately 21 per cent of those with anthracosilicosis compared with less than 2 per cent of the men serving as controls.

Wide differences were found in the extent of physical impairment in the several occupational groups. The highest rate of disability from all causes combined was found in the group of men that had changed more than 5 years before the date of examination from very dusty to relatively nondusty occupations in the industry. In a

Table 8.—Prevalence of Bronchitis, Pneumonia and Tuberculosis Under Certain Conditions of Exposure

Exposure	Bronchitis	Pneumonia	Tuberculosis
Outdoor and indoor life	low	low	low
Indoor industries	low	low	high
Coal trade	high	high	low
Alcohol trade	moderate	high	high
Heat and fumes	high	high	low
Dust of			
1. Animal origin	low	low	low
2. Vegetable husks and debris, certain inorganic materials	high	medium	low
3. Silica	high	high	high

number of instances the change in occupation probably was made on account of physical condition. Miners at the coal face, rock workers, and men who had had appreciable exposure to harmful dusts in other industries also showed evidence of much greater physical impairment than was found in the control group.

Moderate or marked physical impairment from any cause was found in 1.7 per cent of the control group, in 9.9 per cent of the regular miners, and among 12.6 per cent of the rock workers.

There was a marked tendency toward increase in the proportion having physical impairments with increase in the number of years of employment in anthracite. This tendency is manifested whether one considers disability of any kind, disability in which pulmonary infection was contributory, or disability due largely to tuberculosis. In each case the occupational groups arrayed themselves according to extent of physical impairment as follows: (1) Rock workers; (2) regular miners; (3) all others exposed to more than 100 million dust particles per cubic foot of air; and (4) men in haulageways except rock workers.

The pathology of anthracosilicosis as observed in these cases is essentially a deposition of coal dust in the lungs, accompanied by an extensive fibrosis, both diffuse and nodular, with associated functional and degenerative changes, (silicosis modified by coal dust).

That excess mortality from respiratory diseases as a whole is experienced by American hard-coal miners is clear from the studies made by the Public Health Service.[4] The anthracite miners' proportionate mortality from all respiratory diseases was about 1½ times that of the other adult males in the same region. When proportionate mortality was computed for ages 16 to 65 in Wales,[4] it was found that respiratory diseases accounted for 53 per cent of the deaths of anthracite miners compared with 38.2 per cent among males in the same social class. The proportion among hewers and getters of anthracite therefore was 1.4 times that of men of the same social status.

Silicosis

There are various definitions of silicosis but all agree that the cause of the disease is the inhalation of silica or quartz dust.[10] Silicosis is a well-recognized clinical and pathological entity at least as characteristic as that of any cause of death known to epidemiologists.[10] The definition of silicosis, adopted at the International Silicosis Conference in 1930 and reaffirmed at the 1939 Conference and generally accepted is:

"Silicosis is a pathological condition of the lungs due to inhalation of silicon dioxide. It can be produced experimentally in animals."

The first investigation of silicosis in the mining industry in the United States was made in 1914-15 by the Federal Bureau of Mines in cooperation with the United States Public Health Service in the Joplin (Mo.) mining district.[11] As only a few men were examined at that time, it was decided to examine a larger number to gain a more accurate idea of the prevalence of consumption among the miners of this district. From

Table 9.—Mortality from Certain Respiratory Diseases of Those Exposed to Siliceous Dust, to Nonsiliceous Dust, and the General Population—by Age Groups[1]

Groups	Bronchitis						Influenza						Pneumonia						Tuberculosis					
	20-	25-	35-	45-	55-	20-65	20-	25-	35-	45-	55-	20-65	20-	25-	35-	45-	55-	20-65	20-	25-	35-	45-	55-	20-65
Siliceous dust	1.1	1.0	13.7	44.6	153.7	214.0	1.1	7.7	11.3	8.7	18.3	47.1	3.3	14.4	30.6	47.2	38.7	134.3	25.6	63.4	141.0	211.6	150.6	592.2
Nonsiliceous dust	...	...	4.9	12.8	41.8	59.5	5.4	4.8	13.7	10.6	14.9	49.6	...	9.6	13.7	28.7	23.9	76.0	13.6	26.3	46.1	56.4	29.9	172.4
General population	0.5	1.7	5.4	13.3	28.8	49.6	2.0	5.2	7.7	9.7	12.0	36.5	4.3	11.5	19.6	24.2	25.7	85.3	20.6	37.6	43.6	39.0	22.7	163.5

[1] Made up from tables 1, 5 and 7.

May 15 to December 31, 1915, 720 miners were examined: 45.7 per cent had silicosis and tuberculosis and 5.3 per cent had tuberculosis.[16] A later report (1917) of this same investigation by Lanza and Childs[17] included the results of the first detailed X-ray studies of silicosis made in the United States.

Investigations of mining conditions by Harrington and Lanza[12] in Butte, Mont., in 1921, revealed that 42.4 per cent of 1,018 miners examined showed definite signs of lung damage due to dust.

From July 1, 1927, to June 30, 1932, the Metropolitan Life Insurance Co., the Tri-State Zinc & Lead Ore Producers Association, and the Federal Bureau of Mines operated a cooperative clinic at Picher, Okla.,[19] to demonstrate to industry a workable method for diagnosis of silicosis, to educate workers in preventive measures, and to serve as a model to industries presenting a dust hazard. Of 27,553 individuals examined during this period 5,366 had silicosis, 742 silicosis plus tuberculosis, and 320 uncomplicated tuberculosis.

The chief cause of disability in silicosis is tubercle infection. The silicotic lung appears to be a more favorable medium for the growth of the tubercle bacillus than the normal lung, not because it is fibrotic, nor because its lymphatic drainage is interfered with, but because it contains silica.[20] Apparently silica dust possesses this characteristic of increasing the liability to pulmonary tuberculosis. That this is true is indicated by the statistics quoted in this paper which indicate also that silica dust increases the liability to other respiratory diseases. (See Table 9.)

The results of virtually all studies are in agreement regarding the high mortality rates from tuberculosis for industries in which large numbers of men are exposed to a silica hazard. These rates are so high that they leave no room for doubt of the cause-and-effect relationship between the hazard and the high mortality.[20]

Joint studies made by the Actuarial Society of America and the Association of Life Insurance Medical Directors[20] revealed that there were 65 deaths where 6 were expected (about 11 times the expected number) from tuberculosis in 1925-1936 among a group of underground miners, most of whom were employed in metal mines. Tuberculosis deaths were fourteen times the expected among copper miners, nine times the expected among gold and silver miners, and eight and a half times the expected among iron miners. In an earlier study[20] covering the years 1915-1926, there were 18 times as many deaths as expected among lead and zinc miners.

An analysis by the field division of the Saranac Laboratory[21] of the roentgenograms of 5,000 white miners exposed to the inhalation of harmful concentration of silica dust shows that the incidence of pulmonary tuberculosis lesions increases as the degree of reaction to dust progresses. In this group of miners tuberculous lesions were found in approximately one-fourth of those with first stage silicosis, one-half of those in the second stage, and 65 per cent of those in the third stage.[22]

Prevention of Dust Diseases in Mining

The data given in this paper point to dust as the greatest contributor to the excessive mortality from pulmonary diseases experienced in the mining industry and to silica dust as the immediate cause of the disease silicosis. Therefore, the principal method of preventing these diseases is to eliminate as far as possible or reduce to harmless concentration the dust in the breathing zone of the workers. Experience has shown that the properties of a dust that determine its capacity to produce injurious effects are its composition, the quantity suspended in the atmosphere breathed by the worker, and its particle size.

Although any dust may be harmful to breath under certain conditions, as indicated by the data presented here that show a higher incidence of pulmonary diseases in nonsiliceous dusty industries than in the general population, physiological studies reveal that, in mining the harmfulness of a dust is proportional to its content of free silica or quartz, in particles small enough to enter the finer spaces of the lungs, and in high enough concentration to overcome the normal defenses of the respiratory system.

The prevention of dust diseases is the function of the physician and the engineer, working together to determine the extent of the dust hazard in industry and methods for its control.

The first step is to determine what dusts are harmful and in what concentrations. The procedure is somewhat as follows: It is observed that respiratory diseases appear more frequently or with greater severity among workers in certain industries or in connection with certain operations within an industry. The physician attempts to determine the extent of the injury to the health of those exposed and the cause. If the cause appears to be exposure to excessive dust, the engineer samples the air to determine the kind, amount, and size of the dust present. The physician and the engineer can correlate the results of their investigations to determine allowable concentrations of dust, exposure to which is not likely to cause harmful physiological reactions. The engineer is then in a position to devise measures for the reduction of the dust to a harmless concentration. The aim, of course, should be to eliminate the dust entirely or to reduce the dust to a concentration that will not cause disability during the working lifetime.

Allowable Concentrations of Dust in Mining

Investigations conducted over a period of years show that exposure to certain concentrations of harmful dusts for a certain time causes varying degrees of respiratory disability but that below these concentrations disabling pulmonary diseases do not occur within a working lifetime. The classical example of this is the experience in South Africa with the reduction in mortality from silicosis that has followed the reduction in air dustiness in the mines of that country.

The reduction in the incidence of silicosis in the South African mines attests the effectiveness of the control measures employed and the practicability of using a definite dust concentration as a guide in setting allowable limits of air dustiness in the prevention of pneumoconiosis in dusty industries. The production rate of silicosis in the scheduled mines of South Africa[23] in 1932-35 was 9.59 per 1,000 compared with 21.95 in 1917-18. (See Table 10.)

The incidence rates for silicosis uncomplicated by active tuberculosis among South African miners in 1936-1937 was between 8 and 9 per 1,000 per annum.[24] The liability among the whole body of miners to contract the disease in 1936-37 was less by 65

Table 10.—**Average Number of Miners Examined Annually and Production Rates for Silicosis in Each Triennial Period Since 1917-18**

Period	Average Number of Miners Examined Annually	Production Rate of Silicosis per 1,000	Period	Average Number of Miners Examined Annually	Production Rate of Silicosis per 1,000
1917-20	14,070	21.95	1926-29	14,624	21.11
1920-23	13,260	19.16	1929-32	16,774	13.87
1923-26	12,523	33.28	1932-35	20,139	9.59

per cent than it was in 1920-23. Among the "new Rand miners" who entered the industry by way of initial examination since 1916 and who have been exposed solely to the progressively improving occupation conditions that have obtained since that date, the liability to contract silicosis was less by 87 per cent than the similar liability among all miners working for an equal period in 1920-23. These "new Rand miners" constituted 77 per cent of all working miners examined. The group of pre-1916 miners, who in 1935-36 constituted less than 17 per cent of the total number of working miners contributed nearly 78 per cent of the new cases of silicosis.

In the study by the Public Health Service[9] of anthracosilicosis among hard coal miners silicosis was not found in a control group of mining employees whose dust exposure averaged less than 5 million particles per cubic foot of air.

The prevalence of anthracosilicosis among the entire group of employees was found to be about 23 per cent.

Among all except rock workers, less than 2 per cent of the men developed anthracosilicosis when the duration of employment was less than 15 years, regardless of the amount of dust in the air.

Among men exposed 15 to 24 years to dust containing less than 5 per cent free silica, 14 per cent of those who had worked where the average dust count was 100 to 199 million particles per cubic foot, 29 per cent of those exposed to 200 to 299 million particles, and 58 per cent of the men who had worked for this period in more than 300 million particles per cubic foot, developed anthracosilicosis.

Among men employed for more than 25 years in dust containing less than 5 per cent free silica, the proportion of persons found with anthracosilicosis under different concentrations of dust was as follows: 5 to 99 million particles, 7 per cent; 100 to 199 million particles, 54 per cent; 200 to 299 million particles, 71 per cent; 300 or more million particles per cubic foot, 89 per cent.

With the exception of miners, their helpers, and rock workers, about 25 per cent of all the men employed underground developed anthracosilicosis after a working period of more than 25 years. This group was exposed to dust having a quartz content of about 13 per cent.

The prevalence of anthracosilicosis among persons who had been exposed for more than 2 or 3 years to dust of which about 35 per cent was free silica, varied from 10 per cent among those who had worked in concentrations of less than 200 million particles per cubic foot for less than 15 years, to 92 per cent among those who had been employed for more than 25 years in dust concentrations exceeding 300 million particles per cubic foot, more than 2 or 3 years of which time was spent in rock work.

Age per se appeared to play a minor role in the development of anthracosilicosis.

Analysis of the data for the purpose of determining safe limits of dust exposure indicated that employment in an atmosphere containing less than 50 million dust particles per cubic foot would produce a negligible number of cases of anthracosilicosis when the quartz content of the dust was less than 5 per cent. In the gangways where the silica content of the dust was about 13 per cent, a safe limit appeared to be 10 to 15 million

Table 11.—**Pneumoconiosis Cases Occurring Among 798 Workers Exposed to Mixed Dust, Classified by Average Dust Concentration, Length of Employment, and Number of Workers Exposed**

Average Dust Concentration (Million Particles per Cubic Foot)	Years in Industry				
	0-4.9	5-9.9	10-14.9	15-19.9	20 and Over
0-9:					
Number of pneumoconiosis cases	0	0	0	0	0
Number of workers exposed	81	56	29	13	8
Percent with pneumoconiosis	0%	0%	0%	0%	0%
10-24:					
Number of pneumoconiosis cases	0	0	0	2	4
Number of workers exposed	123	94	66	29	23
Percent with pneumoconiosis	0%	0%	0%	6.9%	17.4%
25-49:					
Number of pneumoconiosis cases	0	0	3	3	6
Number of workers exposed	43	45	31	11	18
Percent with pneumoconiosis	0%	0%	9.7%	27.3%	33.3%
50 and over:					
Number of pneumoconiosis cases	0	4	5	4	4
Number of workers exposed	45	44	25	8	6
Percent with pneumoconiosis	0%	9.1%	20.0%	50.0%	66.7%

particles per cubic foot. The limit of toleration for rock workers was set tentatively at 5 to 10 million particles per cubic foot of air. Similar results were obtained by the Public Health Service in an investigation of pneomoconiosis among mica and permatite workers. (See Table 11.)

The relation of the average dust concentration and duration of exposure to the percentage of workers found to have pneumoconiosis was as follows: Of those who had worked in an average concentration of 50 million particles of dust per cubic foot of air, 9 per cent had pneumoconiosis in 5 years, 20 per cent in 10 years, 50 per cent in 15 years, and 66 per cent in 20 years. Of those who worked in an average concentration of 25 million particles 10 per cent had pneumoconiosis in 10 years, 27 per cent in 15 pears, and 33 per cent in 20 years. Of those who had worked in an average concentration of 10 million particles of dust, 7 per cent had pneumoconiosis in 15 years and 17 per cent in 20 years. (See Fig. 1.)

The data obtained in other studies of dusty trades, anthracite mining, asbestos textile manufacture, and the pottery industry have been treated in a similar fashion and have yielded similar, although usually less regular results. The position of the threshold value below which no cases were found and the magnitude of the trends between per cent affected and both time and intensity of exposure varies in different sets of data, depending, to a large extent, on the chemical nature of the dust to which workers were exposed and possibly on the regularity of employment.

It is tempting to seek to summarize the data of table 12 and figure 1 into a simple mathematical relation such as the following: With each twofold increase in average dust concentration above 10 million particles per cubic foot, the probability of finding cases of silicosis (in men exposed for comparable lengths of time) is approximately doubled. Application of the standard methods of curve fitting would yield more refined descriptions of these data. Nevertheless, it does not seem to be advisable to set up any mathematical treatment because, of all the men who entered the industry, only the survivors have been studied. There is no adequate way of finding out whether or not men who dropped out of the industry were in a better or worse state of health as far as silicosis is concerned than men who remained in the industry, and thus there is no way of introducing a correction for this element of selection into a mathematical

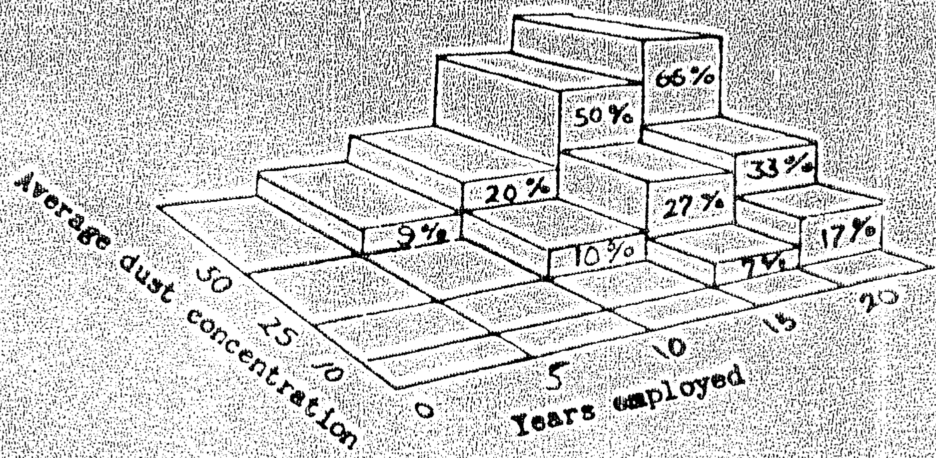

Figure 1.—Relation of average dust concentration and duration of dust exposure to the percentage of workers found to have pneumoconiosis. Based on data presented in Table 11.

treatment. It seems to be preferable to present the facts as simply as possible, together with the precautions to be kept in mind in studying them, and to emphasize that the principal use of these data is to show the degree of improvement in health to be expected in the future if dust formation and dust dispersal are brought under control in these and in similar industries.

Methods of Dust Control

After the physician and engineer have learned by observation and experimentation what kinds of dust are harmful and in what concentrations, it is the function of the engineer to evaluate the hazard in a particular industry, plant, or mine and devise measures for its elimination. The first step is to become thoroughly familiar with the industry being studied to determine the dusty occupations, the number of persons in each, and the various activities and time devoted to each activity in any one occupation.[23]

The amount of harmful dust created by various activities can be determined by taking samples of the atmosphere in their vicinity and counting and identifying the dust particles. Sampling of air is also a means of checking the efficiency of any control measures that may be adopted.

Several devices are available for collecting and counting dust samples. The impinger, however, is the instrument used most frequently in the United States. The Bureau of Mines and the Public Health Service have issued publications describing the method of sampling dust by the impinger (as well as by other methods) and procedures for counting and identifying the particles.[24, 25]

Dust sampling is complicated by the fact that air dustiness fluctuates rapidly from moment to moment. A single dust count represents only the amount of dust in the atmosphere at the time and place of sampling and gives no indication of the average exposure of the worker over a period of years, especially if he has not worked continuously at one job. The ultimate lung injury that he may suffer will depend upon the integrated effect of the dust over a long period.[26] A proper measure of dust exposure requires a picture of the variations in dustiness. The best procedure is to determine the dustiness during different stages of an operation and, with the aid of a time study, break down the worker's day according to the time spent in each step; from these data the average dust exposure of the worker can be calculated.

Drilling.—Experience in South Africa[27] with new methods of sampling have revealed that more dust is produced by rock drills

Table 12.—Period Worked at Face by First-Stage Silicotics

Job	Average Number of Years	Number of Men	Job	Average Number of Years	Number of Men
Shovelers' helpers (bruno men)	6.8	8	Machinemen (drillers)	11.4	348
Shovelers	8.4	428	Powdermen	11.5	24
Drillers' helpers (dummies)	8.4	79	Shovel bosses	15.8	21
Trackmen	9.8	52	Ground bosses	19.0	54
Roof trimmers	11.3	26			

than had been suspected, the difference consisting entirely of dust too fine to be detected by the older methods. The importance of control of drilling dust as a measure of the prevention of silicosis is demonstrated by the fact that the incidence of silicosis has remained consistently and considerably higher among machine drillers than among those who have never worked machines, and the excess incidence among machine drillers has been in direct proportion to the amount of time spent upon rock drilling.

Until relatively recently drilling of holes for blasting was a negligible producer of dust or air dustiness in coal mines especially other than anthracite mines. The hand-operated auger drill produces very little fine dust, but with the extension of mechanized mining power drills are becoming more and more essential and some of them are heavy producers of finely divided dust; this is especially true of reciprocating drills of the jackhammer type, drilling dry and using compressed air in the clearing of holes either in coal or in roof or floor material.

Blasting.—The exceptionally heavy incidence of silicosis among rock drill miners in the early period of the gold-mining industry in South Africa[a] was due to the exposure of the rock-drill miner not only to drilling dust but to high concentrations of dust from blasting, and frequently to the inhalation of varying amounts of the irritant fumes produced by blasting, owing to the methods of blasting then in use. Blasting produces large quantities of very fine dust, the finest fractions of which tend to remain suspended in the mine air for a long time, unless removed by ventilation.

Shoveling or Mucking.—In the Picher, Okla., study,[a] it was difficult to show the relationship of the duties of the men to silicosis because of frequent change of occupation. All examined were divided into two groups—those exposed to large amounts of dust (those employed at the face) and those exposed to relatively small amounts (those away from the face). In the order of exposure to the dust hazard, the men at the face included shovelers' helpers, shovelers, drill helpers, machinemen, trackmen, roof trimmers, powdermen, shovel bosses, and ground bosses. According to analysis of the occupations of face workers the hazard was greater for shovelers' helpers and shovelers than for machinemen if length of time required to produce first-stage silicosis is a criterion. It is noted from table 13 that the average number of years worked by shovelers' helpers and shovelers was 6.8 and 8.4 years, respectively, while that for machinemen was 11.4 years.

Loading and Hauling.—Under some conditions hand loading of coal throws into the air of the working place considerable quantities of dust, but the amount is about one-tenth that caused by some types of mechanical loading. The greatly increased occurrence of dust from mechanical loading is due not only to the stirring of the dust into the air by the loading machines themselves but also to the greater rapidity of breaking down and taking coal from the face regions which increases other dust-producing processes, especially blasting, cutting, and hauling.[a]

Poorly constructed or poorly maintained pit cars or over-topping of coal in cars allows fall off or fine material to sift through to the tracks to be ground under the wheels of rolling equipment or the hoofs of mules and then to be thrown into the air by speeding cars or shuffling mules or men.[a]

Where conveyors (either the shaker or belt type) are used they form potential sources of dust clouds at the points where the coal is dropped or thrown which occurs at the discharge ends only. Also, where conveyors are used conditions at the face differ from those experienced with the older methods of working in that the miners are closer together, there is a tendency with the more systematic working for a larger number of the men to perform dust-raising operations at the same time, and the air speed at the faces is higher.[26] These conditions, if not controlled, tend to increase the dust exposure to the face workers.

Machine coal cutting.—When coal-cutting machines came into the picture early in the present century to supersede in large part both hand cutting and blasting off the solid, the really heavy producer of coal dust that the worker has had to endure was at hand, and this was especially true of the chain machines operated by electricity. Top cutting is the worst offender in so far as impregnating the air with dust is concerned, shearing occupies an intermediate position, and undercutting is the least offensive in this respect. However, undercutting machines under some conditions (such as cutting dry in friable coal with dull bite in a confined place with little or no circulating air) may produce air dustiness so dense as to reduce visibility almost to zero with available types of mine lighting and to cause between 100,000,000 and 500,000,000 (or even more) dust particles to be carried per cubic foot of air of the face region.[26]

Methods of Control

The principal measures for controlling dust in mining operations are ventilation, wet methods, proper blasting practice, the use of personal respiratory protection, and physical examination.

Ventilation.—The more or less generally accepted conclusion that coal miners suffer less from miners' consumption than metal miners, who either die early in life or are incapacitated in middle age, is due almost entirely to the superior working conditions in coal mines as a result chiefly of ventilation.

Approximately in order of their importance, the main features that affect air in metal mines are (1) movement, (2) temperature, (3) relative humidity, (4) gases, and (5) dusts. In coal mines the order of importance would probably be (1) movement, (2) gases, (3) dusts, (4) relative humidity, and (5) temperature.[31]

The matter of movement of air from the surface, through the working faces or places, and then back to the surface is by all means the most important consideration in effecting adequate ventilation of mines and in protecting the health and forwarding and maintaining the working efficiency of the underground workers. If adequate quantities of pure air are directed to the places where men work, most of the requirements of health and many of the demands of safety will be well served.[31]

Ventilation probably is the most effective dust-control measure although under some conditions it ranks second to wet methods. Where ventilation can be applied effectively, dust can be removed from the air or its concentration can be so diluted as to render it almost harmless.[29]

Wet methods.—As dry drilling is the dustiest operation in mining, wet drilling will keep air dustiness within safe limits if used with care and judgment in collaring wet, using plenty of clean, dirt-free water, and keeping the drills in good repair with adequate regulation of the proportion of water and compressed air flowing through the drill steel.[29]

In tests by the Bureau of Mines[32] the dust concentration in the air during actual drilling decreased as the water flow through the drill increased. The water flows for stopers was 0 to 3 gallons per minute, and that for drifters from 0 to 1.02 gallons per minute. The rate of decrease for stoper drills was greater for water flows from 0 to 1.3 gallons per minute than for higher water flows. The rate of decrease for drifter drills was similar to that for stoper drills at corresponding water flows and rather constant for water flows of 0 to 1.02 gallons per minute.

The results of this study shows that as water flow through the drills was increased the dust concentrations in the air decreased, but they do not show whether the decrease was caused directly by the increased water flow, by some condition influenced by variation in water flow, or by a combination of these factors.

In most pneumatic rock drills air passes through the drill steel with the water. Ordinarily some of the high-pressure air supplied to the drill for its operation escapes into the back end of the drill steel, even when the operating throttle is not in the blowing position, and travels up to the face of the hole being drilled. The amount of air escaping is affected by the water flow through the drill steel; as the water flow through the drill steel increases the air flow decreases. Mining officials in South Africa concluded that such air leakage, although probably facilitating removal by the water of the cuttings from the hole, was responsible for entrapping fine dust and blowing it into the air during drilling.[a] Consequently they have devoted much attention to designing drills that permit the minimum practical air leakage through the drill steel and have established regulations on the use of such drills. Canada is also doing much work along this line, and recent reports state that such drills are practical and produce about one-fourth the dust concentration of corresponding drills without the "dustless-head" features.[a]

The results of this study show that operators can reduce dust concentrations resulting from drilling by increasing the water flow through the drill steel, either by increasing water pressure or by the use of water tubes of larger inside diameter.

Tests also have been conducted by the Bureau of Mines[a] on the effectiveness of spraying water along the outside of the drill steel compared with that of standard wet-drilling practice. The tests show that spraying water along the outside of the drill steel should not take the place of regular wet drilling. However, if a method is developed by which the device may be used on holes of any inclination, it might prove to be a valuable accessory to regular wet drilling in collaring and drilling the first 2 feet of a hole. Tests show that the greatest amount of dust is thrown into the air of a working place in drilling the first 2 feet of a hole.[a]

Wet drilling standards have been adopted in New York State for drilling in various classes of rock. The requirements for drilling in Class II rock (rock containing more than 10 per cent free silica) in confined areas, which include the use of mechanical ventilation, are quoted below.[a]

1. "Wet drilling shall mean the continuous application of water through the central hole in the hollow drill steel to the bottom of the drill hole. The central hole in the steel shall not be less than 3/16" diameter.

2. "The water flow shall be maintained continuously whenever the drill is in operation, including the period of collaring or starting the drill hole. The valve in the water line shall be of such design that it has only two fixed positions, namely, closed and completely open. Six months after date of approval, all wet drills shall be equipped with a combination air throttle and water valve of such design that the required rate of water flow through the drill steel will be insured whenever the air throttle is in the operating positions, half speed as well as full speed.

3. "The water shall be clean and bacteria free and shall be delivered to the drills under pressure from an adequate source of supply. Portable water tanks for individual drills shall not be used unless approved by the Industrial Commissioner.

"Wet drilling in Class II rock in confined areas shall be used with mechanical ventilation, or in confined areas under decking by natural ventilation, if approved by the Industrial Commissioner and subject to the following provisions:

1. "The rock surfaces for a distance of 30 feet from the heading or other drilling area shall be maintained in a damp condition.

2. "Hand-held drills (maximum piston bore, 3") minimum rate of water flow through drill steel, 0.75 gallon per minute; maximum rate of air flow through drill steel at full speed, 2.0 cubic feet per minute; maximum rate of air flow through the drill steel at half-speed operation, 1.0 cubic foot per minute; minimum rate of general ventilation in the drilling area, 500 cubic feet per minute per drill and shall be increased if found upon tests by the Industrial Commissioner that the dust concentration is not in accordance with the requirements of the Code.

3. "Drifter-mounted and wagon-mounted drills (maximum piston bore, 4") minimum rate of general ventilation per drill in the drilling area, as shown in the table 'Limitations in Air and Water Flow Through Steel.'

4. "In the case of positive-pressure ventilation, the air must be well distributed over the drilling and must not create drafts

at the various drilling positions, in a manner satisfactory to the Industrial Commissioner. The intake for the ventilating system must be located at a point free from contamination with dust or provided with an efficient filter.

5. "In the case of exhaust ventilation, the location of the intake pipe or pipes must be such as to insure the removal of air from the entire drilling area in a manner satisfactory to the Industrial Commissioner.

6. "The required ventilation may be obtained by means of a recirculating air-cleaning apparatus provided the dust concentration in the air at the breathing zone of the drill operators is maintained at a level below that required in Rule 33-2.3 and the apparatus is otherwise acceptable to the Industrial Commissioner.

7. "The above rates of ventilation shall be increased whenever necessary to reduce dust concentration to the amount permitted by Rule 33-2.3."

Proper blasting practice.—Methods of controlling dust and fumes in mines by proper blasting practice have been determined by members of the Bureau of Mines staff by observation and experiment.[24, 25] If at all feasible, blasting should be done at the end of the working shift or on an off shift, and the dust- and gas-laden air should be removed or thoroughly diluted before the men return to work. Ventilation is an essential agency in cleansing the air where blasting has been done. Results of investigations by the Bureau of Mines[24] show settling rate of dust after blasting under the following conditions:

1. The atmosphere was bratticed off for 3 hours while the dust samples were being taken. In this period, under these conditions, the dust concentration dropped from approximately 5,000 million particles per cubic foot to 50 million particles per cubic foot.

2. The atmosphere was bratticed off until 26 minutes after blasting when the brattice was raised and natural ventilation (which was virtually negligible except for eddy currents) was allowed to dilute the dust-laden air. It required 2 hours and 20 minutes after blasting for the dust concentration to drop from approximately 5,000 million particles per cubic foot to 50 million particles per cubic foot, and 2 hours and 50 minutes to drop to 15 million particles per cubic foot.

3. The atmosphere was bratticed off until 37 minutes after blasting, when the brattice was raised and 10-inch canvas tubing installed to about 50 feet from the face. At 46 minutes after blasting, about 1,000 cubic feet of air per minute was forced into the face. It required 66 minutes after blasting for the dust concentration to drop to 50 million particles per cubic foot, and 70 minutes to drop to 15 million particles per cubic foot.

The accompanying table shows the time, in minutes, required for the dust concentration to drop from 825 million particles per cubic foot to 50 million and to 15 million particles per cubic foot under the three different conditions:

Ventilating Condition	Time, in minutes, to drop from 825,000,000 particles per cubic foot to—	
No ventilation	121	181
Natural ventilation	105	135
Mechanical ventilation	20	24

In addition, the place (walls, floor, roof or top, and timbers) should be wetted thoroughly before blasting is done, and a water blast should be used during and after the blasting. The region should be wetted thoroughly when the men return to the face region after blasting, and the muck pile should be kept well wetted at all times while it is loaded out, as the water not only lays the dust but also either absorbs or otherwise aids in diluting or eliminating harmful or poisonous gases that follow blasting and that usually cling to the blasted material.

Tests[25] on the effectiveness of a spray of water mist in reducing the concentration of dust in the air after blasting and during mucking of the blasted material were conducted in three headings in medium hard to hard rock. The use of the spray apparently made it possible to reduce the concentration of dust generated and thrown into the air during blasting more than 99 per cent from the amount present when the spray was not used. Dust dissemination during mucking of material sprayed several hours before mucking was begun was much less than during shoveling of material thoroughly sprinkled just before and during mucking; and, of course, the dust present after use of either the spray or the sprinkling method is far less than if the mucking had been done dry.

In general, the larger the quantity of explosive used, the more finely divided the blasted material, the more heavily the air will be impregnated with dust and smoke, and the greater will be the quantity of poisonous gases left at the place; hence, methods should be used that will tend to reduce the quantity of explosives used and of gases and dust produced. In this connection it will be found that the use of stemming or of some types of blasting plugs now available will confine more definitely the explosive, hence, increase its efficiency and reduce the quantity of explosive used and also reduce the amount of poisonous gas produced and possibly reduce the violence of the blast and its tendency to raise dust and disseminate it into the surrounding air. It would be well for users of explosives to investigate types of explosives that are known to give off minimum quantities of harmful gases on detonation and to use them; also, the discontinuance of the use of fuse and the substitution of electric blasting would aid in reducing the amount of poisonous gases from blasting. Explosives that have been held in storage too long or that have been stored under unfavorable conditions as to moisture, temperature, etc., are likely to give off maximum quantities of harmful gases, if they detonate at all; hence, utmost care should be taken in the storing of explosives to see that they are not held too long before being used.

Personal respirator protection.—This method of control of air dustiness is unsatisfactory in underground mining except for temporary use in emergencies. Although dust respirators give adequate protection against dust, they afford the wearer essentially no protection against toxic or asphyxiating gases, and are too cumbersome and uncomfortable for constant wear.

The Bureau of Mines has established a schedule of minimum requirements for mechanical respirators, one type of which is for protection against dust generated by disintegration as in drilling and blasting. About 30 respirators have been approved under this schedule.

Physical examination.—Although strictly speaking physical examination is not a dust-control measure, it is an important means of determining the efficacy of the methods employed to reduce the dust hazard. If workers exposed to dust are examined periodically increased incidence of respiratory disease can be discovered and measures taken to reduce the amount of dust in the air or remove any affected workers to a less hazardous environment.

In South Africa all white applicants for underground work are examined and certified to be physically fit and free of any disease of the respiratory organs and then reexamined every 6 months to determine and report all cases of simple silicosis, tuberculosis with silicosis, and simple tuberculosis that may have developed. In this way comparable records can be obtained for measuring the degree of pneumoconiosis and the extent of impairment of working capacity among employees from year to year. Comparable records will not be obtained unless periodic examinations are conducted in a standardized way, preferably by a permanent medical board composed of physicians specially trained and having adequate experience in the diagnosis of pulmonary diseases.

Summary

1. The principal pulmonary diseases to which the miner is subject are bronchitis, influenza and pneumonia, pulmonary tuberculosis, anthracosilicosis, and silicosis.

2. Statistics indicate that much higher morbidity and death rates from pulmonary diseases are experienced in dusty than in nondusty industries, especially where silica dust is used or produced.

3. Investigations by the Public Health Service reveal that hard-coal miners suffer a high mortality rate from influenza and pneumonia not only during influenza epidemics but at other times as well. In 1915-23 and 1906-25 influenza and pneumonia were responsible for 40 per cent of the total deaths among hard-coal miners compared with 25 per cent among males at ages 15 to 65 who were engaged in pursuits other than coal mining. Six per cent of hard-coal miners had pulmonary tuberculosis compared with 2 per cent in the adult male population of the United States. The rate for metal miners is still higher.

4. Anthracosilicosis was found in about 23 per cent of 2,711 employees of three anthracite mining companies studied by the United States Public Health Service in 1933.

About 63 per cent of those having anthracosilicosis showed evidence of disability, compared with less than 10 per cent in the control group. Moderate and marked degrees of disability handicapped approximately 21 per cent of those with anthracosilicosis compared with less than 2 per cent of the men serving as controls.

5. The occupational groups in anthracite mining, arrayed by the Public Health Service according to extent of physical impairment, are (1) rock workers, (2) regular miners, (3) all others exposed to more than 100 million dust particles per cubic foot of air, and (4) men in haulageways except rock workers.

6. The principal pulmonary disease in metal mines is silicosis and the chief menace in silicosis is tubercle infection. Apparently silica dust alone increases the liability to pulmonary tuberculosis.

Joint studies made by the Actuarial Society of America and the Association of Life Insurance Medical Directors revealed that there were 65 deaths where 6 were expected (about 11 times the expected number) from tuberculosis in 1925-1936 among a group of underground miners, most of whom were employed in metal mines. Tuberculosis deaths were fourteen times the expected among copper miners, nine times the expected among gold and silver miners, and eight and a half times the expected among iron miners. In an earlier study covering the years 1915-1926, there were 18 times as many deaths as expected among lead and zinc miners.

7. As dust is the greatest contributor to the excessive mortality from pulmonary diseases in the mining industry, the principal method of preventing these diseases is to eliminate as far as possible or reduce to harmless concentrations the dust in the breathing zone of the worker.

8. The aim should be to eliminate the dust entirely from the air breathed. Where this is not always feasible it may be possible to reduce the dust to a concentration that will not cause disability during a working lifetime.

9. Analysis of data collected by the Public Health Service to determine safe limits of dust exposure indicate that employment in an atmosphere containing less than 50 million dust particles per cubic foot produces a negligible number of cases of silicosis when the quartz content of the dust is less than 5 per cent; when the silica content is about 13 per cent, 10 to 15 million particles appears to be a safe limit.

10. The amount of harmful dust created by various activities in mining can be determined by sampling the atmosphere in their vicinity and counting and identifying the dust particles. Sampling of air is also a means of checking the efficiency of dust control measures.

11. The impinger is the dust-sampling instrument used most frequently in the United States.

12. The dustiest operations in mining are dry drilling, blasting of dry rock or ore, shoveling or mucking, loading and haulage, and machine coal cutting.

13. The principal measures for controlling the ill effects of dust in mining operations are ventilation, wet methods, proper blasting practice, the use of personal respiratory protection, and physical examination of workers.

14. The efficiency of these measures in the reduction of the incidence of dust diseases is attested by the experience in the mines of South Africa where among the whole body of miners the liability to contract silicosis in 1936-37 was less by 65 per cent than it was in 1920-33. Among the "new Rand miners" who entered the industry by way of initial examination since 1916 and who have been exposed solely to the progressively improving occupational conditions that have obtained since that date, the liability to contract silicosis was less by 87 per cent than the similar liability among all miners working for an equal period in 1920-23. These "new Rand miners" constituted 77 per cent of all working miners examined.

Conclusion

The mortality and morbidity from pulmonary diseases are excessive in the mining industry as a result of exposure to large amounts of dust in the air breathed. Therefore, control of the dust hazard is necessary to prevent these diseases. No single measure of control is applicable to all dusty operations and processes, therefore all the means of prevention must be practiced to insure success in the solution of the problem.

REFERENCES

1. Collis, Edgar L. Occupational Dust Diseases: Bull. Hygiene, vol. 6, 1931, pp. 663-670.

2. Collis. The General and Occupational Prevalence of Bronchitis, and Its Relation to Other Respiratory Diseases: Jour. Indust. Hygiene, vol. 5, 1923-24, pp. 264-276.

3. Collis. The Mortality Experience of an Occupational Group Exposed to Silica Dust, Compared with that of the General Population and an Occupational Group Exposed to Dust Not Containing Silica: Jour. Indust. Hygiene, vol. 15, 1933, pp. 395-417.

4. Brundage, Dean K. Mortality of Coal Miners: United States Public Health Bull. 210, 1933, 17 pp.

5. Office of Industrial Hygiene and Sanitation. The Health of Workers in Dusty Trades. III Exposure to Dust in Coal Mining: United States Public Health Bull. 208, 1933, p. 10.

6. Sayers, R. R., Meriwether, F. V., Lanza, A. J., and Adams, W. W. Silicosis and Tuberculosis Among Miners of the Tri-State District of Oklahoma, Kansas and Missouri—I, for the Year Ended June 30, 1928: Bureau of Mines Tech. Paper 545, 1933, 30 pp.

7. Dublin, Louis I. The Mortality of Bituminous Coal Miners from Influenza-Pneumonia, October to December, 1918: Jour. Indust. Hygiene, vol. 1, 1919-20, p. 483.

8. Collis, Edgar L. The Coal Miner: His Health, Diseases, and General Welfare: Jour. Indust. Hygiene, vol. 7, 1925, pp. 221-243.

9. Sen, Prafulla Kumar. Pneumoconiosis in South Wales Coal Miners and Its Relation to Tuberculosis: Jour. Indust. Hygiene, vol. 19, 1937, pp. 225-257.

10. Office of Industrial Hygiene and Sanitation. Anthraco-Silicosis Among Hard Coal Miners: United States Public Health Bull. 221, 1935, 114 pp.

11. Lanza, A. J., and Higgins, Edwin. Pulmonary Disease Among Miners in the Joplin District, Missouri and Its Relation to Rock Dust in the Mines: Bureau of Mines Tech. Paper 105, 1915, 48 pp.

12. Harrington, D., and Lanza, A. J. Miners' Consumption in the Mines of Butte, Montana: Bureau of Mines Tech. Paper 260, 1921, 19 pp.

13. Roberts, John. Silicosis: A Review is Given of Some Recent Researches on the Cause of the Disease: Colliery Guardian, vol. 147, 1938, pp. 290-292.

14. Lanza, A. J. (Editor). Silicosis and Asbestosis: Oxford University Press, 1938, 439 pp.

15. Collis, Edgar L. The Statistical Characteristics of Dust Phthisis (Pulmonary Silicosis): Jour. Indust. Hygiene, vol. 8, 1926, pp. 457-465.

16. Higgins, E., Lanza, A. J., Laney, F. B., and Rice, G. S. Siliceous Dust in Relation to Pulmonary Disease Among Miners in the Joplin District, Missouri: Bureau of Mines Bull. 132, 1917, 116 pp.

17. Lanza, A. J., and Childs, Samuel B. I. Miners' Consumption: A Study of the Disease Among Zinc Miners in Southwestern Missouri, II. Roentgen-Ray Findings in Miners' Consumption: United States Public Health Bull. 85, 1917, 40 pp.

18. Meriwether, F. V., Sayers, R. R., and Lanza, A. J. Silicosis and Tuberculosis Among Miners of the Tri-State District of Oklahoma, Kansas, and Missouri. II. For the Year Ended June 30, 1929: Bureau of Mines Tech. Paper 552, 1933, 28 pp.

19. Kettle, E. H. Experimental Silicosis: Jour. Indust. Hygiene, vol. 8, 1926, p. 491.

20. Lanza, A. J., and Vane, R. J. Industrial Dusts and the Mortality from Pulmonary Disease: Am. Rev. Tuberc., vol. 39, 1939, pp. 419-436.

21. Cummings, Donald E., Downs, Robert N., and Berg, Melvin. Tuberculous Lesions in Male Industrial Workers: Am. Rev. Tuberc., vol. 39, 1939, pp. 439-455.

22. Union of South Africa. Report Upon the Work of the Miners' Phthisis Medical Bureau for the Three Years Ended 31st July, 1935: Published by the Government Printer, Pretoria, S. A., 1936, 76 pp.

23. The South African Mining and Engineering Journal. The Incidence of Silicosis: A statistical Examination of the Position—Progressive and Noteworthy Reduction—Mining Industry's Initiative in Investigating the Dust Problem: Vol. 49, 1938, p. 717.

24. Bloomfield, J. J., and DallaValle, J. M. The Determination and Control of Industrial Dust: United States Public Health Bull. 217, 1935, 167 pp.

25. Brown, Carlton E., and Schrenk, H. H. A Technique for Use of the Impinger Method: Bureau of Mines Inf. Circ. 7026, 1938, 20 pp.

Schrenk, H. H., and Feicht, Florence L. Bureau of Mines Midget Impinger: Bureau of Mines Inf. Circ. 7076, 1939, 7 pp.

Foster, Wilder D., and Schrenk, H. H. Petrographic Indentification of Atmospheric Dust Particles: Bureau of Mines Rept. of Investigations 3368, 1938, 10 pp.

26. Drinker, Philip, and Hatch, Theodore. Industrial Dust, 1936, 316 pp.

27. South African Mining and Engineering Journal. Miners' Phthisis and Working Conditions: Vol. 49, 1938, pp. 521-523.

28. S.A.M.E. Journal. Future of the Miners' Phthisis Problem: Vol. 49, 1938, p. 13.

29. Harrington, D. Formation, Collection, and Treatment of Coal Dust in Mines: Bureau of Mines Inf. Circ. 7089, 1939, 11 pp.

30. Davies, A. L. Airborne Coal Dust: Abatement of the Nuisance in Intensive Conveyor Mining: Coll. Guard., vol. 153, 1936, pp. 755-758.

31. Harrington, D. Mine Ventilation: Bureau of Mines Inf. Circ. 7047, 1939, 16 pp.

32. Brown, Carlton E., and Schrenk, H. H. Relation of Dust Dissemination to Water Flow Through Rock Drills: Bureau of Mines Rept. of Investigations 3393, 1938, 6 pp.

33. Johnson, John A., and Agnew, Wing G. Dust Produced by Drilling When Water is Sprayed on the Outside of the Drill Steel: Bureau of Mines Rept. of Investigations 3478, 1939, 6 pp.

34. Industrial Bulletin. Standards for the Testing of "Wet" Drilling Equipment and "Wet" Methods of Dust Control: New York State Dept. of Labor, vol. 17, 1938, pp. 63-64.

35. Brown, Carlton E., and Schrenk, H. H. Control of Dust From Blasting by a Spray of Water Mist: Bureau of Mines Rept. of Investigations 3388, 1938, 13 pp.

36. Johnson, John A., Agnew, Wing G., and Mosier, McHenry. Stemming in Metal Mines. Progress Report 1: Bureau of Mines Rept. of Investigations 3509, 1940, 27 pp.

ADJOURNMENT

Public Utilities Section

Officers 1939-1940

General Chairman—H. A. Ptolemy, Public Service Co. of Northern Illinois, Chicago, Ill.
Vice-Chairman—Charles S. Bowden, Ohio Public Service Co., Alliance, Ohio.
Secretary—P. L. G. Hasskarl, Pennsylvania Power & Light Co., Allentown, Pa.
Engineering Committee—
E. R. Kropp, Union Electric Co. of Mo., St. Louis, Mo.
Paul R. Kuhn, Pennsylvania Edison Co., Altoona, Pa.
A. A. Rall, Kansas City Power & Light Co., Kansas City, Mo.
Data Sheet Sub-Committee—E. C. Bookman *(Chairman)*, Virginia Electric & Power Co., Richmond, Va.
W. H. Brown, Northern States Power Co., Minneapolis, Minn.
Safety Instruction Card Sub-Committee—W. Briley Wright *(Chairman)*, Eastern Shore Public Service Co., Salisbury, Md.
T. S. Shinn, Carolina Power & Light Co., Raleigh, N. C.
D. E. Woods, Central Power & Light Co., Corpus Christi, Texas.
Exhibit Committee—J. F. McCabe *(Chairman)*, Duquesne Light Co., Pittsburgh, Pa.
J. D. Hall, Atlantic City Electric Co., Atlantic City, N. J.
John P. McCann, New England Power Service Co., Boston, Mass.
Film Strip Committee—E. A. Rust *(Chairman)*, Erie County Electric Co., Erie, Pa.
H. H. Berman, Consolidated Gas, Electric Light & Power Co., Baltimore, Md.
H. E. Shedd, Appalachian Electric Power Co., Bluefield, W. Va.
Health Committee—Dr. Hart E. Fisher *(Chairman)*, Chicago Rapid Transit Co., Chicago, Ill.
Membership Committee—Wm. L. Cone *(Chairman)*, Utah Power & Light Co., Salt Lake City, Utah.
L. P. Hoffman, Florida Power & Light Co., Miami, Florida.
News Letter Committee—E. S. Miner *(Chairman)*, American Telephone & Telegraph Co., New York, N. Y.
A. A. Klinge, Public Service Co. of Colorado, Denver, Colo.
J. B. Porcher, Ohio Edison Co., Akron, Ohio.
J. O. Speed, Alabama Power Co., Birmingham, Ala.
J. E. Stott, Georgia Power Co., Atlanta, Georgia.
Poster and Safety Kinks Committee—W. H. Kussmaul *(Chairman)*, Northern Indiana Public Service Co., Hammond, Ind.
W. L. Smith, Los Angeles Department of Water & Power, Los Angeles, Calif.
Program Committee—D. C. Duncan *(Chairman)*, Appalachian Electric Power Co., Bluefield, W. Va.
E. M. Chase, Central Vermont Public Service Corp., Rutland, Vt.
George G. Waldrop, City Light & Water Utilities, Fort Wayne, Ind.
J. L. Weeks, South Carolina Electric & Gas Co., Columbia, S. C.
Publicity Committee—J. C. Martin *(Chairman)*, Bureau of Safety, Inc., Chicago, Ill.
P. K. Stiles, Ebasco Services, Inc., New York, N. Y.
Statistics and Contest Committee—J. M. Orts *(Chairman)*, Public Service Corp., Newark, N. J.
J. D. Ellis, Northwestern Electric Co., Portland, Oregon.
D. F. McMurchy, Tennessee Valley Authority, Chattanooga, Tenn.

Members at Large—
H. J. BURTON, Consumers Power Co., Jackson, Mich.
C. H. DAVIS, Commonwealth Edison Co., Chicago, Ill.
C. H. DINSMORE, Wisconsin Power & Light Co., Madison, Wis.
E. P. DURFEE, Consolidated Edison Co. of N. Y., Inc., New York, N. Y.
H. W. LUECK, Commonwealth Edison Co., Chicago, Ill.
C. N. RAKESTRAW, Cleveland Electric Illuminating Co., Cleveland, Ohio.
J. M. STRIKE, St. Joseph Railway, Light, Heat & Power Co., St. Joseph, Mo.

Councilors (Past General Chairmen)—
JOHN J. BARADA, The Laclede Gas Light Co., St. Louis, Mo.
E. S. BEAUMONT, The Peoples Gas Light & Coke Co., Chicago, Ill.
C. B. BOULET, Wisconsin Public Service Corp., Milwaukee, Wis.
G. A. DOELLER, Dayton Power & Light Co., Dayton, Ohio.
J. B. DOUGLAS, The Philadelphia Gas Works Co., Philadelphia, Pa.
ROY M. GODWIN, Philadelphia Electric Co., Philadelphia, Pa.
E. J. KREH, Philadelphia Co., Pittsburgh, Pa.
WILLS MACLACHLAN, Electrical Engineer, Toronto, Ont., Canada.
B. B. MCCULLOCH, Bureau of Safety, Inc., Chicago, Ill.
R. S. METZGER, Toledo Edison Co., Toledo, Ohio.
GEORGE OPP, Detroit Edison Co., Detroit, Mich.
F. M. PEPPER, Illinois Bell Telephone Co., Chicago, Ill.
C. I. RUTLAND, Texas Power & Light Co., Dallas, Texas.
C. B. SCOTT, Bureau of Safety, Inc., Chicago, Ill.
H. E. WEBB, West Penn System, Pittsburgh, Pa.

Special Representatives—
C. J. GEFVERT, Consolidated Edison Co. of N. Y., Inc., New York, N. Y. (A.G.A.)
W. R. SMITH, Public Service Electric & Gas Co., Newark, N. J. (EEI)

Officers 1940-1941

General Chairman—CHARLES S. BOWDEN, Ohio Public Service Co., Alliance, Ohio.
Vice-Chairman—P. L. G. HASSKARL, Pennsylvania Power & Light Co., Allentown, Pa.
Secretary—D. C. DUNCAN, Appalachian Electric Power Co., Bluefield, W. Va.
Engineering Committee—J. F. MCCABE *(Chairman)*, Duquesne Light Co., Pittsburgh, Pa.
H. H. BERMAN, Consolidated Gas, Electric Light & Power Co., Baltimore, Md.
W. P. BINKS, Tennessee Valley Authority, Chattanooga, Tenn.
E. C. BOOKMAN, Virginia Electric & Power Co., Richmond, Va.
PAUL R. KUHN, Pennsylvania Edison Co., Altoona, Pa.
A. A. RALL, Kansas City Power & Light Co., Kansas City, Mo.
P. K. STILES, Ebasco Services, Inc., New York, N. Y.
J. M. STRIKE, St. Joseph Railway Light, Heat & Power Co., St. Joseph, Mo.
Data Sheet Sub-Committee—J. T. O'BRIEN *(Chairman)*, Jersey Central Power & Light Co., Asbury Park, N. J.
J. G. DICKINSON, Wisconsin Electric Power Co., Milwaukee, Wis.
E. L. FITZGERALD, Ohio Edison Co., Springfield, Ohio.
W. H. KUSSMAUL, Northern Indiana Public Service Co., Hammond, Ind.
Safety Instruction Card Sub-Committee—W. BRILEY WRIGHT *(Chairman)*, Eastern Shore Public Service Co., Salisbury, Md.
H. E. CRAIN, The Ohio Power Co., Canton, Ohio.
J. E. O'BRIEN, North Penn Gas Co., New York, N. Y.
D. E. WOODS, Central Power & Light Co., Corpus Christi, Texas.
Exhibit Committee—J. B. PORCHER *(Chairman)*, Ohio Edison Co., Akron, Ohio.
J. D. HALL, Atlantic City Electric Co., Atlantic City, N. J.
B. A. THORNTON, Indiana & Michigan Electric Co., South Bend, Ind.

Film Strip Committee—L. P. HOFFMAN *(Chairman)*, Florida Power & Light Co., Miami, Florida.
J. L. MCNEALEY, Columbus & Southern Ohio Electric Co., Nelsonville, Ohio.
H. C. ROSS, Pacific Gas & Electric Co., San Francisco, Calif.
H. E. SHEDD, Appalachian Electric Power Co., Bluefield, W. Va.

Health Committee—DR. HART FISHER *(Chairman)*, Chicago Rapid Transit Co., Chicago, Ill.

Membership Committee—J. O. SPEED *(Chairman)*, Alabama Power Co., Birmingham, Ala.
W. L. SMITH, Los Angeles Department of Water & Power, Los Angeles, Calif.
D. W. PRAIRIE, Northwestern Electric Co., Portland, Oregon.
D. A. FLEMING, Rural Electrification Administration, Washington, D. C.

News Letter Committee—J. M. ORTS *(Chairman)*, Public Service Corp., Newark, N. J.
W. H. ADAMS, The Manufacturers Light & Heat Co., Pittsburgh, Pa.
A. A. KLINGE, Public Service Co. of Colorado, Denver, Colo.
P. J. MCMAHON, Sanitary District of Chicago, Chicago, Ill.
J. J. STEUERWALD, Indianapolis Power & Light Co., Indianapolis, Ind.

Poster and Safety Kinks Committee—E. M. CHASE *(Chairman)*, Central Vermont Public Service Corp., Rutland, Vt.
RAYMOND ROLLINS, Missouri Public Service Corp., Warrensburg, Mo.
J. E. SCOTT, Georgia Power Co., Atlanta, Ga.
J. L. WEEKS, South Carolina Electric & Gas Co., Columbia, S. C.

Program Committee—E. S. MINER *(Chairman)*, American Telephone & Telegraph Co., New York, N. Y.
P. A. ALBERTY, The Ohio Fuel Gas Co., Columbus, Ohio.
GEORGE G. WALDROP, City Light & Water Utilities, Fort Wayne, Ind.

Publicity Committee—J. P. MCCANN *(Chairman)*, New England Power Service Co., Boston, Mass.
E. R. KROPP, Union Electric Co. of Missouri, St. Louis, Mo.

Statistics Committee—E. A. RUST *(Chairman)*, Erie County Electric Co., Erie, Pa.
W. L. CONE, Utah Power & Light Co., Salt Lake City, Utah.
JOHN MACLELLEN, Ontario Hydro Power Commission, Toronto, Ont., Canada.
T. S. SHINN, Carolina Power & Light Co., Raleigh, N. C.

Members at Large—
H. J. BURTON, Consumers Power Co., Jackson, Mich.
C. H. DAVIS, Commonwealth Edison Co., Chicago, Ill.
C. H. DINSMORE, Wisconsin Power & Light Co., Madison, Wis.
E. P. DURFEE, Consolidated Edison Co. of N. Y., Inc., New York, N. Y.
C. N. RAKESTRAW, Cleveland Electric Illuminating Co., Cleveland, Ohio.

Councilors (Past General Chairman)—
JOHN J. BARADA, The Laclede Gas Light Co., St. Louis, Mo.
E. S. BEAUMONT, The Peoples Gas Light & Coke Co., Chicago, Ill.
C. B. BOULET, Wisconsin Public Service Corp., Milwaukee, Wis.
G. A. DOELLER, Dayton Power & Light Co., Dayton, Ohio.
J. B. DOUGLAS, The Philadelphia Gas Works Co., Philadelphia, Pa.
ROY M. GODWIN, Philadelphia Electric Co., Philadelphia, Pa.
E. J. KREH, Philadelphia Co., Pittsburgh, Pa.
WILLS MACLACHLAN, Electrical Engineer, Toronto, Ont., Canada.
B. B. MCCULLOCH, Bureau of Safety, Inc., Chicago, Ill.
R. S. METZGER, Toledo Edison Co., Toledo, Ohio.
GEORGE OPP, Detroit Edison Co., Detroit, Mich.
H. A. PTOLEMY, Public Service Co. of Northern Illinois, Chicago, Ill.
C. J. RUTLAND, Texas Power & Light Co., Dallas, Texas.
C. B. SCOTT, Bureau of Safety, Inc., Chicago, Ill.
H. F. WEBB, West Penn System, Pittsburgh, Pa.

Special Representatives—
H. A. PTOLEMY, Public Service Co. of Northern Illinois, Chicago, Ill. (A.G.A.)
W. R. SMITH, Public Service Electric & Gas Co., Newark, N. J. (E.E.I.)