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SUPPLEMENT I

SUMMARY OF

REPORT OF MEDICAL COMMITTEE

A. J. LANZA, M.D., Chairman

The report to be published is planned as a comprehensive treatise on the subject of silicosis. More than merely a detailed technical report on various medical phases, it attempts to present the subject as an entity and in a form which will appeal to the industrialist and the layman.

Chapter I points out that dust is a natural—it may be said, a normal constituent of the air and it shows how it can become a menace to human beings. There is a brief history of silicosis and the more interesting and important theories and fallacies that were advanced to explain it. Those phases of silicosis which have been the subject of research are detailed—those which have been settled, more or less conclusively, and those which have not.

Chapter II is a brief history of silicosis in foreign countries, mostly within the British Empire.

Chapter III is a history of silicosis in the United States. The various industries are examined one by one—metal mining, coal mining, iron mining, granite, sandstone, marble, slate, talc, diatomaceous earth, excavation in building and construction, potteries, porcelain, glass and cement, abrasives, foundries, rockwool, asbestos—with a synopsis of experimental research in the United States.

Chapter IV deals with the nature of silicosis and tuberculosis, the pathology, diagnosis and prevention. This is obviously the most technical chapter in the report. However, the authors and contributors have endeavored to express their knowledge and experience as clearly and as concisely as possible.

The conclusion of the report is a summary, which is given below:

The extensive studies of silicosis in this country and abroad have given us a very clear idea of the cause of this disease, its pathology, its complications, and its prognosis. On the basis of our present knowledge, it may be stated that

1—Silicosis results only from the inhalation of dust containing free silica (SiO^2).

2—The time required for the development of silicosis varies from a few years to twenty or more, depending on the

concentration of the silica particles in the air and on the constancy of exposure.

3—Beginning silicosis is recognizable only by properly taken roentgen films of the chest; small nodular shadows *distributed throughout* both lungs are the characteristic appearance. There are no other symptoms or physical signs associated with early simple silicosis which can be depended upon for making a diagnosis.

4—Associated with silicosis is a marked predisposition to tuberculosis. In the majority of cases of severe silicosis, a tuberculous infection is found.

5—Silicosis can be prevented by protecting the industrial worker from inhaling silica dust. This may be accomplished by reducing the concentration of dust in the atmosphere or by the use of suitable respirators or similar devices. The first method is always the method of choice.

6—Concentrations to which the dust must be reduced in order to be safe have not been absolutely determined. There is evidence that a concentration of more than five million particles per cubic foot of a highly siliceous dust is dangerous. Therefore, it may be stated that it is desirable to avoid counts of more than five million particles of dust containing free silica to a high percent in working places.

Granite dust which contains about 35% free silica, when in concentrations of ten to twenty million particles per cubic foot, has been found not to cause disabling silicosis in a working lifetime. Anthracite dust, containing less than 5% free silica has been found not to cause disabling silicosis (anthraco-silicosis) in concentrations of less than fifty million particles per cubic foot.

7—Industrial dusts, containing silica, are frequently not all silica, being mixed with other materials. It is possible that some of these non-silica components may prevent or modify the action of silica in the body and may alter the tendency towards a complicating tuberculosis.

8—Asbestos, which is a silicate, is the only dust other than free silica, which has been shown to cause a lung fibrosis with disability. Asbestosis, so-called, is distinct from silicosis both in its pathology and appearance on roentgen films.

9—Simple—that is, uncomplicated—silicosis, as seen in industries in the United States, causes relatively little severe disability.

Control of silicosis calls for adequate medical and engineering measures.

Medical Control: A practical program of pre-employment and periodic examination of all workers exposed to dust containing silica is essential. Such examinations should include a complete physical examination of each individual, a careful history of past occupational exposure to dust, and a chest roentgenogram with a standard technic.

The value of such procedure may be summarized as follows:

1—Protection of prospective employees, who may have diseased lungs, from silica exposure.

2—Discovery of the hazardous jobs, as a result of finding the silicosis cases, in order to eradicate these hazards.

3—Discovery of active and open cases of tuberculosis which are in contact with other employees, especially protecting the younger workers who are susceptible to contact infection.

4—Discovery, through periodic examination of those with inactive tuberculosis, of any reactivation of their tuberculosis before they have been active too long, so as to protect especially the younger employees. Such early discovery of a reactivation also offers the infected individual a better chance for cure of his tuberculosis.

5—Discovery of the early cases of simple silicosis through periodic examination to give them added protection from further excessive dust exposure.

6—Determination, through periodic physical examination, of the adequacy of the dust control program.

A careful consideration of the foregoing summary as well as the varied experiences of the members of the Medical Committee clearly indicate that there is a wide field for research still in this matter of pulmonary dust diseases. There is no phase of employee health which concerns the employer more than does this question of dust diseases, and the ever increasing extent to which the employees' health is being made a responsibility of the employer demands that every available opportunity for increasing our knowledge be explored.

We still do not know the nature of the relationship between silicosis and tubercle infection. We do not know the extent to which exposure to silica dust to an amount insufficient to cause definite silicosis may reactivate arrested tuberculosis.

The following research projects are listed, therefore, for the consideration of Air Hygiene Foundation:

1—Relationship between silicosis and tuberculosis, with especial reference to the question of activation or re-

activation of tubercle infection consequent upon exposure to silica, especially in massive doses, over a short period in the absence of definite evidence of silica action (*nodulation*) in the tissues.

One of the phases of the dust question that has given rise to a great deal of confusion and misunderstanding is this question of the possible *effects of* the inhalation of large amounts of silica for a short time. Cases have occurred of individuals being so exposed, it being understood that the length of exposure was not sufficient to develop true silicosis, and these individuals have later *succumbed to* tuberculosis. What are we, therefore, justified in concluding with respect to the possible occupational causes of tuberculosis in such individuals? These and similar questions are of utmost *importance* to employers and employees alike.

2—The effects of other substances upon the action of silica in the body. It has been claimed from time to time with a considerable amount of justification that where other substances are *present in* the dust along with the silica, these substances may modify the action of silica. That is to say, they may retard the action of silica so as to actually prevent or, at least, delay the development of silicosis while, on the other hand, certain other substances have been credited with greatly intensifying the action of silica. The real nature of these cases of quickly developing silicosis, to which the term "acute silicosis" has been loosely and improperly applied, has never been studied in a satisfactory manner.

3—Study of the mechanism by which silica exerts its injurious effects upon the body. This, to a certain extent, is a corollary of number one. The pathologist can demonstrate what silica does in the pulmonary and other tissues of the body, but so far no reasonable explanation has been offered or demonstrated as to why silica acts as it does. Various explanations have been offered, such as that silica acts mechanically, chemically, and physio-chemically. It has also been suggested that the electrical charge of the silica particles may be a factor in its action in the tissues.

It is quite probable that if we knew the exact manner in which silica acts and of its relationship to the tubercle bacillus, we would have much more useful knowledge with respect to tuberculosis itself.

4—Research in the technic of roentgenography. It has

long been apparent to medical specialists in the field of pulmonary diseases and to roentgenologists that the satisfactory solution of the problem of pulmonary diseases depends upon the earliest possible diagnosis both to in*sure adequate treatment and prevent further progress of* the disease. In the last few years, the technic of taking x-ray films has greatly improved. Inasmuch as it would appear that to an ever increasing extent preemployment medical examinations will include chest roentgenograms, a man may be hired or rejected on the basis of his x-ray film. It is, therefore, evident that the very best technic that can be evolved is the *least with which industry can be satisfied.*

SUPPLEMENT II

SUMMARY OF

REPORT OF PREVENTIVE ENGINEERING COMMITTEE

PROF. PHILIP DRINKER, Chairman

The report of the Preventive Engineering Committee having been published by Air Hygiene Foundation and distributed to its members, only a brief review of a few of the more important sections of the report will be necessary at this time.

It should be emphasized that dust control is primarily a maintenance job and should be made routine procedure. Granting that a firm applying dust control for the first time is dealing with something which to it is new, there is no excuse for not at once adding the necessary equipment to the general production machinery and putting it under the direct responsibility of the company's engineers.

Methods of Determining Dust

Some dusts (as lead) are determined by chemical methods and the concentrations in air are recorded gravimetrically as milligrams per cubic meter. Others (as silica) are given by particle count, which in such cases is the easier method. Neither gives the whole story, but in either case it may be possible to secure the information necessary for the purpose.

Present dust-sampling and dust-estimating methods, the results by which usually are not comparable one with another, will be amended and changed from time to time. Where dust control alone is in question, however, the Preventive Engineering Committee advises the use of the simplest possible procedure which will give the necessary data for guidance.

No useful purpose would seem to be served by determining accurately extremely dense dust concentrations. In such cases, it is obvious that the workplace is much dustier than it should be. It is probable that any sampling procedure which fixes concentrations in groups 100% apart is sufficient and that the results of any attempts to come closer to the concentration at the moment of sampling are simply misleading. Thus ranges such as 0-5, 5-10, 10-20, 20-40, etc., suffice for dust control.

Analysis of Dust.—Where mixed dusts are involved, there are two necessary precautions: (1) selection of the sample, so that it shall be representative, and (2) use of a technic by which the various constituents can be determined.

Dust Collection

The dust collecting plant consists of four essential parts: (a) the exhaust hoods, (b) the piping, (c) the dust arrestor, and (4) the fan or blower.

If dust collecting is to be installed in any plant, it usually is well worth while studying each process with the help of experimental hoods and a portable blower. A series of such studies gives the engineer the data he needs for his final design work, and permits him to select with confidence his piping, dust arrestors, and fans.

Published data for the design of hoods is comparatively meager. In practical work the engineer must rely largely on his own experience and use purely empirical methods. Obviously such lack of data results in needless expenditures of fan power, for the engineer is forced to allow much too large factors of safety. Such data as are available are listed in the following table:

Minimum Air Velocities Required to Capture Certain Industrial Dusts

Industry	Process	Required air velocity: At point of origin	Required air velocity: At face of hood	Criterion
Granite cutting	Hand pneumatic tool	220 FPM		Reduced concentration to safe level.
	Surfacing machine	1500 FPM		Reduced concentration to safe level.
	All tools		1500 FPM	Reduced concentration to safe level.
Grain elevators	Elevator boot & head gamer		500 FPM	Visual test.
Paint Spraying	Spraying booth		50-200 FPM	Reduced concentration to safe level.
Sand pulverizing	Bagging machine	400 FPM		Reduced concentration to safe level.
Electric welding		100-250 FPM		Visual test.
Quarrying and mining	Horizontal drilling with Kelly-Hatch trap	60*		Reduced concentration to safe level.
	Vertical drilling with Kelly-Hatch trap	200*		Reduced concentration to safe level.
Electric plating	Chromium plating	50**	1500 FPM	Reduced concentration to safe level.
	Steam to acid tanks	75-100 FPM		Reduced concentration to safe level.
Hatters' Fur	Brushing	200*		Usual Practice.
	Cutting machines	350*		Usual Practice.
	Blowers	2000*		Usual Practice.

*Cubic feet per min. per foot of slot (common practice).
**Cubic feet per min.

Recommendations as to hood design, requisition velocities, and the like, can now be obtained from the appropriate departments of many states, some of which embody these recommendations in codes.

Protective Equipment

On the other hand, information available regarding dust respirators, air supplied masks, sand blast helmets and other protective equipment is fairly complete and commercial competition in its use is keen. The role of such equipment in industry is perfectly definite, although sometimes misunderstood and abused. In general, better results are obtained by controlling pollution or dustiness at its source; the use of protective equipment should be the second step, not the first in the dust control project.

Permissible Dustiness

If the breathing of dust causes disability of any sort—silicosis is only one manifestation—it follows that there must be some degree of air cleanliness from which no disability will result to the average man during the average working period. The super-cautious person may claim that the permissible concentrations, commonly called thresholds, are not precise and generally have not been established. This is perfectly true, but emphasizing instead of answering the question merely passes the responsibility along to the engineer. Such an attitude is childish and indefensible.

The absurdity of splitting hairs in order to achieve precisely the degree of cleanliness which fits medical knowledge is accentuated when the engineer begins his design work. He does not base his calculations on dust counts, but on the volumes of air to be handled, together with the best data he can get on the gross dust loading—cubic feet or thousands of cubic feet per hour and pounds of dust per day. If left to his own devices he will do his best to achieve a dust concentration substantially lower than any medical knowledge warrants. Why, then, wait for the mythical thresholds before installing the equipment?

In addition to those which have been proven to be harmful, there are processes in which dustiness is heavy but the dust of no proven harm. While there is no satisfactory medical answer at present to the question of what should be done in such cases, the engineer is making a bad mistake if he lets men breathe heavy dust concentrations of any material. If no reason for dust control can be found, then one should read transcripts of some of the recent suits at common law in which fantastic damages for alleged silicosis were granted to men who breathed dust containing little or no silica. The defendant in such suits is always embarrassed to explain away heavy dust concentrations, while the proof of a clean workplace makes an excellent impression upon everyone. Incidentally, the clean place induces better work by all.

The engineer must remember that it is he and not the physician who must answer that dreadful question: "Was this place being operated according to the best modern practice?" The courts and the compensation boards are not impressed with subtle distinctions between dusts with 10% and 40% quartz, especially when the medical experts are reluctant to make definite statements as to the comparative significance of such differences.

It would be as well to realize that men working in dusty trades suffer far more from respiratory troubles of all kinds than do men who work in clean air. The evidence that excessive dustiness of any kind is harmful is beyond argument. In our opinion this Foundation would be making a grave mistake if it wastes time on futile attempts to refute this fact. The evidence is overwhelming and would be admitted by any disinterested person.

Investigations Needed

The handicap in this general field lies chiefly in the lack of fundamental data. The demand for dust control installations is bound to help clear up this situation, but this Foundation would contribute greatly to present needs if it would sponsor research along a few definite lines.

For example, we have design data for exhaust hoods on very few processes. It would not be difficult to obtain very complete data on hood design for all of the various dust-producing processes involved in the crushing, grinding, powdering, and general handling of rock. Such studies make admirable thesis subjects for graduate students in engineering and can be carried out with the cooperation of firms who supply or use the machinery in question.

There are some fundamental data on solubility and toxicology of various dusts which can be obtained by careful work in the laboratory. There are a number of institutions well equipped to study such problems. At the risk of duplicating the recommendations of the Medical Committee of this Foundation, we suggest that the Foundation establish without delay a central agency for studying routinely and continuously the comparative toxicity or harmfulness of different dusts.

As was shown in the table, page 15, we have design data for exhaust hoods for only a few processes. It would be entirely practicable to study all of the important processes which create dust such as crushing, grinding, and general handling of rock and rock products. A very important source of dustiness in all plants handling finely powdered materials is the so-called

transfer points in conveying systems of any kind. Thus, when one belt conveyor dumps crushed rock on to another or into a hopper, an exhaust hood is usually indicated but one looks in vain for fundamental data from which to design such a hood.

A very important source of dustiness is in the packaging of powdered materials. If one suggests to a plant manager that his process of putting fine material into cans or bags is too dusty he often answers that any suction device would carry off most of the powder but this is far from true. Again we have no fundamental data for designing exhausts for such systems yet no one could dispute the fact that packaging processes cause a great deal of dustiness.

There are no reliable data to indicate the difference in dustiness from blasting with and without dust control during the rock drilling. It seems to be the general opinion that dustiness from blasting is a necessary evil and the fact that such dustiness can be reduced greatly by preventing the accumulation of either wet or dry dust upon the rock is ignored. It would not be at all difficult to obtain figures which would be of use to any firm mining rock of any kind.

We have no data on the abrasive effects of transporting dust pneumatically. The problem is important in the design and maintenance of dust-collecting plants. It happens to be a problem which lends itself nicely to solution by research.

It is possible that a study of the dustiness created by drilling in different kinds of rock would be useful. Again that is a problem admirably suited to research.

We should consider the outlook of this Foundation poor indeed if it considers its objectives begin and end with silicosis. At the moment silicosis looms large in the public eye, but that is not a phase which is likely to last. On the other hand, the name of this organization implies that it has a broad outlook upon the hygienic problems arising from air pollution of all kinds. Such problems will always be present.

SUPPLEMENT III

SUMMARY OF

REPORT PREPARED FOR LEGAL COMMITTEE

By T. C. WATERS

This report, "Critical Study of Provisions for Occupational Disease Legislation", presents a discussion of the important basic principles to be considered in occupational disease legislation, and reviews the right of an employee for compensation for occupational disease injuries under:

(1) Workmen's Compensation Acts.
(2) Occupational Disease Acts Now Effective.
(3) Actions at Common Law.

The report sets forth the legal basis for recovery in common law actions, outlining the procedure with respect to such causes, and treats with the advantages and disadvantages of this method of determining disputes between employers and employees involving occupational disease injuries sustained by employees in the course of their employment. It treats with the following common law defenses available to employers:

(1) Assumption of Risk.
(2) Contributory Negligence.
(3) Negligence of Fellow Servants.
(4) Failure of Proof of Employer's Negligence.

The need is shown for eliminating common law actions; making employers insurers of the health of their employees, depriving the employer of his common law defenses and depriving the employee of his right to maintain such actions.

Compensation Legislation

Described in detail are the following provisions relating to proposed legislation to provide compensation for occupational disease injuries:

1. *Designation of State Agency for Administration.* It is recommended that the administration of such legislation should be assigned to the Bureaus or Commissions now established under existing Workmen's Compensation Acts.

2. **Medical Board.** Need is emphasized for the creation of a Medical Board to determine controversial medical questions arising in the administration of the law, and it is recommended that a Medical Board of three physicians should be

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SPECIAL MEETING OF MEMBERS

PITTSBURGH, PENNSYLVANIA
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ently from any of these dusts when inhaled by themselves. That opens quite a field for speculation. The same thing has been observed, for instance, with gases. Dr. Mayers, of the New York Division of Industrial Hygiene, has shown that, for instance, carbon monoxide when inhaled in combination with hydrogen sulphide is more dangerous than either carbon monoxide or hydrogen sulphide when inhaled alone.

Again this year The Saranac Laboratories, under the guidance of Dr. Gardner, held one of their notable symposiums on dust disease of the lungs. The general field of dust and dust diseases is still active, and there still remains a very considerable amount of research to be done.

There is also a growing interest in the subject of cancer as a possible result or as possibly being associated with industrial hazards. With respect to dust inhalation, all the evidence is negative, that there is no particular relationship between the inhalation of dust and the incidence of cancer. Other forms of irritants, gases, fumes, and so forth, may have some such effect. That topic is a live one and is being investigated, as is also the possibility that fungus diseases of the lungs perhaps are more common than we have supposed.

With respect to the specific activities of our Foundation, I am very happy to report that the Air Hygiene Foundation has been able to assist and help set in motion two definite lines of research. One is being carried on by Dr. Gardner and his colleagues in Saranac and the other by Dr. Warren and his colleagues at the University of Pennsylvania. I won't describe them because these two gentlemen are going to speak for themselves.

Finally I might say that it is the hope and expectation of your Medical Committee to produce or sponsor during the coming year some bulletins or pamphlets dealing with pertinent matters coming within the realm of their work and of interest to yourselves. We hope that you will find these useful.

Your next speaker will be Dr. Gardner. I don't have to introduce Dr. Gardner to this audience. He is well known to industry from one end of the country to the other. He has done more work, more research in the fields of the occupational diseases with which he is concerned than any man in this country.

It gives me great pleasure to introduce Dr. Gardner, the Director of The Saranac Laboratories.

"MIXED" DUSTS AND "PROTECTOR" DUSTS

LeROY U. GARDNER, M. D.

It is my privilege to report to you upon certain investigations in the field of silicosis which have been in progress at The Saranac Laboratory for a considerable period of time. With your help I hope that these studies may continue.

In 1933 we undertook a field study for one of the gypsum companies and were impressed by the fact that men who had been exposed for many years to atmospheres containing gypsum dust mixed with apparently hazardous quantities of silica dust showed no evidence of silicosis. Experiments were then inaugurated in which animals were compelled to inhale high concentrations of quartz mixed with gypsum dust. Both guinea pigs and white rats failed to develop the silicotic reactions which would have been expected from the amount of silica introduced into the atmosphere.

Subsequently field studies in the iron ore, cement and other industries furnished evidence that other non-silicious materials might prevent or at least retard the inhalation of silica dust. Animal experiments with mixtures of hematite and quartz dust have shown very definite evidence of protective action against silica. Calcium fluoride apparently falls in the same category. Granite, a natural mixture of quartz and various silicates, is known to cause silicosis in human beings but its action is so slow that fifteen or twenty years of exposure is necessary before disease develops. Inhalation experiments with this dust have invariably failed to produce silicosis in animals. Recent injection experiments have demonstrated that tissue reaction to quartz in this combination is long delayed. The same quantity of quartz that would provoke specific tissue changes in two months, if it were injected in pure state, is held in check for two years when it is administered with the silicates of granite.

Such observations in animals are not new for experiments have frequently failed to reproduce disease with mixtures of silica and other substances which are well known causes of silicosis in human beings. Either the experimontor claimed to have caused the "early stages" of the disease, although his illustrations indicated that such was not the case, or he condemned the experimental method. In many cases he concluded that associated irritations of the lungs due to infection, mine gases, etc., were essential. It seems much more probable that the failures were due to the presence of protectors which delayed the rate of reaction to silica.

Quite recently the Banting Institute has published a report

of experiments in which it was shown that metallic aluminum had prevented the development of silicosis in rabbits. The observations covered a period of six months during which time controls subjected to pure quartz dust developed early silicotic nodules. Animals breathing a mixture of quartz containing one per cent. aluminum formed no nodules. These observations would seem to furnish another example of the same general principle. This protector is apparently active in very small quantities. Whether it will continue to prevent silicotic fibrosis from developing over a period of several years remains to be demonstrated.

The evidence now available makes it seem improbable that a silica hazard is defined solely by the number and size of the silica particles in an industrial atmosphere. The other components of a dust modify its action. Some may inhibit, others retard and perhaps some will be found to prevent its injurious effects. Because these possibilities are recognized it becomes difficult to set up definite standards of permissible dustiness in industrial atmospheres. A concentration of quartz particles which may be extremely dangerous when associated with "contaminating" particles of one type may be quite harmless when mixed with some other material.

Not enough is known about the action of protector substances to warrant the recommendation that they be employed to prevent silicosis in industry. Our aim should be to reduce existing dust concentrations rather than to increase them by adding more dust. Even though it may be shown that the health hazard is slight or non-existent, excessive dust concentrations are at best a nuisance; they often interfere with effective production and in extreme cases they add a safety hazard. I would very strongly oppose the recommendation that protector dusts be used to attempt to prevent silicosis at the present time.

But I do believe that we should attempt to discover more about their action. At present our knowledge is fragmentary. We know that many apparently unlike substances may act as inhibitors. Some are more potent than others. Some seem to exert their effects within the body, preventing the silica from acting on the tissues. Some, like gypsum, seem to combine with the silica in the atmosphere, forming clumps which are too heavy to remain suspended in air and too large to pass the barriers of the nose and upper respiratory tract.

We should know more about the underlying principles which govern the behavior of different mixtures. We should investigate the action of various substances commonly associated with quartz in industrial atmospheres. If they have

protective action we should discover in what proportions they are effective. We should know whether their effect is permanent or temporary. We should discover how and why such substances influence the reaction to silica by the body.

With such information at hand it may be possible to apply the knowledge in a practical manner. If it cannot be used to prevent silicosis it may well explain why certain individuals in a particular industry develop the disease and others do not. It will very probably be discovered that certain industrial dusts which have hitherto been considered hazardous because of their free silica content are in fact relatively harmless. This has already been demonstrated in a few industrial processes like the manufacture of certain gypsum products and of cement, which involve the use of silica. Codes and legislation have taken cognizance of the fact and have been less rigorous in their standards for these industries. When the facts are fully known, other manufacturers, whose operations involve the generation of relatively harmless mixtures containing free silica will likewise benefit. While everyone should keep dust concentrations within reasonable limits, it is only the hazardous dusts which require the more elaborate and expensive measures of prevention.

To solve these problems it is necessary to have elaborate apparatus for the long-time exposure of animals and a personnel especially trained in the fields of experimental pathology, chemistry, physics, and petrography. All these sciences must be brought to bear upon the question. We must have very accurate information about the minerals with which we work, their behavior when suspended in air, in fluids and in contact with the tissues. We must know their effects upon the living body both singly and in combination with one another. The factor of time cannot be too greatly reduced in the study of a chronic disease like silicosis. To attempt it will only defeat one's purpose. While this program may seem expensive, it promises results which will be profitable, from both the scientific and practical aspects.

PRACTICAL ASPECTS OF THE CHOICE AND USE OF ROENTGENOGRAPHIC APPARATUS AND TECHNIQUE IN INDUSTRY

S. REID WARREN, JR.

A roentgenogram placed on the uniformly illuminated diffusing glass plate of a film viewing device presents to the observer a pattern of areas of different brightnesses. Of two contiguous areas which differ in perceived brightness, that one which is brighter is said to be less dense. The difference in density is called the contrast of the two areas. The border between the areas is characterized by its sharpness, which depends upon the x-ray apparatus and technique as well as upon the position, shape and material of the object edge of which the border is the shadow. Density, contrast, and sharpness are the three measurable characteristics of the roentgenogram upon which scientific analysis of the roentgenographic process is based.

The roentgenologist learns by experience that film patterns having relative densities and contrasts within certain limits probably represent normality of the part of the body which has been exposed to x-rays; deviations of relative densities and contrasts beyond these limits, on the other hand, are interpreted by him as a result of abnormal conditions within the part.

The process of diagnostic interpretation is largely subjective. The conception of a normal roentgenogram has not been defined rigorously in terms of quantities which can be accurately measured. Therefore each roentgenologist has his own standard of normality. In addition there has been no general effort to define standards of density, contrast and sharpness for roentgenograms of various parts of the body. This prevents the development of accurate diagnostic criteria, uniform for all roentgenologists.

There are three methods of making roentgenograms. Two of these do not produce roentgenograms which are diagnostically comparable. *Unfortunately,* these two procedures are the most generally used. The third method produces comparable roentgenograms. Only a very small fraction of all the roentgenograms made at the present time is produced by this accurate reproducible process.

The first procedure may be described as the "hit-or-miss" method. The technician hopefully guesses the exposure factors and the factors for processing the film, and the result may or may not be useful from the diagnostic point of view.

Films made in this manner differ greatly in density and

contrast. Many roentgenograms are being made now by this *wasteful and inaccurate method.*

The second procedure has been developed by many able roentgenologists based upon training and experience. Each of these physicians chooses technical factors which produce *roentgenograms having density and contrast* which his observation has shown to be best from his diagnostic point of view. This may be described as the "rule-of-thumb" method. Roentgenographic techniques used in this country are in large part determined in this manner. *Occasionally,* accurate observation and careful correlation enable a physician to arrive at technical procedures which produce roentgenograms of excellent quality by this method. A far larger number acquire the ability to use films which are *not of optimum* quality from the physical point of view. Films produced in a given laboratory by this method are often comparable.

The third procedure is the scientific method. The determination of roentgenographic techniques upon a scientific basis depends upon an accurate quantitative measurement of all of the factors which contribute to the exposure, processing and examination of the roentgenogram. This method is the only one which permits standardization of roentgenographic technique. Such standardization fosters the development of accurate diagnostic criteria; legal proceedings in which roentgenograms are offered as evidence may be concluded quickly and justly only if roentgenographic technique is standardized; finally standardization reduces the cost of roentgenography by eliminating waste of time and materials.

In order to develop standard roentgenographic techniques with a view to producing comparable films in all laboratories at all times, the following problems must be solved:

1. What kind of roentgenogram, described in terms of density, contrast, and sharpness, has the greatest diagnostic value? An investigation of this problem requires accurate methods for measuring density, contrast, and sharpness. The quality and intensity of the light by which the film is observed must be measured. It is necessary also to investigate the psycho-physiological phenomena of visual *perception.*

2. What technical factors such as x-ray tube voltage, x-ray tube current, exposure time, focal spot-film distance, produce these standard roentgenograms? The data of a scientifically controlled investigation of available roentgenographic apparatus

are the prerequisites for the solution of this problem.

3. *How may roentgenographic techniques* be transferred from one laboratory to another, and how may the quality of roentgenograms in a given laboratory be maintained constant?

These problems have been studied at the X-ray Laboratory of the Moore School of Electrical Engineering of the University of Pennsylvania for the last fourteen years under the direction of Dr. F. M. McPhedran and Professor Charles Weyl of the Moore School. The technical details of this work have been described in papers published in the roentgenological journals. It is relevant for my purpose today simply to *list in broad outline the methods which have been used to* solve the problems. The Moore School X-ray Laboratory has been equipped for making comparative tests of roentgenographic apparatus and for producing roentgenograms under *all conditions* which may be encountered in clinical x-ray laboratories. By close collaboration with the manufacturers of x-ray apparatus and auxiliary materials, practically all of the devices used in the production of chest roentgenograms in this country have been tested. It has been necessary in the course of this work to devise special methods of physical measurement. These methods are described in published papers and in a book entitled Apparatus and Technique for Roentgenography of the Chest, published in 1935. These investigations have led to the definition of roentgenographic standards in terms of density, contrast, and sharpness. Comparative analysis of roentgenographic apparatus has formed the basis of methods for producing roentgenograms of standard density, contrast, and sharpness.

There are many interdependent factors which affect the quality of a roentgenogram. The most important factors are the x-ray absorbing characteristics of the roentgenographed objects, the x-ray tube voltage, the x-ray tube current, the exposure time, the focal spot-film distance, the size and shape of the focal spot, the characteristics of *intensifying screens,* the sensitivity of the x-ray film, the developing time and the developing temperature. Each of these factors has been investigated by controlled experiments. For example, the *x-ray tube current is determined by the value of the x-ray* tube cathode current and the x-ray tube voltage. These factors are in turn affected by the characteristics of the supply transformer and line and of several auxiliary devices included in the roentgenographic machine.

This work forms the basis of specifications of the apparatus

and ..nical methods by means of which roentgenograms having a scientifically pre-determined density, contrast, and sharpness, may be produced at minimum cost. These specifications are applied to clinical practice by means of a consultation service organized by the National Tuberculosis Association. Members of the staff of the Moore School X-ray Laboratory consult with roentgenologists concerning the choice of new equipment, and calibrate apparatus now installed with a view to recommending modifications of the equipment and technique which will permit the production of roentgenograms of standard quality. It is important to note that the work which has been done in this laboratory has always been directed toward practical application in clinical roentgenography. The standards which have been developed are based upon accurate experimental data. The factors of convenience and cost are always considered, if they do not compromise accuracy.

There are problems of roentgenographic procedure which require close collaboration between roentgenologists, physicists, and engineers. They require for their solutions three factors: (1) scientific control of apparatus and technique based upon accurate physical measurements; (2) accurate diagnostic interpretation of roentgenographic results; (3) a large number of patients to test adequately the methods which are devised.

The Air Hygiene Foundation has asked Dr. E. P. Pendegrass, Roentgenologist of the University of Pennsylvania Hospital, and the Moore School X-ray Laboratory to collaborate in work upon some of these problems. This work has been started.

One of the most important examples of these problems is the question of whether or not the use of a photographic emulsion suspended on the surface of paper will produce roentgenograms which are adequate from the diagnostic point of view. This problem is particularly important to industries who want to protect their employees and themselves. It is a simple matter to determine that the density range and the contrast obtained with paper roentgenograms are inferior to those obtained with transparent films. However, to the best of my knowledge, no scientifically controlled test has been conducted to show whether or not the results obtained with paper are adequate for diagnosis. Methods for investigating this problem are available, and are now being applied at the University of Pennsylvania under the auspices of the Air Hygiene Foundation. This is to be the first of a series of investigations of problems which require cooperative clini-

...cal and technical analyses. The results of the cooperative analysis of paper and film will show whether paper is adequate under all conditions or under some special conditions which will be specified upon the basis of the experimental data. Industrial physicians, insurance company physicians, and lawyers rightly demand standardization in this important field.

Compensation laws in some states require of industrial employees a roentgenographic examination in conjunction with other medical examinations. Is it more effective and more economical to permit a local roentgenologist to do this work, to purchase apparatus for permanent installation in the factory or to contract for the services of one of the companies which make roentgenograms with transportable roentgenographic apparatus? This problem also must be studied by close collaboration between those who understand the physical aspects of the problem and those who are interested chiefly in the medical aspects of the problem.

At the present time the practice of roentgenography is much more nearly an art than a science. The methods for producing roentgenograms upon a scientific basis are available. There remain two problems—first, the dissemination of descriptions of the scientific methods; and second, the investigation of problems which depend upon the close cooperation between physicians and physicists. High quality roentgenographic service is of course important to diagnosticians; high quality roentgenographic service at low cost is necessary if industry is to cope successfully with the problems with which it is now faced. I hope sincerely that you will plan further cooperative studies of these problems.

REPORT OF PREVENTIVE ENGINEERING COMMITTEE

PROF. PHILIP DRINKER, Chairman

My report will be brief and consists in what I might call news items in the engineering aspects of air hygiene.

One of the most significant developments in the field of occupational hygiene during the past year has been the adoption, on May 1, of New York State's code governing dustiness in rock drilling. This code divides all rock formations into two classes, I. being those with less than 10% free silica by weight, and II. being those with more than 10% free silica. If drilling is done in class I. rock, dust counts must be below 100 million per cubic foot, and below 10 million if the rock falls in class II. This means, in effect, that dry drilling can only be used with local exhausts and adequate air cleaning. It happens, also, that wet drilling without ventilation will not achieve adequate air cleanliness in the case of the high quartz or class II. rock.

At this writing is seems very likely that other states will copy this code almost verbatim. After all, New York adopted it as the result of extensive investigation and hearings and it is unlikely that other states will assemble better information on which to base their codes. It is probable that substantially this same code will be adopted for dust exposures of all kinds. If so, it will mean that the upper limit of dustiness in any kind of work and in any kind of dust will be 100 million particles per cubic foot.

Many states and insurance companies are adopting or approving non-silica parting compounds for use in foundries. There is the same tendency in other industries to substitute for silica non-silicious substances. So far, the silica and sand producers apparently have not attempted to devise or promote methods of using silica that will pass hygienic codes, such as that cited from the New York Law.

Considerable interest has been expressed by the report from Toronto and by another report from London on the use of protective dusts to nullify or reduce the potency of quartz in causing silicosis. The research back of this suggestion and the appraisal of the suggestion itself belongs to the Medical Committee, but engineers will be asked how the proposed protective dust should be applied. This Committee does not feel that the use of protective dusts has yet emerged from the academic, and they should not be used in practical problems. The literature on the subject is, however, very interesting and

well worth reading. It can be obtained through the office of the Managing Director.

At the present time, there is being developed commercially an ever-increasing list of organic compounds that were laboratory curiosities five or ten years ago. In many cases, the effects of these new substances upon men are not known. In spite of this lack of knowledge, the engineer is often called upon to estimate their concentration in air and to devise methods for eliminating or controlling health hazards in connection with their use. Several firms engaged in the manufacture of such materials are now attempting to devise means for the routine appraisal of the health involving their use.

The Bureau of Mines has released a new code, Schedule 19A, under which hose masks, air masks, abrasive blasting helmets will be examined and certified for approval. This schedule follows the same general lines as their previous schedules and fills a very important industrial need. Industry will do well to take advantage of the schedule by demanding that only Bureau of Mines' approved equipment will be purchased. It is likely that the various states will accept for approval only such equipment. It would be entirely in accordance with what has happened when the Bureau's other schedules for dust respirators and gas masks were first published. States, instead of setting up their own bureau, say, "If you get the Bureau of Mines' approval that is all we want."

Our Committee proposes to issue a series of bulletins on such subjects as the following: Dust control in rock drilling; design and operation of paint-spray booths; design and installation of local exhaust hoods; routine dust sampling and control; design and care of dust arrestors; design of duct work for exhaust systems; bench marks in control of dusts and fumes; use and care of protective equipment; determination of gases, specifically benzol, chlorinated hydrocarbons, and probably an acid gas, such as sulphur dioxide; probably two bulletins on the identification of dusts, that is, combined microscopy and chemistry.

These bulletins will be short, not over 1,500 words and preferably not over 1,000. They will contain a few simple illustrations, but there will be almost no references and no controversial matter. They will not illustrate or extol any particular article or machine. Both the outline and the finished bulletin will be criticized very thoroughly by our Committee. Our program is tentative, and we may expand or contract it, as circumstances warrant.

As Mr. Meller pointed out, we are to have two fellowships

from the Foundation at the Harvard School of Public Health next year, in matters of interest to this group. The men will be candidates for either the Doctor of Science degree in Industrial Sanitation, or for the Doctorate of Public Health in Industrial Hygiene. These men will have at least two years at the school, possibly three, and will be available for employment to the members of this group or to any one else who is interested in their services at the conclusion of that period of work. Their thesis subjects will, we hope, be matters which can be printed and made available to all of you.

I have been asked to comment briefly on the Bausch & Lomb dust counter. We are frequently asked "Should we buy it or should we not?" I own one and use it on industrial problems.

From the nature of the Bausch & Lomb instrument and the way it operates it cannot possibly imitate the impinger apparatus. However, a slight modification in the construction has made the conversions possible at comparatively low dust concentrations. But if one wants a short cut to the impinger data as obtained by the Public Health Service, do not buy the Bausch & Lomb instrument.

The other question is, if one uses the Bausch & Lomb counter can one adequately control dustiness in a plant or a mine? My answer is that generally the instrument is satisfactory.

A year or two ago our laboratory published a description of an instrument not unlike the Bausch & Lomb counter. That instrument is applied today with great success in appraising dust control equipment in a granite cutting establishment. It gives no trouble at all, but again the results cannot be converted directly to impinger counts. If one wants results in terms of impinger counts the only certain way to get them is with an impinger.

OBSERVATIONS ON AIR DUSTINESS IN DRILLING

D. HARRINGTON

Probably the reason for asking me to appear on this program today is that drilling is primarily one of the difficulties in connection with dustiness in mines, and probably also one of the reasons is that the United States Bureau of Mines, with which I am associated and have been associated for a number of years, was one of the pioneers in this matter of trying to find out what it is all about, or at least what something of it is about in connection with dust disease.

Early at the beginning of the Bureau of Mines, in 1910, the Bureau got under way in this matter of trying to see first of all what was the situation and what could be done about the occurrence of dust in mines, with particular reference to metal mines, as far as health was concerned. Early in the game Dr. Lanza, Dr. Sayers, Mr. Higgins and a number of others of us started out on it, I getting into it as early as 1916, which you will admit is a long time ago.

Oddly enough, some of the problems which were confronting us at that time in connection with drilling and air dustiness confront us yet. The problems of twenty years ago are largely the problems of today. As proof of this I have before me a publication issued by the Bureau of Mines in March, 1922, the subject being "Drilling and Dustiness in Metal-Mine Air." I am going to read a few paragraphs from that publication issued in 1922—fifteen years ago—as illustrating that while progress has been made, nevertheless the problems still remain largely as they were.

> "Notwithstanding all the effort made to introduce wet drills to prevent dustiness of air of metal-mine working places, there has during the past few years arisen in Australia and South Africa an impression that wet drills, including the Leyner type, actually cause undue quantities of finely divided ore and rock to rise into the air, these fine particles being chiefly attached to particles of fog or spray escaping from holes using water drills. This is said to have created consternation in the ranks of the mine operators who have complied with drastic wet drilling regulations, and purchased and operated various types of wet drills at no inconsiderable expenditure in both money and effort.
>
> "In view of this situation and the fact that wet stopers are being rapidly introduced with considerable success in many of the metal mines of the

United States, the writer, who has for the past five years been engaged largely in studying the dust problem in the metal mines of the West for the U. S. Bureau of Mines, has compiled the dust sampling of air of drilling places in 214 working places in 13 mines at time of drilling, using various types of wet and dry drills with upper, inclined, horizontal and some down holes.

"The result of these tabulations indicates that irrespective of the conditions in South Africa and Australia, the use of wet drills in the United States results in a decided decrease of dustiness of the surrounding air as compared with dry drilling, whether the holes are upper, inclined or horizontal, and practically irrespective of the types of drill used. Nevertheless, there are some dangers from dust in air surrounding wet drilling operations unless certain precautions are taken."

The final paragraphs of this paper are these. As I said a minute ago, this paper was published in 1922.

"The dust studies to date in metal mines of the United States by the U. S. Bureau of Mines indicate definitely that wet drills as used in drilling of all classes of holes aid decidedly in reducing dustiness of air in drilling places. However, it has been found that wet drills whether of the Leyner type or stopers, if not operating satisfactorily or if out of repair, may throw into the air of working places a mist or fog, laden with minute mineral particles which when breathed has the same effect as dry dust and is fully as dangerous. In addition to danger when wet drills are not efficiently used, if water or compressed air and water forced through the drill is under excessive pressure, say over 100 pounds per square inch, there may be danger of escape of mist or fog laden with mineral particles, hence these pressures should be held below 100 pounds per square inch, which in general is the practice in the United States.

"Wet drills must be kept in repair and must be operated with intelligence. As far as proved by the sampling of the U. S. Bureau of Mines, the wet drills, even when at their worst, still give conditions much more healthful than do dry drills."

Practically all of the statements contained in that article obtain today.

Still going into the history, I have before me also a publication of the Bureau of Mines issued in July, 1922, entitled, "A Summary of Investigations of Dust and Ventilation in Metal Mines," as given by the Bureau of Mines, with bibliography. In that is a list of some fifty odd papers published by the Bureau of Mines up to that time on the subject of dust and ventilation in metal mines. Throughout that list are the names of Dr. Sayers, Dr. Lanza, Mr. Yant, and others who are still writing on the subject.

Now for the matter at hand.

The Air Hygiene Foundation Committee on Preventive Engineering had before it five problems—at least five problems which were announced. Two of those five problems were assigned, indirectly at least, to the U. S. Bureau of Mines, and those are the problems on which I am going to talk today.

Problem II of the Preventive Engineering Committee's report states: "Study of dustiness created by drilling in different kinds of rocks. The U. S. Bureau of Mines has underway a series of experiments in an experimental rock tunnel. The study indicated can be included in this program."

Problem III is "A study of the difference in dustiness from blasting with and without dust control during rock drilling. This project will be included in the program of the U. S. Bureau of Mines in its experimental tunnel."

The Bureau of Mines for years carried out studies in connection with silicosis, dust disease, dust and ventilation in mines, health affected not only by dust but by gases, and other health phases which occur chiefly in underground mines. A few years ago, when the economy program came on us, we were confronted with the necessity for discontinuing very largely that work, and it was recessed for several years. A little over two years ago Congress gave us $50,000 with which to resume that type of work. About $25,000 a year was allotted to laboratory work and about an equal amount to field work.

In connection with the laboratory work, persons doing it were assigned partly to do their work in the laboratory and partly in the field, it being felt that the laboratory technician should become familiar with the conditions, difficulties, trials and tribulations of the fellow in the field who has to apply the results of any research which might be underatken and if there might be results obtained. Accordingly we had our research men go into the field in the western part of the United States and also in the Lake Superior region and in other parts of the country as well.

On the other side of the picture the field men, who were

going to tackle this problem also, it was felt should obtain the point of view of the laboratory men. They should at least have some knowledge of what the laboratory man was doing and what it "was all about" as far as the instruments and instrumentalities in connection with taking of samples and determining of air dustiness were concerned. Therefore we brought in a number of our engineers and had them spend considerable periods of time in the laboratory in Pittsburgh. We also brought some of them into the mines where the laboratory men were working when in the field. In other words, we tried to get a pretty firm foundation for our men who were going to do this work.

It has taken us a considerable length of time to do that. We feel now that we are about ready to capitalize on some of the work which has been thus undertaken.

One of the numerous things which we have tried to do in connection with this research on silicosis, or whatever you wish to call it—I prefer to call it pneumoconiosis or dust disease, which is much more simple and much more expressive, as a matter of cold fact—is that we are now preparing to issue and in a relatively short time will issue a series of short papers on various phases of what has been found. Some of those papers are going to be on drilling, many of them will be on dust. At the present time there are in process of publication in mimeographed form two papers, one of them entitled "Relation of dust concentration in mine air to depth of hole during wet drilling." That paper is now in stencil form and it should be issued any time within the next few weeks. Another paper entitled, "Effect of drilling angle on dust concentration in mine air" is pretty well along toward completion and probably will be issued within the next few weeks or at least by the first of the year.

In addition to these papers we have probably half a dozen other papers which are written, have been submitted, and are now undergoing editorial scrutiny. They also will be published. They are not so definitely concerned with drilling as the first two, although some other papers are going to be published in connection with drilling.

These papers embody only a small amount of the data available. We are trying to have one or two papers issued per month for the next several months, probably for the next year, on some phase of the research which has been done in the laboratory and in the field on dust.

As far as drilling is concerned, the studies have been undertaken and have been carried out not only in going mines but also in an experimental tunnel which the Bureau has opened

at Mount Weather, Va., outside of Washington, in a quartzitic formation. A considerable amount of the work is going to be done there under controlled conditions. Much of the work, however, has been done in going mines, under working conditions largely, but also in isolated places in working mines under more or less controlled conditions.

One of the studies which we undertook and on which we thought we had some results, but on which we have not as yet seen fit to release the data, is the effect of sharpness of drill bits on dust produced in drilling. South African authorities have issued some data on this subject and have indicated that the duller the bit the greater the amount of dust likely to be obtained in the wet drilling. We tried it out and to our amazement our results were definitely opposite, as far as we have been able to ascertain so far. We are not going to tie ourselves very tightly to these findings however at this time because we feel that there are some variables which we have not yet taken into consideration. As far as we have been able to ascertain so far, the sharper the bit the greater the air dustiness produced. We may modify that—we probably will modify it sooner or later. At any rate we are not able to give out anything of a definite nature on it now.

There are so many different factors which enter into this matter of drilling and air dustiness that it would take much more time than I have now to give you any intimation as to what it is all about. In the first place it is obvious that dry drilling gives much more dust than wet drilling. It is also obvious that under some circumstances wet drilling produces air dustiness. We are now of the opinion that a considerable amount of that air dustiness produced by wet drilling is due to the fact that the starting of the hole, the collaring of the hole as it is called, is responsible. In other words, the collaring is very often done practically dry, and that collaring dry is very often done even when the drill operator doesn't purposely restrict the amount of water going through the drill steel. The fact of the matter is that we are pretty well assured now that until the hole has a depth of approximately a foot, the water which is delivered through the drill steel does not have sufficient amount of time or sufficient amount of contact with the fine rock material to mix with it in such a manner as to hold the dust in connection with the water.

In other words, the time element enters into the matter. It may be necessary before wet drilling can be made as successful as it should be that some sort of extra precautions, either in the form of the use of a foam or of some external apparatus which will introduce the extra amount of water or mist

or something of that kind, be provided until the hole gets a depth of six inches to a foot at least.

That is one of the main problems confronting us at the present time. We in the Bureau of Mines have done a little—not much—and we are going to do more experimenting with the use of wetting or foam agents with regard to drilling. A considerable amount of work has been done on that in foreign countries, particularly in Great Britain, and to a limited extent in South Africa. We have not as yet been able to get anything which would give us any intimation as to what may be the effect of the use of foam, or at least we have not seen or heard of any foam agent which, as far as we have been able to find out, is an unqualified success.

There appears to be no doubt whatever that the amount of dust which may be expected from wet drilling is largely dependent on the amount of water forced through the drill steel. In other words, if you restrict the amount of water going through the drill steel you are likely to get an increase in the amount of dust; conversely, by increasing the amount of water going through the drill steel there is likely to be a definite lowering of the amount of dust coming into the air.

We have done a little—not as much as we expect to do or should do—in connection with the use of dust traps with dry drilling, and we have made some observation where types of dust traps are being tried in wet drilling. Sooner or later we expect to get some data for publication on that subject as well. We have also done some work and will do more in the near future with the so-called South African dustless type of drill, which tries to prevent the use of compressed air with the water through the drill steel. That drill has been utilized a little in the United States, particularly in the western part, but has not as yet been considered to be successful. To put it differently: The mine operators where the drill has been used feel that it is not necessary, that by the use of common sense methods with present day types of wet drills and wet drilling, air dustiness can be held within suitable limits without going to the extreme of adopting the South African type of drill. On the other hand, in Ontario two of the large mining companies, we are informed very definitely, have gone completely over to the South African type of drill. They are the Dome Mine, and the Hollinger Mine, both in Northern Ontario.

I had a chance to talk to one of the mining men from that region about two months ago, in Vancouver, B. C. He said that this particular type of drill not only does the work with much less air dustiness, but that it also is fully as successful

from the viewpoint of upkeep and cost per foot of drill hole as the other types of drills. That may be true, of course, in connection with their type of ore or conditions, and it may not necessarily be true in the United States.

The whole matter of drilling, as far as we can find out, may be summed in this way. Dry drilling is, of course, very much more a dust producer than wet drilling—probably in the ratio of six, eight, or possibly ten to one. Wet drilling produces some dust. Particularly is that true unless the collaring is very carefully done and the amounts of air and water through the drill steel are not controlled. But if reasonable precautions are taken with wet drilling and suitable precautions are also taken as to ventilation, as to the wetting of the muck pile, as to the time at which the blasting is done, as to the precautions which are taken after going back to the face after blasting, we feel—in fact we know—that under present day conditions mines can be conducted with air dustiness at the working faces, including dustiness due to drilling, such that there need be no particular harm to workers in those places as far as dust disease is concerned.

REPORT OF LEGAL COMMITTEE

A. C. HIRTH, Chairman

The position of industry insofar as the legal aspects of the occupational disease problem is concerned has not changed since this subject first received consideration by the Foundation. The admonitions and warnings that we have frequently voiced during the past two years are as applicable now as they were then, and the mere fact that there is less litigation than heretofore does not mean that your problem is solved. We are still faced with a problem of a more permanent nature, that is, the problem of occupational disease legislation. Labor is becoming increasingly insistent that legislation covering this subject be passed, and that the content of such legislation be formulated by them. In some few states manufacturers have been successful in securing the adoption of their ideas with respect to such legislation, and it requires only a comparison of these laws with those in which no participation on the part of industry occurred to show the tremendous importance of our active concern in this matter.

It may be interesting to very briefly summarize the work of the Legal Committee to date.

During the first year of the Foundation's existence your Committee issue Bulletin No. 1 of the Legal Series prepared by the law firm of Williams, Eversman & Morgan of Toledo. This bulletin included a survey of existing statutes and court decisions relating to the rights of employees for compensation for injuries caused by occupational diseases resulting from air pollution. It analyzed the Workmen's Compensation Acts and Occupational Disease Acts of every state in the Union with respect to their provisions for compensation for occupational disease injuries, and reviewed the state decisions dealing with the rights of employees to maintain actions at common law against their employers for such injuries. On two different occasions this bulletin has been brought up to date.

The statement of the result falls far short of describing the monumental proportions of the task. So far as we can ascertain no similar work has ever been compiled. It was therefore necessary for us to blaze our own trail. Few law libraries contain all of the necessary information. Men were sent to the largest and best equipped of such libraries in the country. Even so, we were frequently unable to find the latest legislative enactments. In such instances, and there were many of them, it was necessary to communicate with state

officials to procure those statutes which had not yet been published. It was even necessary in some cases to engage public reporters to make typewritten copies of the recently enacted legislation.

In addition to the various statutes it was necessary that we wade through hundreds of pages of books of rules and regulations issued by the various state commissions. Our correspondence and long distance telephoning incident to this work was in itself a man-sized job. What has been said does not include the study of court decisions in which the various statutes of all the states are construed and applied, and in which the common law, which exists irrespective of statutes, is defined. Hundreds of cases were studied but omitted from the report. A digest of some 440 court decisions was included as part of the basic survey which comprises close to 700 pages in rather small type.

Following Bulletin No. 1 the Foundation published Bulletin No. 2, which was a critical study of provisions for occupational disease legislation prepared for the Committee by Mullikin, Stockbridge & Waters, Attorneys of Baltimore. The purpose of that bulletin was to present to the members of the Foundation a discussion of the important basic principles to be considered in such legislation.

Our description of this work is not given you with any thought of "peddling our wares", but rather to impress upon you that these various bulletins represent an investment which if each of you were called upon individually to make, would be burdensome to say the least. Whether or not they are of value to you will depend, of course, on how much use you make of them.

It has been the aim of your Legal Committee to furnish you with those tools which are necessary to properly plot your course through the labyrinth of legal complications which have been created by the occupational disease problem. But we cannot use them for you.

We are now ready to submit Legal Series Bulletin No. 3, prepared by Mr. Theodore C. Waters, Chairman of the Maryland Occupational Diseases Commission. In the course of Mr. Waters' experience in such capacity, he actively participated in one of the most thorough surveys that has ever been made on this subject. Innumerable witnesses testified before the Commission and every possible source of information was thoroughly explored. His opinion, therefore, as to the legislative aspects of our problem should be given careful consideration by you in determining your policies on this subject.

Your Committee has read the bulletin with a great deal of care and interest. It might aptly be described as a "road map" on occupational disease legislation. I shall not attempt, however, either to name it or review its contents, as its author is with us today.

COMPENSATION LEGISLATION—A CRITICAL REVIEW

THEODORE C. WATERS

In reviewing the activities of Air Hygiene Foundation, I have been impressed with its progress and accomplishments. When the organization was originally conceived, those of us interested in its activities felt that it had a definite purpose to serve in the field of industrial hygiene. Its officers, trustees and committees have devoted their efforts to the solution of many of the problems that have served to perplex our modern industrial society, and I feel that the Foundation is to be congratulated upon its various activities, which have proved to be of material assistance to its member organizations. For the past several years we have all benefitted by the research work done by the distinguished scientists who have served upon its committees and I know that I express the sentiments of the member organizations when I thank these committees for the signal services that they have rendered.

At the last annual meeting of the Foundation, we discussed some of the problems presented to industry by the contemplated enactment of legislation compensating occupational diseases. Since that time many new laws have been enacted, creating new problems for those who may be concerned with their administration.

I have been asked to discuss briefly the bulletin prepared by the Legal Committee, which is now being printed and will shortly be submitted to the membership as Legal Bulletin No. 3. In the time that has been allotted to me it would be impossible to present an intelligent analysis of this bulletin, but there are several subjects treated therein that I desire to call to your attention for careful consideration.

During the past year occupational disease amendments to existing Workmen's Compensation Laws have been enacted by the States of Delaware, Indiana, Michigan, Pennsylvania, Ohio and Washington. Therefore, today there are twenty-one states whose laws now provide compensation for occupational diseases. In the following states Commissions have been appointed for the purpose of studying and recommending compensation legislation:

Alabama	Georgia	Maine	New Mexico
Arizona	Kansas	Maryland	Oregon

It is apparent that a new emphasis has been placed upon the need for compensating occupational disease injuries, and

in the course of the next few years all of the industrial states will have probably enacted laws for this purpose.

In choosing three of the subjects discussed in the new bulletin, I do not mean to minimize the importance of the other subjects treated therein. However, in view of the present trends of occupational disease legislation, the following subjects are of special interest at this time:

(a) Provisions compensating partial and total disability from silicosis.

(b) Limitation provisions.

(c) Provisions dealing with pre-employment and periodic post-employment physical examinations of employees.

Compensation for Partial and Total Disability from Silicosis

Occupational disease laws generally award compensation for partial and total disability in the same manner and under schedules similar to those for disabilities caused by accidents. In several of the laws recently enacted, compensation for partial disability caused by silicosis has been denied. The basic theory of the Workmen's Compensation Acts is to provide compensation solely for disability, and the legislatures of certain of the states have come to recognize that many employees who have some presently determinable evidence of silicosis are engaged in trade, not knowing of the existence of the disease in them, showing no noticeable disability, and fully capable of performing their regular duties. Precedent for the denial of compensation for partial disability was established by the method of awarding compensation for silicosis in South Africa, where medical classification of the stages of the disease were provided in the law. In the first stage (ante-primary), relatively low compensation was payable, so that the employee would be compensated for the time that might elapse from the date of his removal from his hazardous employment until he could find employment in some other trade.[1] The West Virginia law follows this idea and defines three stages of the disease, providing compensation in the amounts of $500 and $1000 respectively for the first and second stages of the disease, with full compensation in the same manner and at the same rate as is provided for permanent disability or death from accidental injuries when the claimant is suffering from the disease in the third stage.

1 The original Ontario statute contained similar provisions.

During the year 1936, New York State amended its occupational disease compensation statute to deny compensation for partial disability due to silicosis or other dust diseases, while during 1937, Ohio, Pennsylvania and Michigan passed laws denying compensation for partial disability from the dust diseases.

The Medical Committee of the Foundation, in its Bulletin No. 1 of the Medical Series, has recognized the difficulty of evaluating partial disability. Similarly, the summary report of the Committee on the Prevention of Silicosis through Medical Control of the National Silicosis Conference has recognized the intricacies of the problem.

In many instances employees have been advised by physicians, untrained and inexperienced in the diagnosis and effect of silicosis, that they have the disease and thereby have sustained disability. Acting on this advice, the employee, now concerned about his condition, leaves his employment, even though that trade may be the only one in which he is able to earn a living He may then find himself unacceptable for employment elsewhere and becomes unable to earn a living wage, with resulting hardships to himself, his family and eventually to his community, which might have been avoided had he been properly advised that he had suffered no actual disability and that the risk of continuing in his employment was negligible. Employers likewise suffer from improper diagnoses, with the resulting persecution of common law suits or unjustified compensation claims. Not only is this litigation excessively expensive, but it may have a far reaching detrimental effect upon the entire employer-employee relationship, tending to destroy public confidence in an industry which may, as a matter of fact, be well managed, properly equipped and operated with full consideration for the health of its employees.

There are persuasive reasons both for and against legislative provisions denying compensation for partial disability from silicosis, but until an approved method is devised for the purpose of evaluating such disability, the denial of compensation for partial disability is not only equitable, but desirable.

With respect to total disability, the problem is much simpler. When the disease is accompanied by active pulmonary tuberculosis, the employee should be removed from the hazard of dust, not only for his own protection, but for that of his fellow workmen, in order to remove them from the possibility of infection. An employee so injured should receive the full total disability benefits of the law. Adequate protection should be afforded to employers to determine the actual cause

of disability so that compensation may not be awarded unless the claimant is determined by competent medical examination to be suffering total disability. Pre-employment examinations will enable employers to avoid the employment of tuberculars and tubercular suspects in industries wherein silica is a hazard, and by this method they may relieve themselves from a considerable portion of the potential total disability benefits that may be awarded under our compensation statutes.

Limitation Provisions

One subject that has not received merited attention is the period of limitations after exposure or injury within which formal proof of claim for compensation must be filed. Our state laws vary widely with respect to this problem, but generally speaking they relate to:

(a) A period of employment within the state as a prerequisite to the filing of claim for compensation and/or

(b) The time within which claims for compensation must be filed after injury or the termination of employment.

The following states require exposure in employments within the state as a prerequisite to the right to file claims:

Illinois—sixty days exposure (all diseases)
Indiana—sixty days exposure (all diseases)
North Carolina—two years exposure (silicosis and asbestosis)
Ohio—five years exposure to silica dust; for other diseases, employee must be resident for ninety days
Pennsylvania—two years exposure (silicosis and asbestosis)
Washington—three years exposure (all diseases)
West Virginia—two years exposure (silicosis)
Wisconsin—ninety days (silicosis)

Another important provision is the requirement that the disease should have been due to the nature of the employment and contracted within a fixed period of time previous to the date of disablement. The following are examples of such provisions:

Michigan, Minnesota and Ohio—one year
Illinois, Indiana, Nebraska and Pennsylvania—two years
North Carolina—three years (silicosis and asbestosis)

All of the compensation acts specify procedure relating to

the filing of claims and fix the time after injury or last exposure within which claims must be filed, and in order to determine the rules of each state, it is necessary to examine the particular state statutes applicable thereto. These statutory provisions lack uniformity as to procedure, and unfortunately, in many instances, the period of limitations runs from the date of injury or manifestation of the disease rather than from the date of last exposure to the disease hazard. This is objectionable to the employer because he is unable to determine his liability in the case of diseases that do not manifest themselves or cause injury until many years after employment or exposure to disease hazard has been terminated. To determine liability, it is essential that the period of limitations run from the date of last exposure.

The refusal and reluctance of representatives of labor to recognize the necessity for physical examinations of employees has impeded the successful administration of these laws, but the question of limitation provisions could be readily solved by the physical examination of employees upon the termination of their exposure to disease hazards, whereby it could be promptly determined whether or not they have suffered disability.

Pre-employment and Periodic Post-employment Examinations of Employees

The medical profession generally, including the Medical Committee of the Foundation, recognize and recommend pre-employment and periodic post-employment examinations of employees for the prevention and control of occupational disease. In spite of the misunderstanding that has arisen regarding their use, pre-employment examinations have served a valuable purpose in avoiding the employment of men in certain industries having hazards to which they may be peculiarly susceptible, as for example, preventing the employment of tuberculars in those industries having silica hazards.

Periodic post-employment examinations have already proved their merit. They make it possible for employees to be advised of conditions not due to their employment that need treatment for the preservation of their general health. Competent medical advice is given, resulting in the treatment and cure of conditions which, undiscovered or unattended, might later cause irreparable damage to an employee's health. From the social standpoint, the benefits of examinations properly conducted may render to the employees invaluable assistance and the workman and his family, as well

as the employer, will reap immediate and obvious benefits therefrom.

Time does not permit a discussion of the legislative provisions of the states dealing with this problem but the Legal Bulletin that will soon be available to members discusses these statutes in detail. Suffice it to say that pre-employment and periodic post-employment examinations of employees are of vital importance to ascertain the incipiency of diseases when employees are or may be exposed to hazards. When a disease is permitted to develop to the stage where it becomes manifest or disabling, it is generally too late to avoid its ultimate disabling effects, and the employee is then limited to the compensation benefits that the statute provides. By prevention, the health of the employee is safeguarded and the employer relieved from the liability for compensation. Therefore, a complete and comprehensive program for medical control, with routine examinations, is essential for the successful administration of these laws.

In the beginning of my remarks I referred to the problems that have arisen and will arise in connection with the administration of occupational disease laws and, for your consideration, I would like to make brief reference to some of the provisions of these laws that will inevitably lead to difficulties. We have been discussing specific provisions of occupational disease legislation common to all laws and I would like to call to your attention some instances of problems that will arise in the future in connection with the administration of these laws. Due to the limitation of time, I can make but brief reference to these problems, without detailed discussion thereof, but I hope that these references will emphasize their importance.

As you know, the New York Workmen's Compensation Act was originally amended to compensate a scheduled list of occupational diseases. In 1935 the Act was again amended to compensate "any and all occupational diseases." There is now pending before the Court of Appeals of the State of New York the claim of Shirley Goldberg against the Marcy Corporation and the Maryland Casualty Company for an occupational disease alleged to have been sustained by the claimant during the course of her employment. The duties of the claimant were to sell tickets for a motion picture theatre in a sidewalk booth which was heated by a small electric heater. Her claim sets forth that her legs were weakened by the heating and that she fell, breaking her ankle and sustaining injury. I quote the following averments from her claim:

> "My condition was caused by the electric heater in the cash box. It drew the blood out of my feet and caused blotches and veins to come out, making my feet weak."

The accident whereby she sustained a broken ankle did not occur during the course of her duties so that her claim was based solely on an alleged occupational disease of inflammation and weakness of the legs caused by her employment. The Referee before whom the matter was heard awarded compensation, which was affirmed by the Appellate Division and, unless reversed in the present appeal, the case will stand as a precedent of what may be expected in the course of the administration of the New York Occupational Disease Law.

I cite this case to bring home to you the hazard presented to industry by those state laws providing general coverage. There are claims now pending under general coverage laws for diseases such as tuberculosis, pneumonia, boils, scarlet fever, flat feet, and countless other diseases not peculiar to or characteristic of the trade or employment wherein a claimant is engaged. I do not mean to imply that compensation will be awarded for all of such cases, but I repeat the warning that general coverage laws may in the future be construed to provide general health insurance for employees. If our present society desires this to be accomplished, our legislatures should say so and not hide the purposes of the proposed legislation behind the name, "occupational disease compensation."

Another instance of immediate interest is the provision of the Pennsylvania Occupational Disease Act that becomes effective January 1, 1938. You are all familiar with the problem of so-called "accrued liability" common to all occupational disease legislation. The Pennsylvania law attempted to take care of this problem as it related to certain diseases by apportioning this liability between the employer and the Commonwealth over a period of ten years, by providing that if disability or death from the disease occurs within the first year after the Act becomes effective, the employer shall be liable for and pay one-tenth of the compensation for such disability or death, the remainder of such compensation being payable by the Commonwealth. For disability or death occurring each year thereafter, the employer assumes an additional one-tenth of this liability until the ten year period is past, after which time full liability is imposed upon the employer. The Act does not specify the diseases to which this provision applies, leaving this for the determination of the

Workmen's Compensation Board. The Board is empowered to determine those diseases that develop to the point of disability only after five or more years of exposure. At the effective date of the Act, therefore, neither the employer nor his insurance carrier will be apprised of the diseases to which this provision applies. It is apparent that such confusion must react detrimentally to all industrial interests and, in a sense, makes the risk imposed by the law uninsurable. Assuming that the disease of silicosis is one of the diseases that the Board will find to be within the terms of this section, we have a limitation of the employer's liability in the law in the amount of $3600. Does the section providing for the apportionment of liability between the employer and the Commonwealth limit the employee's right to compensation to $3600, or does it mean that during the first year the Act is effective, the employer pays one-tenth of the disability or death benefits, not to exceed $3600, and the Commonwealth pays the remaining benefits granted by the general law? Such a construction is possible and would result in claimants becoming disabled the first year after the Act becomes effective receiving substantially more compensation than claimants becoming disabled ten years after the Act becomes effective. If this is the proper construction of the Act, I hazard the guess that during the first few years it is effective, there may well be an avalanche of claims thereunder.

I regret that time does not permit the discussion of many of the other important legislative provisions that are treated in the Legal Bulletin upon which I have been asked to make report. In closing, I believe it proper to express the warning to the Foundation, its members and supporters, that during the next few years careful attention should be paid to the administration of the occupational disease laws now effective, so that unjust and inequitable construction may not be placed upon the provisions of these laws. I believe that the members of this Foundation are ready, willing and able to accept their responsibility for occupational disease injuries to their employees, but will seek to avoid unjust and inequitable claims that may hereafter be asserted against them. It is important that those industries having occupational disease hazards should carefully scrutinize all proposed rules and regulations adopted by administrative agencies and that false and improper claims should be contested to the utmost. The next few years may well determine the ultimate course of the administration of these laws and your continued attention to this matter is vitally necessary to the protection of your own interests.

CORRELATION OF AMERICAN RESEARCHES IN INDUSTRIAL AIR HYGIENE

H. B. MELLER

The rapid expansion of interest and activities in the field of industrial health necessarily has resulted in a certain amount of overlapping of effort. One of the functions of Air Hygiene Foundation is to unify and correlate activities in this rapidly-developing field so that the sum total of our knowledge on the subject may be efficiently advanced.

In line with this objective, the Foundation recently set out to compile a rough directory of institutions and individuals engaged in researches on those occupational diseases in which Foundation members are interested. In other words, we attempted as a preliminary move to take a partial inventory of institutions and research specialists working in this field.

A test list of 200 such institutions and individuals was carefully prepared. We did not include research by individual companies or corporations for their own advantage, nor did we include the work of independent consultants nor the excellent and valuable studies being conducted in particular industries by some of our national trade organizations. Our survey was concerned only with the broad, fundamental problems affecting industry as a whole.

Of the institutions and specialists contacted in the survey, more than half sent answers to the questionnaire. It was most interesting to note that in every case the question, "Are you willing to cooperate by supplying reasonable information and other advice looking toward coordination of research in the field of air hygiene?" was answered in the affirmative.

An analysis of the replies revealed that there is an increasing number of specialists entering this field of research; that more hospitals, through their pathological and roentgenological departments, are broadening their activities; that more institutions of learning are inaugurating departments of industrial medicine or industrial hygiene; that many states and some cities are including regulation of industrial disease hazards in their program. And, of course, there is the continued broad, valuable work of the U. S. Public Health Service and of the U. S. Bureau of Mines.

These findings are convincing evidence of an increasing regard for the health of workmen, and cognizance of the advantages that will accrue to employers as well. A pertinent query now confronts us, namely: How can the greatest advantage be taken of the opportunity afforded by these

increasing facilities, so that they may be directed, through cooperation and coordination, toward securing in the shortest practicable time authoritative answers to perplexing questions that are serious in their importance and in their need for early solution.

Let us consider briefly some facts of relevance.

There are the Federal and State agencies with their prepared programs.

There are outstanding institutions whose sole, self-imposed responsibility is the conduct of research. These institutions either are endowed entirely or in part, partially supported through private grants, or are entirely dependent upon outside funds. That the interest, research and support of this group should be encouraged cannot be gainsaid.

The number of departments of industrial medicine and of industrial hygiene in educational institutions is increasing, and it is hoped will increase more rapidly. Such departments will undoubtedly be a tremendous asset to labor and industry in training physicians, engineers, chemists, and physicists for this field of research and control.

But in the programs of proposed research activities which have come to us from these sources, there is implied a large amount of unnecessary duplication, if all are able to proceed as they indicate they wish to do; which brings to mind a logical question: Should industry be asked to pay over and over again for the same research projects? Or should it, instead, use a central control to aid in direction of scientific effort and financial support in order to minimize wasteful duplication and spur research progress on a long list of problems crying for attention? Obviously, far more could be accomplished and for far less money if the expenditures were so directed.

We are not discussing the research being done by individual companies or corporations for their own advantage, the work of consultants whose laboratories are industrial plants, nor the excellent and valuable studies being conducted in particular industries by some of our national organizations. All such studies are desirable and valuable, but have no direct bearing on the program under discussion except insofar as the Foundation, in its turn, is able to cooperate with these organizations to steer clear of those researches whose results will be made available to industry through the efforts of others. This will be a move of progressive type toward reducing unnecessary duplication in research.

Nor is there included research in educational institutions where it is conducted for the purpose of benefitting industry in particular districts, in which case appeal for research support from local industries is natural and proper. But where problems affect industry broadly and/or where support is sought from a widely distributed group, it is our opinion, which we hope will be shared by others, that the best interests of all concerned will be served and the greatest return secured from the investment if the problem is considered part of a comprehensive program devised for the benefit of all; and if the place at which the work is to be done is chosen with that broad outcome in mind. This action in itself will prevent considerable duplication that otherwise would likely occur.

We refer in the discussion here only to the broad program of investigation for application in which industry as a whole is interested. The results of the survey carried out by us so far give definite indication that the men directly engaged in this field are willing to aid in coordination of the work. They realize that duplicate effort is costly, not only in money, but—what is of greater moment—in time. The scientist, we are convinced, can therefore be depended upon to do his part; but there must be evolved a plan, which can be preliminary in its nature, as the basis for consideration of such timely and essential questions as who should do what, who should refrain from which activities, and why. Scientists engaged in this field can work out a practicable arrangement of inestimable value in hastening the clearing-up of many uncertainties which have had their effect upon current legislation. These scientists must however be stimulated to bring about this result through a central agency.

The coordinated program should be made up of basic problems, the solution of which is needed by all industry, or at least by groups of industries. As rapidly as answers are found they can be used to practical benefit, not only in plants but also in clearing up uncertainties that have affected legislation. It is one thing to comply with regulations under an existing law; it is quite another to attempt to clarify and add to existing facts so as to clear up controversial points considered in formulating that law.

Industry knows more or less clearly what needs to be accomplished. Industry is aware that, in addition to researches on problems of special or immediate interest, a long-range program is necessary to supply incontrovertible facts that then may be woven into sound laws, fair to employers and employees alike.

The path to this goal will be made very much shorter if executives in industry will work closely with scientists who would welcome a comprehensive program, equitably distributed, carefully coordinated, and adequately financed.

On the one hand, interested scientists would be spared in large part service as salesmen to secure necessary financial support for their investigations. (Bear in mind what has been said about local service, or services or studies carried on by or for specific industries or groups.) These specialists would be able to devote all their attention to constructive effort.

Industry, on the other hand, through its executives, would be able to keep in close touch with the program as a whole as well as with parts that might be of special or immediate interest, and this connection would accelerate the progress by thus getting a maximum return for the money spent in research. Industry should definitely pool its interests, helping in the formulation of the program, and supplying the necessary sinews of war. Science will cooperate to the full in solving the problems of industry, if industry is a part of the army in the field and is prepared for a vigorous attack.

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