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Foreword

THE TRANSACTIONS of the Twenty-Fourth Annual Safety Congress, National Safety Council, 1935, are published in two volumes. This volume, the first, contains the general sessions, the special subject sessions, and the Industrial Section sessions. It is supplemented by a smaller volume containing the sessions of the Street and Highway Traffic Section, the Child Education Section and Home Safety.

All industrial members of the Council automatically receive the large volume. The smaller is sent to members believed to be chiefly interested in the sessions it covers. It may, however, also be secured by other Council members upon request.

Many members have found it worth while to distribute copies of these Transactions to supervisors, foremen and others in an administrative or supervisory position who may make practical use of them for reference purposes. For the benefit of those who desire extra copies the following quantity prices are quoted: One to ten copies of the large volume, $1.50 each; eleven copies and over, $1.25 each; copies of the smaller volume, 50c each.

IN ACCORDANCE with the plan of publication followed for the past several years the Transactions are published again this year as a condensed record of the proceedings at the National Congress. The papers of each session or division of the Congress have been edited carefully to eliminate extraneous matter and to abbreviate the less essential portions because of space limitations. In other words, the material herein presented is not a verbatim report of all the speeches presented at the Congress, but rather an abridged version, made as compact as possible, yet without any injury to the technical aspects of any address. The original manuscripts are on file in the library of the National Safety Council, where they are available for additional reference. In several cases, where illustrations were sent by the speakers to the Council, these also are on file.

The National Safety Council at its Congresses seeks to eliminate from discussion matters which are not pertinent to the aim of the Congress or which are contrary to Council policies, but it cannot accept responsibility for the views expressed either in the papers presented or in the discussions based upon the papers.

NATIONAL SAFETY COUNCIL, INC.

20 North Wacker Drive, Chicago

Occupational Diseases

FRIDAY MORNING SESSION

October 18, 1935

The session was called to order by Mr. W. Dean Keefer, director, Industrial Division, National Safety Council. Dr. C. H. Watson, newly-elected President of The National Safety Council and Medical Director, American Telephone and Telegraph Company, New York City, presided.

Present and Prospective Occupational Disease Legislation

By F. ROBERTSON JONES

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New York, N. Y.

Since the prevention of diseases is, to some degree, a community problem, the state ought to do its part toward the prevention of occupational diseases, along with all others. The public health authorities should study the causes of such diseases, their prevalence, virulence and the means for their prevention. They should advise as to such means of control, and, as a last resort, appeal to legislatures for power to order compliance with their rules. Statutory regulations for prevention, emanating from other sources, such as are common in "labor" or "factory" laws, have too serious drawbacks to be efficient. They are apt to be inflexible and quickly become "out of date"; and they are too apt to be perverted for the establishment of fictitious bases for wasteful and demoralizing damage-suit litigation. Scientific bureaus of occupational hygiene, under direction of public health authorities, are the best public instrumentality. Efficient bureaus of that character are now to be found in several states; but, generally, such public health organizations are inadequately manned and equipped. Therefore the primary need in occupational disease legislation is for measures to improve our public health services.

Emphasis should be placed on prevention, not merely because "an ounce of prevention is worth a pound of cure," but because public measures for the assurance of relief to victims are perilously susceptible of being so perverted that those affected will tend to rely upon and abuse the protection afforded as a substitute for, instead of as a supplement to, means for self-protection.

Expert opinion now calls strongly for the entire elimination of employers' liability for "damages" for occupational injuries—by disease as well as by accident—based upon negligence. That remedy is too uncertain in operation, litigious, demoralizing and wasteful; it furnishes relief to too few of the victims unless it be so liberalized as to be grossly unjust and financially perilous to employers—and thereby harmful to industry and all dependent upon industry.

Losses from ill-health among workmen are primarily subjects for self-providence or for "social insurance"—for "sickness insurance" to help out during brief illnesses, and for "invalidity," "old age" and "widows' and orphans'" insurance where illnesses or infirmities result in long or permanent disability or untimely death. The cost of these insurances against the common misfortunes of life cannot rightly or expediently be imposed wholly upon industry, but needs to be distributed somewhat in proportion to responsibility. And benefits, at a high scale of maximum earnings, as in workmen's compensation, simply cannot be provided for all such workmen's misfortunes. In invalidity, old-age and life insurance, at least, the benefits must be graded, more or less, in proportion to the individual workmen's contributions to the requisite reserves; and the right to benefit must be conditioned upon some minimum number of contributions. It is only for some relatively small proportion of the injuries and physical ills to which workmen are subject that it is reasonable and practicable to impose the full responsibility on industry.

From its beginnings, the workmen's compensation law has covered all injuries to health resulting from occupational accidents. Further it has now, in this country and abroad, been extended to cover many specified diseases, not resulting from accidents, classified as "occupational." And in a few states in this country and Latin America it has been extended indefinitely further to cover "all inclusively" all injuries to health "arising out of and in the course of the employment" or all "occupational diseases," undefined, "arising out of the employment."

In this country there is strong political pressure in favor of this "all inclusive" coverage of injuries by disease based upon the contention that there is no difference in principle between "injuries by accident" and "injuries by disease"; therefore, industry ought to be liable for both classes of injuries on the same terms and conditions. This contention is fallacious. The fundamental principles of the compensation law are that industry shall be held responsible and liable to compensate for the losses from those injuries only which are caused by "trade risks", resulting from employment and which the employer can control; and that the liability for such risks shall be sufficiently well defined as to be insurable at practicable and equitable rates, fixed in advance. The standard compensation laws have been framed to carry out those principles in application to injuries by accident. But the factual conditions relative to injuries by disease are so different from those relative to injuries by accident as to necessitate different treatment.

The crucial difference between accidents and diseases is the time factor. An accident is a sudden event, happening at a definite time and place. Generally the causal relation between the employment and the accident and between the accident and the resulting injury can be traced with reasonable certainty. Generally the employer is automatically identified. And there is a clear-cut event from the date of which time-limits on notices, claims, etc., can be measured. In contrast, many diseases attributable to occupational risks are of slow contraction, and may be of equally slow progress to harmful results. In silicosis there may be an interval of as much as twenty or thirty years between the first exposure and disability or death. In the meantime, many causes for disablement or death, other than the occupational disease may have operated. Often it is a matter of extreme difficulty to determine whether disability or death really has resulted from an occupational disease or from other causes. Medical diagnosis of the mere existence of a particular disease is often uncertain; yet for the proper operation of compensation for occupational diseases it is essential to obtain true medical diagnoses, not merely of the existence of the disease, but also of its causes and consequences.

A further difficulty is that, where the disease is of slow contraction, it may be contracted by a workman under several different employers or insurance carriers. In such cases it is essential for the protection of the workman that some one existent employer or insurance carrier shall be directly liable for the entire compensation. That is a highely vicarious and harsh liability to impose upon an employer or insurer —whether or not accompanied by a right to claim contribution from earlier employers and insurers—and, in all fairness, should be subject to strict limitations.

Moreover there is a difficulty incidental to the provision of new insurance for compensation for such diseases of slow contraction as silicosis. Under such conditions, the liability imposed upon the employer includes a liability for disability or death in the future; in other words, a liability, not merely for future risks but also for the cost of a volume of physical impairments already incurred though the liability therefor is not yet matured. In insurance parlance, these are termed "accrued liabilities." Such accrued liabilities, under a law newly imposing a liability to compensate for silicosis, would, it is estimated, in a state such as New York, aggregate many millions of dollars. This cost is additional to losses from current risks; and how to meet it and how to fix reasonable charges for insuring it is a complex financial problem.

The situation, then, in my opinion, is this: The principle of compensation, regardless of fault, may well be extended to cover those disabling diseases that are characteristic of and peculiar to and have their origin in the occupation or process in which a person is engaged. This would exclude the diseases of ordinary life, and would be applicable only to the specific hazards which arise out of and because of industrial processes and occupations. The provisions for such coverage should be separate and distinct from the provisions of law applicable to compensation for accidental injuries, and these distinctions should be constantly emphasized. The problem of formulating such provisions is relatively simple with reference to those recognized diseases set forth in the older occupational disease laws, since such diseases are reliably diagnosable, of quick contraction and non-progressive. But it is difficult in respect to such progressive diseases of slow contraction as silicosis and asbestosis—now generally regarded as being truly "occupational." Fortunately, however, there are promising models for our guidance in some of the foreign compensation laws, whereas experience under indefinite, "all inclusive" coverage in Connecticut, Massachusetts, Wisconsin and California is helpful with lessons of faults to avoid.

In my opinion, a law for the compensation of occupational diseases should contain provisions to the following effect:

1. Diseases to be made "compensable" should be distinctly specified—by listing in a "schedule" or otherwise. They should include all those diseases, but only those, to be found in the state, which, according to prevailing medical opinion, can be traced, in individual cases, to origins in "trade-risks"—*i. e.*, risks, not of ordinary life, but created by special practices or processes in industrial occupations.

2. There should be a special regime for expert adjudication of medical questions in occupational disease cases.

3. There should be definite periods of exposure required as a condition to the right to compensation for various occupational diseases; the time within which, in order to be compensable, disability or death must follow exposure should be limited; and cases resulting from exposures prior to the effective date of the compensation coverage, or in industries wholly outside the particular state, should be excluded.

4. Prompt notice either of the first manifestation of the disease or of disablement —the time of such event to be determined as a medical question—should be strictly required; and every presumption should be against the validity of a claim not made as promptly as practicable.

5. In case an occupational disease merely aggravates, prolongs or accelerates disability or death due primarily or proximately to a non-occupational disease or infirmity or, above all, to old age, the compensation should be reduced to be proportionate to the degree to which the occupational disease contributes to the disability or accelerates death.

6. The employer, as of the time of the workman's last substantial exposure to hazards of the disease, and the insurance carrier then on the risk should be liable for the entire compensation—with or without right to contribution from earlier employers and insurers. But all such liabilities, whether directly for compensation or for contribution to the compensation payable by others, should be subject to brief time limitations.

7. In incurable diseases, especially silicosis, the obligatory medical benefits should be specially limited in time and kind.

8. In silicosis and other diseases of slow contraction, there should be special provisions for limited compensation to workmen laid off before actual disablement, with the alternative, under some conditions, of waiver of compensation by such workmen for aggravations resulting from being allowed to continue in the hazardous occupation.

9. A law newly imposing liability to compensate for silicosis and other diseases of slow contraction should leave a substantial interval for preparation between the date of its enactment and that when it shall take effect; the compensation for such diseases should be specially reduced and limited below what would otherwise be appropriate until the "accrued liabilities" are worked off.

10. Compensation for occupational diseases should be insurable separately from compensation for accidents; and, in the initial stage, at least, of a regime of compensation for such diseases as silicosis, the rating practices now imposed upon insurance carriers need to be radically modified.

The above program is sound and would be highly conducive to occupational disease prevention. But I am not so confident that it would be safe. The pressure is strong for "liberality" in compensation laws. Merely a few among a large number of probable slight diversions from what I suggest would convert compensation for occupational diseases into indefinite health, old-age and life insurance for workmen in many industries. The cost might ruin the industries, and, at least, would be so considerable as to make the risks "uninsurable," except on the unlimited assessment plan, with all its financial perils and uncertainties.

In regard to prevention, there are still some practices to be decided upon in perfecting a regime of compensation for occupational diseases about which there remains much doubt. For example: Such a regime will practically compel employers, in giving employment, to discriminate against all the ailing or aging—against all except the most healthy and robust. That seems to be desirable in occupations when the occupational disease hazards are great. But is it desirable otherwise?

Again, an ideal common to those of us who emphasize prevention is to require the prompt removal from exposure of workmen manifesting the first symptoms of an occupational disease. But for the elderly or skilled workman the loss of his trade-job may be worse, in every respect, than the danger of continuing his exposure. How then should such cases be defined and treated and how should the law be framed to effect or induce such treatment?

Political impatience is the chief obstacle to a just and equitable settlement of the occupational disease problem. If those thoroughly informed as to this complex subject who have sincerely at heart the welfare of workers could be delegated the authority to devise a solution, some progress might be made. But when political propaganda is injected into the situation there is little chance for an adjustment satisfactory to all concerned. The greatest need today is the divorcement of occupational disease legislation from politics or political considerations.

Some Practical Considerations in Dust Control

By J. J. BLOOMFIELD

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The prevention of occupational diseases due to the inhalation of industrial dust is primarily an engineering problem. Until recently, however, little attention had been devoted to the control of dust, accounting for the paucity of fundamental data on the subject. The consequences of the neglect to furnish adequate protection from dust hazards are now being felt, and the cost is becoming a serious drain on industry. It is now well established that exposure to certain kinds of dust, such as those containing considerable amounts of quartz, has increased the morbidity and mortality rates from respiratory diseases; while metallic dusts, such as lead and its compounds, have been associated with general systemic poisoning of workers. It is obvious, therefore, that any serious attempt to control the dust hazard should, in time, result not only in the improvement of the health of workers, but also be of definite economic benefit to industry.

The benefits of a preventive program in the field of accidents are well known. Industry is fast realizing the need of a similar preventive program with respect to occupational diseases.

Evaluation of the Dust Hazard

The first step in the evaluation of the dust hazard is the determination of the occupational exposure to the dust in question. A typical example of such a study may serve to clarify the methodology involved.

Table 1 shows the various occupations in a granite quarry and the number of workers employed in each occupation. Drillers are the only persons using pneumatic tools, known to produce considerable quantities of dust. In other words, 38 per cent of the quarry personnel are shown to be exposed to a potentially dangerous dust hazard. The occupational analysis at once indicates that the dust investigation

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Table 1—Occupational Classification of Granite Quarriers

Occupation	Number in Each Occupation
Drillers:	
Leyner	17
Plug and jack hammer	37
Other quarry employees:	
Superintendent	1
Foreman	7
Compressor engineer	1
Hoisting engineers	12
Locomotive engineer	1
Locomotive fireman	1
Steam-shovel man	1
Crane operator	1
Derrick men	24
Muckers	24
Blacksmiths	6
Tool boys	2
Water boys	1
Machinists	3
Air-line repairers	1
Pipe fitters	2
Total	142

Table 2—Occupational Dust Exposure of Granite Quarriers

Occupation	Number in each occu-pation	Dust counts in millions of particles per cubic foot of air. Weighted Average
Leyner drillers	17	144.4
Plug and jack-hammer drillers (quarry-hole)	37	112.1
Plug drillers (yard)		36.9
All other workers	88	5.8

should especially concern itself with these workers. The next step involves the determination of the occupational dust exposure. Table 2 shows the results of such a study.

It is apparent in this table that the drillers are exposed to high dust concentrations, especially the Leyner and jackhammer drillers working in the quarry hole. From a further analysis of the occupational dust exposure of drillers it is possible to determine which activities are responsible for the dust. For example, experience has taught us that the various activities comprising the processes of most dusty occupations are usually associated with dissimilar dust exposures. For this reason it is essential to estimate the amount of time spent in each activity in any one occupation and to determine the dust exposure for each. Table 3 shows the results of such a study in the case of a Leyner driller.

It will be seen that a Leyner driller has five different dust exposures. A differential analysis, as presented in Table 3, yields several valuable findings. First, it enables one to obtain a true average dust exposure for workers engaged in the occupation of Leyner drilling. (In this case the weighted average is 144.4 as contrasted with 213.4 million particles per cubic foot found during drilling operations only.) Second, it enables one to determine which activity, or activities, contribute most to the

Table 3—Summary of Dust Exposure of Leyner Drillers in a Granite Quarry

Activity	Average dust exposure in millions of particles per cubic foot of air (a)	Number of hours spent in each activity (b)	Particle-hours in millions per cubic foot (a × b)
Drilling	213.4	4	853.6
Changing drills	9.8	1	9.8
Watching drills	8.0	2	16.0
Broaching	6.0	¾	4.5
Blowing off holes	1,085.0	¼	271.3
Total		8	1,155.2

$$\frac{1{,}155.2 \text{ particle-hours in millions per cubic foot}}{8 \text{ hours}} = 144.4 \text{ million particles per cubic foot}$$

dust hazard. It is evident that the practice of blowing off holes by means of inserting a compressed air line into each hole is attended with a great amount of dust; and though this activity lasts but 15 minutes of the 8-hour working day, it is responsible for 23 per cent of the total dust exposure. It is evident that 23 per cent of the Leyner driller's dust exposure may be at once eliminated by prohibiting this practice. And lastly, such an analysis indicates the necessity for devoting all one's efforts to the removal of dust during the drilling process, since this activity accounts for 74 per cent of the total dust exposure, although a Leyner driller spends but one-half of the working day at his drill.

So far we have dealt with an industry in which the workers, as a rule, do not change their occupation. Often workers have had several occupations, either in the same industry or in several different kinds of establishments. If the worker has been employed in various occupations in the industry, it is a simple matter to determine his total dust exposure in that industry. This is important from the viewpoint of correlating a worker's dust exposure and his clinical condition. A typical example is shown in Table 4.

Table 4—Total Occupational Dust Exposure of an Anthracite Coal Worker

Occupation	Number of years in each occupation	Dust concentration in millions of particles per cubic foot	Millions of particle-years per cubic foot
Slate picker	2	380	700
Patcher	2	71	142
Mule driver	3	71	213
Miner's laborer	3	480	1,440
Miner	15	480	7,200
Section foreman	5	7	35
Total	30		9,790

$$\frac{9{,}790 \text{ millions of particle-years per cubic foot}}{30 \text{ years}} = 326 \text{ millions of particles per cubic foot}$$

In Table 4 the worker's occupations are arranged in the order of employment, the last one being his present occupation. It is obvious that had one considered this occupation only, the dust exposure would not have yielded a true state of affairs, nor would it have been possible to correlate this dust exposure with the man's clinical picture. In the above technic, correct weight is given to the number of years spent in each occupation and the dust exposure associated with each. Only by such an analysis is it possible to arrive at a fair estimate of a worker's dust exposure and his proper disposition. Such an analysis is justified by the fact that results obtained with this technic yield excellent correlations with the clinico-roentgenological studies conducted on anthracite coal miners.[2]

It is thus apparent that there is more to engineering dust surveys than the taking of dust samples and their analysis. Owing to the fact that the making of dust studies is rapidly being adopted in industry, it has seemed necessary to emphasize the important factors in such investigations. Although the making of dust counts, *per se*, is not a difficult procedure, the collection of dust samples in industry and their proper interpretation should be done by a thoroughly trained investigator. The examples just given show the value of this technic in the subsequent steps to be taken in the control of the industrial dust hazard.

General Dust Control Methods

The selection of any method of dust suppression will depend primarily upon its effectiveness in reducing a given hazard and its adaptability. A large percentage of reduction in dust does not necessarily indicate that the method used is efficient, unless the reduction has actually been sufficient to bring the exposure below the safe limit, and does not interfere with the industrial operations involved. In general, there are four methods of dust control: (1) substitution of nondust-producing or harmless substances; (2) isolation of the dusty operation; (3) wetting the dust at its source; (4) local exhaust ventilation. These methods may be supplemented by personal respiratory protection.

The first method has a limited application. One example is the use of a non-silica parting compound for a silica compound in connection with the making of foundry molds. Table 5 shows that although the use of parting compound, in this particular study, only necessitated an exposure of 54 minutes of the 540 minutes of a molder's work day (10 per cent), actually this activity accounted for approximately 58 per cent of the molder's total exposure. It is obvious that the employment of a parting compound, which is not as harmful as one composed of free silica, will lessen the dust hazard in this instance to a considerable extent.

Table 5—Dust Exposure of Molders

Activity	Time of Exposure in minutes (a)	Average Dust Exposure in Millions of Particles per Cubic Foot (b)	Particle-Minutes in Millions (a × b)
Use of Parting Compound........	54	63.8	3,445
Remaining tasks in molding.......	412	4.4	1,813
Pouring	58	3.1	180
Dumping molds ("shake-out")....	16	32.5	520
Total......................	540	....	5,958

$$\frac{\text{5958 million particle-minutes}}{\text{540 minutes}} = \text{11.0 million particles (per cu. ft.)}$$

In the case of abrasive cleaning with steel instead of sand, we have the example of the substitution of a substance involving a lesser dust exposure as well as the use of a material not as toxic as sand.[3] Table 6 shows the improvement effected by this type of substitution. Not only is the dust concentration reduced from an average of 969 to 155 million particles per cubic foot, but the potential exposure to quartz dust is diminished from 42-99 to 3 per cent.

Table [illegible]

Type of Abrasive	Average dust concentration in millions of particles per cubic foot	Percentage of Quartz
Sand	969	42-98
Steel	155	3

The second method of dust control, isolating the dusty process, possesses many possibilities, but unfortunately is not widely used. The theory underlying isolation is to concentrate the dust sources to one locality or to a single closed space. *In this* way, a minimum number of employees are exposed. At present, many foundries, during shake-out expose workers who normally are engaged in occupations with low dust concentrations. Thus, molders in a foundry may be exposed to a dust concentration of 3 million particles per cubic foot under normal occupational conditions, but when shake-out operations are carried on close by, their exposure may be increased to more than 50 million. The same condition exists when annealing flasks containing ground slag are emptied in malleable iron foundries, exposing grinders and tumbling barrel attendants at work close by.

Perhaps the best example of isolation of a dusty process is the abrasive cleaning room. This completely encloses a hazardous process and exposes only the blaster who is generally equipped with a protective helmet. The room is also exhausted, which further reduces the dust concentration. Processes which are isolated require good ventilation. Other examples of isolation are the automatic turntable for abrasive cleaning, tumbling barrels, and batch-mixing rooms found in some pottery establishments.

The third method, perhaps the oldest known, is the practice of wetting the dust at its source. In Table 7 an example is depicted in connection with the drilling and loading of rock in anthracite coal mine operations.[3] It is apparent that a tremendous reduction in dust has been effected by this method. However, as already pointed out, unless a particular method is attendant with a reduction of the dust to a safe limit, it cannot be considered successful. In the present instance, the workers engaged in drilling are still exposed to unsafe concentrations of a highly dangerous dust and the more positive method of controlling the dust in drilling operations by dust traps would be indicated. For drilling and loading operations involving an exposure to dusts less toxic than those containing high amounts of free silica, as in the case of coal or certain talcs, the reduction shown by the use of wet methods may be considered effective.

Table 7—Contrasting "Wet" and "Dry" Methods of Rock Drilling and Loading

Processes	No. of Samples	Average dust count in millions of particles per cubic foot "Dry"	"Wet"
Drilling	23	568	33
Loading	10	636	32

The fourth method—exhaust ventilation—is perhaps the most effective, and one with the widest application. We cannot discuss here the details of the theory and design of local exhaust systems, except to point out there is a real need for more fundamental studies of the type conducted by DallaValle with reference to the design of local exhaust hoods, which he has presented in Public Health Bulletin 217. The work of Hatch and his colleagues[4] on the control of the silicosis hazard in the hard rock industries is another example of a scientific approach to the dust elimination problem.

Table 8—[illegible] of Results [illegible] Exposure of Mine Workers Under Controlled and Uncontrolled Working Conditions

Operation	Dust Concentration in millions of particles per cubic foot of air: Controlled	Uncontrolled	Remarks
Firing charge	46	834	Unless at least 15 minutes elapsed after firing a charge, miners found to be exposed to high dust concentrations.
Loading coal or rock..	32	636	By wetting the loaded material the dust count is reduced as shown.
Loading coal	4-26	291-1138*	Mechanical loading decreases the dust exposure as indicated.
Drilling	33	568	Wet drilling is effective in reducing the dust concentration. Further reduction would necessitate exhaust ventilation.
Hauling coal in mines.	1.2	17	Wetting coal and empty cars reduces dust in haulageways.
Preparation of coal...	24	380	Wet breakers reduce dust counts as shown.

* The lower result is associated with the hand loading of wet coal while the higher average is based on the hand loading of dry coal.

It is apparent that there are no set rules for the mechanical protection of workers from the industrial dust hazard. Specific conditions in an industry, or a plant, will determine the type of protection to be employed. The present discussion has emphasized the importance of approaching the problem from the standpoint of the occupational exposure. Studies in representative plants of an industry often reveal the various methods which may be employed in controlling the dust hazard. The following two examples indicate the value of such investigations.

Table 8 indicates the various control measures which were found in use in the anthracite coal mines investigated in the study referred to earlier. Although no single mine practiced all of the control measures shown in this table, by an occupational study in several representative mines it was possible to show that methods are not known and practiced for the elimination of the dust hazard in this industry.

Another example is indicated in the results of a study now in progress in connection with mercurialism among workers in the hatters' fur cutting industry. Table 9 shows the exposure to mercury dust and vapor of some of the workers in this industry

Table 9—Exposure of Hatters' Fur Workers to Mercury Dust and Vapor Under Controlled and Uncontrolled Conditions

Occupation	Total Mercury Exposure in Milligrams per 10 cubic meters: Uncontrolled	Controlled	Method of Control
Blowers	4.6	..	None practiced
Shippers	7.2	..	" "
Cutters	4.0	1.8	Local exhaust ventilation
Sorters	3.8	1.7	"
Brushers	3.1	1.2	"
Drummers	2.5	0.6	Segregation
Clippers	1.5	0.7	"

under controlled and uncontrolled working conditions. It is apparent that where some measure of control is practiced by such methods as segregation or local exhaust ventilation, a material reduction in the exposure to mercury has been effected. It is our belief that in the case of the blowers' exposure, a reduction may be effected by mechanical enclosure and local exhaust ventilation, and that the shippers' exposure to mercury vapor may be lessened by a general system of ventilation sufficient to change the air in the store room frequently enough to bring the mercury concentration to a lower level. Unfortunately, in the present investigation, it has been impossible to find a plant in which an attempt has been made to reduce the exposure for these two occupations.

In some dusty occupations the methods of controlling dust have not been developed. In fact, operations such as removing the cores from very large foundry castings, sand-blasting, handling of used storage battery plates, paint chipping, and cadmium oxide manufacture appear to offer no practical means of adequately controlling the dust generated. In such cases, it is therefore necessary to furnish the worker with personal respiratory protection devices to prevent his exposure to the harmful effects of the dusts present. These devices consist of various types of respirators, masks, and helmets.

It is important to hold in mind the limited use of personal protection devices. Because a worker cannot with comfort wear a mask or helmet continuously, such devices must be employed intermittently. Their use is generally extended to those operations where all other methods have failed or supplementary to them, as in storage battery repair where the exposure to small amounts of lead breathed is known to be detrimental to health.

It should be pointed out that the U. S. Bureau of Mines is equipped to conduct approval tests of respirators used for protection against various dusts and fumes (Schedule 21). These tests are conducted against the dust for which the device is to be used and are rated, not on an efficiency basis, but on the quantity of dust which actually passes the respirator. The results of a study of masks or helmets of the positive pressure type, made during the sandblast investigation conducted several years ago by the Public Health Service in cooperation with the National Safety Council,[7] showed that the only practical safeguard to the worker inside the sand-blast room was to provide him with a mask or helmet of the positive pressure type. In studying the efficiency of such devices it was found that a relationship existed between the amount of air supplied to the helmet and the concentration of dust inside the helmet during blasting. To determine the optimum air volume to be supplied to such protective devices, it was necessary to obtain dust samples from inside the helmet while varying the air volume, at the same time maintaining the dust concentration in the sandblast room (outside the helmet) constant. The positive supply of 6 cu. ft. of dust-free air per minute will protect a worker under the operating conditions now in practice in sand-blast rooms. The ultimate criterion of protection, however, is the result of dust determinations of the air within the helmet, that is, the air actually breathed by the worker and not the volume of air supplied.

Too much emphasis cannot be stressed on the necessity of maintaining in good order the personal respiratory devices for the protection of the worker against various toxic dusts. Maintenance of exhaust ventilation systems, and other types of protective equipment, should be a rule in industry rather than an exception. Too often the term "good housekeeping" has been interpreted as signifying only the periodic removal of dust collected on floors, rafters, etc. Although such practice contributes to the general state of cleanliness of a workroom and should always be in force, the time has surely come when serious attention should be given to the installation and rigid maintenance of all types of dust control devices. In every plant there should be some responsible individual charged with the periodic inspection of all workrooms as to sanitation, ventilation, and maintenance of all dust removal and other protective devices. Perhaps the best criterion of the effectiveness of these devices is the periodic determination of the dust content of the air at the workers' breathing zone. Only by constant vigilance and an approach to the problem as outlined in this paper may one hope to make progress in the control of the dust hazard in industry.

Often the benefits of even a most extensive program of dust control are not immediately realized. This is especially true in dealing with fibrosis-producing dusts in plants where some of the workmen have already inhaled sufficient quantities to here

[illegible] mercury [illegible] (or an equivalent reduction in mortality), [illegible] per year per 1,000 employees. And this estimate [illegible] considerably below the average, in which there are [illegible] hazards. In plants where hazards are known to exist [illegible] of this conservative estimate. When one realizes [illegible] approximately 15 millions of workers engaged in manu-[illegible] industries, then it is evident that the magnitude of the problem has not been overemphasized.

References

1. Bloomfield, J. J. and Dreessen, W. C.: Silicosis among granite quarriers. Public Health Reports, Vol. 49, No. 23, June 8, 1934.

2. Anthraco-Silicosis among hard coal miners. Public Health Bulletin No. 221, 1935.

3. Bloomfield, J. J., and Greenburg, Leonard: Sand and metallic abrasive blasting as an industrial health hazard. Jour. Ind. Hyg., vol. 15, no. 4, July, 1933.

4. Hatch, Theodore, Drinker, Philip, and Choate, Sarah P.: Control of the silicosis hazard in the hard-rock industries. I. A laboratory study of the design of dust control systems for use with pneumatic granite cutting tools. Jour. Ind. Hyg., vol. 12, no. 3, March, 1930.

Hatch, Theodore, Kelley, George S., and Fehnel, J. W.: Control of the silicosis hazard in the hard-rock industries. II. An investigation of the Kelley dust trap for use with pneumatic rock drills of the "Jack-hammer" type. Jour. Ind. Hyg., vol. 14, no. 2, February, 1932.

Hatch, Theodore, Warren, Henry, and Kelley, George S.: Control of the silicosis hazard in the hard-rock industries. III. Design and operation of a dust-control system for use with pneumatic rock drills in open excavation. Jour. Ind. Hyg., vol. 14, no. 7, September, 1932.

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Silicosis and Silico-Tuberculosis
Medical Problems of an Important Industrial Disease

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A hidden element of the cost of production is industrial disease. Industry has reached a stage beyond the concern only of wages and hours. Far more important is conservation of man power by preventive medicine and improved engineering. Disease preventive measures are not a cost, but, in the long run, a great economic saving.

Incidence. In the United States it has been computed that there are from 500,000 to a 1,000,000 people employed in occupations where a silicosis hazard exists. In New York City there are about 65,000 such employees. In a representative group of granite workers in Massachusetts silicosis alone was present in about 15 per cent and silicosis complicated with tuberculosis in almost 8 per cent. Tuberculosis was the cause of death in over one-third of the granite workers which is four times the incidence for males of 20 years and over in this country. In foundry men studied in Massachusetts, silicosis was less frequent (about 9 per cent) and less advanced in degree than in granite workers. The duration of exposure in foundry workers with pneumonoconiosis has averaged many more years than that required to produce silicosis in an industry such as gold mining. The tuberculosis hazard in foundries is nearly as great as that reported for some of the other dusty trades, but the figures are much lower than those of miners of gold, silver, copper and lead, among whom the mortality from tuberculosis is 8 to 18 times the general expectancy. Death rates for all non-tuberculous infections have been reported higher among workers in siliceous dusts than in the general population. It is suggested that the worker in silica succumbs more often to acute pulmonary infections rather than surviving the chronic fibrosis.

Silicosis is defined as a pathologic condition of the lungs due to the inhalation of silica, whether free or combined in such a state as to be capable of setting up its characteristic pathogenic effects. The principal factors that determine the incidence of silicosis are (1) the percentage of free silica in the inhaled dust; (2) the concentration of silica particles less than 10 micra in diameter in the atmosphere; (3) the duration of exposure to the dust, and (4) the susceptibility of the individual exposed as modified by age, complicating infections, etc. The occupational disease resulting from such inhalation has been defined as "morbid results of occupational activity traceable to specific causes or labor conditions and followed by more or less extended incapacity for work."

Metabolism of Silica. Significant amounts of silica are present in all body tissues and fluids. It enters the body through the digestive tract and the lungs. Most of that entering the stomach is eliminated in the stools, but a fairly large amount is absorbed into the blood as shown by the constant excretion of silica in the urine. All vegetable foods contain silicon especially the hulls of grains, hay and straw. The low silica content of the liver, spleen and kidneys indicates the little retention of the absorbed silica in the body. Silica content of the urine of animals may be influenced at will by diet. The body possesses a very efficient mechanism for the disposal of silica because of the low kidney threshhold. Silica entering the lungs in particulate form is expectorated in part with its enveloping cells, but most of it is carried into the pulmonary lymph channels. Many such particles reach the lymph nodes and even the spleen by way of the blood. The finest particles however, may be dissolved in alkaline body fluids and carried away in solution, to be excreted in the urine. There may be a constant drainage of silica from the lung through the inhalation of extremely fine particles of silica in dusty atmospheres, so small that they are not seen under the microscope.

Attempts to influence the absorption of silica from the lungs by administration of alkali have been inconclusive. Elimination of silica by way of the sputum from patients having deposits of silica in their lungs appears to be higher than those having no history of exposure to dust. Only small amounts of silica are in the blood and this level is little different in normals than in silicotics.

Pathology. This disease is essentially a fibrosis of the lungs developing especially in such industries as hard-rock metal mining, granite cutting, metal grinding and sand-blasting. The pathological changes are believed to result from two causes, a blocking of the lung lymphatics by mononuclear cells laden with dust in addition to the action of colloidal silica, the exact nature of which is in doubt. The small particles under 10 micra are the only ones capable of penetrating the lung tissue.

Although silica plays the dominant role in the production of silicosis, the admixture of other dusts tends to modify the pathological changes in the lungs so that these resemble then those of other forms of dust inhalation, and the modification bears some relation to the percentage of free silica in the mixture. Silicates, as in asbestos, produce a definite change in the lung, as well as other dusts such as marble, coal, etc. Such changes are represented by a fibrosis brought about because relatively insoluble minute particles of minerals in sufficient concentration have been brought by the activity of phagocytic cells into intimate contact with the pulmonary connective tissue. This fibrosis is a diffuse cellular one that occurs in the walls of the smaller bronchi and of all their finer divisions and extends to involve the supporting connective tissue of the adjacent blood vessels and to some extent also the walls of adjacent air spaces. However, when the great majority of the inhaled particles are composed of or contain silica, there develops, in addition, a specific and localized type of fibrosis called the silicotic nodule—an orderly whorled arrangement of cells and fibres, and with sharp definition from the adjacent parenchyma. Many dusts create a generalized fibrosis but only one, namely one combined with silicon dioxide produces the special fibrosis of silicosis. Sericite, known as white mica, which is a hydrated silicate of aluminum and potassium, has not produced in animal experiments the silicotic nodule, but instead generalized fibrosis resulted.

Dusts must be differentiated into those which are *chemically active* and those which are inert when inhaled into the respiratory tract. Silica is a chemically active dust which must necessarily be *soluble* to a degree in the body fluids and its activity depends on its solubility. This activity which is manifested in the areas where dust particles are carried along the lymph stream by phagocytes, causes lesions of two types, "toxic" and "sclerotic," both of which have been reproduced experimentally. Toxic lesions depend upon local necrosis and [illegible] and appear to favor the growth of tubercle bacilli; the sclerotic lesions produce the nodular fibrosis. The inert dusts are insoluble in body fluids and cannot exert chemical action in the lung tissue, but if they accumulate to a marked extent their effect is mechanical which may lead to a certain amount of diffuse fibrosis around the dust deposits. Certain dusts, such as carbon, may have physical effects, they may adsorb toxic substances and it has been suggested that on this basis there is a relatively lower incidence of active clinical tuberculosis in silico-anthracotics than in silicotic lungs.

Other dusts may even protect, as in the case of certain clays, gypsum and aluminum oxide. Pure pneumonoconiosis may be only a laboratory disease, as the pulmonary fibrosis of workers in dusty trades probably results from the combined action of dust and infection, whether it be tuberculous or not.

In silicosis it is not the mineral particles that are breathed in during life that record the cause of disease, but the particles that have been dissolved. Risk to work, efficiency and health may be greatly accentuated through the inhalation of finely divided particles even of a chemically inactive dust when there has occurred a lymph stasis which is known to follow exposure to silica. This lymphatic blockage leads to retention and accumulation of the inert dust. In soft coal miners who get what is called "miner's asthma" we have this accumulation of carbon. Such patients are very liable to have a high incidence of bronchitis with mechanical and physical changes due to retention of anthracotic dust. Furthermore, unequivocal cases of silicosis, with or without tuberculosis, can no longer be doubted.

Tuberculosis. Most apical tuberculosis is acquired before the age of 25 and so silicosis at the age of 30 makes a previous tuberculosis more serious. Most workers with tuberculosis going into the mines before the age of 30 die of tuberculosis by the age of 45. The silicotic develops a sputum that contains tubercle bacilli late in life and the children who are contacts with tubercular silicotics develop very little clinical tuberculosis. It is impossible to say definitely that tuberculosis engrafts itself upon the silicotic or vice versa, for we see apical tuberculosis in silicosis that spreads downward, while other silicotics show only the tuberculosis in the lower lobes. It has been found that most silicotics die of tuberculosis.

The diagnosis of silicosis is made primarily on two findings, the proper history of occupational exposure to siliceous dust and the presence of abnormal shadows on the pulmonary X-ray. The physical examination and the patient's symptoms are of less value. There are other diagnostic aids such as the finding of large quantities of silica particles in the sputum, quantitative determinations of silica in urine, and at post mortem, chemical analyses of the lung ash supplemented by petrographic examination, roentgen-ray spectrum analysis and special incinerating studies of lung tissue. We must at times rely on the pathologist to determine the amount and distribution of fibrosis due to silica and from microscopic studies give an opinion on the importance of this fibrosis as the ultimate cause of disease and death.

Lung fibrosis may be present without any silica. Silica may be present in lung tissue or the pulmonary lymph channels without associated fibrosis. Finely divided siliceous particles from lung tissue may contain innocuous silicate which cannot be distinguished from harmful silica particles. Hydrated silica which is not doubly refractive cannot be demonstrated with prisms. Therefore in the pathological section the presence of siliceous fibrosis can be suspected but cannot be specifically identified with the siliceous material that it may contain. Accordingly the microincineration method of Irwin with hydrochloric acid is now included in the microscopic examination of any lung as a means toward a surer diagnosis.

Diagnostic difficulties in clinical medicine may be more obvious if we examine first the occupational history. Quartz grinders working under conditions of massive exposure may develop silicosis in acute form even in a period of months, whereas in other occupations it may take 25 years. Workers in the same industry, indeed in the same room, experience different degrees of exposure dependent upon perhaps the dust-filtering capacity of the nose and functional condition of the lung as determined by constitutional characteristics and antecedent disease. The size and colloidal structure of the particles of silica, as well as the dosage and total amount of silica, will influence the rate of development of the disease. Apparently particles that are larger than 10 micra are not phagocytosed in the lung. So a definite history of exposure must be established and in general hospitals where patients are migratory, conditions under which they worked are very vaguely described and there are not available data on dust counts and silica concentration, so that the history is often misleading.

As to symptoms, patients can perform strenuous labor despite extensive disease and the symptoms of dyspnea and cough are common to many diseases. Fever is absent unless infection occurs, but most important is the great disproportion between a patient's complaints and what is seen on the X-ray, the latter showing extensive abnormal shadows in comparison with the symptoms.

On physical examination, extensive disease may be present and few abnormal physical signs. The physical signs are merely those of a general pulmonary fibrosis with emphysema, such as restriction of costal and diaphragmatic movement, diminution of or intensified breath sounds and a hyperresonant note. Rales are usually absent unless infection is present.

As to the *X-ray*, there are 3 essential types of shadows described, linear strands, small discrete shadows, and homogeneous shadows of varying sizes; these correspond to the fibrous strands, silicotic nodules, and the conglomerate masses of fibrosis. The nodular shadows are usually characteristically around the hilum, or conglomerate nodular shadows of bat-wing appearance extend into both upper lung fields, or nodular shadows may be distributed in the upper two-thirds of the lung fields, perhaps more pronounced on the right side, with the lower third kept clear by emphysema. With infection present, the shadows are less sharp or the linear strands interconnect or fuse. Large conglomerate shadows appearing out from the hilum leaving the periphery of the lung clear throughout because of emphysema. The distribution of some of these lesions may be determined by the posture assumed by the workers, and infection may likewise determine an ultimate atypical distribution. Many variations from these patterns are seen in the X-ray, especially under excessive exposure or when other dusts are inhaled, or in the presence of infection. It is probable that the main source of the diagnostic difficulties is caused by the emphysema which muffles the physical signs and is respon-with emphysema, such as restriction of costal and diaphragmatic movement, diminusible in great part for the absence of symptoms. It may blot out, even on X-ray, the silicotic lesions of fine size. Examples of such difficulties in diagnosis as encountered by us are the following:

Case I—Mr. T. A forty-five year old man entered the New York hospital complaining of mild cough and expectoration of four months' duration. He appeared acutely ill, his fever was 103 degrees and respiration 28. Rales were elicited over the upper half of both sides of the chest. Examination of his eye grounds revealed bilateral retinal tubercles: his sputum contained numerous acid-fast organisms. The X-ray revealed fine mottled shadows distributed throughout both lung fields and a small cavity at the left apex. A diagnosis of miliary tuberculosis was made. However, after one weeks' stay in the hospital, his temperature and pulse returned to normal and during the following month he gained 18 pounds. The signs in his chest now became confined to the left apex. In view of his unusual progress the diagnosis of miliary tuberculosis was doubted. His occupational history revealed that up until three years before entrance to the hospital he had worked for 20 years polishing leather on a sandpaper wheel. There were numerous machines in the work room and no precautions were observed to clear the very dusty air. His sputum was examined through the kindness of Dr. Burke of Raybrook, N. Y. who found it laden with numerous doubly refractile silica particles. He expressed the opinion that this was consistent with silicosis for he had found such numerous particles only in cases of silicosis. The patient subsequently died of a tuberculous meningitis. Retinal tubercles were demonstrated on microscopic section. The pathologist's report was miliary tuberculosis. Ashing of the lung showed increased silica content, consistent with undue exposure to dust (more than 2 mgm. silica per gram dried tissue).

Case II—Mr. R., aged 54, entered the New York hospital complaining of hemoptyses, dyspnea and chest pain. On physical examination there were rales and dullness over the upper third of the right chest anteriorly. He ran a low grade fever but was robust and felt quite well. The chest X-ray disclosed enlarged hilum shadows, particularly on the right, and diffuse mottled discrete shadows throughout both lung fields with a circumscribed density near the right apex. He gave a history of having worked for [illegible] years as a cutter and sizer of [illegible] paper box boards. The rooms were in a continuous cloud of dust. Examination of the dust revealed 3 per cent silica content. The hemoptysis, we felt, was to be explained on the basis of infection or neoplasm, but we did not know whether we were dealing with one of these processes alone or an associated silicosis or [illegible]. A small nodule in the neck was subsequently removed and showed carcinoma. We are inclined to believe that this does not explain the whole process, as the man is still alive and certainly, from the X-ray standpoint, we cannot say that there is no silicosis.

Case III—Mr. C. A dish-washer, aged 46, entered Bellevue hospital because of cough and expectoration, associated with dyspnea. There was some dullness and rales at the right base posteriorly. Chest X-ray revealed a homogeneous shadow at the right base. His sputum contained no tubercle bacilli and lipiodol study revealed no abnormalities. Bronchoscopic examination disclosed a bleeding mass in right main bronchus. Symptoms and disease progressed during the following four years. Discrete mottled shadows first appeared in the upper right lung field and the shadow at the right base cleared somewhat. Three years later extensive abnormal shadows were present throughout both lung fields, particularly on the right. Diagnosis of chronic penumonia of unknown etiology was made. At no time was a diagnosis of silicosis entertained, because as far as could be determined he had no history of exposure. Furthermore if there were silicosis it behaved very atypically having the lesion confined practically to the right base at the beginning and then spreading to the left lung. Autopsy however, revealed a typical silicosis associated with a small degree of tuberculosis. A picture of the lung showed how much more extensive the silicotic process was in the right lung. There was stenosis of the right middle lobe bronchus with bronchiectasis in this lobe. Chronic infection in the lung field probably accounted for the unusual localization. This case illustrates how necessary it is to have the history of dust exposure for without it here we are unable to even suggest a diagnosis.

Case IV—Mr. C., aged 45, complained of cough and dyspnea with slight expectoration and gave a history of having worked for many years repairing tires, using talc powder. It was difficult to obtain accurate details as to the possibility of silica exposure except that the rooms were filled with clouds of dust. Rales were present at both apices and a few tubercle bacilli were found in the sputum. Discrete and stringy shadows were disseminated throughout both lung fields. We know from the positive sputum that tuberculosis is present. The patient has, however, been well for a period of two years. The doubtful history of exposure together with the numerous discrete nodular shadows in his lung, which are consistent with silicosis, makes this patient a problem. Is this tuberculosis alone or is this tuberculosis with silicosis? The patient is still living a year later and working.

Conclusion. Cases such as these are exceptional, but their existence must always be borne in mind. If occupational history is inadequate and X-ray, clinical and laboratory studies prove misleading, the diagnosis may present great difficulty. However, a comprehensive study of all possible data usually clears up the problem with reasonable certainty.

ADJOURNMENT

Dust Hazards in the Quarry Industry

By J. WM. FEHNEL

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Quarrying is a special type of mining, the methods of working are the same in some instances. While hazards in quarrying and mining have been recognized and standards of operation adopted for their elimination, the health hazards have not received great notice. This is probably due to their slow progress in producing disability or death.

The oldest published data on the harmfulness of exposure to dust deals with the mining industry. Some of the records date back before Christ, and as early as 1556 Agricola[1], according to Mavrogordato[2], in his De Re Metallica, described the perilous occupation of miners due to inhalation of dust and pointed out that permanent injury to the lungs resulted from exposure to certain kinds of dust, but not to all kinds.

In 1780 Ackerman[3], quoted by Koelsch, described miners phthisis as the most "frequent and specific" mine workers' disease and said that physicians did not agree regarding the true definition of it.

The first investigation of health hazards in the mining industry in the United States was made in 1914-15 by the United States Bureau of Mines in cooperation with the U. S. Public Health Service in the Joplin, Mo. mining district. Of 93 men examined, 64 showed definite evidence of pulmonary disease, 3 were suffering from non-pulmonary disease, and 26 were seemingly well. A further examination of 720 miners made from May 15 to December 31, 1915 showed that 45.7 per cent had silicosis and tuberculosis and 5.3 per cent had tuberculosis. A report in 1917[5] on this study by Lanza and Childs contained the first detailed X-ray studies of silicosis made in the United States. The operations in this district are principally in shallow mines.

A recent study by the United States Public Health Service[6] of the exposure to dust in coal mining showed that 2 per cent of anthracite miners and their helpers, with less than five years exposure, showed signs of pneumoniconiosis and that the rate increased to 16 per cent among those with more than fifteen years exposure. These are records for persons under 45 years of age.

Kibbey[7] reported in 1931 that practically all miners working in the bituminous coal mines of his company in Alabama had anthracosis demonstrated by X-ray and there was a high mortality rate from tuberculosis among them. Kibbey does not associate the tuberculosis to inhaied coal dust but rather to a retarded calcium metabolism due to deprivation of sunlight.

The Industrial Health section of the Metropolitan Life Insurance Company, in cooperation with the Department of Industrial Hygiene of the College of Physicians and Surgeons of Columbia University and the New York Tuberculosis and Health Association, undertook during 1928 a study[8] of the rock dusts to which are exposed rock drillers and other hard rock workers engaged in excavation and subway construction in the Borough of Manhattan, New York City. Forty-two per cent showed

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[1] Agricola, Georgius. De Re Metallica: Book I. Trans. from first Latin ed. of 1556 by Herbert Clark Hoover and Lou Henry Hoover, 1912, p. 6.

[2] Mavrogordato, M., The Etiology of Silicosis. Rept. 4th Meeting of Permanent Internat Commission for the Study of Occupational Diseases, Lyon, April 3-6, 1929, pp. 1-22.

[3] Koelsch, Franz. Theophrastus von Hohenheim, called Paracelsus. Of the Miners' Consumption and Other Miners' Diseases. Deut. Gesell. Gewerbehyg., N. F. 12. 1925, 69 pp.

[4] Lanza, A. J., and Higgins, Edwin, Pulmonary Disease Among Miners of the Joplin District, Mo. and Its Relation to Rock Dust in the Mines, Technical Paper 105, Bureau of Mines, 1915.

[5] Lanza, A. J. and Childs, Samuel B. Miners' Consumption: A Study of the Disease Among Zinc Miners in Southwestern Missouri, U. S. Public Health Bulletin #85, 1917.

[6] U. S. Public Health Service. Treasury Dept., Public Health Bulletin #208, The Health of Workers in the Dusty Trades, III. Exposure to Dust in Coal Mining, 1933, pp. 7-19.

[7] Kibbey, C. H., Relative Pneumonia Fatality Among Surface Workers and Miners, American Journal of Public Health, Vol. 22, No. 4, 1932, pp. 360-366.

[8] Smith, Adelaide Ross, and Fehnel, J. Wm., Silicosis Among Rock Drillers, Blasters, and Excavators in New York City, Journal of Industrial Hygiene, Vol. XI, No. 2, Feb. 1929.

early silicosis and 15 per cent well developed silicosis in the examination of 208 drillers, blasters and excavators. Evidence of tuberculosis, both active and inactive, was found in 9 per cent of the total examined. The great majority of these workers had previously worked in other mining operations, both coal and metal.

Atmospheric dust samples were taken at eight locations, six of which were building foundation excavations and two in subway construction work. The building foundation work is comparable with quarry operations as far as general methods are concerned, but the area is more confined, so that the dust concentrations may be higher.

The dust counts on dry jackhamer drilling varied from 53 million to 17.5 billion particles, less than 10 microns in greatest diameter, per cubic foot of air, and the free silica of the rock ran from 0 per cent to 84 per cent. In many instances, workmen engaged at other operations than drilling were exposed to high dust concentrations, as general air samples taken show from 16 to 200 million dust particles per cubic foot of air.

In subway tunnel work general air conditions ranged from 2 to 37 million, mucking from 4 to 270 million and water Leyners drilling at headings from 136 million to 2 billion. The tests on wet drilling were made at two different locations and were taken while 5 wet drills were operating.

So far we have only mentioned dust concentrations and free silica, so it is interesting to note the comparison of particle sizes found with dry and wet drilling. In the one tunnel there was little seepage of water, so that the workings were dry and the particles of dust generated by wet drilling showed 96 per cent less than 10 microns in size, 75 per cent less than 5 microns and 50 per cent less than 3 microns.

In the other tunnel there was an excess seepage, necessitating the wearing of boots and the constant operation of pumps. Here the dust generated at the heading by the same number of wet drills showed 99 per cent less than 10 microns, 98 per cent less than 5 microns and 50 per cent less and 1.7 microns. In comparison, the particle sizes found in the dust generated by dry drilling with a jackhamer showed 95 per cent less than 10 microns, 65 per cent less than 5 microns and 50 per cent less than 4 microns.

Later tests substantiated the conclusions that wet drilling did not allay the extremely fine dust but did substantially lower the total count. In a test conducted in October, 1931 in a tunnel in the Bronx, New York City, seven CPS type axial water feed drifters were mounted on two benches at the heading with five on the upper and two on the lower bench. A water pressure of 75 pounds was maintained and the drilling rate was 100 feet per drill in five hours. The dust concentration averaged 47.5 million particles per cubic foot over a 30-minute period of sampling.

In a study of underground iron ore mining comparisons were made of wet and dry methods of drilling and it was found that the reduction of dust was ten to one. While this appears to be a long step toward the solution of the dust problem in drilling, nevertheless when we consider that concentration as high as 5 and 6 billion particles were found, reduction to one-tenth of this concentration by wet drilling is not sufficient, especially when a considerable amount of free silica is present.

The Ministry of Health of the Welsh Board of Health published a report[9] on an Investigation Into the Alleged High Mortality Rate from Tuberculosis of the Respiratory System among Slate Quarrymen and Slate Workers in the Gwyrfar Rural District, in which a thorough investigation of working conditions in the quarries and cutting sheds was made and living conditions noted. Physical and X-ray examinations were made and the incidence of tuberculosis and mortality statistics compared for various types of occupations. Unfortunately, no determinations of dust concentrations of the atmospheres to which the workmen were exposed was made, nor were determinations of the chemical or petrographical composition of these dusts made. It was noted that the mortality curve for tuberculosis reached its maximum at a late age and it was concluded that:

1. The workers in the slate sheds are exposed to an injurious dust.
2. The dust concentrations are not very great and the workers and quarry managers, together with the local medical men, do not consider the inhalation of the slate dust to be injurious.

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[9] H. M. Stationery Office, London. 1927, Ministry of Health, Welsh Board of Health, Reports on Public Health and Medical Subjects No. 38.

3. The living conditions are not responsible for the high death rate from tuberculosis in this district.

A report by Rogers [10] in the New England Journal of Medicine in August, 1932 indicates that slate dust may contain a higher percentage of free silica than granite, but the tuberculosis rate is not as high in the slate as in the granite district of Vermont.

While we have made many comparative studies of mining operations, in underground work and also some comparisons with open cut or typically quarrying operations, we have found that general ventilation plays a very important part in the control of the dust concentration.

For instance, we found that dust concentrations as high as 6 billion particles per cubic foot were commonly encountered in drilling underground and we encountered in comparison the following dust conditions in quarry work:

Type of Rock	Quarry Operations Drilling	Dust Concentrations
Limestone	Jackhamer	29.5 million particles, less than 10 microns, per cu. foot.
Cement rock..............	" (wagon type drill).	25.4 " "
Asbestos	"	(28.8
		(33.6
"	"	(54.2
"	" " " "	96.4

Mucking operations in general show low dust concentrations, approximating the general air dustiness of the locality. Conditions are, of course, modified by air currents so that while the shoveling operations may not produce a heavy dust concentration, drilling operations close by may set up dust that grossly pollutes the breathing zone of workers engaged in mucking.

Normally the dust concentrations in quarry operations are dependent upon the worker. In few instances is the worker required to remain exposed to a heavy dust concentration, and then only for a short period of time. It is usually possible for him to work in a position away from the direction of the air currents carrying the dust clouds. This is especially true where the drill is of the mounted type. In case of hand jackhamer drilling, the operator is required to bear down with his full weight in order to supply the required feed to the drill. Here the rate of drilling is more or less dependent on the physical characteristics of the man and often the contractor picks only the heavier men for this work. With mounted drills, the weight applied or the feed is constant and the rate of drilling is not only more regularly progressive but also the operator is not required to be constantly exposed to the arising dust cloud.

Tests on mucking show that the dust generated is dependent upon: 1. the fineness of the material; 2. the dryness of the material; 3. the rate and method of handling.

In recent studies in the iron mines in upper Michigan with mechanical scraping of relatively wet material, the dust in the breathing zone of the tugger operator closely approximated the general air of the mine area. In quarry and building foundation work the same conditions held, but in most instances the dust concentrations of the general air were too high for safe breathing over a period of time.

A test run recently[11] of hand shoveling in a dry mine indicated that greater dust concentrations were generated when the material was thrown from the shovel into the car. Samples taken with two men shoveling showed an average dust concentration of 83 million particles, but on applying suction to the top end of the car to entrap and remove the arising dust, the dust concentration was reduced to 8 million particles.

Crushing operations are usually associated with quarry operations. These operations, together with screening or sizing of materials, are usually done on the dry material. Usually the crushing and screening plants are mechanical, requiring only

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[10] Rogers, Edward J., Silicosis or Pneumoconiosis in Vermont Granite Cutters and Slate Workers. New England Journal Medicine, Aug. 4, 1932, Vol. 207, pp. 203-208.

[11] The American Institute of Mining and Metallurgical Engineers, Technical Publication No. 637, Control of Dust in Mines, Feb. 1935, N. Y. C.

a few employees at stations and more often only intermittent attention is necessary for the [illegible] of the machinery.

In some cases the screening operations are done wet and the resulting dust generated is greatly reduced over the same operation done on dry material and especially, as is common practice, with no covers over the screens.

In a survey of a silica grinding plant, the following dust concentrations were obtained:

Location of Sampling	Total Count in Millions of Particles, less than 10 microns, per cu. ft. air sampled
Crusher room	4.25
Grinding room	9.52
Bagging room	69.33

These tests were taken in the summer and there was good general ventilation with all doors and windows open. The crusher and grinding room operations were mechanical, requiring the attention of one oiler intermittently, but the bagging room had two men at the two bagging machines and two men trucking the bagged silica into a car for shipment. These four men were exposed to the highest dust concentration in the whole plant.

A similar study of a feldspar mill operating with open vibrator screens showed the following concentrations:

Location of Sampling	Total Count in Millions of Particles, less than 10 microns, per cu. ft. air sampled
At roughing roll	2,656
At roll crusher	1,589
At screens (feeder end)	4,652
At screens (take-off end)	8,885

Samples taken in a wet limestone screening plant showed 0.91 million particles as the general air dustiness. This limestone was burned to make caustic lime and samples taken at the kilns showed:

Charging floor	2.5 million particles
Bottom of kilns (discharge of kilns)	1.7 " "

Summing up, our experience gained over a number of years by making surveys of varied industries, we have definitely concluded that:

1. Dust is principally produced by mechanical operations and in the mining and quarrying industries, drilling operations are the chief dust producers.

2. Employees at other operations than drilling are often exposed to a high dust concentration due to pollution by dust generated by the drills.

It is, therefore, logical to conclude that the proper way to eliminate dust is to entrap and remove it at its source. While wet drilling may, in certain instances, be effective, the use of water offers other difficulties, especially in freezing weather.

The effectiveness of the Kelley Trap has been demonstrated experimentally and its adaption to drilling operations in its first commercial use on the foundation of the Metropolitan Life Insurance Company's Home Office Building at 24th Street and 4th Avenue, New York City[22] was successful.

A series of later tests conducted in the Balmat mine of the St. Joseph Lead Company[22] showed the practicability and efficiency of the Kelley system under severe mining conditions.

The dust health hazards of the quarry industry are such that they can readily be eliminated by efficient and economical measures.

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[22] Hatch, Theodore, Kelley, George S., Fehnel, J. Wm., Control of the Silicosis Hazard in the Hard Rock Industries, II. An Investigation of the Kelley Dust Trap for Use with Pneumatic Rock Drills of the "Jackhamer" Type, Journal of Industrial Hygiene, Feb. 1932.

[illegible]

Group B—The B. F. Goodrich Co., Pacific Div., Los Angeles, Calif., 756,268 hours, no injuries.

Groups C and D—Four tied for first place—Samson Tire & Rubber Corp., Los Angeles, Calif., 657,486 hours, no injuries; The Goodyear Tire & Rubber Co., Bowmanville, Canada, 293,711 hours, no injuries; Van Cleef Brothers, Chicago, Ill., 127,868 hours, no injuries; The Richardson Co., New Brunswick, N. J., 88,650 hours, no injuries.

Compounding Materials Used in the Rubber Industry, Their Classification and Health Hazards.

Groups II, III and IV

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At the sixteenth annual Safety Congress, the writer gave his first paper on materials used in the rubber industry. That paper was the outgrowth of an effort on the part of the Health Hazards committee of your section to provide authentic data on the hazards existing through the handling of compounding materials used in the industry.

That first paper was revised in 1931 and used as the basis for a safe practices pamphlet on rubber compounding ingredients issued by the National Safety Council. The paper gave a general summary of the usual ingredients used for compounding rubber, divided into four groups:

Group I—Organic Accelerators and Dry Organic Compounds.
Group II—Dry Inorganic substances.
Group III—Gums, Oils, Resinous Materials and Waxes.
Group IV—Liquids and Gases.

The first group was a comparatively new line of ingredients, developed largely since the war by our new chemical industries. Some of them had given no small amount of worry to our safety departments in the matter of toxic poisonings, skin irritations, and other discomfitures to many rubber workers. Their chemistry and physiological effects were not well understood. For these reasons my paper was confined to this Group I and was made the basis of a safe practices pamphlet.

On account of the upset conditions prevailing in industry during the past few years, the other three groups were never completed. Early last spring, your section urged the writer to continue with work on the remaining groups as originally out-

[illegible] of the other groups along [illegible] all of the usual compounds [illegible] that new materials are [illegible] and new and unusual uses are being made of [illegible].

It has been the writer's object to limit the description of materials to those facts most pertinent to the safety engineer. This classification is a sort of ready reference or dictionary of compounding materials used in the rubber industry. Each ingredient is listed alphabetically, together with a brief description of its properties, its use in the industry, its relative health hazards and its safe handling. I believe that this is all that the safety department requires in the majority of cases. Where more information is necessary, recourse may be had to such works as Hamilton and other sources of information.

GROUP II—Dry Inorganic Compounds

Most of the compounds in this group are of a soft mineral powder type of a particular size less than 200 mesh and many of them less than 300 mesh or even finer. Very few of them contain hard or abrasive particles such as silica, corundum, etc. Likewise only a very few are toxic, so on the whole this group is comparatively free from health hazards. However, they are all more or less dusty when handled carelessly and there is always the ordinary dust hazard present. Good storage bins, conveyors, hooded mills, and efficient exhaust fans can readily eliminate all dust hazards and in most cases also prevent harm from the toxic or silica-bearing compounds.

There are several compounds whose handling should receive special consideration, such for instance as lead or silica bearing compounds. These are so designated in the following conspectus of materials in this group.

Aluminum Flake. A fine cream colored powder consisting primarily of aluminum silicate. Used as a filled in rubber. It is non-gritty and non-toxic.

Ammonium Carbonate. A white crystaline or lumpy powder having a strong, pungent odor of ammonia. Readily decomposes and gives off irritating odor during mixing. Used in sponge rubbers. Slightly toxic but very little hazard in connection with its handling.

Antimony Sulphides. There are two types, the golden and the red antimony sulphides. They are used for coloring rubber articles. Some grades contain a considerable percentage of free sulphur and calcium sulphate. They are slightly toxic and also are irritating to skin and mucous membrane. No hazard with careful handling.

Asbestine. A fibrous variety of talc used in rubber as a filler, especially in packings and gaskets. Is a magnesium silicate. In appearance, it is a white powder, non-gritty and non-toxic. It should be borne in mind that many of these silicates, when not pure, may contain traces of silica. No hazard if dust is kept down.

Asbestos. A fibrous magnesium silicate used in many types of rubber goods, especially of the packing and gasket type, and where the rubber must withstand considerable heat. It may be obtained in many different lengths of fiber, varying from an inch long down to almost a powder. Grayish white usually, in appearance. There is no hazard connected with handling this material in compounding.

Barium Dust. A trade name for barium sulphate (which see).

Barium Sulphate. A heavy white powder used for reinforcing rubber and also as a filler. Insoluble in most solvents. It is non-absorbable and non-toxic. No hazard in handling.

Barytes. Commercial name for natural deposit of barium sulphate.

Beckton White. A trade name for lithopone.

Blanc Fixe. A trade name for barium sulphate.

Blue Lead. A grayish-blue powder used as a mild accelerator and for compounding. A mixture of active lead compounds and very toxic. (See lead compounds.)

Cadmium Yellow. A fine light yellow powder of cadmium sulphide, used for coloring rubber. Slightly toxic. It can cause irritation of mucous membranes and also gastritis. No hazard with careful handling to keep hands clean and dust down.

Calcined Magnesia. (See magnesium oxide.)

[illegible] crystals or lumps. Very [illegible] but absorbed in water [illegible]. It is irritating to skin but non-toxic.

Carbon Black. An exceedingly fine dusty black powder. Used in tremendous quantities for tires and many lines of rubber goods as a reinforcing ingredient. The dust is difficult to cope with, but is [illegible] and non-toxic.

Carbonate of Ammonia. (See ammonium carbonate.)

Carbonate of Magnesia. (See magnesium carbonate.)

Caustic Soda. Same as sodium hydroxide. A white deliquescent substance usually in the form of sticks, flakes, or lumps. Very soluble in water. It is dissolved in water and used as a bath or wash for rubber articles to cleanse, remove bloom, grease, etc. It is very caustic, disintegrates organic tissue and should be handled with great care to keep from the flesh. Otherwise not toxic, in the ordinary sense of the word. Also used in reclaiming.

Chalk. (See whiting.)

China Clay. (See clays.)

Chrome Green. A green mineral powder pigment used for coloring rubber. Slightly toxic and causes irritation of mucous membranes and possibly slight ulcers. No hazard with reasonable care.

Chrome Yellow. A deep yellow powder used for coloring rubber. This is a chromate of lead, although there are also chromates of zinc and barium. But the lead salt is the one usually used for rubber. While the chromate is relatively insoluble and inert, it is always wise to handle lead compounds with extreme care, due to the presence of very active lead impurities which might be present. (See lead compounds.)

Clays. There are an innumerable number of different kinds of clays ranging in colors from white to black. The ones used for rubber compounding are usually the white variety ranging in color from exceedingly white to cream or buff. Most of the clays are very fine smooth powders varying greatly in both their chemical and physical properties. They are of natural origin and chemically a hydrous aluminum silicate. The clays are usually non-gritty and are non-toxic. They are used as fillers and for reinforcing.

Crimson Antimony. Another name for red antimony sulphide.

Diatomaceous Earth. A very soft earthy rock composed of the silicious skeletons of small aquatic plants called diatoms. It grinds to an impalpable powder and is extremely light and fluffy. It is used for filler in rubber compounds. It is non-toxic but care should be taken to keep down excessive dust.

Emery. A fine abrasive powder used with rubber for making erasers and emery wheels. Basically it is an aluminum oxide. It is non-toxic but very sharp and dangerous to inhale. Take same precautions as for silica. Also called corundum.

Fossil Flour. (See diatomaceous earth.)

French Chalk. (See talc.)

Fuller's Earth. A clay relatively high in magnesia. Used as a filler in rubber goods. Non-gritty and non-toxic. (Also see clays.)

Golden Antimony. (See antimony sulphides.)

Graphite. A grayish-black soft greasy powder. Used for lubricating rubber moulds and as a filling material for such compounds as gaskets, packings, etc. It is an impure form of native carbon. It is non-toxic.

Ground Glass. A very fine powdered glass used for compounding rubber to make erasers and other rubber abrasive utensils. It is very sharp and same precautions should be observed as for silica. It is harsh on the hands but non-toxic.

Gypsum. A grayish-white powder used for compounding rubber. It consists of a pulverized natural hydrous calcium sulphate. It is non-gritty and non-toxic.

Hard Rubber Dust. A very fine ground hard rubber, grayish to black in color. It is very light and fluffy and sticks to whatever it touches. Ordinarily it consists mostly of vulcanized hard rubber which is rubber and sulphur but may also contain other mineral or organic substances used in compounding rubber. Dust should be kept down, but otherwise the material is not hazardous or toxic.

Heavy Magnesia. Heavy calcined magnesia, or magnesium oxide. (See magnesium oxide.)

Hypo. Lead hypo sulphite. (See lead compounds.)

Iron Oxide. The red oxide of iron. (See red oxide.)

Infusorial Earth. (See diatomaceous earth.)

Kaolin. A white china clay. (See clays.)

Kieselguhr. (See diatomaceous earth.)

Light Magnesia. The light calcined magnesium oxide. (See magnesium oxide.)

Note:—Magnesium carbonate is often spoken of as light magnesia.

Lamp Black. A black carbon pigment obtained by burning oils and oily residues. Carbon black is often miscalled "lamp-black." Its characteristics are similar to carbon black, (which see). It is not used to any great extent. It is not toxic.

Lead Compounds. Before the advent of organic accelerators, the lead compounds were the most widely used accelerators of vulcanization. Some of these lead compounds are still used in large quantities. The usual lead compounds used in rubber compounding are:—blue lead, lead thiosulphate, hyposulphite, or hypo, lead oleate, lead oxide or litharge, sublimed white lead, and basic white lead. Blue lead, lead thiosulphate, and hypo lead are no longer used to any extent. These are active compounds of lead which reacted readily with sulphur at vulcanizing temperatures to speed up vulcanization. They are more or less active compounds and readily assimilated if taken into the system either through breathing or through food contaminated by contact with dirty hands or clothing.

Lead oleate is still used to a considerable extent both as an accelerator and for extruded and moulded goods. It gives a good finish and eliminates bloom in certain types of stocks. It is an active poison and should be treated with care. It is a soft, waxy substance, so there is no danger of dust, the real danger being of sticking to hands and clothing. It can be handled with perfect safety if cleanliness is observed.

Lead oxide or litharge is probably the most extensively used lead compound and the one to be most feared. It is a heavy, fine orange to brown colored powder. The dust is very fine but being of a very heavy gravity, settles quickly. Those handling this material should wear a dust mask if there is the slightest danger of inhaling any dust or getting it in the mouth or saliva. It is dangerous to handle tobacco, gum, fruit or any food until after a thorough clean-up. Mixing mills should be hooded and every precaution taken to keep down dust. Lead oxide is a very active material and consequently very toxic. There is no need to enlarge on Lead Poisoning as the subject has been very thoroughly covered and I am sure all rubber factory safety heads are familiar with the symptoms and treatment of lead poisoning cases. Litharge can be safely handled if reasonable care is exercised in its use. The worker should be instructed as to its serious toxic properties and pains taken to instruct him how to safely handle it.

Sublimed white lead is largely lead sulphate with about 15 per cent of active lead oxide present. It is the free lead oxide which is the active accelerating ingredient and also the real toxic substance. While much less toxic than the litharge, it should, however, be handled with the same care as the latter substance.

Basic white lead is a white powder consisting of a basic carbonate of lead. It is not now used to any great extent for rubber compounding. But it is a very active and toxic substance and should be handled with as much care as litharge where used.

Anyone using the above lead compounds to any extent should post themselves on the symptoms of lead poisoning, its treatment and avoidance of trouble from poisoning.

Lime. A fine dry white powder used quite extensively in rubber compounding as a secondary accelerator and drying ingredient. This compound is the so-called hydrated calcium oxide or slaked lime. It is slightly caustic and irritating to mucuous membranes but non-toxic. No hazard is involved in its use.

Litharge. Lead oxide. (See lead compounds.)

Lithopone. A very fine white powder consisting of barium sulphate and zinc sulphide of high coloring powder. It is one of the most widely used pigments for producing white rubber goods. Being rather inert, there is no hazard connected with its use other than the general dust hazard. The zinc present in the material might be dissolved if considerable quantities of dust were taken into the system, but zinc in such quantities would not be considered as a toxic material.

Magnesium Carbonate. Also called [illegible] carbonate and light carbonate. [illegible] one of the lightest [illegible] non-toxic [illegible] effects. It is an [illegible] medical [illegible]. No hazard connected with its use other than [illegible] of dust.

Magnesium Oxide. Also called magnesia oxide and calcined magnesia. It is obtained by heating the magnesium carbonate. There are two grades used extensively in the rubber industry, one called heavy calcined magnesia and the other light calcined magnesia. The heavy calcined product is more dense and slightly darker in color than the light calcined material. They are both used as auxiliary accelerators and to neutralize acid reactions. The percentage used is relatively small in most cases. The dust is slightly irritating to mucous membrane but non-toxic. No hazard connected with its use.

Magnesia Usta. Same as magnesium oxide.

Mica. A form of aluminum silicate which when ground fine is a soft glistening powder. The particles are flat in shape and slide over each other giving the slippery properties noted in graphite. The color runs from a cream white to gray, but the grade usually used for rubber is a fairly good white. It is used for dusting raw rubber to keep the slabs from sticking together and also for dusting finishing goods, especially spread and coated goods to give a smooth glistening and pleasing finish. Mica is also used in packings and mechanical goods as a filler where goods are to resist heat and acid. The material is non-toxic and there is no hazard other than the dust hazard. Cheap grades might contain traces of silica.

Oxide of Magnesia. (See magnesium oxide.)

Oxide of Iron. (See red oxide.)

Paris White. (See whiting.)

Plaster of Paris. (Seee gypsum.)

Plumbago. (See graphite.)

Pumice. A grayish powder consisting of ground lava. It is a complex silicate of aluminum, potassium and sodium. It is used as a soft abrasive for producing a smooth, polished surface on rubber goods such as mechanicals and rolls. Also it is used as a filler in acid and heat-resisting rubber goods. It is non-toxic but reasonable care should be exercised in keeping down dust.

Prussian Blue. There are a number of so-called prussian blues with varying shades and solubilities, all belonging to the iron blues. They are fero-feri-cyanide compositions. The blues used for rubber are the insoluble type and prepared to withstand the temperatures of vulcanization. They are used in comparatively small quantities and there is no hazard connected with their handling.

Red Oxide. A fine red pigment very dense and heavy, and consisting of the red oxide of iron. It is also called iron red. It is one of the most widely used red pigments for coloring rubber. It is non-toxic and no danger involved in its handling. Advisable to keep dust down as it flies readily.

Red Ochre. A dull brownish red powder used for coloring rubber goods. It does not give the brilliancy of red oxide. It consists of a ground natural impure form of iron oxide. It is more gritty as a rule than the regular red oxide and often contains silica. It is non-toxic, but care should be exercised in keeping down dust due to possibility of silica being present.

Rotten Stone. (See tripoli.)

Sand. (See silicon dioxide.)

Silica. (See silicon dioxide.)

Silicon Dioxide. Also called silica and quartz, sand, etc. A very hard abrasive powder varying in particle size from a very fine powder to large, sharp particles which we know as sand. The color may vary from almost pure white to yellow or brown or grayish. This is the material which has been so widely discussed in cases of silicosis. It occurs as an impurity in many dusts and powders and is usually present in common road dust. In rubber compounding, its use is confined to such special rubber articles as erasers and abrasive wheels. A very fine grade is also used as a special filler for certain rubber goods. However, its use is not general throughout

Safety Section, AAR-Steam Railroad Section, NSC

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A complete report of these sessions is published by the American Railway Association in a booklet entitled, "Proceedings of the Fifteenth Annual Meeting of the Safety Section, Louisville, Ky., Oct. 15 to 17, 1935." Copies of the booklet are available from the Association of American Railroads, N. Y. C. The following is a condensed record.

TUESDAY MORNING SESSION

October 15, 1935

The opening session of the Safety Section, Association of American Railroads—Steam Railroad Section, National Safety Council, was called to order by General Chairman T. H. Carrow, Supt. of Safety, Pennsylvania Railroad, who presided.