TRANSACTIONS

25th National Safety Congress

NATIONAL SAFETY COUNCIL, INC.

ATLANTIC CITY, NEW JERSEY
OCTOBER 5 to OCTOBER 9, 1936

Ambassador, Chelsea, Ritz-Carlton Hotels
and Atlantic City Auditorium

Copyright, 1936, National Safety Council, Inc.

PLAINTIFF'S EXHIBIT
P11 Evid

admitted as to notice only

P11

Foreword

THE Transactions of the Twenty-fifth National Safety Congress, 1936, are published by the National Safety Council in two volumes. This, the first, contains the general, the special subject, and the Industrial Section sessions. The second volume contains the sessions of the Child Education, Home Safety, Street and Highway Traffic and Vehicle Fleet Sections.

All industrial members of the Council automatically receive Volume I. Volume II is sent to members believed to be interested chiefly in the sessions it covers. Other Council members, however, may obtain it upon request.

Many members have found it worth while to distribute copies of the Transactions to supervisors, foremen, and others in an administrative or supervisory position who may make practical use of them for reference purposes. The following quantity prices are quoted on extra copies: 1 to 10 copies of the large volume, $1.50 each; 11 copies or more, $1.25 each; copies of the smaller volume, 50 cents each.

THE Transactions are published 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. Thus 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 injury to the technical aspects of any address. The original manuscripts are on file in the Council's Bureau of Information, where they are available for additional reference. 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. 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

National Safety Council, Inc.

HONORARY MEMBERS

Association of Iron and Steel Electrical Engineers
Robert W. Campbell
Arthur Williams
Lew R. Palmer

OFFICERS (1936-1937)

Dr. C. H. Watson, President
D. D. Fennell, Vice-President for Public Relations
Dr. Hart E. Fisher, Vice-President for Health
John B. Gibson, Vice-President for Community Safety Councils
Hon. Harold G. Hoffman, Vice-President for Public Safety
Albert S. Regula, Vice-President for Engineering
A. V. Rohweder, Vice-President for Industrial Safety
R. T. Solensten, Vice-President for Membership
Albert W. Whitney, Vice-President for Education
W. E. Worth, Vice-President for Finance and Treasurer.
W. H. Cameron, Secretary and Managing Director

EXECUTIVE COMMITTEE (1936-1937)

George J. Adams, Paper and Pulp Section
C. M. Allen, Metals Section
C. B. Auel, Past President
J. I. Banash, Past President
C. W. Bergquist, Past President
Harold S. Buttenheim, The American City Magazine
W. H. Cameron, National Safety Council, Inc.
Robert W. Campbell, Past President
Robert I. Catlin, Aetna Casualty & Surety Company
Lewis A. DeBlois, Past President
C. W. Dempsey, Food Section
Marcus A. Dow, Past President
D. D. Fennell, Consulting Engineer
Dr. Hart E. Fisher, Chicago Rapid Transit Company
R. B. Fortuin, Lehigh Valley Safety Council
C. W. Gibbs, Mining Section
John B. Gibson, Western Electric Company
Harry Guilbert, The Pullman Company
Hon. Harold G. Hoffman, Governor of New Jersey

OFFICERS AND DIRECTORS, *Continued*

E. C. Holden, Jr., Marine Section
Harry J. Kelley, Wood Products Section
Walter G. King, Past President
Wm. C. Knoelk, Milwaukee Safety Commission
John E. Long, Past President
Thos. H. MacDonald, United States Department of Agriculture
E. J. Mehren, Portland Cement Association
W. J. Melville, Chippewa County Safety Council
I. W. Millard, Industrial Gloves Corporation
Harold L. Miner, E. I. du Pont de Nemours & Company
E. J. O'Brien, Jr., Louisville Safety Council
Lew R. Palmer, Past President
C. E. Pettibone, Past President
Albert S. Regula, Industrial Relations Counselors, Inc.
Lt. Col. Henry A. Reninger, Past President
A. V. Rohweder, Duluth, Missabe & Northern Railway Company
D. L. Royer, ASSE-Engineering Section
George E. Sanford, General Electric Company
Charles B. Scott, Past President
Carl L. Smith, Cleveland Safety Council
C. W. Smith, Standard Oil Company (Indiana)
Walter Dent Smith, Delaware Safety Council
R. T. Solensten, Elliott Service Company
C. P. Tolman, Past President
George G. Traver, Chicago Safety Council
Robert R. Wallace, Worcester Safety Council
Dr. C. H. Watson, American Telephone & Telegraph Company
A. W. Whitney, National Bureau of Casualty & Surety Underwriters
W. E. Worth, International Harvester Company
Arthur H. Young, Past President

DIRECTORS (1936-1937)

George J. Adams, Paper & Pulp Section
C. M. Allen, Metals Section
Nelson R. Anderson, Seattle Traffic & Safety Council
Frederick Archer, Child Education Section
A. L. Armstrong, Chemical Section
J. I. Banash, Consulting Engineer
John J. Barada, Public Utilities Section
Ernest W. Beck, United States Rubber Products, Inc.
C. W. Bergquist, Western Electric Co.
David S. Beyer, Liberty Mutual Insurance Co.
Clifford M. Bishop, Brooklyn Safety Council

OFFICERS AND DIRECTORS, Continued

E. F. Blank, Jones & Laughlin Steel Corp.
C. F. Beckenhauer, Kenosha Safety Council
S. D. Boyd, York County Safety Council
A. W. Bissland, Petroleum Section
F. S. Brown, Standard Accident Insurance Co.
S. W. Burchell, Automobile Club of Rhode Island
Harold S. Buttenheim, The American City Magazine
Preston D. Callum, Baltimore Safety Council
W. H. Cameron, National Safety Council
Robert L. Catlin, Aetna Casualty & Surety Co.
M. A. Clark, Automotive and Machine Shop Section
H. Herbert Corson, Safety Department, Nashville Chamber of Commerce
Frank Emery Cox, Berkeley Traffic Safety Commission
Robert W. Crowther, Springfield, Massachusetts Safety Council
J. E. Culliney, Bethlehem Steel Co.
Lewis A. DeBlois, Consulting Engineer
Jay E. Decker, Mason City Safety Council
C. W. Dempsey, Food Section
James B. Douglas, Philadelphia Gas Works Co.
Dr. Louis I. Dublin, Metropolitan Life Insurance Co.
D. D. Fennell, Consulting Engineer
Donald A. Finkbeiner, Toledo Safety Council
Dr. Hart E. Fisher, Chicago Rapid Transit Co.
Howard B. Fonda, Burroughs Wellcome & Co. (U. S. A.) Inc.
William Forsyth, Superior, Wisconsin Safety Council
R. B. Fortuin, Lehigh Valley Safety Council
Alexander Foster, Jr., Quarry Section
C. W. Gibbs, Mining Section
John B. Gibson, Western Electric Co.
Harry Guilbert, The Pullman Co.
Isaiah Hale, The Atchison, Topeka & Santa Fe Railway Co.
Major Bolling H. Handy, Richmond Safety Council
D. T. Harrington, U. S. Bureau of Mines
R. C. Haven, Vehicle Fleet Section
G. T. Hellmuth, Chicago, North Shore & Milwaukee R. R. Co.
Chas E. Hill, New York Central Lines
Hon. Harold G. Hoffman, Governor of New Jersey
E. C. Holden, Jr., Marine Section
Frederick B. Hunt, Cement Section
P. G. Hunter, Power Press Section
Morris E. Hurley, Eastbay Safety Council
Mayor Norman A. Imrie, Columbus Safety Council
Edwin A. Kayser, St. Louis Safety Council
Thomas P. Kearns, Industrial Commission of Ohio

OFFICERS AND DIRECTORS, Continued

K. T. Keller, Detroit Industrial Safety Council
Harry J. Kelley, Wood Products Section
Thos. L. Kelley, Paterson Safety Council
J. M. Kerrigan, Rubber Section
Wm. C. Kimble, Street & Highway Traffic Section
C. L. LaFountaine, Great Northern Railway Co.
A. H. Laube, Madison County Safety Council
J. E. Long, The Delaware & Hudson Railroad Corporation
W. R. Love, Safety Div. Birmingham Chamber of Commerce
L. T. McArthur, Peoria, Illinois Safety Council
Thos. H. MacDonald, United States Department of Agriculture
Miller McClintock, Traffic Audit Bureau
T. H. McKinney, Retired
F. W. Matson, Minnesota Safety Council
James R. Mays, Elizabeth Safety Council
E. J. Mehren, Portland Cement Association
W. J. Melville, Chippewa County Safety Council
I. W. Millard, Industrial Gloves Corporation
E. M. Miller, Employees Publication Section
James K. Miller, Grand Rapids Safety Council
Harold L. Miner, E. I. duPont de Nemours & Co.
R. B. Morley, Industrial Accident Prevention Association
Ernest Murphy, Albany Safety Council
E. J. O'Brien, Jr., Louisville Safety Council
George C. A. Orr, The Detroit Edison Co.
Geo. Oppenheimer, Kansas City Safety Council
Lew R. Palmer, The Equitable Life Assurance Society of the United States
Wilson Palmer, Meat Packing, Tanning & Leather Industries Section
A. E. Parker, Transit Section
David A. Patton, Newark Safety Council
Mrs. G. M. Pelton, Evanston Safety Council
Charles W. Pendock, Safety Division, Milwaukee Assn. of Commerce
C. E. Pettibone, American Mutual Liability Insurance Co.
Gen. George B. Pillsbury, United States Engineer Office
Arthur Potterton, Hudson County Safety Council
Albert S. Regula, Industrial Relations Counselors, Inc.
Lt. Col. Henry A. Reninger, Lehigh Portland Cement Co.
A. V. Rohweder, Duluth, Missabe & Northern Railway Co.
D. L. Royer, ASSE-Engineering Section
G. E. Sanford, General Electric Co.
Henry C. Schaffner, Erie Safety Council
Karl G. Schoeffler, Rahway Safety Council

OFFICERS AND DIRECTORS, Continued

HARRY A. SCHULTZ, United States Steel Corp.
EARL S. SHARTZER, Utica Safety Council
GEN. JOHN H. SHERBURNE, Massachusetts Safety Council
DR. L. A. SHOUDY, Bethlehem Steel Co.
ERNEST L. SIMONDS, New Haven Safety Council
CARL L. SMITH, Cleveland Safety Council
C. W. SMITH, Standard Oil Co. (Ind.)
EDWIN C. SMITH, Blackstone Valley Safety Council
WALTER DENT SMITH, Delaware Safety Council
W. A. SNOW, Construction Section
R. T. SOLENSTEN, Elliott Service Co.
P. EARL SPITZER, Contra Costa County Safety Council
E. C. SPRING, Lansdale, Pa.
GEORGE R. STEPHENS, Safety Bureau, Buffalo Chamber of Commerce
ARTHUR M. TODE, Consulting Marine Engineer
HAROLD M. TOOMBS, Refrigeration Section
GEO. G. TRAVER, Chicago Safety Council
W. W. TRENCH, Schenectady Safety Council
W. D. TURBEVILLE, San Antonio Safety Council
ROBERT R. WALLACE, Worcester Safety Council
DR. C. H. WATSON, American Telephone & Telegraph Co.
HARRY M. WEBBER, Retired
E. T. WHITER, Western Pennsylvania Safety Council
S. E. WHITING, Liberty Mutual Insurance Co.
A. W. WHITNEY, National Bureau of Casualty & Surety Underwriters
T. A. WILLSON, Accident Prevention Equipment Manufacturers' Section
T. A. WILSON, Textile Section
W. H. WINANS, Union Carbide & Carbon Corporation
E. W. WIRTH, Rochester Safety Council
HARRY WISE, SR., Chattanooga Safety Council
J. M. WOLTZ, Youngstown Sheet & Tube Co.
W. W. WOOD, Steam Railroad Section
W. E. WORTH, International Harvester Co.
E. J. ZAUFT, Safety Bureau, Duluth Chamber of Commerce
EARL W. ZIMMERMAN, Safety Div. Syracuse Chamber of Commerce
G. L. ZWICK, St. Joseph Safety Council

fore long you have to think of something else to maintain the interest of the men.

Mr. Bonsib: Remember that everything that we do is a result of two great principles, pride and fear. Fear gets results, in the way of discipline, but pride is the greatest instinct man has. Lie awake at night thinking of how you can do your work better, and you will think of things that will appeal to the employees' pride. Pay attention to statistics, but use them correctly. Get statistics along lines that will show you where the trouble is, and what causes it.

With such statistics you can stimulate the competitive instinct, because deep down in his heart every man honestly believes he is just as good as somebody else, and he wants to show it.

Chairman Boulet: The meeting is adjourned.

ADJOURNMENT

Occupational Diseases

FRIDAY MORNING SESSION

October 9, 1936

The session was called to order by the chairman, Dr. Hart E. Fisher, Vice-President for Health, National Safety Council, and Chief Surgeon, Chicago Rapid Transit Co., Chicago, who presided, introducing the speakers.

The Lesser Known Facts About Common Occupational Diseases

By DR. ROBERT B. HUNT

Medical Advisor, American Mutual Liability Insurance Co., Boston

Probably the leader in the parade of industrial diseases is an acute or chronic inflammation of the skin which we call dermatitis. This disease may present itself in any type of shop, factory or foundry. Any paste, powder, gas or liquid which comes in contact with the employee's skin, even the water supplied by the town in which he lives or works, may be the potential cause of such a skin disturbance.

The wide diversity of causes together with the varying susceptibility of different individuals makes the problem of control difficult.

Much investigation is under way to determine why one person may be susceptible to a certain substance while another is not. It has been proved many times that a poisonous substance formed within the body has been able to prolong the action started by some external influence. A printer developed a marked dermatitis from ink which persisted for two years. Finally food tests were made and showed that he was susceptible to lettuce, which, when removed from his diet cleared the skin. He returned to his usual occupation without a return of symptoms.

The poisoning of allergic substances is usually an accumulative process. It takes time to produce a manifestation of disease, but let any other substance cause the disease, and the irritating food may be of sufficient strength to magnify its action.

All cases of dermatitis cannot be cured by eliminating offending foods, but further investigation along these lines may give us a clue with which to lessen the loss of time from work and the discomfort now produced by industrial dermatitis.

Metals

Lead

The distribution of lead poisoning is quite extensive.

The skin of the body is a protective covering, and as long as it remains intact it does a good job except in the case of tetraethyl lead, which is used in blending gasoline and which is readily absorbed through the skin, having a tendency to create changes in the nervous system. The effect of other forms of lead, through that avenue of entrance, is practically nil, which explains the extremely low poisoning rate in typesetters, painters and others who continually come in contact with metallic lead.

Lead in any form, introduced through the mouth, acts rather slowly when compared with the inhalation of lead dust or fumes. However, no matter what the portal of entry may be, lead is acted upon by the body fluids and so converted that it may eventually be deposited within the bones.

Those bony safe deposit vaults may retain their lead contents for days or for years, and if the exposure is removed, may also free the employee of all signs and symptoms of lead poisoning. But imagine the surprise of that supposedly cured person when years later, perhaps following some type of infectious disease or the excessive use of alcoholic beverages, he awakes to find that he suffers the aches and pains and paralyses of an acute lead poisoning. As the body fluids alter lead that it may be deposited, so may those fluids attempt to de-lead the body, and too rapid absorption may produce the original disease with all its discomforts.

One can readily see, then, that in some cases investigation of previous occupations is quite necessary to determine the original contact with lead.

Heating of molten lead causes a black scum of lead suboxide to form on its surface, and the heat from the metal disburses the fine powder into the air. Hence, in the process of smelting ores such as zinc, copper and silver, mixed with lead, we find a rather high lead poisoning rate.

Those engaged in the manufacture of lead wire and cables, batteries, glass, pottery and rubber industries, plumbers and users of dry colors offer their share of lead poisoning.

Probably the greatest source of lead poisoning may be found among those who sandpaper, scrape, chip or burn lead paint, for the dust and fumes caused by those activities are rather rapid in their action. Such workers may become incapacitated in a few days because the inhalation of lead dust causes the maximum amount of absorption into the blood stream in the minimum space of time.

Chromium

Chromium is a metal widely used as a foundation for colors, and dusts from its various salts may produce lesions of the skin and mucous membranes of the nose. Chromium plating by electrolysis may cause fumes which are similarly irritating. Although chromium poisoning does not usually cause death, the number of days of absence from work on account of incapacity which it causes is gradually increasing.

Other Metals

The most efficient portals of entry of foreign substances into the body are the nose and mouth. The smaller the dust (the size of smoke particles for example) the greater the speed of absorption by the blood. Fumes from hot metals carry not only poisons but numerous minute dust particles. This explains the incapacities occurring among those engaged in acetylene and electric cutting and welding. When men are so employed over a prolonged period of time, the constant inhalation of fumes and dust might produce symptoms of the metal upon which they work. In the shipbuilding trade, particularly in the construction of metal ships, we find occasional cases of metal-fume fever. "Brass chills" and "spelter shakes" from zinc are names applied by the lay people to such diseases. The terrific heat applied to some of our common metals and alloys by acetylene torches produces sufficient fumes to cause a temporary incapacity in 24 hours. Permanent disability from such causes is rare, however.

Diseases Due to Dust

Twenty-five per cent of all workers exposed to high concentrations of inorganic dust are expected to develop changes within their lungs due to that agency. We are at a loss to explain why the other seventy-five per cent are not so affected.

Mining, quarrying, foundry work, grinding, sandblasting, abrasive soap manufacturing, asbestos work, the making of emery and carborundum products and many other occupations offer opportunities for employees to inhale microscopic dust particles and create a foundation for possible future incapacity.

We are interested particularly in those men who work with sandstone, quartz, flint, granite, and sand, because they expose themselves to silica, and the chemical changes between that dust and the body fluids, in the presence of tuberculosis, may and usually do lead to a fatal ending.

It is safe to say, in light of our present knowledge, that the action of other inorganic dusts is much less virulent and incapacitating. That, however, does not allow us to lower the vigilant methods to improve dust control and protect employees, because all dusty occupations are potential trouble makers.

Although the actions of various dusts differ within the body, the exposure to asbestos fibres, present in the weaving and grinding of dry asbestos material, offers another type of dust which may cause fatalities among workers.

The organic dusts from cotton, silk, wool, tobacco, flour and similar substances are practically harmless. Such dusts rarely reach the lungs but may cause irritation of the windpipe and larger air tubes and result at the most in a mild bronchitis.

The factor which should be borne in mind, particularly when dealing with silicosis and asbestosis, relates to the progression of such disease. When changes occur within the lungs as a result of the presence of such dusts, nature forms scar tissue to heal such lesions but may fail to stop when the job is finished. As a result, the continuation of that healing process may lead to such structural changes within the lungs that partial or total incapacity may follow months or years after the employee has been removed from his dusty occupation.

Benzole-Benzene

Benzol is a distillate of coal tar used extensively in industry. It is an essential ingredient in the manufacture of explosives. It is an excellent solvent for grease, oils and cements, and because of that property it is important in many phases of the rubber and cleaning industries. In the manufacture of shoes benzol may be an ingredient of the dressing applied to the leather and of the cement which fastens the heels and soles. Not only in the shoe trade but in other branches of industry where employees work with gummy, sticky material, the workers soon learn of the solvent and cleansing action of this liquid and use it freely for that purpose upon themselves. The subsequent outbreak of skin afflictions may be the first indication of such unauthorized use.

Benzol is extremely poisonous, entering either through the nose or mouth or absorbed through the skin. Its action within the body is varied and may produce a multitude of signs and symptoms. The bone marrow becomes affected which in turn alters the character of the blood; hemorrhages are common; it may cause death.

The fumes from benzol are heavier than air and lie near the floor, which is an important point in the engineering problem of ventilation.

The members of the benzene group are absorbed through the skin, and more cases of poisoning are found when men perspire than when their bodies are cool. Probably the answer to that is that the fumes may solidify as they cool and the powder may settle on the skin. The sweat on the body may dissolve this dust so that it is more readily absorbed through the increased surface blood supply.

Chlorinated Hydrocarbons

This group of petroleum derivatives has been known to science for years but during the past decade its advance into the industrial field has been widely distributed and most important. Led by carbon tetrachloride and its chemically associated members, it has furnished industry with refrigerants for ice chests, excellent solvents for rubber, wax, oil and grease, thinners for lacquers and a very fine household necessity for the removal of spots from clothes. Hospitals have been using it more and more for the removal of adhesive plaster.

Due to the non-flammability of carbon tetrachloride, it is used in fire extinguishers. The rapid evaporation produces fumes which may smother a small blaze, but we must not forget that excessive heat of the actual fire may bring about combustion sufficient to produce such byproducts as hydrochloric acid and phosgene gas. Like its associated member, chloroform, it may produce sleep when inhaled by an individual, and only 1/350 of an ounce in a quart of air is necessary to produce such action. That thought must be remembered when a large quantity of these liquid products is spilled on the floor, perhaps accidentally. Action should be started at once before the liquid gasifies, and employees should be notified to keep their heads up to avoid the low ceiling of gas.

Chemists have developed and introduced to industry many new products, the basis of which is the chlorinated hydrocarbons. These derivatives of petroto think, inability to draw a personal lesson from the experience of others, overconfidence and a desire to make good on the job. These can only be overcome by careful and systematic handling on the part of the supervisor. His is the responsibility of putting over to the worker the value and advantages resulting from a close observance of rigid safety inspections.

Systematic Organized Safety Effort

There should be little need to make a plea for more concerted action along this line. As safety men, we know how easily the small employer could be put out of business as the result of even a few accident losses. The larger employer, as well, cannot afford to overlook the situation—his losses, through waste of time, money and materials, will seriously affect his profits and hold his company up to the public as a very inefficient organization. The ever increasing cost of compensation insurance will undoubtedly be a factor in forcing more consideration for well organized safety work. Personally, I emphasize the side of humanity above the dollar and am satisfied from long experience that where humanity rules, the profits will be satisfactory. Where a real safety program is followed, without doubt efficiency and economy of the highest order will also prevail.

The Present Status of Control of Dust and Fumes in Industry

By H. B. MELLER

Managing Director, Air Hygiene Foundation of America, Inc.; Head, Air Pollution Investigation, Mellon Institute of Industrial Research, Pittsburgh, Pa.

The problem divides itself naturally into medical, preventive engineering and legislative phases, and includes consideration of the responsibilities of employer and employee to each other and to the public.

It is axiomatic that, in case of physical disorder, impairment of function or disability, the more thoroughly the cause and course of action are known, the more certainly can possible remedies be applied or preventive measures taken.

In the diseases or affections under consideration, there are facts upon which preventive methods are based, and upon which further studies now in course or contemplated are, at least in part, predicated.

During the development of the present state of knowledge of the influence of some air contaminants on health, naturally many theories were advanced that later scientific work has modified or displaced. However, not always has the correction been as widely and thoroughly disseminated as was the original theory; this condition, perhaps, has led to some confusion in the minds of many who have not followed too closely the evolution of knowledge in this field.

Classification of Dusts

There are available different published classifications of dusts. Included in such classifications are dusts, the exposure to inhalation of which are, or are likely to be, occupational. Those that are inherently toxic when inhaled or otherwise absorbed and which cause systemic poisoning, include lead, arsenic, mercury, manganese. Examples of dusts which have the ability to penetrate the deep lung tissues and to be retained there are quartz, flint, chert, asbestos, talc, coal, iron, clay, slate, and other types of rock dust.

Attention here will be centered upon this last group and upon pneumoconiosis, the general term used to designate lung conditions caused by dust. Silicosis, which is caused by the inhalation of free silica, has been prominent recently in the public press, sometimes in a way that made misunderstanding possible, if not probable.

Aside from silica, many of the insoluble mineral dusts may bring about slight changes in the lung tissues, which may be demonstrated on the roentgenogram if there is silica in the dust that is inhaled. As far as is known today, most of them are relatively or entirely harmless.

Ability of Dusts to Cause Injury

It has been established that the potentiality of siliceous dusts to cause lung damage is, with few exceptions, dependent upon their content of free silica (SiO_2). The development of silicosis depends, therefore, upon the concentration of dust containing free silica in the air breathed. In other words, the total amount of free silica breathed and retained seems to be the primary factor; the length of time necessary for a sufficient accumulation is important, but less so than the total load.

Silica occurs also in chemical combination in silicates. Some of these compounds have been proved to be relatively harmless to health, some are still in the realm of doubt, and one—asbestos—may cause the industrial disease called asbestosis, which is the result of lung damage similar to, but not identical with nor as serious as, that produced by free silica.

Importance of Particle Size. The size of dust particles in the air which an individual may breathe is important. Not often are particles larger than 10 or 12 microns found in the deep lungs, except in the case of asbestos dust, where fibers as long as 200 microns have worked their way down lengthwise.

Uncomplicated Silicosis. Silicosis, uncomplicated by an infection, is more of an impairment than a disability. It is not seriously disabling until it reaches an advanced stage, and does not of itself greatly shorten the life of a silicotic.

Silico-Tuberculosis. When a silicotic dies, the immediate cause of death is usually some type of intervening lung infection. It is not known just why the presence of silica in the lungs increases susceptibility to tuberculosis, but when an adult with silicosis is exposed to tuberculosis, an active infection may occur, regardless of the previous state of health. It is thought probable that silica dust can reactivate healed tuberculous lung lesions of the adult type; how long after such lesions have healed the reactivation is possible is not certain. Exposure of silicotics to tuberculosis or of tuberculous individuals to silica dust is serious and should be avoided.

After silicosis has become well established in the lungs, medical science has not found a way to arrest the progress of the silicotic process toward the stage of disablement except through limiting or preventing further exposure to silica dust. Nor has medical science found a way to prevent tuberculosis from being superimposed upon silicosis, except through control of contact. The course of silico-tuberculosis is chronic and is very difficult to influence by treatment, according to phthisiologists.

Medical Control. As a basis for intelligent determination of the physical fitness of a man for a job in a dusty trade, physical examination, with stereoscopic roentgenograms of the chest, is necessary. Along with this study goes, naturally, the preparation of an occupational history with detail as to the exact nature of previous work and of exposure to industrial dust—not a valueless recording of occupations as "laborer," "machinist," etc. Dr. Sayers, of the U. S. Public Health Service, has developed a method of securing information for a proper occupational history; among others, Cummings, of Saranac Laboratory, also has worked out a useful history blank.

Standards have been developed for the diagnosis of silicosis. There is also a suitable technic for taking roentgenograms of the chest in order to bring out the characteristic lung changes.

From the considerable amount of work that has been done, it is possible to forecast with a reasonable degree of accuracy the silicosis potentiality of various dusts.

Periodic physical examinations, including roentgenograms, are essential if employers are to be enabled accurately to learn the effect of individual exposure and intelligently to transfer affected workmen to lower dust concentrations before serious injury has been done, or to work out a system of rotation where indicated as desirable in order that exposure may be intermittent. Such examinations are helpful also in showing the efficiency of engineering control methods.

The ability to place responsibility in case of claim for injury is no small part of the value of such initial and periodic examinations.

Asbestosis. Clinical experience has shown that the inhalation of a sufficient amount of asbestos dust causes a serious type of fibrosis, which is not accompanied

Industrial Dusts

WEDNESDAY MORNING SESSION

October 13, 1937

The meeting was called to order by Chairman A. S. Regula, Executive Secretary, Industrial Relations Counselors, Inc., New York City, and Vice-President for Engineering, National Safety Council, who introduced the speakers.

What Industrial Dusts Are Harmful? Why?

By SENIOR SURGEON R. R. SAYERS

Chief, Division of Industrial Hygiene, U. S. Public Health Service

While dusts exist everywhere in the atmosphere, it has been recognized for centuries that workers in certain dusty occupations are less healthy than those not so exposed. The number of persons exposed in dusty occupations comprises one of the largest industrial groups. The occupational diseases of workers in dusty atmospheres have been found to be due to entrance of dust into the system by inhalation, by ingestion, by direct absorption through the skin, by irritation of the skin, or by a combination of the foregoing.

The suspensions of particulate matter in air have been broadly termed dusts, fumes, and smokes. Such a classification is necessarily arbitrary, since the line of demarcation between them is not very sharp, and the chief differentiation is based on the size of the particles. Investigations by the Public Health Service in dusty industries[1] revealed that about 70 per cent of the dust particles examined were between 1 and 3 microns in size, only about 20 per cent were less than 1 micron, and the median size was 1.3 microns. Industrial dusts are mainly less than 10 microns in size. However, fibrous dusts in the air, such as asbestos, have been found to contain particles as large as 200-400 mircons in the greatest diameter.

While, generally speaking, according to Collis, dusts are more injurious as their chemical composition differs from that of the human body, or from the elements of which the body is normally composed,[2] it is difficult to establish a comprehensive definition for *toxic* dusts. Sollmann,[3] after analysis of various definitions for poison, felt that it is very difficult to give a definition which will not be ambiguous in some cases, but believed that the following covers most of the points which must be considered in classing a substance as such:

> "A poison is any substance which, acting directly through its inherent chemic properties, and by its ordinary action, is capable of destroying life, or of seriously endangering health, when it is applied to the body, externally, or in moderate doses (to 50 Gm.) internally."

Some dusts are known to be poisonous, while others, in the concentrations usually encountered, are comparatively harmless. However, it may be stated that *breathing* dust in high concentration is not desirable.

According to Fairhall, the damage arising from the inhalation of toxic dust may be either local or remote, and depends upon whether the material is a protoplasmic poison, whether it is caustic in reaction, or whether it is absorbed into the blood stream and carried to other centers which are in turn affected.[4]

It is now well established that exposure to certain kinds of dusts, such as those containing considerable quantities of free silica, has increased the morbidity and mortality rate from respiratory diseases; while metallic dusts, such as lead and its compounds, have been associated with general systemic poisoning.[7] Dusts may be swallowed with saliva, water, or food, and direct poisoning has been traced to absorption by this method; other dusts may act as irritants and produce affections of the skin, irritate mucous membranes of nose, eyes and throat, often causing inflammatory diseases of these organs.[8]

Some inorganic dusts are able to penetrate the deep lung tissues and are sufficiently insoluble to be retained there. Some of these may be active in the human tissues, causing definite and permanent injury, while others are inert and may be retained for years, apparently without serious damage; some are gradually absorbed without causing pathological changes.[1]

All inhaled particles are soluble, at least to a small extent. If harmless, cell activity is stimulated so that phagocytes remove the dust. If the solute is toxic, the viability of the phagocyte is affected and an ineffective accumulation results. At the same time, further solute may diffuse into neighboring tissues, setting up an irritation and subsequent fibrosis. The nature as well as the solubility of the solute is an important factor, but of two substances of approximately equal toxicity, the more soluble form causes the greater damage. However, substances of such low solubility as silica may ultimately produce extensive injury.[7]

Kettle has stated that harmful dusts, if inhaled into the lungs, may activate a latent tuberculous infection; they may exaggerate an active tuberculous lesion or a coincident infection. If sufficient quantities of a harmless dust are inhaled, some of it remains in the lungs and causes a mild degree of fibrosis merely through mechanical irritation, but such fibrosis is never sufficient to interfere with the function of the lung.[7]

Some writers state that while the influence of nonpoisonous dusts on health is a debatable subject, abnormally high death rates from bronchitis and pneumonia are sometimes attributed to chronic exposure to nontoxic dusts. Large amounts of dust are occasionally found in supposedly normal lungs, at autopsy.[8]

According to Drinker, there are four different types of reaction produced in man by the inhalation of dust. The first and most important are the pneumoconioses, such as silicosis and asbestosis, which cause specific lung pathology and often are followed by pulmonary tuberculosis. The second type of reaction is caused by toxic dusts like lead, cadmium, and radium. A third type of malady follows the inhalation of finely divided metallic fume particles such as zinc oxide, and is known as metal fume fever. The fourth reaction, allergic in character, is caused by breathing organic dusts such as pollen and certain types of pulverized wood and flour. In all four cases the sole cause of the disability may be dust inhalation, but the reactions from toxic dusts result from swallowing as well as from inhalation.[9]

For various reasons it is difficult to set up an absolute classification for dusts. Opinion is rapidly changing regarding so-called inert or harmless dusts and further investigation may prove some of them to be injurious. Some dusts may have both a toxic and an irritant action; while on the other hand, the poisoning resulting from exposure to a dust may be the combined effect of more than one mode of entrance into the body. However, the following classification of dusts, according to physical characteristics and physiological effect, is used for convenience.

I. Organic Dusts

Organic dusts are those which contain carbon, and were originally supposed to come from organized substances derived from animal or plant life. Living dusts come under this classification, and are thought to be of the same order of size as industrial dusts, with which they are frequently associated. Bacteria are usually between 0.5 and 3 microns, except in a few cases, such as the anthrax bacillus, which ranges from 1 to 1.25 micron in breadth and 1.5 to 10 microns in length and 10 or 12 microns in diameter. However, it is possible that the larger and heavier varieties, like the larger and heavier dust particles, settle due to gravity, and do not remain suspended in the air.

Many thousands of organic substances, carbon-containing, are made synthetically by chemical processes, such as dyestuffs, explosives, etc.

1. *NONLIVING ORGANIC DUSTS.* As the name implies, these are comprised of nonviable particles, which may or may not be inherently toxic or irritant, but which nevertheless produce untoward effects in the human organism. "Allergic" dusts, or those to which only certain persons are or may become hypersensitive, with resulting asthma, rhinitis, or other disturbances, are included in this classification.

a. *Toxic and/or Irritant.* Toxic or irritant dusts are all organic dusts which produce untoward symptoms, either systemic or local. Those producing local symptoms are usually described as irritant; those producing general or systemic symptoms are termed toxic. A dust may be both toxic and irritant.

In reported cases of injury or death following inhalation of dust from organic compounds, among the chief offenders are paranitraniline, the dinitrobenzenes, chlorodinitrobenzenes, trinitrophenol, and nitronaphthalene. Eye damage due to inflammation of the cornea has occurred among workers exposed to methyl violet dust. The dust from paraphenylene diamine derivatives is particularly irritating and dangerous, causing not only a severe form of dermatitis where the dust comes in contact with the skin, but also producing acute inflammation of the mucous membrane of the respiratory passages.[9] Toxic dusts may be generated during the handling of powdered dyes and in preliminary dyeing operations, particularly the hydro-extractor process, where particles are disseminated in all directions.[11] Coal tar and indigo dyes are substances most frequently used.

Cases of amblyopia have been reported from exposure to inhalation of tobacco dust.[8] It has been found that inhaled tobacco dust exerts a nicotine action on the organism fifteen times greater than that produced by the same quantity of smoked tobacco with an equal nicotine content.[8]

Severe dermatitis is experienced by many workers handling powder containing T.N.T., which is used in making high explosives. Picric acid, which is also used for this purpose, requires drying, and in this latter state has been found to produce a dermatitis. Picric acid is also the oldest synthetic organic dyestuff.[11] Dermatitis occurs among handlers of silk with varying frequency. Salls determined that a rash occurring among workers in a silk factory was due to dust from silk cocoons imported from Africa.[14]

Persons engaged in the manufacture of quinine and quinine preparations suffer from skin phenomena, which occur for the most part on exposed parts of the body, and may be caused by ingestion or by quinine dust, or powder form of the preparation, exerting a direct irritating effect on the skin.[8] Dermatitis due to other vegetable dusts such as vanilla, powdered arnica, pyrethrum, etc., have been reported.[8]

Dental lesions, of occupational origin, have been reported among workers in sugar. The gingivitis caused by sugar dust is classified as purely mechanical, with later-developing caries. Digestive disorders, respiratory conditions, and cutaneous conditions (especially of the face) were also found.[12]

Dock workers, transporters of grain, workers in grain and flour mills, etc. are exposed to dusts during their work. Dusts from cereals may contain many impurities, which may cause an irritating action on the respiratory passages, as well as inflammation of the skin. Digestive disturbances, dental defects, diminution in hearing, and conjunctivitis have been observed among millers, and have been attributed to the dusts to which such workers are exposed.[8]

b. *Allergic.* Many apparently innocuous substances may produce reactions in persons of peculiar personal susceptibility. The term "allergy" is used to describe this condition of hypersensitiveness or susceptibility, and allergic phenomena most frequently manifest themselves in skin reactions. However, they may cause acute reactions elsewhere in the body. When the respiratory tract is involved we have such well known diseases as hay fever or asthma. These diseases may develop as a result of hypersensitiveness to such substances as pollens from plants, horsehair, rabbit's fur, furs, feathers, etc.

For instance, furriers, workers in clothing industries who are exposed to wool dust, etc., may suffer from hay fever or asthma.[15] It is unnecessary for the offending dust to reach the depths of the lungs—giant pollens for example are reported to produce their effect after being caught in the upper respiratory passages. Should such an offending substance be finely ground it could reach the alveoli and as a result probably all physiologic reactions would be accelerated.[7]

In a survey of a plant where resin is mixed, ground, and molded, it was found that 80 per cent of the occupational dermatitis there was due to hypersensitivity to hexamethylenetetramine and formaldehyde contained in the dust to which the workers were exposed.[17] During the first processes of cotton spinning, cotton-strippers are exposed to dust arising from cotton husks and debris, which produces a typical form of asthma.[1]

Ordinary wood dust has been of interest due to its purely mechanical action, but still greater care is required in handling certain kinds, especially woods coming from abroad, because of the essential oils impregnating them, which when freed in the dust may affect the health of the workers concerned. Some of the woods capable of causing skin lesions are Brazil wood, satinwood, teakwood, cumaru or tonka wood, black ebony wood, West Indian mahogany, Japanese tagayasan, coccoloba, chestnutwood, olivewood, California sequoia, etc. All persons who handle these woods are not injured, only those particularly susceptible to the substances they contain becoming affected.[16]

2. *LIVING ORGANIC DUSTS.* These contain particles *capable of exhibiting the phenomena of life*[2] (especially the property of reproduction or multiplication), such as bacteria and fungi. They are usually found in low concentrations and are associated with nonliving dusts in the air.

a. *Bacteria.* One of the most important among these is the *anthrax bacillus*, which is contained in the dust from skins, furs, wool, and animal hair, *horns, hoofs, bones,* etc. This disease may occur in two forms: *cutaneous* (in which the organism affects the skin), and *pulmonary* (when it is inhaled, as in the form of anthrax known as woolsorters' disease).[12]

Cases of tetanus, reported in connection with *jute manufacture,* were traced to the raw material, the bacillus having been found in the factory dust.[18] *Diphtheria,* tuberculosis, smallpox, typhoid, or other bacillus-produced diseases, may *result from exposure* to infected dusts.

Bacterial sensitization can be the cause of any of the allergic diseases, namely, asthma, perennial hay fever, urticaria, angioneurotic edema, eczema, or migraine headaches.[19]

b. *Fungi.* Dusts containing the mycelia and spores of parasitic fungi give rise to annoyance and discomfort. "Maltster's" itch from the dust alone has been reported. In Provence, reeds used for ceilings are stacked while still wet and undergo fermentation; they become covered with a white powder (a dry fungus of the Mucor family: Sporotrichum dermatodes), which is scattered when the bark is stripped off. This powder is irritating to the skin and mucous membranes. Mycelia and spores of moulds are commonly found to cause rashes; for instance, the black powder coming from macerated sugarcane stalks. Among basket makers, the mycelium and spores, in the form of a white mould (hyphomycete) [illegible] the rattan canes used, get shaken out when the canes are split, hammered, and [illegible] causing painful fissures to develop on the skin where they alight.[16]

A form of asthma or spasmodic cough suffered by cotton weavers and known as aspergillosis, has been considered due to inhalation of spores of a mildew which sometimes occurs on the threads.[17] In a study of silicosis among miners, made by the Public Health Service, a number of cases of typical miliary calcification were encountered. Unstained smears of those cases examined were positive for fungus, [illegible] types of *Aspergillus fungi being identified.* All of the subjects but one were farmers, teamsters, feedmill workers, or residents of small agricultural towns where grain is marketed. Farmers are exposed to fungi threshing wheat, baling hay, or handling various small grains.[1]

Some other fungus diseases such as actinomycosis and blastomycosis are associated with occupational exposure to dust. The former occurs among workers handling straw, hay, grass, vegetable debris contaminated with mould, etc. Actinomycosis is likely to affect people engaged in commercial handling, storing, and cleansing of grain (grain distilleries, flour mills, grain crushing, breweries, and malting houses, etc.)[1]

II. Inorganic Dusts

Inorganic compounds are of mineral origin, not *requiring a living organism* to produce them.[2] A number of dusts not usually classed as toxic may, under some conditions, produce untoward effects on the human organism. Classified under inorganic are toxic and/or irritant, fibrosis-producing, and nonfibrosis-producing dusts.

a. *Toxic and/or Irritant.* Toxic dusts are those which are inherently toxic when inhaled, ingested, or otherwise absorbed. Among those which produce systemic poisoning, some of which are also irritant, are the dusts from heavy metals and their salts such as lead, mercury, arsenic, cadmium, zinc, etc. Irritant dusts are injurious by reason of their strong irritative or corrosive properties.

As a rule, inhaled irritant substances immediately cause a reaction in the upper respiratory tract of such severity that they are prevented from reaching the lungs, although they may cause lung damage by extension of inflammation if the mucous membrane is corroded.[1] Lime, calcium oxide, and the di-chromates are examples of irritant dusts. An inorganic dust may possess both toxic and irritant properties, and the poisoning produced may be the combined effect of more than one mode of entrance into the body.

Of the directly poisonous dusts, the most widely prevalent are those of certain lead compounds, particularly the oxide, carbonate and the chromate. The dust is readily absorbed by the mucous membrane; some dust passes into the stomach and is dissolved by the gastric juice.[1]

According to Fairhall, *perforated nasal septum* is a common occurrence among workers with bi-chromate dusts.[4] In a study made by the U. S. Public Health Service it was found that continuous daily exposure to concentrations of chromic acid mist greater than 1 milligram in 10 cubic meters is likely to cause definite injury to the nasal tissues.[20] It is believed that a similar concentration of the dust would be equally toxic.

In the case of poisoning from some heavy metals, exposure may be to both dust and vapor. For instance, investigations have shown the safe limit of *total* exposure to lead oxide dust and fumes to be less than 1.5 mg. per 10 cubic meters of air, except for prolonged exposure.[21] In exposure to mercury dust and vapor, it was shown that the incidence of chronic mercurialism increases rapidly with increasing mercury concentration, after such concentration exceeds 2.0 mg. per 10 cubic meters.[22]

Alkalis and metallic oxides are common causes of dermatoses. Lye, potash and lime are known to cause irritation to plasterers, cement-makers, bricklayers, masons, stonecutters, modellers, and metal platers.[16] Ulceration and perforation of the nasal septum occur among workers exposed to the dust of soda ash; systemic poisoning also occurs from inhalation of calcium cyanamide dust.[16]

[illegible] of dermatitis, scleroderma and cancer are reported to have been caused by exposure to dust of arsenic compounds. Certain aluminum salts are skin irritants and aluminum dusts may contribute to the infection of skin and mucous membranes, through mechanical action.[16]

b. *Fibrosis-Producing Dusts.* The most important of these are the inorganic, slightly soluble dusts which cause fibrous changes in the lung tissues, some of which are serious, and some of which cause little or no disability.[1] So far as is known, no inorganic substances other than silicon derivatives cause more than a very moderate degree of fibrosis of the lung. Moreover, there seems to be no evidence that any other constituent of ordinary dusts can influence so unfavorably a pulmonary infection.[5]

Although other dusts, when inhaled in sufficient concentrations over a long period of time, have been shown capable of producing a pulmonary fibrosis, nevertheless, the pneumoconiosis characterized by nodular fibrosis has to date been shown clinically and experimentally to be associated only with the inhalation of dusts containing free silica.

Since this dust, to exert its harmful action, must enter the finer divisions of the lung, the particle size of the atmospheric dust may bear a definite relationship to the injurious effect produced. The silica must be present in the air in particles small enough to enter the finer air spaces and of such dimensions that the phagocytic cells may engulf them. The greater majority of particles found upon microscopic examination of the lung fall within the limits of from 1 to 3 microns.[6] Examples of siliceous dusts are granite, quartz, sand, pumice, slate, etc.

In a recent study among anthracite miners, the correlations between exposure to dust (which contained silica) and the evidence of constitutional changes left little doubt as to the etiological significance of the dust in the air breathed. Like correlations were found between the silica exposure and the extent of pulmonary changes.[23] When the inhaled dust consists of silica combined with bases, silicates, some degree of change in the pulmonary tissue may result. In this respect asbestos dust seems to be unique among silicates in the prevalence and severity of the disease it causes.[24]

The chief distinction between silicosis and conditions due to simple reactions caused by other dusts is the active proliferative reaction in the tissues which results in progressive nodulation. Silicosis, when once established, strongly predisposes the lungs to infection, especially with the tubercle bacillus. Chronic interstitial pneumonia, chronic bronchitis, and emphysema are frequent complications of advanced degrees of silicosis.

The relation of the acute respiratory infections to the reaction due to dusts other than free silica has never been established, though a heightened incidence has often been shown statistically in workers in dusty trades. It is fairly certain that a dust damaged lung, whatever the cause, fares much worse if an acute infection does supervene upon it.[1]

In a study conducted by the U. S. Public Health Service among marble finishers in Vermont, it was found that marble dust when inhaled in the concentrations found in the examined plants produced a mild, bilateral, linear fibrosis in some cases, but no serious lung changes were noted and there was no disability due to the dust, even after years of exposure.[14]

c. Nonfibrosis-Producing Dusts. These are inert, that is, they do not cause fibrous tissue to be produced, but may become encapsulated or lie free in the tissues; or they are absorbed without production of fibrous tissue. Included among them are alundum, coal, corundum, emery, limestone, magnesite, marble, plaster of paris (gypsum), and polisher's rouge.

Dust Control

Engineering and medical control are the two most important factors in combating the industrial dust hazard, and are to a large extent complementary.

Engineering Control. As Lanza[4] has stated in a recent paper, "It is a basic principle in dealing with a dust hazard that the dust should be attacked at its point of origin and thus prevented from being disseminated into the atmosphere." After the dust has been spread throughout the air it is difficult to deal with it, and reliance must be placed on individual protection, which is never wholly satisfactory.

Lanza further cites various methods used in controlling dust. These will be reviewed but briefly, since a paper dealing with the subject of dust control in detail, will follow on this program.

Dust may be entrapped at its source by suction devices and thus removed and collected. Familiar examples are exhaust hoods in grinding operations, and the devices used in rock drilling.

Generally speaking, the exhaust ventilation method, where applicable, is to be preferred in controlling a dust hazard. Water may be used to entrap dust and prevent its dispersal, and under certain circumstances it may be of advantage to combine the use of water and the use of suction. Sometimes a dusty process can be completely enclosed in a sealed room or compartment. It must be remembered, however, that any mechanical device of this kind offers adequate protection only if it is properly designed, installed, and maintained.

A great deal of attention has been paid to the subject of individual protection against dust, and there are many types of respiratory protective devices now available. They are generally of two types: those which provide fresh air from an uncontaminated source and those which rely upon a filter medium for removing dust from the air breathed. Where the use of such a device is indicated, only one of the types approved by the U. S. Bureau of Mines should be used. As a rule, it may be said that masks, respirators, or other such protective devices should be used only where exposure to the dust is intermittent and brief, or where some unusual condition makes adequate dust control impracticable.[7]

Where bacteria or other living dusts in the air are associated with a process, sterilization methods such as increased temperature, ultraviolet radiation, and chemicals like chlorine or other bactericidal substances may be of use. Pasteurization temperatures (about 140° F.) will kill most organisms except those bearing spores. Steam disinfection is used for horsehair, and proves to be practicable if the temperature does not exceed 230° F. Wool fibres, however, lose their elasticity by steam disinfection, and the "Duckering" process now used in England includes soaking of the wool in a formaldehyde solution, and drying in a current of air at a temperature of 160° F.[12] There are few occupations in which there would be a sufficient concentration of dead bacteria to cause untoward effects in man.

In the case of dusts producing external irritation, auxiliary protective measures may include the use of protective clothing,

gloves, goggles and aprons; as well as protective salves, ointments, or other compounds to delay or diminish the irritant action. General rules for hygiene and good housekeeping should also be observed.

Medical Control. Equally important, and closely interrelated with the engineering phase, is medical control of occupational hazards. In addition to directing the proper placement of new workers, and guarding the health of all employees, medical control is a check on the efficacy of the engineering control methods already instituted, or a measure of the need for new protective devices.

It has been stated that "Industry has found that the best way to treat industrial injuries and illness is to prevent them."[18] and medical control, through preemployment and periodic physical examinations, is one of the most important factors in such prevention.

The preemployment examination is made to determine the employee's physical and mental fitness for work. It serves to disclose the presence of any contagious disease, reveals any minor physical defects which might later become serious, or whether the examinee's condition precludes his employment in certain or in all types of work. It should be remembered that such preemployment examinations are not to be made for the purpose of eliminating an employee, but rather for allocating him to the type of work for which he is physically suited. A worker should be given employment unless totally unfit, or unless his disability, even though slight, would cause him to be a hazard to himself or his associates. Furthermore, the practice of preemployment examinations should be extended to include executives and officials of industrial organizations.

"The purpose of periodic physical examinations is to secure and maintain physical fitness and thereby lengthen work spans."[18] Reexamination of employees sometimes results in the discovery of defects and disabilities which were not observed at the time of employment. In such cases, an occupational adjustment should be made to provide continued employment, but remove the risk of permanent injury.

Reexamination of employees is required by law in certain occupations in which the handling of poisonous or otherwise deleterious substances may result in the contraction of disease.[9] Since some occupational diseases tend to clear up and recur, records of previous occupations should be included in the physical examinations. The frequency of examinations should be determined by the medical director, unless otherwise specified by law. Those exposed to known occupational disease hazards may have weekly or monthly examinations.[9]

"It should always be kept in mind that the basic principle of physical examinations in industry is to keep men on the job and not allow the physical examination to be merely a weeding out process."[18]

References

[1] Bloomfield, J. J. and DallaValle, J. M. "The Determination and Control of Industrial Dust." U. S. Public Health Bulletin No. 217, April, 1935.

[2] Collis, Edgar L. "Industrial Pneumonoconioses, with special reference to Dust Phthisis." Milroy Lectures, 1915. H. M. S. O., London.

[3] Sollmann, Torald. "A Manual of Pharmacology." W. B. Saunders & Co., Philadelphia, 1932.

[4] Fairhall, Lawrence T. "Toxic Dusts and Fumes." Journal of Industrial Hygiene and Toxicology, November, 1936.

[5] Bloomfield, J. J. "The Sampling and Analysis of Industrial Dusts." American Public Health Association, Yearbook, 1935-36.

[6] Gibbs, W. E. "Dust Hazard in Industry." Ernest Benn, Ltd. London, 1925.

[7] Air Hygiene Foundation of America, Inc. "Silicosis and Allied Disorders." Medical Series, Bulletin No. 1. Pittsburgh, Pa. April 15, 1936.

[8] Katale, F. H. "The Action of Harmful Dusts." Inst. of Mining and Metallurgy, London, June 11, 1931.

[9] "Dusts, Fumes, and Smokes." Occupation and Health Series, International Labour Office, Geneva, 1930.

[10] Drinker, Philip. "Causation of Pneumoconiosis." Journal of Industrial Hygiene and Toxicology, October, 1936.

[11] "Dyeing." Occupation and Health Series, International Labour Office, Geneva, 1930.

[12] Legge, Sir Thomas. "Industrial Maladies." Oxford University Press, London, 1934.

[13] Burstein, A. "Nicotine Action from Inhaled Tobacco Dust." Journal of Industrial Hygiene, December, 1932.

[14] White, R. Prosser. "The Dermatergoses, or Occupational Affections of the Skin." H. K. Lewis & Co. Ltd., London, 1934.

[15] Schwartz, Louis. "Skin Hazards in American Industry." U. S. Public Health Bulletin No. 215, October, 1934.

[16] Downing, J. G. "Industrial Dermatoses: Treatment and Legal Aspects: Review of Recent Literature." Journal of Industrial Hygiene and Toxicology, July, 1935.

[17] "Occupational Lesions in Workers in Sugar." Belgium Letter, Journal of American Medical Association, Sept. 10, 1927. Abst. Journal of Industrial Hygiene, February, 1928.

[18] "Flour Mills." Occupation and Health Series, International Labour Office, Geneva, 1930.

[19] Mayers, Max R. "Susceptibility to Dermatitis." The Industrial Bulletin, Albany, N. Y. Feb. 1932, vol. 16, no. 2.

[20] Drinker, Philip, and Hatch, Theodore. "Industrial Dust." McGraw-Hill Book Company, Inc., New York, 1936.

[21] Schwartz, Louis. "Skin Hazards in American Industry. Part II." U. S. Public Health Bulletin No. 229, Sept. 1936.

[22] "Poisonous Woods." Occupation and Health Series, International Labour Office, Geneva, 1930.

By Hours of the Day
By Body Part Injured
By Nature of Injury
By General Cause
By major subclassifications under General Cause
By Primary Basic Causes
By Secondary Contributing Causes
By Foremen in Charge
By Manner of Performance
By Agency (Machine, Material, etc.)
By Part of Agency
By Method of Contact

The figures may be summarized [illegible] days of time lost, medical expense, compensation awards, or other associated data.

WEDNESDAY AFTERNOON SESSION

October 13, 1937

Methods for Protection Against Silicosis, and When They Are Justified[1]

By DANIEL HARRINGTON

Chief, Health and Safety Branch, U. S. Bureau of Mines, Washington, D. C.

While the hysteria with regard to silicosis and other occupational diseases has largely subsided and this subject is being more carefully considered and soberly judged, it would be poor policy for any employer to maintain that the storm has ended and that he can relax and revert to conditions as they were some years ago. The fact is that the plan of paying occupational-disease compensation is now in its infancy and can be expected to grow rapidly.

At present while all the States of the Union, including the District of Columbia and excepting only Arkansas and Mississippi, have compensation acts, only the following make provision for occupational diseases to some extent: California, Delaware, Connecticut, District of Columbia, Illinois, Indiana, Kentucky, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Rhode Island, Washington, West Virginia, and Wisconsin.

Silicosis is compensable in one way or another in California, Connecticut, District of Columbia, Illinois, Kentucky, Massachusetts, Missouri, New York, North Carolina, North Dakota, Ohio, Pennsylvania, West Virginia, and Wisconsin, and possibly in other States. It will be surprising if comparatively comprehensive occupational-disease legislation is not on the statute books of nearly every state in the Union within the next five years.

With this situation confronting him, a far-sighted industrialist who has the good of his organization at heart will immediately start to "put his house in order" by studying possible occupational disease hazards to employees and promptly applying known remedial measures or attempting to develop such measures if none exist. Unquestionably one of the most important of the surveys to be made relates to dust occurrence.

While the state dust laws and regulations apply primarily to silica dust and resultant silicosis insofar as the health hazard is concerned, those most familiar with dust occurrence and its possible hazard [illegible] only that the breathing of large quantities of dust of free silica (SiO_2) is probably the greatest hazard to health likely to be met where dust is involved, but that not only silica dust is harmful to health unless it occurs in very finely divided form and is breathed in relatively large quantities more or less continuously for a considerable length of time. Moreover, many thoughtful experts on dust harmfulness are now becoming convinced it is to be expected that health will be harmed when human beings are obliged to breathe high concentrations of any kind of dust more or less continuously. Professor Philip Drinker, of Harvard, as chairman of the Preventive Engineering Committee of the Air Hygiene Foundation [illegible] expressed the considered opinion of a body of outstanding dust experts as [illegible]

"There is no satisfactory medical answer [illegible] to this question, but the engineer [illegible] a bad mistake if he lets men [illegible] heavy dust concentrations of any [illegible]. If no other reason for dust control can be found, then one should read transcripts of some of the recent suits at common law in which fantastic damages for alleged silicosis were granted to men who breathed dust containing little or no silica. The courts and compensation boards are not impressed with subtle distinctions between dusts with 10 per cent and 40 per cent quartz, especially when medical experts are reluctant to make definite statements as to the comparative significance of such differences.

"It would be well to realize that men working in dusty trades suffer far more from respiratory troubles of all kinds than do men who work in clean air. The evidence that excessive dustiness of any kind is harmful is beyond argument."

It should also be remembered that the inhaling of dust is by no means the only hazard in industrial work that may require compensation payment; and even here the harmful effect of breathing dust is not necessarily confined to the lungs, as some kinds of dust are known to have detrimental health effect on the nose, throat, and bronchial passages as well as (indirectly) on the heart, stomach, and possibly other internal organs. Externally, dust may cause injury to the eyes, ears, and skin; and some dusts, in contact with the perspiration, are absorbed with definite harm to the health of the victim.

Dust Cuts Visibility

Moreover, heavy concentrations of dust in the air reduce visibility materially. Obviously, in industrial occupations in which but limited amounts of natural light are available or in which artificial light is used entirely, any decrease in visibility due to air-dust concentrations (and the decrease in visibility may, under some circumstances, amount to 75 per cent or more) is likely to result in materially reducing efficiency and also in the more frequent occurrence of accidents accompanied by an increase in compensation commitments. Some dusts (coal, [illegible], and scores of others, mineral and [illegible] mineral) are explosive and many are subject to spontaneous combustion with consequent hazards to health, safety, and property. Many dusts have detrimental effects of various kinds on property as distinguished from persons. Machinery, growing vegetation, animals, dwelling houses, and other types of property are damaged by dusts, and compensation of some kind often is obtained from industrial concerns through damage suits or otherwise.

From the viewpoint of respiratory harmfulness, it is generally stated (though actually knowledge on this point is by no means certain) that the particle sizes of dust (such as that of free silica) that affect health adversely upon entering the lungs are those that are less than 10 microns in size, different persons having different ideas as to what the maximum may be—10 microns or 8 or 6, and some say that the harm really is done by particles less than 2 microns in size. As against this, it is stated that fibers of asbestos dust as long as 200 microns have been found in the lungs of men, and that undoubtedly these long asbestos fibers exerted at least some detrimental effect.

Since a micron is only about one twenty-five-thousandth of an inch, or much smaller than the naked eye can see, it is usually assumed that the larger dust particles that can be seen floating in air, and which settle out relatively fast are not harmful to health. Certainly, this is not so, as the larger particles that float in the air (some of them 100 or more microns in size), if present in considerable quantities clog the air passages to the lungs, some of which have agencies that under ordinary conditions intercept dust particles before they can reach the lungs and this clogging then allows the smaller and probably most dangerous dust to enter the lungs unimpeded.

A common-sense opinion as to what constitutes an atmosphere so dusty that dust-prevention action should be taken is that any atmosphere in which dust can be seen by the naked eye is too dusty, not only for health but also, at least in many cases, for safety and efficiency. If the visible dust is eliminated, much of the invisible or probably most dangerous dust will unquestionably have also been removed and very likely the health as well as other hazards much minimized or even removed.

After the visible dust has been removed, it may be necessary, under some conditions or with some types of dust, to make more in-

1. Published by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright.)

If not it will probably be best for him to be advised of this fact at the outset and given assistance in securing rehabilitation vocational training; after which he may return to his former place of employment qualified to do some special work. In this case he [illegible] be given consideration for reemploy[illegible].

He will be happy because he [illegible] overcome a handicap and learned [illegible] can still be independent.

Industrial Tuberculosis—A Public Health Factor

By H. J. SPECTOR, B.S., M.D.

Assistant Health Commissioner and Chief of Medical Section,

St. Louis Health Division, St. Louis, Mo.

The term industrial tuberculosis is somewhat misleading because it may be thought that industry is the direct causative factor in the production of tuberculosis. But tuberculosis is a germ disease, directly caused by the tubercle bacillus. No industry, no matter how harmful it may be to the human body in general, is capable of directly producing the disease tuberculosis without the presence of tubercle bacilli.

How can we explain then the high mortality rate from tuberculosis in certain industries?

To seek an answer to this question, one must consider the subject of so-called industrial tuberculosis from the broader aspect in general, but especially from the viewpoint of possible existing predisposing factors incidental to certain industries. The contributory factors which may play a role in the development of tuberculosis are many in number, but for the sake of clarity may be classified under two main headings: (1) environmental, and (2) social and economic.

Environmental Factors

Industrial environment has long been recognized as a most important contributory factor in the causation of upper respiratory diseases. For instance it is known that employees in dusty trades, and those usually exposed to high temperatures, excessive moisture, to bad weather conditions generally, and to noxious fumes are among the workers who frequently are forced to absent themselves from their employment because of sickness.

1. Inorganic Dust

One of the most serious environmental factors existing, especially in the mining and some abrasive industries, is the presen[illegible] inorganic dust in concentrated [illegible] taining abnormal amounts of [illegible] Industries like hard rock mining, quarr[illegible] grinding and sand blasting have a [illegible] morbidity and mortality rate from [illegible]culosis attributable to this cause. Emplo[illegible] exposed to such an atmosphere over a [illegible]longed period of time will develop [illegible] and the latter will lead to the develo[illegible] of tuberculosis in many instances.

Asbestosis is a disease similar to [illegible] which may contribute to the morbidi[illegible] tuberculosis. However the evidence a[illegible] cut in this direction is not conclusive.

2. Organic Dust

There has been considerable discussion [illegible] to the role of organic dust in the produc[illegible] of tuberculosis. The high mortality [illegible] from tuberculosis in tobacco workers, [illegible] workers and tailors was responsible [illegible] early belief that organic dust was a con[illegible]tributory factor in the production of tuber[illegible]culosis. The work of Landis of Philadel[illegible] which is based on autopsy studies of [illegible] lungs of 50 patients who had been exp[illegible] for many years to organic dusts, dispro[illegible] this concept since none of these pat[illegible] showed evidence in their lungs of [illegible] tuberculosis. At the present time it [illegible]erally held that organic dusts do not pro[illegible] disabling disease of the lungs and are [illegible] predisposing factors in the development [illegible] tuberculosis.

3. Noxious Fumes

The effect of noxious fumes on the [illegible] and their relation to tuberculosis has [illegible] studied by Winternitz of Yale, Metz [illegible] U. S. Veterans Bureau and others. [illegible] these investigators seem to point [illegible] that noxious fumes in great [illegible] will produce immediate irrita[illegible] in the upper respiratory tract [illegible] such serious complications of the [illegible], pneumonia and in some cases [illegible] of the patient.

[illegible] on soldiers who were gassed [illegible] the world war, made by Metz, indi[illegible] further that noxious fumes, when in[illegible] into the lungs, do not lead to the [illegible] of either acute or chronic pul[illegible] tuberculosis in most instances. From [illegible] observations the writer is inclined [illegible] agree with this viewpoint.

[illegible] Improper Sanitation and Ventilation

[illegible] exposed to changeable temper[illegible], to excessive moistures and working [illegible] improperly ventilated and unsanitary [illegible] will expose themselves to the risk of [illegible] their resistance, thus predisposing [illegible] to the development of tubercu[illegible] as well as other respiratory diseases.

Social and Economic Factors

It is an accepted fact that tuberculosis, [illegible] an infectious disease, is capable of [illegible] and actually does produce active [illegible] in people regardless of their [illegible] and economic rank. It is also true [illegible] poverty goes hand in hand with tuber[illegible] and that most tuberculosis will be [illegible] in underprivileged people.

This fact has recently been confirmed [illegible] by Miss Whitney, who in a study [illegible] death rates by occupation reveals that the [illegible] skilled worker, the one who usually works [illegible] hours and most often in an unventilated [illegible] unsanitary environment, the one who [illegible] receives meagre compensation for [illegible] services, has a very high mortality rate [illegible] tuberculosis. On the other hand, the [illegible] who receives a fair salary and [illegible] is usually out of doors with little physi[illegible] exertion has a comparatively low death [illegible] while the lawyers, the judges, the [illegible], and the manufacturers, representa[illegible] of the higher economic bracket of so[illegible], have the lowest death rates as seen in [illegible] accompanying table.

Of great public health interest is the fact [illegible] servant, the cook and the waiter, [illegible] of the lower economic rank, [illegible] high mortality rates. Since [illegible] represent frequent sources of [illegible] community, the control of

TABLE I

Death rates from tuberculosis per 100,000 gainfully occupied males 15 to 64 years of age in selected states according to economic groups (1930)

Tuberculosis (Respiratory Form)

Average, all occupations	87.3
Average, professional group	38.1
Average, lawyers & judges	31.2
Physicians and surgeons	29.4
Average, proprietors, managers & officials	44.8
Bankers, brokers, moneylenders	22.5
Managers and officials	27.9
Builders, building contractors	41.1
Average, clerks & kindred workers	62.1
Real estate agents	28.8
Average, agricultural workers	36.7
Average, skilled worker & foreman	72.2
Moulders, founders, casters	[illegible]
Policemen	46.[illegible]
Average, unskilled workers	185.1
Factory & building construction laborers	248.2
Average, servant classes	173.1
Servants & cooks	156.[illegible]
Waiters	169.8

tuberculosis in this economic group becomes a major public health problem.

Miss Whitney's study was based on mortality statistics of males only. Some insight into the morbidity according to occupation can be had from a recent study that we have made in the St. Louis Health Department on 31,990 reported cases of tuberculosis male and female as seen from the viewpoint of occupation.

We found in Table II that the occupations of 19,439 or 60 per cent could be classified under 10 major heads, while the remaining 12,551 could be classified under 695 occupations. It is interesting to note that "house-

TABLE II

Showing occupations of 31,990 reported cases of tuberculosis in city of St. Louis (190[illegible]-193[illegible] incl.)

Total No. of Tuberculosis Cases	31,990
Total No. of Occupations	705
60% of Cases in 10 major occupations	
40 of Cases in 695 remaining occupations	

1. Housework	7651	8791 or 45% of people in the ten major occupations either did house work or handled food.
2. Unskilled labor	5119	
3. Clerical work	2311	
4. Shoe workers	881	
5. Porters	661	
6. Waiters & Cooks	660	
7. Teamsters	639	
8. Salesmen	519	
9. Students	516	
10. Laundresses	480	
Total	19,439	

Dusts, Fumes, Gases and Vapors

WEDNESDAY MORNING SESSION

October 12, 1938

Assembling in the Grand Ballroom of The Stevens Hotel, this meeting was called to order by Chairman Walter S. Paine, Manager, Engineering and Inspection Department, Aetna Casualty & Surety Company, Hartford, Conn., and Vice-President for Engineering, National Safety Council. Chairman Paine briefly outlined the session objectives, and then introduced the speakers.

Recent Developments in Detecting Hazardous Dusts, Fumes, Gases and Vapors

By WARREN A. COOK

Superintendent, Engineering Department, Zurich General Accident and Liability Insurance Company, Ltd., Chicago

In discussing the determination of injurious dusts, fumes, gases and vapors, I am very sure that you are not interested so much in a meticulous dissertation on such phases of the subject as whether the logarithm of the reciprocal of the hydrogen ion should be 9.5 or 9.0 for the determination of lead by the dithizone method, but rather in a discussion of this matter along broad lines, pointing out what types of potentially injurious materials should be looked for, whether determination of them is in order, a brief discussion on some of the more important and common methods of determination, and interpretation of the results obtained.

Foolhardy to "Work in the Dark"

Working in the dark without any means of illumination where there may be hazardous conditions serious enough to cause loss of life or severe injury would be considered most foolhardy; yet every day men conduct their operations in atmospheres containing dusts, gases, and vapors which may cause death or severe injury to health without being able to see or otherwise perceive the potentially hazardous condition.

Most gases and vapors can no more be seen than the well-known black cat in the coal cellar. Some of them cannot even be detected by odor, though odor is itself no reliable criterion as is evidenced by the gas, hydrogen sulfide, which has a most obnoxious odor but has caused many a case of poisoning.

How, then, are we to know whether the atmosphere in which we work is safe or injurious? Are we to wait until we see the effects of unhealthful or irrespirable atmospheres on our men or is it not more intelligent to determine, within the limitations of modern methods and practical applications, just what sort of atmosphere we are subjected to?

The importance of having facts before us is well illustrated by an atmospheric condition where a life could be snuffed out in a few minutes, even though the more common situation is where excessive exposures may require weeks, months or years to cause their injurious effects.

Thirteen years ago this month a powder crew was walking down the tunnel of a new water supply system of a Connecticut city. Their duty was to inspect the roof and the face, to see that all the shots were fired. On approaching the tunnel heading immediately after the blast, they found that flying rock had broken the compressed air line, which had been left turned on in order to blow the smoke and gas away from the face of the tunnel. The crew, consequently, ran into a heavy blanket of smoke, but they were hardened workers, used to smoke and gas, and a little smoke, even though they knew it contained carbon monoxide, did not hold them back.

They found the roof intact. But four of the holes had not fired. Caps with 5-foot fuses were inserted in sticks of dynamite, one for each of the holes. The gas condition by the time this work had been accomplished was beginning to make these men feel a bit groggy. Following the usual practice, the powder foreman sent the rest of the men back down the tunnel before he lighted the fuses.

The men walked back through the smoke to the car, about a quarter of a mile down the tunnel. There they waited for the foreman. Seconds passed. The time stretched to a minute. Down the tunnel came the boom of the blast—but no foreman. The men rushed to the heading and found the foreman stretched on the tunnel floor, nearly covered with rock from the blast, where he had collapsed from the effects of the carbon monoxide.

This is a true story up to a certain point but I have omitted a part of the story, and the ending, I am glad to say, is pure fiction. The part of the story which I omitted was that carbon monoxide determinations were being taken when these men got up to the heading, and a concentration of .5 per cent carbon monoxide was shown to be present by means of the Hoolamite carbon monoxide detector. With such a high concentration it was realized by the man making the determinations that it would not take long for exposed persons to collapse. He informed the crew of the condition and hurried them back to the car to wait until the smoke and gas had cleared enough to permit them to work safely and fire the blast.

The difference between fact and fiction in this case, between a brief delay and a fatal case of carbon monoxide poisoning, was the ready availability of a simple means of determining the carbon monoxide concentration on the job.

The present tendency in development of methods of determination of injurious materials in air is toward such simple, quick acting devices. As many of you know, the Hoolamite carbon monoxide detector operates merely by pressing a rubber bulb ten times and comparing a purple color which develops in presence of carbon monoxide with a standard color scale mounted on the instrument, an operation which requires about a minute. Instruments of this type are especially important for cases which may cause acute poisoning such as carbon monoxide, hydrogen cyanide, and hydrogen sulphide.

An instrument for determination of hydrogen cyanide, similar to the Hoolamite carbon monoxide detector, has recently been developed by the United States Bureau of Mines workers, and, together with a number of other of these simple detectors, is now available commercially. By combination of such material, we can actively do much which was [illegible] formerly when laborious chemical laboratory methods were necessary.

Potentially Hazardous Materials

The first step in an organized endeavor to avoid environmental conditions which may cause injury to health is a listing of materials, used or produced, which may under certain conditions be deleterious. It was found in a study by the United States Public Health Service of potential hazards in a typical industrial area (1) that a considerable percentage, nearly 20 per cent, of the workers were exposed potentially to carbon monoxide. The report by no means intimated that this percentage of workers were being poisoned by carbon monoxide but rather that if things went wrong and a concentration of the gas built up to dangerous proportions these men might become poisoned.

So I suggest that you go through your plants and see what operations involve potentially injurious materials. Of the dusts, those which may produce silicosis occur not only in the well-known industries where major studies of conditions have been conducted but in other industries as well though usually to a lesser extent. In silverware manufacturing, for example, one man may be exposed day after day to tripoli dust in making up a polishing compound for use within the plant. A list of industries in which such dust exposures may exist is given in the report of the National Silicosis Conference.[2]

The toxic dusts and fumes are more readily spotted. We recognize and guard against lead exposure in storage battery plants, but often overlook such an operation as where red lead is being mixed with a vehicle by a worker in one corner of the top floor of the plant to color lettering on a steel part. It is not so much whether a pound of lead or a ton is used in a day, but the extent to which it contaminates the air breathed by the worker.

Carbon monoxide, hydrogen sulphide, hydrogen cyanide have been mentioned as examples of gases. The first of these occurs where producer gas or water gas is used. The last named should be looked for where fumigating may be done from time to time. Where dry ice is used in quantity or fermentation processes are conducted, carbon dioxide is liberated and has caused deaths usually at the bottom of confined areas such as ships' holds and fermentation tanks.

Vapors are present wherever organic solvents are used. Death may result quickly where high concentrations exist as has occurred when a drum of solvent was dropped on a basement storage room floor and split open, and again where carbon tetrachloride was being used for fumigating a flour mill and the fumigator sprinkled the liquid in the basement as his last operation. It was his last.

Injury from continued exposure to solvent vapor at concentrations which cause their effect after weeks of exposure is the more common condition. The various solvents differ widely in the concentration of vapor necessary to cause injury. These are divided into groups in accordance with their toxicity in a paper delivered before the Northwestern University Symposium on Occupational Diseases a year ago.[3]

Where Should Determinations Be Made?

After going over your plants and learning where potentially hazardous materials are present, it is my suggestion that, before making actual determinations of concentrations in air or instituting control measures, you make a thorough survey of the conditions and divide the various operations where these materials are present into groups: (1) those which are obviously safe; (2) those which are admittedly causing injury to health or are worse than good industrial practice dictates; (3) those conditions where it is not readily discernible by general observation whether the exposure is within safe limits.

Certain conditions we know definitely and can say definitely will not cause injury to health. I would not say that those are to be forgotten, but at least they need not be the subject of initial action. If, for example, a gas containing 30 or 40 per cent carbon monoxide is used for hot plates, and those hot plates are connected with rigid conduit rather than with rubber tubing, you can feel reasonably safe that the carbon monoxide exposure is within safe limits, and I would not recommend that determinations be made. Where spray painting is being done in a well ventilated booth in such a manner that there is no excessive rebound into the face of the sprayer, determinations of vapor or pigment need not be made even though the odor of the solvent is detectable. From time to time it may be well for state authorities to check some of these lesser exposures, but there is a considerable number of such exposures which can be accepted as safe.

The second group of exposures—that where conditions are admittedly severe—is another where determinations are not essential. Institute control measures immediately. If there are clouds of dust containing free silica in your plant, go to work on them. If excessive lead absorption is shown by development of symptoms or by high basophilic aggregation percentages, reduce the lead exposure. It may be desirable to make determinations even in these cases either to provide a before-and-after picture of exposures to show what improvement is effected or to obtain a clear picture of just what part of an operation is responsible for the excessive exposure to the end that control measures can be more specifically applied. This latter use of air analysis data is of especial value where the materials are invisible as is the case with gases, vapors and even some of the more toxic dusts such as quartz and lead.

The principal use for determination of

sible for any difficulties which have been encountered. I cannot conceive of any rehabilitation worker, after having spent considerable time in studying, analyzing and training one of his clients, being willing to shrug his shoulders and say to the employment office, "There, now this is your problem"; nor can I imagine any employment service worker terminating his interview with a physically disabled person with a remark such as, "Well, you're crippled, the State Rehabilitation Service will have to take care of you."

To me, it will always have to be a responsibility of both agencies and [illegible] and means of disclosing opportunities [illegible] suitable employment for the physically [illegible] abled can, perhaps, best be summed up [illegible] offering this recipe: To equal quantities [illegible] a knowledge of the applicant's ability [illegible] the job requirements add an unbo[illegible] amount of initiative, perseverance, [illegible] cooperation and hard work and success [illegible] be assured.

ADJOURNMENT

Occupational Disease

THURSDAY MORNING SESSION

October 13, 1938

The session for the discussion of outstanding problems in the field of occupational disease was called to order by the [illegible] P. J. Angsten, Chairman, the Illinois [illegible] Commission, Chicago, who presided. The Chairman emphasized the importance of the selected subjects to be presented by eminent speakers, and promptly introduced the first scheduled speaker.

The Trend of Occupational Disease Legislation

By HENRY D. SAYER

Manager of the Casualty Department, Association of Casualty and Surety Executives

Let us consider the differences between the accidental injury and the occupational disease. For these distinctions are important and must constantly be borne in mind when we consider either legislation on the subject of disease, or engineering methods of prevention or control.

Generally speaking, accidents occur at a specific moment in point of time, and, from the standpoint of fixing liability under any plan of insurance, it is in the future; that is to say, at the moment of the acceptance of liability under any insurance contract the accident for which liability may be assumed has not yet happened. That [illegible] [illegible] is not so with the occupational disease. Insurance by its very nature can only assume liabilities that have yet to [illegible] not those that have already accrued.

[illegible], speaking generally, the industrial accident is something that can be seen— [illegible] though unforeseen. It may be visualized and described in words, setting forth specifically the time, place and manner of happening. It can then be determined, after the happening of the event, whether it was preventable or inevitable; blame, if any, can be [illegible]; the worker involved, or his [illegible] or superintendent, can be shown [illegible] and effective measures can be [illegible] against a like future hap-

But some will say, truly, not all accidents happen in the manner described; that not always are they held to occur only at a specific moment or under circumstances where they can be visualized and described. By administrative and court decisions, it is true in some jurisdictions that the definition of "accident" has been greatly broadened. We find the entrance of disease germs into the human system without visible trauma, with resulting sickness or death, and even the specific time and place not definitely known, except that it is shown to have probably occurred in the employment, being held to be an accident.

(Hiers vs. Hull, 178 App. Div. [illegible] N.Y. [illegible]; an anthrax case; Vennen vs. New Dells Lumber Co., 161 Wis. 370, a typhoid case, and others.)

Poisoning of the body through the effects of a deleterious or toxic substance used in the employment, the dangers of which were unknown to the worker, the employer having been negligent in safeguarding properly the use of such substance, has been held to be the result of an industrial accident.

(Victory Sparkler & Specialty Co. vs. Francks, 147 Maryland, 368, and the very recent case of Black vs. Creston Auto Co., Iowa Supreme Court, August 5, 1938, 281, N.W. 189.)

And where negligence of the employer has been shown, an injury to health, even though not occurring through a happening at a given time and place, but by repeated

Industrial Hygiene

Industrial Dusts—What Every Supervisor Should Know

By L. E. HAMLIN, M.D.

Medical Dir., American Brake Shoe Company, Chicago, Ill.

[illegible] manufacturing procedures are capable of generating varying amounts of dust [illegible] may be visible, invisible, dangerous or [illegible]. It is therefore important that these [illegible] be properly classified in order [illegible] protect the health of employees and provide safe environments in which they may [illegible] their daily occupations.

[illegible] the supervisor should have [illegible] knowledge of industrial dusts since [illegible] responsibility for enforcing measures designed for their control usually falls upon [illegible]. Unless he has a good idea of the actual risks confronting him, he will be at a disadvantage in securing cooperation from those under his direction. Ability to answer questions concerning plant hazards in a convincing manner is a very important factor in any dust control program, and if the supervisor cannot explain the necessity of avoiding exposure to toxic materials the worker under his charge is very unlikely to pay attention to it.

On the other hand, a brief explanation [illegible] the ring of sincerity and truth [illegible] frequently correct unnecessary misunderstanding. For example, a capable [illegible] employee was worried about contracting silicosis because he worked in a [illegible] where at times there appeared to be [illegible] dust in the atmosphere. He did not know that this dust was free from [illegible] or other harmful ingredient, but his [illegible] did.

Knowledge of his own department enabled the supervisor to convince the workman that not only was the dust inert but also [illegible] were under way for the installation of new ventilating equipment which would [illegible] the particles that were already present. [illegible] was satisfied and the company [illegible] to retain the services of a [illegible].

[illegible] some of the fundamental [illegible] should know about industrial dusts? Dust is formed by reducing earthy materials to small size. Processes like grinding, crushing, blasting, and drilling produce dust particles of sizes from the submicroscopic to the visible.

Fumes are formed from combustion, sublimation and condensation. Those from burning or melting lead or zinc are typical examples. The size of the particles is generally below one micron. (A micron is 1/25,000th of an inch.)

Smoke is usually of organic origin from such things as burning tobacco, wood, oil or coal. The particle size is usually below a half micron.

Mists or fogs are formed by condensation of water vapor and the particle or droplet size varies widely.

The most important item to the supervisor is the realization that he may be dealing with a dust which can produce bodily harm. His first consideration should be "How is the man himself affected? Is the dust present in sufficient amounts in the air to be a source of danger? Does it exist in the pure state or is it mixed with other dusts? What is the actual count of particles per cubic foot of air, and what percentage of these is of respirable size (below 10 microns and especially those below three microns? How long does it take to develop occupational disease of the lungs from exposure to dust?"

All this may appear to be outside the scope of the supervisor's activities since after all his job is concerned primarily with production. However, most industries place the responsibility for carrying out safety measures on the foreman and it is apparent that his department will suffer if these are not properly enforced. Safety therefore includes precautions against occupational disease as well as accidents so that some knowledge of methods for controlling exposure from dangerous dusts, toxic fumes or other harmful materials is a proper part of the supervisor's armament.

It is not advocated that his duties be so expanded as to encroach upon the field of the industrial hygienist but it is reasonable and logical to suggest that he equip himself with the essential details concerning occupational risks in the department he manages. This information can be readily obtained from his company medical department or through other agencies such as the Division of Public Health of state and federal governments. These bureaus welcome inquiry of this type and their services are usually available without charge.

Much confusion and misunderstanding exists about the capacity of various dusts arising from occupational procedures to cause physical disability. Exaggerated reports and misrepresentation by individuals unfamiliar with their specific properties have incriminated certain materials known to be quite inactive and absolved others proven to possess harmful qualities. Experience accumulated through years of intensive study and research indicates that the great majority of industrial dusts have little effect on health other than their nuisance value and contribution toward poor housekeeping.

However, the fact that they are unlikely to cause occupational desease should not be used as an excuse to do nothing about them. A good working environment demands that they be removed in spite of their innocuous characteristics and the smart supervisor will do all he can to accomplish their elimination.

The wide assortment of dusts met with in industry makes their classification into "harmful" and "inert" categories difficult. Those arising from organic sources such as animal and vegetable products as a rule do not cause serious harm but are capable of producing local irritation like dermatitis or skin rashes, dental conditions, and inflammation of the eyes and the mucous membrane lining of the upper air passages.

The majority of harmful dusts encountered in manufacturing processes are inorganic in character. The specific effect on health varies. Chromium, cadmium, arsenic, and their compounds produce local irritation as do the organic dusts but they can also cause general intoxication if present in sufficient amounts. The dusts or fumes derived from the heavy metals like lead, [illegible] manganese can be highly toxic [illegible] from these substances has been [illegible] for many years.

Recently serious and even fatal [illegible] has been found to occur from exp[illegible] beryllium and some of its compounds [illegible] another occupational condition [illegible] "Shaver's Disease" has produced [illegible] age to the lungs of workers [illegible] fumes arising from the fusing of [illegible] the chief ore of aluminum, in the [illegible] ture of artificial abrasives.

Generally speaking, the particle [illegible] is most dangerous is in the range of [illegible] to three microns in diameter. [illegible] larger than these seldom reach [illegible] or terminal air saces of the lungs [illegible] are filtered out by the "cilia" [illegible] protective mechanism of the nose [illegible] and large bronchi. There is also [illegible] dence that particles below one-half [illegible] in size may be retained in the lungs [illegible] cient quantities to result in disease. [illegible] means that the visible dust in a [illegible] place may not be as dangerous as the [illegible] ticles which are not seen by the [illegible]

Industrial hygienists emphasize [illegible] also point out that although the [illegible] visible dust in the atmosphere in the [illegible] of a certain job appears great, it [illegible] necessarily mean that the workman [illegible] haling significant quantities of harmful [illegible] ticles. The exposure may be [illegible] and of brief duration, or the air [illegible] breathing level of the employee [illegible] sufficiently clear that no undue [illegible] volved.

With the exception of beryllium [illegible] bauxite few of the aforementioned [illegible] cause damage to lung tissue and [illegible] plained previously, not every [illegible] exposed does develop occupational [illegible]

At the present time it is generally [illegible] that the most important sources of [illegible] trial disease of the lungs are free [illegible] combined silica and asbestos. [illegible] silicon dioxide which makes up [illegible] mately 60 per cent of the rocks and [illegible] of the earth's crust, is the specific [illegible] the ailment affecting the lungs of [illegible] in dusty trades, known as silicosis.

It is very important to recognize [illegible] that this widely known condition [illegible] be acquired from any material [illegible]

[illegible] also that it happens only [illegible] smaller than ten microns in [illegible] have been inhaled over [illegible] time, such as from two [illegible] an average of ten years. [illegible] "silica" usually means quartz [illegible] are many varieties. There [illegible] forms of free silica.

[illegible] or fibrosis of the lungs [illegible] from the action of uncombined [illegible] characteristic nodular shadows [illegible] roentgenograms of those af- [illegible] this is the only way the [illegible] detected as it causes no [illegible] the early, uncomplicated stage.

[illegible] may produce x-ray patterns [illegible] difficult to differentiate from sili- [illegible] unrelated illnesses may re- [illegible]. The x-ray picture ob- [illegible] the inhalation of iron oxide [illegible] some welders and grinders [illegible] which are all too often [illegible] for those seen in silicosis. Since [illegible] (siderosis) is harmless, the [illegible] of such misdiagnosis are ob- [illegible]

[illegible] with industrial diseases of [illegible] those charged with evaluating [illegible] has resulted in employees be- [illegible] abrmed, forsaking their [illegible] forfeiting seniority while industry [illegible] good workmen and production. It has also paid unjust claims for disability. In a situation of this sort the supervisor suffers along with the rest since his department is bound to be affected by these conditions.

To attempt to tell the supervisor all he should know about the extensive subject of industrial dusts is an impossible assignment. Suffice it to say that the more he learns about them through his own volition, the better his qualifications for his job will be. Through such enterprise he will enter a new field of endeavor and discover a fascinating experience which will pay dividends both to himself and his company.

The complexity of problems which confront the director of any department in today's exacting requirements presents a formidable challenge to his resources, and this, along with the working man's reasonable insistence on a better place to work, demonstrates that a knowledge of industrial hygiene may well be a most important factor in the efficient discharge of his duties.

The best treatment of any disease associated with industry is not to let it happen in the first place. The problem is for engineers rather than physicians, but, regardless of the one on whom the burden falls, the final outcome depends upon the interest and efficiency of the man who manages a department.

Occupational Dermatitis; Teamwork in Engineering and Medical Control

By WALTER F. SCHOLTZ

[illegible], Industrial Hygiene, Allis-Chalmers Mfg. Co., West Allis, Wis.

[illegible] accepted the challenge that occu- [illegible] presents to industrial [illegible] accordingly it can be stated [illegible] proper care and intensive educa- [illegible], occupational dermatitis can [illegible] and great savings effected.

[illegible] the institution and maintenance [illegible] measures workmen can be pro- [illegible] dermatitis producing oils, [illegible]. The ideal control measures [illegible] foremen all along the line— [illegible] manufacturing of the basic mate- [illegible] completed fabricated part.

[illegible] today is becoming so cognizant of the benefits of good preventive measures that they are not only relying on the worker alone, but are seeking the teamwork of everyone concerned.

Since the proof of the pudding is in the eating, I would like to state what has been done through a concentrated program of occupational dermatitis control and prevention which started in 1943 at the West Allis works of our company. This concentrated program has resulted in a 74 per cent decrease and a reduction from 10.3 to 2.7 in the number of cases per million manhours of exposure.

Table 1 continued

Propyl acetate	200
Tetrachloroethane	5
Tetrachloroethylene (perchloro-ethylene)	100
Toluene (toluol)	200
Trichlorethylene	100
Turpentine	100
Xylene (xylol)	200

Table 2

Some Common Solvents and Their Relative Volatility

(Volatility increases as the volatility index increases)

Substance	*Volatility Index*
Acetone	23
Amyl acetate	4
Amyl alcohol	5
Benzene	15
Butyl acetate	7
Butyl alcohol	6
Carbon disulfide	24
Carbon tetrachloride	16
Chloroform	17
Cyclohexane	22
Ethyl acetate	15
Ethyl alcohol	14
Ethylene dichloride	12
Ethyl ether	23
Methyl acetate	20
Methyl alcohol	18
Methyl ethyl ether	25
Naphtha (petroleum)	10
Propyl acetate	10
Tetrachloroethane	3
Tetrachloroethylene (perchloro-ethylene)	6
Toluene (toluol)	8
Trichloroethylene	11
Turpentine	7
Xylene (xylol)	5

Table 3

Ventilation Rate Design Data for a Number of Common Solvents

Substance	*Molecular weight*	*Specific gravity*	*Required dilution air in cu. ft.*
Acetone	58	0.79	11,400
Acrylonitrile	53	0.80	[illegible]
Amyl acetate	130	0.87	15,000
Amyl alcohol	88	0.82	14,100
Benzol	78	0.88	142,500
Butanone	72	0.81	21,600
Butyl acetate	116	0.88	16,000
Butyl alcohol	74	0.81	52,700
Butyl cellosolve	118	0.90	16,400
Carbon disulfide	76	1.26	257,000
Carbon tetrachloride	153	1.58	51,000
Cellosolve	90	0.93	21,500
Cellosolve acetate	132	0.97	29,000
Chloroform	119	1.50	32,000
Cyclohexanol	100	0.96	[illegible]
Cyclohexanone	98	0.95	[illegible]
Dichlorobenzene	147	1.32	5,300
Dichloroethylene	97	1.27	[illegible]
Dichloroethyl ether	143	1.22	165,000
Dioxane	88	1.03	11,100
Ethyl acetate	88	0.89	11,100
Ethyl alcohol	46	0.81	[illegible]
Ethylene dichloride	99	1.26	32,000
Ethyl ether	74	0.72	11,100
Methyl acetate	74	0.94	[illegible]
Methyl alcohol	32	0.79	[illegible]
Methyl cellosolve	76	0.96	56,000
Monochlorobenzene	113	1.11	[illegible]
Naphtha (petroleum)	110	0.75	[illegible]
Perchloroethylene	166	1.62	[illegible]
Propyl acetate	102	0.87	[illegible]
Propyl alcohol	60	0.79	[illegible]
Stoddard solvent	150	0.80	[illegible]
Styrene monomer	104	0.91	[illegible]
Toluol	92	0.86	[illegible]
Trichloroethylene	131	1.48	[illegible]
Turpentine	136	0.87	[illegible]
Xylol	106	0.88	[illegible]

1952

Transactions Nat Saf Conv

The Importance of Non-Siliceous Dust in Industrial Operations

By EDWARD C. J. URBAN

Industrial Hygiene Eng., Saranac Laboratories, Saranac Lake, N. Y.

A [illegible] concern related to the health of workers in mining, tunnelling, granite quarrying, in the foundry industry and in all of the other so called "dusty trades" for many years in the past, has been for the protection of the workers from breathing air borne particulate matter, arising as the direct result of their occupations, which might cause disease.

It has been shown by geo-chemical study that eight primary elements make up 98 per cent of the earth's crust—this is based on the standard assumption for the outer 10 miles of thickness. In the order of their predominance these are: oxygen, silicon, aluminum, iron, magnesium, calcium, sodium and potassium. The chief element, oxygen is present in 47.2 per cent of all rocks. Silicon (Si) constitutes 28 per cent. The remaining six elements combined, total but 24.1 per cent.

It has been further determined that eight compounds or simple combinations of these basic elements are present in 97.6 per cent of the lithosphere. The principal compound is silicon dioxide (SiO_2) which occurs in almost 60 per cent of all rocks. The remaining compounds are chiefly oxides of the other seven elements previously mentioned.

Chemically silicon dioxide is plainly acidic while the metallic oxides are basic in character. In nature, silicon dioxide occurs in two main forms. Twelve per cent exists as a definite independent compound, Free Silica. The remaining 48 per cent of the silicon dioxide occurs in complex chemical combinations with the basic oxides as "silicates." These silicates are the chief rock forming minerals and several hundred species have been identified.

There are many varieties of Free Silica. The types which are present more commonly in industrial atmospheres can be classed as those being either crystalline or amorphous.

In Free Crystalline Silica the atoms are arranged in repeated uniform patterns giving the particles a definite structure. Quartz is the variety which has been formed at temperatures below 573 degrees C. and is the most common. It occurs as the ordinary crystalline form or as cryptocrystalline chalcedony, flint, chert or jasper.

The two high temperature varieties of crystalline free silica are Tridymite which results from heating above 870 degrees C. and Cristobalite from heating above 1470 degrees C. Both of these are not common in nature but do occur in industrial processes which involve high temperatures.

In Free Amorphous Silica the atoms are arranged in a non-uniform manner and as a result, the particles have no definite structure. Several varieties of Opal occur. In this class may be included natural diatomaceous earth. A distinction however, must be made between the natural mineral as it is found in place and the diatomaceous earth which for industrial reasons has been heated to high temperatures. This latter product can contain Cristobalite in varying quantities. Vitreous Silica is silicon dioxide which was heated to a fusion temperature with the mineral still retaining its amorphous state.

During the past several years technological advancements and industrial demands have created a variety of new artificially produced amorphous silicas. These synthetic products are for use as fillers, insulation, diffusion coatings for incandescent lights, in strengthening cotton thread, a substitute for certain materials in vulcanized rubber and as water repellent coatings for cloth.

It is a well recognized fact, substantiated by laboratory research and observations in industry that free crystalline silica as quartz is the specific causative agent of the pulmonary disease Silicosis. Further, it has been common practice in the consideration of industrial dust exposures which involved a silica hazard to imply that quartz was present and that it was the chemical substance of chief concern. Because of the preponderance of quartz in the rock minerals of the earth and our lack of knowledge relating to the toxicity of other Silicon dioxide forms, this view was to be expected.

Recent studies, particularly those made at The Saranac Laboratory, however, have demonstrated that certain varieties of free silica other than quartz, yet similar to quartz in chemical composition, can produce pulmonary lung changes in animals. These lung changes are unlike Silicosis. In addition, clinical studies have reported that diatomaceous earth, for example, may produce pulmonary changes in workers inhaling dust and that amorphous natural diatomite is less hazardous than is the crystalline cristobalite content which was formed subsequently by high temperature calcining processes.

Currently observations are underway at the Saranac Laboratory also, concerning the effects upon animals to prolonged inhalation of several of the new artificial amorphous silicas. These studies are significant in two respects. The first relates to the particle size and the second to the chemistry of these new products.

One of the earlier comprehensive studies made in this country of the size distribution of dusts found in various industrial environments was reported by L. L. Bloomfield of the U.S. Public Health Service in 1933. Some of his work is shown as Reference A on the slide. A light field microscope system with a magnification of 1,000 diameters was used which allowed particles as small as .5 micron to be measured and somewhat smaller particles to be seen. The data indicates that the greater percentage of the particles were larger than 0.5 micron. H. L. Green reported in the Transactions of the Faraday Society in 1936, the data shown on the slide as Reference B. With the magnification of 1,500 diameters which Green used, particles of .1 micron were measured and as small as .2 micron were seen. His data shows a higher percentage of fine particles, less than .5 micron in size, than does Reference A, probably due to the difference in the magnifications of the two systems. However, these data do agree in the fact that most of the dusts observed were microscopic in size, that is, they were .2 micron in size and larger.

It has been the contention of some investigators that there is a limit to the extent to which solids can be reduced in size by ordinary disintegration methods. This limit supposedly is imposed by the operation of cohesional or surface tension forces upon each separate fragment of material as it is being formed during the process of disintegration. The lower limit of particle size [illegible] such disintegrations aerosols was [illegible] to be in the order of 0.1 micron.

Perlite is a volcanic glass. This [illegible] mined from the earth and later subjected [illegible] industrial processing shows [illegible] few dust particles are present which are [illegible] than one micron in size.

In an electron-photo micrograph of a [illegible] borne sample of common quartz dust [illegible] quartz had been ground and ball-milled [illegible] dustrially to reduce it to a fine [illegible] Only a few particles less than one [illegible] in size are present.

It would seem that photographs [illegible] to the view that the ordinary disintegration [illegible] processes in industry as crushing, [illegible] drilling and blasting do not produce [illegible] sub-microscopic size. However, [illegible] observations must be made with the [illegible] microscope to substantiate this.

The significance of sub-micrographic [illegible] particles is a subject which receives [illegible] attention in the literature. The [illegible] thought has been that if particles [illegible] enough in size, even if they are [illegible] into the lungs they will not be retained [illegible] will be expelled with the expired air.

Four observations have been completed [illegible] The Saranac Laboratory with dry [illegible] of four different kinds of artificially [illegible] duced free silicas. All the aerosol [illegible] sub-microscopic in size. The particle [illegible] ranged from .02 to .2 micron. These [illegible] compounds are identified as [illegible] Preparation was made by a cool [illegible] chemical process. B, C, and D were [illegible] pared at high temperature.

In an electron-photo micrograph of [illegible] duct A, the primary particles are [illegible] fine in size with large surface areas.

In a photograph of Product B, the [illegible] cles are sub-microscopic. This dust [illegible] to have a lesser tendency to [illegible] aggregates.

In Product C, the particles are [illegible] under one micron in size. In some [illegible] they tend to resemble Product B in [illegible] appearance.

The fourth product D differed from [illegible] others in several respects. A, B, and [illegible] prepared outside of the Laboratory and [illegible] to us in bulk for study. These [illegible] were then generated as aerosols by [illegible] disseminating technics. Preparation D [illegible] liquid which chemically contained [illegible]. This liquid was combined in the Laboratory with a gas and burned. The resulting fume was practically pure amorphous [illegible] silica.

In a recent photograph which was produced by an outside agency, the primary particles are very fine in size. We think that [illegible] large spheres are Latex that had been added to the sample as a reference for size measurement.

The X-ray diffraction patterns of each of the four aerosols show wide diffuse rings indicating that the materials are amorphous and not crystalline in structure. On the basis of the X-ray the materials are indistinguishable but because of the diffuse nature of the rings it is difficult from the X-ray data to determine how much, if any, of the silica in each preparation may have been combined as silicate with the metals present.

Data pertinent to the experimental observations with the four silicas are summarized. Analysis of the parent or bulk material of A, B, and C showed that silicon dioxide was the chief constituent, but that small amounts of the oxides of iron, aluminum, magnesium, sodium, calcium and potassium were also present. Some moisture in [illegible] combination with the silica was [illegible] in each sample and was removed by [illegible]. The corresponding increase in total [illegible] content is indicated. Preparation A [illegible] formed in the absence of heat. D is [illegible] pure silica. Consequently A and D [illegible] undoubtedly amorphous. Heating in the presence of certain metals was required to [illegible] B and C. It is judged that these preparations may be partly glasses or [illegible] silicates.

[illegible] species of laboratory animals [illegible] exposed to the inhalation of these four [illegible] 8 hours each day, 5½ days per week [illegible] periods of two years/or longer. The [illegible] atmospheric concentrations of the [illegible] to which these animals were subjected [illegible] from 26 to 42 mg/cu ft. On the [illegible] pathological findings A and D produced pulmonary damage and were judged to [illegible]. The disease produced was not like [illegible] to quartz. B and C were considered inactive.

[illegible] can be made from these [illegible] which have important significance [illegible] dust exposures.

1. Particles as fine as .02 micron can be breathed and retained in the lungs in sufficient quantity to produce disease.
2. Forms of free silica other than quartz can produce pulmonary damage.

Aluminum pneumoconiosis, or Shavers Disease has been recognized as a specific disease, different from other pneumoconioses, including silicosis. It has occurred in bauxite workers, particularly those exposed to electric furnace fumes. An electron photomicrograph shows the particles to be much less than one micron in size. Chemically the fume is composed chiefly of aluminum and amorphous silica with possibly some glass present.

Shavers Disease is another example of sub-microscopic particles causing pulmonary damage.

Industrial environments which contain predominantly sub-microscopic dust particles or more properly, dry aerosols, pose a real problem for the industrial hygienist.

First: The particles are too small to be seen by ordinary microscope technics. At the present time estimation of atmospheric concentrations must necessarily be made on some weight basis. The proper collection of these particles may be difficult. They may be, and some of them definitely are, fine enough in size, to pass through a No. 41 Whatman filter paper. Some because of their peculiar hydrophobic property cannot be wetted by ordinary liquid collecting agents.

The particles of one of the materials with which we are familiar, carry a static charge high enough to disrupt the operation of the electrostatic precipitator. Further, and probably of most importance, if the material has any degree of toxicity, because of the fineness of the particles, allowable concentrations of exposure will necessarily have to be low. The collection of sufficient dust to weight accurately will in itself be a problem.

Second: The determination of the chemical composition of these aerosols will require more detailed analytical work which will include chemistry as well as X-ray diffraction studies. Micro-chemical methods may have to be applied as the amounts of dust collected may be small.

Obviously new and specialized methods both for the collection and analysis of such aerosols will have to be developed. And finally, a dust control system to fit specific requirements which may be different from those of ordinary dusts must be devised.

It may appear that this discussion has related mainly to dusts containing silica. Most of the views which have been presented, however, can be applied equally as well to other materials. Even with substances which have been considered inherently inert, it should be recognized that certain factors may operate to alter this condition.

Referring again to Shavers disease, powdered metallic aluminum and hydrated aluminum have been used as therapeutic agents in the control of silicosis on the theory that particulate quartz is inhibited by these materials. On the other hand, recent laboratory studies intended to duplicate Shavers disease at the University of Toronto have demonstrated that sub-microscopic alumina by itself or in combination with silica fume can cause lung changes. As an opposite, with asbestos the fibres longer than 10-20 microns appear to cause disease while the finer particles do not.

New industrial processes are being developed which utilize heat and high energy releases. In effect, new methods of disintegration have been created. The effluents from such processes may have properties entirely different from the [illegible] ployed. Such factors may have [illegible] duced as change in particle size, area, surface coatings, electrical [illegible] adsorption and absorption qualities alter their behavior.

Increased production activity [illegible] vanced mechanization is a signific[illegible] in creating correspondingly denser [illegible] of dustiness. The experience in [illegible] mines in England and more recently [illegible] country are examples. Carbon has [illegible] considered inert. Pulmonary changes [illegible] lungs of coal miners have occurred [illegible] authorities feel that the carbonaceous [illegible] ponent of the coal itself is responsib[illegible]

It would appear that the terms, "[illegible] hazard," or "siliceous dusts" need [illegible] cation since some forms of free silica [illegible] than quartz may be capable of [illegible] reactions which are different from [illegible] action of quartz itself.

Of increasing concern in certain [illegible] environments are the sub-microscopic [illegible] ticles and considerable research [illegible] to be done to determine their [illegible] A matter of no small import we [illegible] regard as that these small particles [illegible] exhibit properties different from the [illegible] materials from which they originated [illegible]

Know the Facts — Electrical Hazards

Interlocking For Safety

By A. L. RICHE

[illegible] Pres., Micro Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Let's start with some words we'll be using. "Interlock" is just a fancy word meaning [illegible] one thing takes place, something [illegible], or something is prevented from [illegible]." From this definition, we can [illegible] there is an interlock between [illegible] and faster, better, easier operation [illegible] electric switches can produce. An [illegible] is a two-hand electric trip for [illegible] press control. Operators have [illegible] production as much as one-third, [illegible] because they felt safe and the electric switches worked more easily than [illegible] trips. This type of machine [illegible] is the choice of state safety com[illegible] and insurance companies.

The principles of electric interlocks are [illegible]. An electric switch which turns on the light when your refrigerator door is [illegible] is an example.

"Limit switch" is another common term. It means a switch which stops motion or [illegible] a signal when something moves to a [illegible] place. A switch fastened to a lathe [illegible] which will turn off the motor when the [illegible] is coming against it, is a limit switch. Such use of limit switches to keep machines from damaging themselves is one of the commonest and best-paying [illegible] tricks. It is as easy to put on any old machine as to design into new equipment. [illegible]

[illegible] is typical of electric interlocks and [illegible] switches which do things automatically [illegible] could be done by hand. Usually they [illegible] the position of a machine part, or [illegible] the reading of a pressure gauge or a temperature measuring device more accurately than can be done by eye. They re[illegible] quickly and accurately than [illegible] they don't forget. Neither are [illegible] about what to do next. On [illegible] blinking light or [illegible] off the hand brake before driving your car. That is such a "nonforgetting" interlock.

This memory-jogging use is just one of the ways that switches produce safety. In some ways they think for the operator, as well as act for his hands and eyes. They can make a machine refuse to run until all is in order; they can stop a machine when something is wrong; they can compel things to be done in the right order. This means safety to the operator and to equipment. It can also insure product quality.

We see electric interlocks and limit switches in machines as different from each other as juke boxes and automatic pilots on airplanes. They are in automatic gear shifts on automobiles and in dial telephone equipment. This success, for so many purposes, depends on well-known basic principles combined with using the best type of switch for the particular job. This is as true in working over an old machine to make it automatic, or to provide safety, as in designing new equipment. On either kind of job, use of the right switch can make the difference between a machine which gives long, reliable, safe service, and one which is always in trouble.

Three Fundamental Kinds of Switches

There are three general kinds of electric switches used in interlock and limit work.

The one longest used is simple contacts, which are moved without snap action. Usually such contacts are mounted on leaf springs. Another form uses bars on the face of a cylinder which turns under fixed contacts or brushes. Their simplicity recommends such units, and they serve well to switch small amounts of power when precision is not required, and there is plenty of operating force and motion. Picking up your telephone works such a switch.