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TRANSACTIONS

26th National Safety Congress

NATIONAL SAFETY COUNCIL, Inc.

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oreword

THE Transactions of the Twenty-sixth National Safety Congress, 1937, 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, Commercial Vehicle and Transit 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 (Volume I), $2 each; 11 copies or more, $1.75 each; copies of the smaller volume (Volume II), 75 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.

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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.[1] 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.[2]

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.[3]

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.[4]

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.[5]

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.[6]

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.[6]

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 4.5 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,[7] 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.[8] 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.[9] Coal tar and indigo dyes are substances most frequently used.

Cases of amblyopia have been reported from exposure to inhalation of tobacco dust.[10] 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.[10]

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.[12]

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 preparatio[n] erting a direct irritating effect on the s[kin]. Dermatitis due to other vegetable [...] such as vanilla, powdered arnica, [...] thrum, etc., have been reported.[13]

Dental lesions, of occupational o[rigin] have been reported among workers in s[ugar]. The gingivitis caused by sugar dust is [clas]sified as purely mechanical, with [...] developing caries. Digestive disor[ders], respiratory conditions, and cutaneous [con]ditions (especially of the face) were found.[14]

Dock workers, transporters of g[rain], workers in grain and flour mills, etc. exposed to dusts during their work. [...] from cereals may contain many impuri[ties] which may cause an irritating action on [the] respiratory passages, as well as inflam[ma]tion of the skin. Digestive disturba[nces], dental defects, diminution in hearing, conjunctivitis have been observed an[ong] millers, and have been attributed to the d[ust] to which such workers are exposed.[15]

b. *Allergic.* Many apparently innoc[uous] substances may produce reactions in [per]sons of peculiar personal susceptibility. [The] term "allergy" is used to describe this c[on]dition of hypersensitiveness or susceptibi[lity] and allergic phenomena most freque[ntly] manifest themselves in skin reactions. H[ow]ever, they may cause acute reactions e[lse]where in the body. When the respirat[ory] tract is involved we have such well kn[own] diseases as hay fever or asthma. T[he] diseases may develop as a result of hy[per]sensitiveness to such substance, as poll[en] from plants, horsehair, rabbit, fur, f[ish], feathers, etc.

For instance, furriers, workers in cloth industries who are exposed to wool d[ust], etc., may suffer from hay fever or asthm[a]. It is unnecessary for the offending dust [to] reach the depths of the lungs—giant poll[en] for example are reported to produce th[e] effect after being caught in the upper r[es]piratory passages. Should such an offend[ing] substance be finely ground it could re[ach] the alveoli and as a result probably physiologic reactions would be accelerate[d].

In a survey of a plant where resin [was] mixed, ground, and molded, it was fou[nd] that 80 per cent of the occupational derm[a]titis there was due to hypersensitivity [to] hexamethylenetetramine and formaldehy[de] contained in the dust to which the worke[rs] were exposed.[16] During the first procescotton sp... ..g, cotton-strippers are ex- ..ed to dust arising from cotton husks and ..ris, which produces a typical form of ..ima.

..rdinary wood dust has been of interest ..e to its purely mechanical action, but ..ll greater care is required in handling ..tain kinds, especially woods coming from ..road, because of the essential oils impreg- ..ting them, which when freed in the dust ..y affect the health of the workers con- ..ned. Some of the woods capable of ..using skin lesions are Brazil wood, satin- ..ood, teakwood, cumaru or tonka wood, ..ck ebony wood, West Indian mahogany, ..anese tagayasan, coccoloba, chestnutwood, ..vewood, California sequoia, etc. All per- ..ns who handle these woods are not in- ..red, only those particularly susceptible to ..e substances they contain becoming ..fected.

2. *LIVING ORGANIC DUSTS.* These ..ntain particles capable of exhibiting the ..enomena of life (especially the property .. reproduction or multiplication), such as ..cteria and fungi. They are usually found .. low concentrations and are associated ..th nonliving dusts in the air.

a. *Bacteria.* One of the most important ..nong these is the anthrax bacillus, which .. contained in the dust from skins, furs, ..ool, and animal hair, horns, hoofs, bones, ..c. This disease may occur in two forms: ..*taneous* (in which the organism affects ..e skin), and *pulmonary* (when it is inhaled, .. in the form of anthrax known as wool- ..rters' disease).

Cases of tetanus, reported in connection ..ith jute manufacture, were traced to the ..w material, the bacillus having been found .. the factory dust. Diphtheria, tubercu- ..sis, smallpox, typhoid, or other bacillus- ..roduced diseases, may result from exposure .. infected dusts.

Bacterial sensitization can be the cause of ..y of the allergic diseases, namely, asthma, ..erennial, hay fever, urticaria, angioneurotic ..dema, eczema, or migraine headaches.

b. *Fungi.* Dusts containing the mycelia ..d spores of parasitic fungi give rise to ..noyance and discomfort. "Maltster's" itch ..om the dust alone has been reported. In ..rovence, reeds used for ceilings are stacked ..hile still wet and undergo fermentation; ..ey become covered with a white powder ..a dry fungus of the Mucor family: Sporo- trichum 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) from the rhattan canes used, get shaken out when the canes are split, hammered, and cut, causing painful fissures to develop on the skin where they alight.

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. 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, two 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 in threshing wheat, baling hay, or handling various small grains.

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 débris 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.).

II. Inorganic Dusts

Inorganic compounds are of mineral origin, not requiring a living organism to produce them. 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. 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.

According to Fairhall, perforated nasal septum is a common occurrence among workers with bi-chromate dusts. 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. 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. 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.

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. 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 cyanimide dust.

Cases of dermatitis, scleroderma and cancer are reported ..ave been c.. ..ed t.. exposure to dust of arsenic compound.. Certain aluminum salts are skin i..ritan.. and aluminum dusts may contribute to th.. infection of skin and mucous mem..rane.. through mechanical action.

b. *Fibrosis-Producing Dusts.* The mo.. important of these are the inorganic, slightl.. soluble dusts which cause fibrous chang.. in the lung tissues, some of which are se.. ous, and some of which cause little or .. disability. So far as is known, no inorgan.. substances other than silicon derivativ.. cause more than a very moderate degree .. fibrosis of the lung. Moreover, there seem.. to be no evidence that any other constitue.. of ordinary dusts can influence so unfavor.. bly a pulmonary infection.

Although other dusts, when inhaled .. sufficient concentrations over a long peri.. of time, have been shown capable of pr.. ducing a pulmonary fibrosis, neverthele.. the pneumoconiosis characterized by nod.. lar fibrosis has to date been shown cli.. cally and experimentally to be associat.. only with the inhalation of dusts containi.. free silica.

Since this dust, to exert its harmful actio.. must enter the finer divisions of the lun.. the particle size of the atmospheric du.. may bear a definite relationship to the i.. jurious effect produced. The silica must b.. present in the air in particles small enou.. to enter the finer air spaces and of su.. dimensions that the phagocytic cells ma.. engulf them. The greater majority of pa.. ticles found upon microscopic examinatio.. of the lung fall within the limits of fro.. 1 to 3 microns. Examples of siliceous dust.. are granite, quartz, sand, pumice, slate, et..

In a recent study among anthracite mine.. the correlations between exposure to du.. (which contained silica) and the eviden.. of constitutional changes left little dou.. as to the etiological significance of the du.. in the air breathed. Like correlations we.. found between the silica exposure and th.. extent of pulmonary changes. When th.. inhaled dust consists of silica combin.. with bases, silicates, some degree of chan.. in the pulmonary tissue may result. In th.. respect asbestos dust seems to be uniq.. among silicates in the prevalence and .. verity of the disease it causes.

The chief distinction between silicosis a.. conditions due to simple reactions can.. by other dusts is the active proliferati..

reaction i… 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.[7]

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.[16]

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[17] 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 given the subject of individual protection from dust, and there are many types of respiratory protective devices now available. These are generally of two types: those which provide fresh air from an uncontaminated source and those which rely upon a filtering 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 device should be used only where exposure to the dust is intermittent and brief, or where some unusual condition makes a more adequate dust control impracticable.[18]

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 temperature (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.[11] 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."[19] 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."[20] 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.[21] S… some occupational cases tend to clear up and recur, record previous occupations should be include… the physical examinations. The frequ… of examinations should be determined the medical director, unless otherwise sp… fied by law. Those exposed to known o… pational disease hazards may have we… or monthly examinations.[20]

"It should always be kept in mind that basic principle of physical examination industry is to keep men on the job and allow the physical examination to be no… a weeding out process."[19]

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The Engineer's Part in Eliminating Dust Hazards

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When one realizes that control of the dust hazard depends upon the combined contributions of the physician and the engineer, he appreciates that the solution requires scientific treatment. By scientific treatment I mean the technical analysis of the hazard to discover the causes which contribute to injury or ill health, and the development of control methods which obey physical law and physiology, and which will be directed at causes that admit of most immediate and economical treatment.

That goes for handling the dust hazard in a given plant. It goes double for acquiring knowledge to the end that the whole problem may reach ultimate solution. Right now our knowledge of the problem is in big chunks, loosely put together and largely empirical.

There are estimates only to judge the magnitude of the dust health problem, and it is so closely associated with other health problems that a clean-cut estimate of it alone is impossible. We do know that it is great in the aggregate, and for the individual plant it may be very bothersome and expensive.

What actually makes quartz dust cause silicosis is not known. It does, so the air breathed by workmen must not contain harmful quantities of respirable quartz dust. Inexpensive methods for making the air clean are still in the realm of dreams. Much work must be done to know more about silicosis and more how to make atmospheres safe *inexpensively*. As an accident prevention job, dust control lies almost entirely within the administrative responsibility. The control measures are capital expenditures of considerable size.

A plant with a dust hazard is sick, it needs an expert diagnosis and scientific treatment, which may include expensive major operations. Home remedies are seldom much good, and supervision and employee safety consciousness alone cannot accomplish anything. There may be observed in countless shops installations for exhausting dust which are derisively called "tin knocker" jobs in which the horsepower dissipated is out of all proportion to the air-borne dust moved. Tonnage efficiency of material moved may be the proper yardstick for pneumatic conveyors but if the material to be moved is air, contaminated with nearly weightless particles of dust, the entire health hazard can lie in the half of one per cent of material not moved.

I do not mean that unless a dust supression job was engineered it can be no good. There are many good installations that were never figured at all but grew like Topsy. The resulting freedom from dustiness was so satisfactory that efficiency held little interest to the owner. This is exceptional, however, and I offer the opinion that dust suppression jobs should be engineered.

A dust-suppression installation is a safety device, designed and operated to provide protection against possible disease and provide a sense of security which must be absolute. Its safety is not rushing air and rattling chips but a minimal residual dustiness. There is no more pathetic defeat for a dust control job than to find faith in its effectiveness so low that workers must wear respirators to find the reasonable safety that was expected from the hoods, ducts and fans.

Diagnosis and Control

Let us examine some of the features by which we recognize this dust hazard problem, leaving out the socio-legal aspects.

In order to develop more fully the engineer's place in this dust control program, it seems desirable to separate as sharply as we can the diagnostic considerations from those which deal with control. In the first compartment we can place all the analytical components which describe the hazard and its exposure, the probability of its producing ill health and all the rest of the medical and industrial hygiene facts which make out a case against the existing dust. In the second compartment place the knowledge of physics and engineering necessary to plan the dust control program and so design it that when installed its performance follows prediction that the probability of industrial disease is reduced to insignificance.

The Industrial Hygienist

Our first feature of interest would naturally be the specific and relative toxicity of silica, silica-bearing and other dusts which make up the dust health hazard. Much might be said to advantage about the quality and quantity of hazard in many dusts. The acquiring of this knowledge has been, and must remain a medical problem. It involves gross and microscopic pathology and x-rays, and experimental animals. Engineers do not talk that language. Industrial hygienists do; they are a happy combination, half doctor and half engineer. Many of them are quite capable of handling the dust health hazard in all its phases of investigation and control. For the purpose of this discussion I throw their interest in with the doctors.

I want to ... ar in my opinion state that the ...eer should not attem... define the quality of health hazard in a plant or industry, nor should he est... threshold limits of safe or permissible... ness. This may be debatable, but I shall... tend that the engineer who writes the ...fications of hazard and dust tolerance is ... an industrial hygienist, and is using a much broader knowledge than engin... alone.

In the first case the quality of the ... hazard is an opinion arrived at after stu... all the environmental conditions includi... general sanitation, occupational a...alysi... a scientific analysis of the dust expo... In the exploration of dust exposure ... nature of dusty operations must be ... from physical, chemical and mech... aspects, the determinations of dustiness ... be not only counted and classified by pa... late sizes, but chemically and mineralo... analyzed. The plant layout must be s... with respect to dust production and dis... tion, and the housekeeping and existing ... control equipment evaluated. The prese... specific hazards, such as toxic gases, a... mal temperature and humidity conditions ... must be explored for their complicating ... upon the whole picture. This is distinct... industrial hygiene job, and some of the ... critical data requires only medical view... This is absolute in the case of tuberc... study and the qualifying of men for em... ment.

So far, not one atom of engineerin... suppress dust is involved. It is entirely ... ysis of hazard. The diagnosis must be ... the dustiness is hazardous to health or ... is safe. If it is hazardous, it must be bro... down to a specified residue. If it isn't, ... it alone. On the second point, if the hygi... can not specify threshold limits grad... upward for relatively less hazardous ... let the engineer not worry about it. ... diagnosis is dust which is harmful an... much of it. The remedy is control of the ... The engineer designs controls which ... produce the lowest practical residual ... ness. He should not attempt to write his ... specifications of threshold limits or po... sible dustiness. This may be an impo... goal in the study of dust health hazard.

Safe Limits

At the present time the medical men ... hygienists believe that quartz dust is below . illion particles. They seem willing to graduate upward to 20 million for medium silica and 50 million for low silica percentages. Five million particles is virtually dust free, and is very difficult and expensive to achieve and maintain. The declaration of safety of the installations must remain in the hands of the medical and hygiene groups in whose hands now lies the responsibility for determining the hazard.

We now enter the chapter of our discussion intended to demonstrate that dust control is an engineering job, that it must be given scentific treatment, not guess work, applying engineering methods which are based upon a knowledge of physical law, the behavior of dust, the performance of air-moving machinery, etc.

Prerequisite Knowledge

Let me recite briefly, a few of the things which, in my opinion, the engineer should know to do this job correctly. He must know how to make a survey. Surveys depend upon sampling, and sampling is not a catch-as-catch-can proposition. It involves the place, the time, the frequency, the amount in a sample, and the number of samples so that maximum, minimum and average data mean something, so that credibility can be given them.

For the type of sample involved he must know how to weigh or count respirable dust, as distinguished from large masses of non-respirable dust which complicate the picture. He must know how to observe the sources of dust floods as distinguished from conditions of normal dustiness. He must know the sources of dust and the principles involved in the dispersion of dust. He must determine how much dust enters the problem because it is part of the material, and what dust is created in the process by the fracturing of the material.

Any less survey cannot tell the engineer what his task of dust control is. To visualize that task intelligently he should know the physics of Brownian motion, laws of resistance to the motion of particles moving in air, both when the air is in turbulence and for stream-line motion. He should know terminal velocities, movements due to centrifugal motion; flocculation and the effects of air motion and the effects of humidification on it. He must know all about the difficulties of wetting and what is known about overcoming these difficulties. He should know the several electrical phenomena which bear upon dust behavior.

Those are all principles of physics which explain the behavior of dust and upon which engineering practice must be based. They must be understood and be taken into account. Dust control is not a matter only of general ventilation; the engineer must study the production as well as the dispersion. The problem should be analyzed to determine the applicability of segregation, enclosure, wetting, local exhaust and general ventilation.

In some instances, substitution of non-hazardous material, or non-dust-producing operations may have specific application, and they should be explored first. This implies plant engineering. I am convinced that many bad installations are bad because plant engineering was not used. In the designing of exhaust systems installed to capture the dust at the points of generation, the physical behavior of air moving toward hoods and in ducts must be known, and that knowledge used. Each system must consist of collection hoods, piping, air-cleaning plant and a source of suction. Before selecting a hood for a job the engineer must know dust dispersion by dynamic projection as well as dust dispersion by air currents, and design the hood accordingly.

Knowledge Needed

The aero-dynamic characteristics of suction hoods appear to be little known because little thought was given to them in designing thousands of hoods which can be found everywhere in industry. All the possibility for entrapping dust and much of the efficiency of the system lies in this factor. Air velocity, static suction, and rate of air flow are all related, and they must be known. It is essential to use high velocity of air in certain types of exhaust systems to entrap dust projected at high velocities as in the case of a granite surfacing machine, and low velocities must be used in others, as in the case of cleaning asbestos fibre of dust to prevent wasting material.

Quantity of air and its velocity must be determined, then the piping should be designed to take into account the behavior of air-flow through pipes at low and high velocities. Where the problem is complicated by the large sized particles which go along with the fine dust, how these behave must be taken into account. Pressure losses are very important elements in the design of an exhaust system. Loss at the hoods, loss at the bends, and loss in the ducts must not be guessed at. Pipe design must take into account the gage of the metal and reinforcing to withstand pressures and erosion.

The selection of a fan and its motive power is a matter of calculation, not guess work. Power consumption in the system is calculable, fans follow certain laws, so the engineer must know the behavior of axial flow, propeller type, radial flow, paddle wheel and other fan performance.

More physics and engineering calculation goes into the air-cleaning apparatus. The selection of gravitation, inertial or filtration method depends upon what the dust is, the calculation for any methods requires knowledge of discharge through stacks, the determination of sizes of settling chambers; the behavior of cyclones. The use or non-use of a filter, and if so, what type, how it should perform, how big it should be, what kind of resistance and how much each kind offers, to say nothing of their proper location with relation to cleaning, accessibility, etc., are all items for accurate engineering determination.

Apparatus to check the behavior of installations must be . and used. Perfor cannot be left to guess work. Supplying cient air to be exhausted is part of the lem. The same may be said of heating

Do I give the problem too severe a up? I think not. Remember these two th

1. You are dealing with hazardous rial so small in size and so little of weight that it is as invisible as the air hears it.

2. Physical laws involved in the beh of dust and air do not permit inexp methods of control. I am acquainted budgets set up for this purpose which ar to more than a quarter of a million d and I know of many where 60 to 80 tho dollars is involved.

The need for this much engineering i ognized by men who know. Already has been done toward getting the know into handbook shape. Perhaps the best of this sort to date is "Fundamentals Rel to the Design and Operation of Ex Systems" developed under American S ards Association procedure.

The Doctor's Part in Controlling Dust Hazards

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Considerable confusion has existed in the past as to just what is the physician's function in the prevention of dust diseases, and just what is the engineer's. It is very obvious upon even casual thought that the two sciences must work hand in hand in their efforts to solve the problem.

The physician through his special training must be able to tell the engineer what dusts are dangerous and what are not. He must know how those dusts enter the body and the manner in which they do their harm. He must be trained in the examination of persons who are to be employed to work in dust, and to discover those who are already diseased, or are peculiarly susceptible to dust disease. He must be able to detect the first signs of disease in workers who are exposed to dust, and must be prepared to recognize the disease when it is fully veloped.

It is not necessarily the physician's f tion to analyze dust. That is a task for chemist and the petrographer. It is not physician's function to count the particl dust in a given industrial atmosphere. T in reality, is the function of the enginee is not the physician's function to de ventilating equipment for the removal dust, nor even to be more than an adv as to the means that must be adopte render the atmosphere safe.

The physician nevertheless must corre with his medical knowledge and with studies of the industrial worker the find of the engineer. A diagnosis of silicosis example, requires not merely character occupational history and characteristic ph ca.   gs, but the knowledge as well that the patient has been exposed to hazardous dusts in dangerous concentrations.

All dusts when inhaled in excessive quantities may be considered as harmful, but only a few can be regarded as dangerous. From the standpoint of their dangerous properties, they may be divided into three general groups.

1. Those which are dangerous because of their poisonous action, such as lead, arsenic, mercury, and similar substances.

2. Those which cause only irritation in the respiratory tract, resulting in such conditions as bronchitis or local inflammation; such substances as vegetable fibre, cork dust, flour, starch, and other relatively innocuous organic or inorganic materials.

3. Those which tend to produce fibrosis of the lungs, thereby predisposing to respiratory infections, especially tuberculosis, such dusts as asbestos, silica dioxide or magnesium silicate.

I shall confine my remarks chiefly to dusts occurring in the latter category.

It has been generally believed that the harmful effects of dusts inhaled into the lungs depended more upon their physical structure than upon their chemical. It was believed, for example, that silica dioxide, or quartz, was particularly harmful because of its crystalline structure, and the hardness and sharpness of its particles. This conception is now known to be faulty. The dusts which cause their damage by mechanical interference with function are the dusts which are relatively innocuous, whose symptoms are transitory, and which subside upon removal from exposure to the dust.

Chemical Effect Is Harmful

The disease of particular interest to us today, silicosis, owes its harmful effects very largely to a harmful chemical reaction occurring between silica dioxide and the body tissues. It so happens that silica dioxide is decidedly a tissue irritant to the body, regardless of the part of the body it invades, it causes local irritation, local destruction of tissue, and the replacement of that tissue by scars.

Thus, given a dust containing silica dioxide in sufficient concentration, in sizes small enough to permit its entrance to the ultimate air spaces in the lungs, we have a situation which offers danger to the worker.

We have no real knowledge as to figures, but as a simple rule, we can adopt for practical purposes the thought that the human body can withstand successfully a concentration of dust containing 100 per cent silica dioxide in a particulate size less than 10 microns, in a concentration not in excess of 5,000,000 particles per cubic foot. If we decrease the percentage of silica dioxide present in the dust, we can correspondingly increase the concentration with comparative safety. We must, of course, take into account the portion of the worker's time spent in the dusty atmosphere.

To arrive at a rough conception of a safe atmosphere, we multiply the percentage of free silica in a given dust by the total number of particles per cubic foot. If the result is under 5,000,000 the condition may be considered relatively safe. If the result is over 5,000,000 the condition must be regarded as unsafe.

Bear in mind too that silicosis is essentially a disease of great chronicity. Except in a few exceptional instances it will require from seven to thirty years for a worker to develop advanced silicosis. It is evident too that coincident dusts may either retard the development of silicosis or hasten it. Recent research seems to indicate that the admixture of aluminum dust to a silicious dust will greatly inhibit the reaction of the latter; whereas a silicious dust combined with some alkaline coincident dusts may hasten the development of silicosis.

Much research is now under way in problems such as this. We have never learned how to cure silicosis, but we are learning rapidly how to prevent it. Our knowledge in this respect seems to be limited to the removal of dust from the breathing zone of the worker. Later discoveries may show us how to modify existing dusts with contaminant dusts that will render silica dioxide innocuous.

Owing to its very great chronicity, it is only the rare case who actually develops disabling silicosis during his industrial lifetime. It is realized, of course, that exceptional instances take place, but the coincident ravages of age usually keep pace with the effects of dust, so that much of the disability usually attributed to silicosis is often, in fact, actually attributable to other diseases or incapacities which advancing years bring in their wake. To me the great peril of silicosis, the peril not only to the industrial worker himself, but his family, co-workers and the public generally, is the accompanying susceptibility to tuberculosis.

Complicated by Tuberculosis

Silicosis per se does not kill. Tuberculosis as a complicating factor of silicosis rarely recovers despite treatment, and the individual so afflicted is not only totally disabled himself, but a definite menace to all with whom he comes in contact, particularly the fellow worker who may have silicosis. So perhaps the most important places in which the services of the physician in a dusty trade are necessary are—first, along lines of discovering and barring from exposure to a silicious dust those persons who may already have arrested tuberculosis; and secondly, discovering those persons already exposed to dust, possibly already silicotic, in whom tuberculous infections may have developed.

It is well recognized that no individual should be exposed to dust containing silica dioxide until he has undergone a thorough physical examination, including carefully made and interpreted x-ray films of his chest. It is likewise obvious to anyone familiar with silicosis that no person who is exposed to silicious dust should be denied the privilege of frequent physical examinations and x-rays of the chest, not entirely to discover the existence of possible silicosis, but to discover a coincident tuberculosis if such exists.

A man so diseased should, in protection to himself and to all with whom he comes in contact, be removed from industry. Let me emphasize the uselessness of a physical examination, unless it be accompanied by properly taken x-ray films, except in cases of gross tuberculosis.

It is the function of the physician, therefore, to conduct in a thorough and an intelligent manner the pre-employment examination of all persons who are to be engaged in a dusty trade. The purpose of this examination should be threefold. First, to discover and bar from employment in dust, any person who is suffering from tuberculosis in an active, a quiescent or an arrested state.

A possible exception might be made in individuals suffering from a so called healed primary complex, or a healed childhood infection. It is well known that exposure to silica dioxi[illegible] ery likely to [illegible] activity a tu[illegible]culous lesion which, quiescent or arrested, and once such is reactivated, the chance of recov[illegible] remote.

The second problem which confro[illegible] physician at the pre-employment phy[illegible] amination is whether a given indivi[illegible] by reason of secondary physical [illegible] more susceptible to the development [illegible] cosis than a normal. Is he sufferin[illegible] diseases of the nose or upper res[illegible] tract, such as chronic sinusitis, disea[illegible] lungs or air passages, or obstruction produce mouth breathing?

We must remember that silica di[illegible] not dangerous until it reaches the lu[illegible] that the normal individual retains nose and the upper air passages quantity of the dust inhaled from th[illegible] phere. In instances where this nasa[illegible] tion is disturbed, exposure to silica dust may be dangerous to that ind[illegible] where it would not be to another.

It is believed that certain disease[illegible] heart and circulation, of the kidney[illegible] bly syphilis, chronic coincident dis[illegible] the lungs, all may render a man m[illegible] ceptible to silicosis than normal. Th[illegible] cian at his pre-employment examinati[illegible] follow certain established criteria respect, and bar from exposure to du[illegible] dusts those persons who through [illegible] disease may be more ready prey to [illegible] or tuberculosis.

Re-Examination Needed

After the applicant for employm[illegible] successfully passed his physical exa[illegible] and is engaged in a dusty trade, [illegible] of the physician is not yet ended. Th[illegible] man must be periodically re-examin[illegible] to discover the early appearances [illegible] monary fibrosis, but what is even m[illegible] portant, to detect the early evide[illegible] complicating tuberculous infection

A man should not be dismissed f[illegible] ployment in a dusty trade merely be[illegible] has evidences of non-disabling [illegible] Workers in dusty trades, especiall[illegible] cutters, moulders, pottery worke[illegible] similar craftsmen, are usually [illegible]ighly and it seems unfortunate from a [illegible] economic point of view to deny th[illegible] ployment so long as they are physi[illegible] to carry on, especially since the act[illegible] abling qualities of silicosis are in de[illegible]

They should be denied employment in a dusty trade if that condition is found at pre-employment examination, but they should not be barred from continuing an employment in which they are already engaged. Of course, in such instances you, as engineers, must realize that you have failed, because if you had kept the breathing zone of the worker free from dangerous dusts, silicosis would not be present on physical examination.

In this work of preventing dust diseases in industry, it should be evident that the closest and most intelligent cooperation between the physician and the engineer is necessary. The physician must, through his knowledge and research, tell the engineer what dusts, or, for that matter, what other substances used in industry are harmful. He must tell the engineer how such dusts or other materials enter the body, how they leave the body and what they do in their passages through or their residence in the body.

Must Make Analyses

The engineer must in turn tell the physician of the harmful dusts and other substances surrounding his workers. He must make chemical and petrographic analyses of the dusts, and other indicated analyses of the atmosphere in the workshop. He must make dust counts and check his counts at regular intervals, conferring with the physician in an effort to discover whether, in the light of their joint knowledge, working conditions are dangerous. He must develop and install carefully designed ventilating equipment. He must arrange for modification of chemical and other industrial processes, where such modification is possible, and must bend his efforts toward removing from the danger zone of the worker the offending substance, whatever it may be.

Too many engineers construe this function loosely. They pass on to the physician as his responsibility certain functions which essentially are theirs; such functions as dust analyses, dust counts, and similar technical duties. All too often it is considered adequate merely to install a fan.

Ventilating devices in dusty work rooms must be constructed only after careful engineering study has given a knowledge of the physical properties of the air and of substances polluting it. It is possible to calculate to a very fine point the volume of air that must be removed from a given spot to remove the dust originating at that place, and the engineer must approach his task from just as scientific an angle as the physician approaches his.

There is no room in industry for haphazard methods on the part of either the physician or the engineer.

ADJOURNMENT

...y checked and repaired ...one, and we will give it ...ation. In addition, I sug- ...nt a man from each de- ... him in to our safety rotating these men so ...ally have them all meet ...e these men a closer in- ...ety work and permit us to Also, I will, until further ...y meetings with all the we can make clear the ad- ...at you men must assume, ...e to see that your men are our safety rules and the ...mployees. We can also ...lividuals who do not seem one hundred per cent.

...fety Work?*

...ephone Co., Chicago

... difficult problems facing ...rn to the foreman his re- ...e safe doing of the job measures, we have taken ...le must feel that the safe ... his responsibility and feel ... to do something about it.

... is there an accident on a ...sidered particularly haz-

...ne that the foreman or to conduct the work ... sure that he does and ... a proper training pro-

...me that a majority of all accidents are directly or ...le to the failure of super- ...el to function properly. that supervisory training ...ing accidents is necessary.

... of a supervisory training more difficult procedure ...t of a technical or voca- ...e. Apart from the tech- ...ed, there does not seem formula. There is, of course, some similarity of procedure in directing the work of any man on any job; but different industries employ such different types of people, under such a wide variety of circumstances, and place such a divergence of requirements upon them that the problem of supervisory training in its more comprehensive aspects is peculiar to each type of industry.

The general treatises on leadership give the groundwork, but the subject matter for any supervisory training course for any particular industry lies within that industry. We must go out and see how our job is being supervised now; analyze the procedure of every foreman and supervisor; compare them and select the best; look upon supervision as a process in itself, and see how best to direct the work of the people. It is a long, tedious, and costly process, but one which, carried through to completion, will pay dividends in the end.

WEDNESDAY LUNCHEON SESSION

October 13, 1937

The Wednesday Luncheon session of the Cement and Quarry Sections was addressed by Isaiah Hale, Superintendent of Safety, Atchison, Topeka and Santa Fe Railroad, who spoke on "The Common Sense of Safety." The address was substantially the same as another address by Mr. Hale before the Steam Railroad Meeting. The complete paper will be found in the Steam Railroad section of this volume.

WEDNESDAY AFTERNOON SESSION

October 13, 1937

Work of the National Silicosis Conference

By R. CAMPBELL STARR

Assistant Safety Engineer, U. S. Department of Labor, Division of Labor Standards, Washington, D. C.

Silicosis is strictly an occupational disease. Medical science has not reported silica dust as affecting any individuals except those who, over relatively long periods of time, have worked in an atmosphere where the air which they breathe contained excessive concentrations of free silica.

The interest of the U. S. Department of Labor in a broad social and economic problem such as this has its origin in the Organic Act, effective March 4, 1913, which created the Department. This act, among other things, gives the Department of Labor the duty "to foster, promote, and develop the welfare of the wage earners of the United States, to improve their working conditions, and to advance their opportunities for profitable employment."

With this in mind, and believing that through joint effort of all concerned, much could be done to eliminate the hazard, the Secretary of Labor called together in Washof the hazard, the fact must be recognized that until silicosis has been wiped out, workers who now have the disease, as well as those who may contract it, must receive workmen's compensation just as do those workers who are injured in accidents.

Accordingly, the committees of the silicosis conference were unanimous in presenting the following recommendations:

Coverage for silicosis in the compensation acts of all States.

This coverage should be compulsory.

Because of competition between the same or similar industries in various States, the laws, rules, and regulations of the several States should be as uniform as practicable.

Should Be Insured

The employer should insure his obligation for compensation either through self-insurance subject to the posting of adequate funds, or with an authorized insurance institution.

Insurance should not be denied any employer, provided the State authorities certify that he complies with the State requirements as to proper safe working conditions, and pays the premiums involved.

Workers having active pulmonary tuberculosis and silicosis should be removed from employment. Such workers should be granted suitable compensation payments and medical care.

Workers disabled from silicosis (but with no tuberculosis) should ultimately be granted the same amount of compensation as those disabled by accidental injury.

Two years is a reasonable minimum limitation period for filing claims subsequent to the date of the last exposure.

Further Activities of the Department of Labor

In carrying out its duty as stated in the basic law, the U. S. Department of Labor has conceived that there is immediate need for the conversion of known facts in the medical and engineering fields working toward prevention, and in the legal, insurance and regulatory phases looking toward adequate workmen's compensation, into a practical, readily understood program which will adequately take care of the silicosis problem.

In its program of cooperation with the 48 States, the Department of Labor has included a section covering silicosis and similar dust diseases. This breaks down into three main sub-headings: (1) Assistance in the preparation of reasonable and adequate codes, rules, and regulations prescribing methods of prevention; (2) assistance in the establishment of equitable standards of workmen's compensation for those employees disabled as a result of the disease; (3) a general educational program among State officials, factory inspectors, etc. so that they will be equipped with adequate knowledge concerning the disease, its method of prevention, and its proper treatment under the workmen's compensation law.

Follows Two Lines

This application program, which is just now getting under way has been commenced along two principal lines: (1) The compiling of practical information concerning actual dust control installations in typical silica hazardous plants, together with approximations as to cost, not only of installation, but also of maintenance of dust control equipment in such plants; (2) a program of visual education supplementing the summary and full committee reports of the National Silicosis Conference. It is contemplated that in this field such media as film strips, lantern slides, posters, illustrated bulletins, etc. will be utilized. Further, in connection with the various exhibits of the department, shown at various large expositions, trade association meetings, labor and technical organization meetings, etc., it is contemplated that much factual information will be used, pointing toward ways and means of correcting the hazard and of establishing adequate standards of workmen's compensation.

Following the address by Mr. Starr a round table discussion of outstanding hazards in quarry operation took place. This concluded the Wednesday program.

Steam Railroad Meeting

WEDNESDAY AFTERNOON SESSION

October 13, 1937

The session was called to order by W. W. Wood, Baltimore and Ohio Railroad, Baltimore, Md., who presided, introducing the speakers and directing the discussion.

The Past, Present and Future of Railroad Safety

By J. M. SYMES

Vice President, Operations and Maintenance Department, Association of American Railroads, Washington, D. C.

No industry in the world requires more diversified study and more exacting application of safety principles than the steam railroad industry. Picture a quarter of a million miles of railroad line covering in a virtual network the vast expanse of the United States. Over this network are operated a billion train miles annually. Vast yard and terminal operations are necessary to make up the beginning of the journey of passengers and goods, and to break up at the end of that journey the 12 million trains that accumulate that billion miles. These trains carry 500 million passengers and one billion tons of freight annually. It requires more than one million railroad employees to run the trains, make them ready for road movement, supervise and safeguard their movement and maintain the equipment and roadbed, as well as perform the many other duties incidental to the production of railroad transportation.

Safety has in the past, is today, and always will be the first principle in railroad operations. But it is within the past fifteen years that greatest advances have been made in railroad safety. During that period we have seen a complete remodeling and modernization of railroad physical properties. Roadbeds have been strengthened; bridges, trestles and culverts rebuilt; tracks have been laid with heavier rail and with treated ties of greater service life and dependability; grades and curves have been eliminated or reduced; signal systems have been modernized and extended; other safety devices have been installed; new and more powerful locomotives, embracing all modern safety devices, have been purchased; new cars, both freight and passenger, have been installed. This capital improvement program has cost the railroads about eight billion dollars since 1923, and a large part, if not all, of that huge sum had a beneficial effect, directly or indirectly, on the safety of operations.

But the engineer's job is never done. As soon as new equipment, new rail, or other devices are installed the engineers go to work to develop more efficient and safer units. The railroads spend millions of dollars annually in research and laboratory work experimenting with engineering improvements. In all this work safety is of primary importance. An invention which might mean great economies to the railroads would not find its way to a single locomotive or car if its use in any way lessened the opportunity for safe operation. Conversely, any improvement, mechanical or otherwise, promoting safety of operation immediately commends itself to railroad officers and employees. The search for greater safety will continue so long as railroad transportation is used.

About a quarter of a century ago, the

THURSDAY AFTERNOON SESSION

October 14, 1937

Safety, An Executive Operating Problem

By R. C. WHITE

Assistant General Manager, Missouri Pacific R. R., St. Louis, Mo.

Safety is an obligation of management. Without the constructive leadership and day-to-day urge from the executive and operating heads, the movement would lapse into a perfunctory activity.

The safety movement is recognized by executive and operating officers as a medium for building up and maintaining that relationship, that fellowship, which broadens our views, enriches character, and brings the Golden Rule into practical application.

Management recognizes that our economic system must enable men to live on an increasingly high plane. It must enable them to fulfill their desires and satisfy their reasonable wants, and give them that feeling of security which is essential to happiness and efficiency.

Having made the decision that safety is an executive problem and responsibility—that accidents must stop—it is then essential that management promulgate, and follow through, a plan that will definitely fix this decision in the minds of all the individuals who collectively comprise the industry. The follow through must be such that department heads, superintendents, and every member of the supervisory force will appreciate the need for a constant, active interest in safety; will understand that passive interest will no more produce results than would the same interest in production. Supervisors must be made to feel that the prevention of accidents demands the same type of heads-up supervision that is given to the other problems affecting cost and service.

The executive must find a way to indicate directly that it is the responsibility of the department heads to carry out management's program, that authority is placed in each superintendent's hands to put accident prevention on the same basis as production.

A complete factual and descriptive report of each accident must be made. This must be followed by a thorough analysis to find the direct and underlying causes and the procedure necessary to prevent a recurrence.

Proof of its sincerity will depend primarily on whether management will make the first essential move in the program—that is, authorize the expenditure of money necessary to make the maintenance and operating plant a safe place to work.

Safety and Efficiency

Analysis of the underlying causes of industrial accidents and preventive measures to be applied has made it increasingly apparent that those factors which are producing accidents are very largely the same factors which tend to lower the quantity and quality of production. Expressed in another way, safety and efficiency are as inseparable as though one word.

In coupling safety with efficiency I have not minimized it as an executive problem, but have endeavored to indicate that its solution is an executive responsibility, both to his individual industry and to the employees that make it a going concern.

Rail transportation is a scientific business in which laboratory research, expert engineering, trained builders, and skilled workers share a part.

One of the main factors is a group of employees who are loyal—who appreciate that their railroad must give the kind of service that will stimulate and accelerate the development of the territory traversed.

The successful solution of our problem demands the type of aggressive individualism in executive leadership that will attract and command loyal, collective, cooperative effort on the part of all who produce rail transportation.

Our major concern is leadership—leader-