

A REVIEW OF THE INDUSTRIAL HYGIENE LITERATURE PERTAINING TO THE
HEALTH HAZARDS OF ASBESTOS EXPOSURE AND PREVENTATIVE MEASURES

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I. Recognition of the Hazards of Asbestos Exposure in the Industrial Hygiene Literature

In 1956 at the time when Zonolite was informed by the State of Montana concerning the hazards of asbestos dust, there existed an extensive and accessible body of published literature on asbestos health effects. My own research has shown approximately 500 publications in medical journals, industrial hygiene, public health and engineering journals, trade publications, and medical textbooks on asbestos and its relationship to asbestosis and/or cancer of the lung up to 1956.

There were journals specializing in industrial hygiene in the U.S. since the early 1900's. There were also periodicals offering abstracts of the literature. In the U.S. the *Journal of Industrial Hygiene* first appeared in 1919. After 1935, it was called the *Journal of Industrial Hygiene and Toxicology*, and it continued until 1949 when it was replaced by the *AMA Archives of Industrial Hygiene and Occupational Medicine*. A regular feature of this journal was a supplement at the end of each volume called Abstract of the Literature of Industrial Hygiene. These abstracts contained key European and U.S. reports on asbestosis and other occupational diseases. For example, the Annual reports of the Chief Inspector of Factories (U.K.) were summarized in these abstracts.

The Industrial Hygiene Foundation was formed in 1936 and published the *Industrial Hygiene Digest* monthly beginning in 1937. Copies of this digest were automatically sent to industrial and insurance companies. By 1944 this digest regularly reviewed more than 200 medical journals from around the world, and an equal number of trade, engineering and science journals. By 1958 this digest provided more than 1500 abstracts annually to subscribers.

From England the *Bulletin of Hygiene* was published from 1926-1967, when it was incorporated into the *Abstracts of Hygiene*. Some abstracts from the *Bulletin of Hygiene* were reprinted in the *Journal of Industrial Hygiene and Toxicology*.

Other information pertaining to asbestos that was available to industrial hygienists appeared in the *Industrial Hygiene Newsletter*, *Archives of Environmental Health*, *U.S. Public Health Reports*, *American Journal of Public Health*, American Industrial Hygiene Association Hygienic Guide Series, National Safety Council, and Labor Organizations and Agencies (e.g., International Labor Organization and Bureau of Labor Statistics), and encyclopedias.

To establish what industrial hygienist knew about the health hazards of asbestos, the following sections A and B provide quotations pertaining to the health hazards of asbestos that appeared in some of the above mentioned industrial hygiene, public health, engineering journals, periodicals, trade publications, and safety and health magazines. Appendix A contains a bibliography of articles published in industrial hygiene, public health, engineering journals, periodicals, trade publications, and safety and health magazines through 1964. Excluded from the following summary are hundreds of publications from the *medical* literature pertaining to the health hazards of asbestos.

A. Asbestosis

(1) Industrial Hygiene, Public Health, Engineering Trade Journals And Periodicals. The term “pulmonary asbestosis” was first used in 1927 by W.E Cooke to describe the fibrotic lung disease caused by inhalation of asbestos fibers. However, before this disease was even named, in the U.S. work involving asbestos was recognized as being “unhealthy” in the early 1900's.

“One of the oldest medical practitioners in the Thetford expressed the view that the asbestos dust floating in the atmosphere of the cobbing room had a weakening effect on the lungs of those employed.” *Effects of Asbestos Dust on Workers' Health in Asbestos Mines and Factories. Labour Gazette 12: 761-762. 1912.*

“The conclusion of this investigation, the most important official inquiry ever made into the subject of industrial diseases, fully warrants the view that while ordinary tuberculous phthisis can not be regarded as a disease peculiar to any occupation, fibroid phthisis in its latter stage, and when the history of the case is known, can be clearly distinguished from tuberculous phthisis; so that it may be regarded as an established fact that fibroid phthisis is a disease peculiar to employment in certain trades, The committee did not arrive at final conclusions regarding persons employed in the slate industry, or employees in the working of asbestos and many other recognized unhealthy trades, partly, no doubt, because of the limited scope of the inquiry and the paucity of conclusive statistical data.”

There is evidently an urgent need for a more qualified and extensive investigation of the health aspects of asbestos manufacture;.... It is therefore to be anticipated that the condition of asbestos workers will attract more qualified attention in this country in the future than it has in the past.

It may be said, in conclusion, that in the practice of American and Canadian life insurance companies asbestos workers are generally declined on account of the assumed health-injurious conditions of the industry.” *Mortality From Respiratory Diseases In Dusty Trades (Inorganic Dusts). F. Hoffman. U. S. Department Of Labor. Bureau Of Labor Statistics. Industrial Accidents And Hygiene Series, No. 17. 1918.*

“The process which appeared most dangerous is the production of asbestos mattresses. These mattresses, which are composed of bags of woven asbestos filled with short asbestos fiber, are placed on a table and beaten out flat by a man with a wooden flail, from which process much dust arises. Women who sew the mattresses into sections with asbestos threads worked close to the man who beat the mattresses and of necessity inhaled the dust. The reorganization of this process with the application of localized exhaust draft was called for...” *Mortality From Respiratory Diseases In Dusty Trades (Inorganic Dusts). F. Hoffman. U. S. Department Of Labor. Bureau Of Labor Statistics. Industrial Accidents And Hygiene Series, No. 17. 1918. p. 179.*

“By 1930, (1) the signs, symptoms, x-ray appearance, and pathological aspects of asbestosis were rather well understood; (2) the disease was fatal in a number of reported cases; (3) the disease was capable of progressing after exposure to asbestos dust had been discontinued; (4) even the people still actively employed in asbestos mining, milling, and manufacturing showed a

high prevalence of asbestosis; roughly half of those surveyed with 10 or more years in the industry were diagnosed with asbestosis". (Wheatley, G.M. *Tuberculosis and Asbestosis*, Document No. 2578, Institute of Occupational and Environmental Health, Quebec Mining Association, 1944; Lanza, A.J. et al., *Publ. Health Rep.* 50: 1 12, 1935; *Asbestos: Medical and Legal Aspects*, second edition, Barry I. Castleman pp. 22 1986).

In 1950, asbestos was recognized by the industrial hygiene community as a very serious health hazard, causing the debilitating, progressive and often fatal lung disease called asbestosis as well as lung cancer. **"...it is now known that with many years of exposure, fibrosis can be produced by such silicates as talc, mica, and kaolin. The most harmful and disabling of this type of silicate is, of course, asbestos. Mention has already been made of cancer produced from the inhalation of chromates and radioactive dusts. Arsenic and even asbestos have been indicated in this connection."** *Industrial Hygiene Newsletter, Volume 11, Number 1, January 1951. p. 9.*

The 1956 sampling report from the State of Montana made it clear to Zonolite management that asbestos was considered a more significant hazard than other dusts. **"A review of the literature indicates that vermiculite or the dust from this material is not especially toxic and is generally included only as a nuisance dust. However, the asbestos dust in the dust in the air is of considerable toxicity, and is a factor in the consideration of reducing dustiness in this plant."**

"I have had, however, the opportunity of visiting asbestos factories in America and of seeing cases of pulmonary asbestosis through the kindness of Dr. Haddow and Dr. Grieve of Armley, Leeds. It may, I think, be shrewdly suspected that there have been several deaths of workers in British factories from the malady, but as no autopsy or microscopic examinations of the lungs have been made, such deaths would probably be certified as pulmonary tuberculosis." *Pulmonary Asbestosis In Its Clinical Aspects. T. Oliver. Journal of Industrial Hygiene. 9: 483-485, 1927.*

"Hence these curious bodies are only known to occur in cases of asbestosis". *Asbestos Dust And The Curious Bodies Found In Pulmonary Asbestosis. W.E. Cooke. Brit. Med. Journ., Sept 28, 1929, vol. 2, pp. 578-580. In Journal of Industrial Hygiene Abstracts. Feb. 1930. p. 34.*

"An interesting description is given of the clinical course of asbestosis, based on four fatalities. The average time of exposure to asbestos dust was under twenty years, and the average age at death 41." *Clinical Aspects Of Pulmonary Asbestosis. A.C. Haddow. Brit. Med. Journ., Sept 28, 1929, vol. 2, pp. 580-581. In Journal of Industrial Hygiene Abstracts. Feb. 1930. p. 35.*

"This case, at that time the third of which the Factory Department had knowledge, was, however, the first in which the four essential conditions, necessary to establish a relationship between the inhalation of asbestos dust and the development of fibrosis, could be demonstrated. These conditions are:

1. Work involving exposure to asbestos dust.

2. The existence, demonstrable clinically and radiologically, of a definite pulmonary fibrosis.
3. The absence of previous or present infections known to cause pulmonary fibrosis-e.g., tuberculosis, influenza, or pneumonia.
4. The absence of previous or present work involving exposure to other dusts, which might cause pulmonary fibrosis.

These conditions being fulfilled, a relationship between the inhalation of asbestos dust and the development of pulmonary fibrosis may be presumed. This disease, insidious in its onset, stealthily advances with but faint warnings of its progress; inexorably it cripples the essential tissues of the lungs, yet for a considerable period causes almost no inconvenience to the worker. As time goes on, however, the lungs find more and more difficulty in re-aerating the blood; and breathing is quickened on slight exertion.

Practically speaking, all that goes under the name of asbestos, in commerce, is either fibrous serpentine or a fibrous mineral of the amphibole, or hornblende, group. The former is the most important commercially; but strictly, the mineralogists confine the term asbestos to fibrous forms of hornblende. These two types are sharply distinguishable, chemically and mineralogically.

Serpentine asbestos, or chrysotile, is a hydrated magnesium silicate, containing practically no calcium, a high percentage of combined water, and a low percentage of iron. The amphibole, or hornblende, varieties contain less magnesium and combined water, and usually more calcium, aluminum, and iron. Members of this group are resistant to acids, but are more difficult to spin, some being quite unsuitable for this purpose. The most important members of this group are crocidolite, amosite, and tremolite." *The Occurrence Of Pulmonary Fibrosis And Other Pulmonary Affections In Asbestos Workers. E. Merewether. Journal of Industrial Hygiene. Vol. 12, No. 6., 1930.*

"Out of 374 workers examined, 105, or 28.1 per cent., were found to be affected with fibrosis of the lungs, in a greater or less degree. No case of diffuse fibrosis clearly due to asbestos was discovered with under 5 years' employment. Three cases were found with 3, 3 $\frac{1}{2}$, and 4 $\frac{1}{2}$ years' work, respectively, who showed clinical signs of fibrosis.

F.W. Simson examined the lungs of a guinea-pig which had been experimentally dusted by Mavrogordato for two hours a day on each of fifty days between February and April, 1925, and which died from other causes in December, 1927. He states that histological sections showed a slight generalized fibrosis. This observer also examined portions of lungs of two native asbestos mill workers; one had been employed for twelve months and had died from a miliary tuberculosis, and the other, employed for two years, had apparently never recovered from an attack of lobar pneumonia a year before death.

In commenting on the amount of fibrosis found, he states that "a comparison between the human cases and the experimental animal showed that the fibrosis was more rapid and extensive in the human cases than in the experimental animal," and, again, that "the amount of fibrosis in two of the human cases... was quite definite, and if due to the presence of asbestos dust, the initial rate of production was rapid when compared with present-day non-infective silicosis on the Rand." *The Occurrence Of Pulmonary Fibrosis And Other Pulmonary Affections In Asbestos Workers. E. Merewether. Journal of Industrial Hygiene. Vol. 12, No. 6., 1930.*

“The increasing use of a very necessary product has created a new occupational hazard, that must be taken into account by Asbestos Worker. The steadily increasing use of asbestos in industrial processes has created a new occupational risk and added to the list of industrial lung affections a new form of chronic pulmonary fibrosis.” *The “Pulmonary Asbestosis” Menace. The Asbestos Worker. 9(9): 9-11. Sept. 1930.*

“Of late, however, evidence has appeared that the dust formed in the treatment of asbestos produces effects which are generally similar to those arising from the silica-laden dust. The fibrous formations are not precisely the same, and they appear to develop more rapidly, though adding less to the patient’s susceptibility to phthisis. After careful enquiries, in fact, asbestosis has been added to silicosis as an occupational disease arising from working in dusty surroundings...” *Mineral Dust in Factories. Engineering. 129: 577-578. 1930.*

“The recently issued Home Office report on the danger to employees in the asbestos industry caused by the inhalation of dust, emphasizes, as preventive measures, ‘the education of the individual, as in other dangerous trades, to a sane appreciation of the risk, and to his personal responsibility in the prevention and suppression of dust’. The protection afforded by respirators was, it is said, only partial, and there was a real danger that the use of them might give a sense of false security.” *Notes and Memoranda. The Engineer. 149:379. 1930.*

“Within the past five or six years industrial hygienists have become interested in the effects of asbestos on the health of workers. As mentioned above, however, it is the general impression, both among miners and physicians, that asbestos dust is not particularly harmful. There can be little doubt, however, that the disease is a clinical entity, and it has been recognized by the English authorities to the extent of its inclusion as a compensatable disease.” *Asbestosis. Pedley, FG., Canadian Journal of Public Health 21: 576-577. 1930.*

“The dust of asbestos reacts with the pulmonary tissues to cause a diffuse fibrosis, without any of the nodules with their whorl-like structure so distinctive of silicotic fibrosis. Nevertheless, the changes caused are more damaging to the functional structure of the lungs, and appear after shorter periods of exposure. Both in onset and in progress to a fatal termination, asbestosis is more rapid than simple silicosis; after five years’ occupational exposure to the dust the incidence rate of fibrosis increases rapidly, and after ten years it advances almost in geometrical progression.” *Occupational Dust Diseases. Collis, E.L. Bulletin of Hygiene 6: 663-670. 1931.*

“The danger to health arising from exposure to asbestos dust was established by an inquiry conducted last year by the Factory Department of the Home Office.” *Asbestos. The Engineer. 152:283. 1931.*

“The physical and chemical properties of asbestos are so unlike those of any other dust previously studied that, when inhaled, particles of this substance provoke an unusual type of reaction in the lung. The fact that a fiber as long as 100 and even 200 microns can be inhaled and ultimately reach the finer branches of the bronchial tree is surprising and controverts the accepted

ideas of the effectiveness of the upper respiratory protective mechanisms.

That the long-continued inhalation of asbestos dust is responsible for the development of pulmonary fibrosis is now unquestioned. From many parts of the world come radiographic reports of fine fibrosis in the lungs of persons exposed by occupation to the inhalation of this substance.” *Studies On Experimental Pneumonokoniosis. VI. Inhalation Of Asbestos Dust: Its Effect Upon Primary Tuberculous Infection. L. Gardner. Journal of Industrial Hygiene. 13: 97-114, 1931.*

“The steadily increasing use of asbestos in industrial processes has created a new form of chronic pulmonary fibrosis. An account of the conditions under which the asbestos-containing rock is mined or quarried and the raw asbestos converted into finished material, together with the results of exposure to these processes, is given by Sir Thomas Oliver in a recent article. Anatomical examination of the lungs of persons who had been subjected to the inhalation of asbestos dust for several years showed ‘well-marked diffuse interstitial pneumonia with chronic bronchitis and emphysema;... There was no evidence produced to show that one variety of asbestos is more capable of producing fibrosis than another, the degree of concentration of the dust and the length of exposure being the important factors.” *Pulmonary Asbestosis. Monthly Labor Review U.S. Dept. of Labor 31: 74-76. 1931.*

“In this long article the author usefully summarizes information relating to the occurrence of occupational asbestosis. The lungs of workers become affected in direct proportion to the length of time they have been exposed to it, until after twenty years of work 80 per cent. are affected. Statistics and information as to the occurrence of lung diseases among asbestos workers in all countries, but particularly Great Britain, are brought together. The fibrosis caused is general throughout the lungs, which are so damaged as to lead to a fatal issue without any secondary infection necessarily occurring.” *Asbestos and Pulmonary Asbestosis. Dhers, V., Abstracts Section of Journal of Industrial Hygiene 13: 49. 1931.*

“A man of 30 years was admitted to the William Wirt Winchester Hospital, West Haven, Conn., on May 26, 1929, at which time he had been exposed to asbestos dust over a period of about thirteen years.” *Pulmonary Asbestosis. A Report Of A Case And A Review. Soper, B., Abstracts Section of Journal of Industrial Hygiene 13: 49. 1931.*

“The recent investigations of the effects of exposure to asbestos dust have resulted in the adoption of measures to control the dust in the textile side of the asbestos industry. Data regarding 20 fatal cases of asbestosis without tuberculosis show that there is a serious hazard involved in continued exposure to heavy concentrations of asbestos dust. The average age at death of the 20 cases was 38.9 years, and the average length of employment, was 14.9 years.” *Industrial Diseases and Poisoning in British Factories. Safety Engineering. ‘The Magazine of Safety’. Published Monthly by Safety Magazine Publishing Corporation. December, 1931. p. 354.*

“There is a consensus of opinion that the asbestosis bodies found in the sputum and lungs of asbestos workers do not stain with the ordinary aniline dyes. This failure to stain has been one of the difficulties in working out their relation to the histology of the disease and in determining their composition.” *A Method Of Staining The Asbestosis Bodies Found In The Sputum Of Asbestos Workers*. Gloyne, S.R., *Journal of Industrial Hygiene* 13: 85-86. 1931.

“The extraction and manufacture of asbestos involves the constant exposure of workers to asbestos dust. A digest of an article in Tubercle, published in the Bulletin of Hygiene, London, December, 1929, gives the results of a study of the clinical and radiological record of 15 cases of pulmonary asbestosis occurring among workers in an asbestos factory. The dust from asbestos produces a form of pneumoconiosis, of which the principal symptom is dyspnea (difficult or labored breathing), accompanied in most cases by a cyanosis in which the skin assumes a slightly leaden hue. The physical signs are a bilateral pulmonary fibrosis attacking the bases of the lungs and, as frequently happens in cases of silicosis, pulmonary tuberculosis may supervene and modify the clinical picture. An account of the conditions under which the asbestos-containing rock is mined or quarried and the raw asbestos converted into finished material, together with the results of exposure to these processes, is given by Sir Thomas Oliver in a recent article.” *Pulmonary Asbestosis*. *Bulletin of the U.S. Bureau of Labor Statistics*. Vol. 541. 1931. pp. 340-341.

“The author records two cases, with postmortem examination, of pulmonary asbestosis occurring in a factory concerned with the crushing, cleansing, and spinning of asbestos and the manufacture of insulation materials.” *Pulmonary Asbestosis*. Beintker, E. In *Abstracts section of Journal of Industrial Hygiene*. 14: 120-121. 1932.

“The writers reporting these cases considered that the individual characteristics of asbestosis are due almost entirely to the chemical composition of asbestos and to the shape of dust particles,...” *Health and Industrial Hygiene*. *Monthly Labor Review*. U.S Dept. Of Labor, Bureau of Labor Statistics. July, 1932. p. 541.

“The authors have examined 33 asbestos workers in the Deutschen Asbestwerken A.-G., of whom 18 were females and 15 males, between the ages of 20 and 65. Only two of these workers had been employed for more than 15 years,... The general condition of the patients was poor. With regard to age, the severity of the disease did not appear to be dependent on the age of the worker, but, on the contrary, on the ‘employment age’ (i.e., the number of years the workers have been in the factory), and on the amount of asbestos dust inhaled, which varies considerably in different processes. The authors found that in every instance where a patient had been working for more than ten years, asbestosis could be demonstrated radiologically.” *Asbestosis of the Lung*. Gerbis and Ucko. *Bulletin of Hygiene* 7: 341-342. 1932.

“After an exhaustive survey of the work on pulmonary asbestosis in other countries, the authors give an account of the work done in Germany together with a short record of cases of the disease which have come under their own observation in Dresden. The general conclusion is that moderately severe asbestosis takes about five years to develop. Of the workers examined who

had had ten years' or more exposure none were free from signs of the disease." *Pulmonary Asbestosis. Kruger, Rostoski, and Saupe. Abstracts section of Journal of Industrial Hygiene 14: 144-145. 1932.*

"There were 9 deaths reported during the year from asbestosis or asbestosis with tuberculosis. In the comparatively short period of time since the disease has been recognized there have been 35 deaths reported from this cause for which full particulars are available. The average age at death in the cases of asbestosis with tuberculosis was 45.7 years and the average length of employment in asbestos 13.5 years, while in the cases without tuberculosis the average age at death was 40.6 years and the average length of employment in asbestos 15.1 years." *Monthly Labor Review. U.S. Dept. of labor. October 1932. p. 836.*

"The slow development of a characteristic type of fibrosis distinguishes pulmonary asbestosis; it produces insidious lung changes; but the patient may be comparatively free from symptoms for several years, usually from 5 to 15; in some cases, before symptoms arise, years elapse after the worker has left the industry and his exposure to asbestos dust. Nevertheless, in my experience, one or two exceptions have occurred wherein symptoms have followed after exposure of 1 to 3 years or less.

A interesting feature of this disease is the length of time which may elapse between exposure to the dust and a fatal termination, and the fact that this period is only one-half of that in silicosis. The dust particles, once they have gained access, continue to injure the lungs, and the disease is a progressive one, which, if sufficient dust is present, ends fatally, the end being determined by some intercurrent complication, such as acute broncho-pneumonia or phthisis.

This disease must be grouped with silicosis as a very serious pneumoconiosis. The average length of employment in fatal cases is only one-half that of silicosis. Inhalation of asbestos dust must be expected sooner or later to produce pulmonary fibrosis, depending upon (a) length of exposure, and (b) nature and concentration of the dust." *Pulmonary Asbestosis: Its Clinical, Radiological, And Pathological Features, And Associated Risk Of Tuberculous Infection. Journal of Industrial Hygiene. P. Ellman. 15: 165-183, 1933.*

"An analysis of approximately \$300,000 in losses of one insurance company doing a general workmen's compensation and liability business, for recent industrial disease claims, showed 54 per cent for cases involving pneumoconiosis (including silicosis, asbestosis, etc.), *The Mechanical Control Of Occupational Diseases. D. Beyer. National Safety News. August 1933. pp. 21-22.*

"Although the total number of workers in asbestos mills is probably far smaller than in many other lines of trade, their health is of paramount importance. The conditions surrounding the greater proportion of the employees constitute a distinct and serious industrial hazard, and often sufficient devices for protection have not been provided. It is doubtful if any single employee in certain departments of these mills can possibly escape some damage to his respiratory system because of the unavoidable inhalation of asbestos dust. Naturally, the longer the service of an employee, the more certain is more or less extensive pulmonary damage.

Signs are supposed to develop in less than 10 years' exposure, but they are frequently discovered within 2 years. The shortest time in my series of cases, from exposure to the development of symptoms and physical signs, was 18 months.

Although the number of asbestos workers is much less than that in many other industries, their occupation is extremely hazardous, and they are amply justified in expecting whatever protection it is possible to give them. Furthermore, the fact that efficient protective devices in this industry, in spite of the added expense, will effect a substantial financial saving, is becoming more apparent. The workers themselves are becoming informed of the danger to health, and many civil suits for damages against factory owners are the result." *Pulmonary Asbestosis. J. Donnelly. American Journal of Public Health. 23: 1275-1281. 1933.*

"It is silica itself, especially in the form of quartz, which is the classical dust producing serious pulmonary fibrosis; silicosis has far overshadowed other pneumoconioses, though the importance of asbestosis, which is due to a silicate, has recently been recognized. One of the sources of dust was tremolite talc;... By using the above classification, the findings for the tremolite talc workers in summary showed that in only 3 cases (5 per cent.) were the x-ray findings within the limits of normal; thirty-eight (67 per cent.) showed more lung fibrosis than usual; fifteen (26 per cent.) showed evidence of an early or first stage pneumoconiosis.

The small number of individuals studied and for most of them the comparatively short duration of exposure, invite caution as to deductions. The following conclusions, however, appear justified: 1. The silicate dusts of tremolite talc and slate induce a fine, diffuse, bilateral fibrosis of the lungs which is definitely demonstrable in the x-ray. 2. While very dusty conditions prevail in certain departments of these two stone trades (tremolite talc and slate) it cannot be said that the resultant pneumoconiosis has lead to disability." *Effects Of Certain Silicate Dusts On The Lungs. Waldemar C. Dreessen. Journal of Industrial Hygiene 15: 66-78. 1933.*

"Space will not permit our entering into all of the details of the subject of pulmonary asbestosis. These are many of the essential pathological changes found in silicosis, such as those suggested and consisting of a moderate cell proliferation and fibrosis." *The Roentgenological Aspects Of Pneumoconiosis And Its Medico-Legal Importance. Pancoast and Pendergrass. Journal of industrial Hygiene 15: 117-135. 1933.*

"1. Prolonged exposure to asbestos dust caused a pulmonary fibrosis of a type different from silicosis and demonstrable on X-ray films.

It is recommended-

1. That the industry seriously face the problem of dust control in asbestos plants.
2. That new employees be examined physically, including X-ray examination of the chest, and rejected for employment, if they show tuberculosis or pneumoconiosis.
3. That employees be examined physically, preferably every year, but at least every 2 years, this examination to include an X-ray examination of the chest.
4. That the industry sponsor studies on known cases of asbestosis, as well as studies on effects of asbestosis on the heart and circulation." *Effects of the inhalation of asbestos dust on the lungs of asbestos workers. Lanza, A.J. et al. U.S. Public Health Report, 50: 1-12, 1935.*

“Within a comparatively short time the occupational disease, pulmonary asbestosis, has become a matter of considerable importance, not only to manufacturers of asbestos products, but also to the workmen engaged in the industry. That the serious industrial hazard of this type of work has not previously received sufficient attention is becoming more apparent.

It is indicated that the owners of asbestos plants, and the workers themselves, are beginning to realize that exposure to asbestos dust is a serious occupational hazard, and it also is apparent that these workers *must* be protected against the hazard as effectively as is possible.

Sufficient evidence has been produced to prove that the inhalation of asbestos dust is productive of serious impairment of health. In fact, the victim of asbestosis, as a rule, eventually becomes totally disabled from engaging in any form of labor.

An industrial worker is entitled to every protection that may safeguard his health, so that he may earn a livelihood for himself and family for at least a reasonable period of years in the work in which he is most skilled. If he is prevented from continuing in such work because of impairment of health through no fault of his own, he is entitled to some remuneration for his loss of earning power.”

Pulmonary Asbestosis: Incidence and Prognosis. J. Donnelly. Journal of Industrial Hygiene and Toxicology. 18: 222-228, 1936.

“The dangerous dust diseases, silicosis and asbestosis, are being widely studied at present. Asbestos is described chemically as a hydrated silicate of magnesia containing little iron and almost no calcium. When it is processed some of these fibers are fragmented. The fine fragments are inhaled by the workers. It is the particles smaller than 10 microns which are the cause of the distinctive pulmonary fibrosis called asbestosis. In addition to duration of exposure and concentration of effective dust, it appears that individual response is an important factor in the production of asbestosis.” *A Survey Of A Group Of Employees Exposed To Asbestos Dust. McPheeters, S.B., Journal of Industrial Hygiene and Toxicology 18: 229-239. 1936.*

“THE INERT GROUP

Asbestos. Interpretation of the significance of the dusts causing inert reactions is more difficult, but it appears logical to assume that dusts which show a tendency to remain in the tissues should be considered as potentially harmful,... It is likewise logical to assume, and it has been proved to some extent in this laboratory, that silica mixed with an inert dust causes a modified proliferative reaction.” *The Physiological Response Of Peritoneal Tissue To Certain Industrial And Pure Mineral Dusts. Miller, J.W., U.S. Public Health Report, 51: 1677-1689. 1936.*

“This study of actual results secured by a dust control program in an asbestos fabricating plant is presented as an example of engineering control of an industrial hazard. Nevertheless, any appreciable decrease in the amount of asbestos dust will cause a decrease in the incidence and severity of the resulting asbestosis.” *A Study Of Dust Control Methods In An Asbestos Fabricating Plant. Page and Bloomfield. Public Health Report, Vol. 52, No. 48, 1937. pp. 1713-1727.*

“The dusts of silicates follow; although many silicates, such as fire clay and pottery clays, appear to exert little if any harmful influence upon the lungs, recent work has shown that certain other silicates, such as basalt and asbestos, react injuriously on the pulmonary tissues. Collis defines asbestosis as a pneumoconiosis that advances to a fatal end without the supervention of any characteristic infection. It is a simple dust condition, just as is simple silicosis; but it is more distressing in life and more rapid in its progress than silicosis.

Silicosis and asbestosis are forms of pneumoconiosis that have been clearly defined clinically;...” *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 2.*

“Dreessen (Journal of Industrial Hygiene, Vol. 15, 1933, pp. 66-78), in his study of the effects of silicate dusts, found pulmonary fibrosis or pneumoconiosis in all 6 workers who had been exposed for 6 years or more to 1,440 million particles per cubic foot of tremolite talc. Of 33 workers exposed to 52 million particles per cubic foot 10 showed signs of pneumoconiosis, 1 after 5 years, 1 after 6 years, 2 after 9 years, 1 each after 11 and 12 years, 1 after 15 years, and 2 after 30 years or more of exposure.” *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 82.*

“...in spite of the fact that similar diseases, such as asbestosis, seemed obviously to imply that mineral silicates could not be regarded as above suspicion.” *The Mining Magazine. July, 1937. pp. 2-4.*

“All manipulation of asbestos fibre, by hand (as in sack filling or emptying, blending, sweeping and shoveling) or mechanically, produces dust which, if uncontrolled, is often in dangerous concentration. The inhalation of this dust over a period of time results in the development of a fibrosis of the lungs, a progressive replacement of the essential active functioning tissue of the lungs by inactive and useless fibrosis or scar tissue. The disease produced, *asbestosis*, is therefore in the same category as silicosis, which it resembles in some respects while differing considerably in others.

Asbestosis, the pulmonary fibrosis of asbestos workers, is insidious in its onset, irregular in its course, and invariable in its mode of termination. It is helpful to visualise the disease as the slow growth of fibrous tissue (scar tissue) around the bronchioles or smaller air tubes of the lungs and between the air cells, wherever the inhaled dust comes to rest. In contrast to silicosis the former is the important site of deposit of asbestos in the lungs, as was shown by Gardner and Cummings. While new fibrous tissue is being laid down like a spider’s web, that deposited earlier gradually contracts. This fibrous tissue is not only useless as a substitute for the air cells, but with continued inhalation of the causative dust, by its invasion of new territory and consolidation of that already occupied, it gradually and literally strangles the breathing tissues of the lungs.

The tissue reaction to the asbestos fibre is dependent on at least two factors: (1) The sharp, needle-like shape of the fibre which, for practical purposes, is indestructible, and (2) The siliceous nature of the fiber.

For these reasons and from consideration of the features present in the recorded fatal cases, the

view must be accepted that the existence of even a moderate degree of asbestosis is a serious and ever present potential risk to life. Since a worker with developed asbestosis may still remain at work and be little concerned as to the state of his health, the question may well be asked "Is asbestosis a serious disease?". To this question, unfortunately, the answer is emphatically "yes".

It will be observed that:

- (1) The average duration of employment in the asbestos industry sufficient to cause a fatal degree of asbestosis was 12.4 years as compared with 35.1 years for all cases of silicosis. The actual average length of exposure to asbestos dust was, however, still less.
- (2) The shortest length of exposure to asbestos dust which ultimately caused death from fibrosis of the lungs was 1.5 years.
- (3) Asbestosis is comparable with the most serious silicosis risks with respect to length of exposure which will cause a fatal degree of fibrosis.

The risk from asbestosis in the asbestos industry is no less grave than the most serious risks from silicosis in the silicosis producing industries. The preventive measures necessary, therefore, will be extensive and stringent. The essential is dust suppression in all processes to a safe level, which level may be determined by reference to a definite concentration of dust in the air of the workrooms or by reference to the amount of dust produced in a process which has been shown to be safe. There are advantages and disadvantages associated with each of these standards, but space does not permit of their discussion here. In Great Britain the second of these alternative methods was adopted." *Asbestos. I.L.O.: Occupation and Health. January 1938. pp. 1-15.*

"Asbestosis is a form of pneumoconiosis caused by long-continued inhalation of asbestos dust. The primary effect of asbestos dust on the body is to set up an interstitial, pulmonary fibrosis. As in silicosis, the chief symptoms of asbestosis are progressive dyspnoea, variable cough, substernal chest pain, decreased chest expansion, emaciation, weakness, clubbed finger tips, and curved finger nails. The percentage of persons affected by asbestosis or by any one of these symptoms depends upon the dust exposure. In all cases the percentage of persons affected by any given sign or symptom of asbestosis is greater than in control groups of industrial workers who were not exposed to inorganic dust." *A Study Of Asbestosis In The Asbestos Textile Industry. W. Dreessen. Public Health Bulletin. No. 241. 1938. p. 116.*

"Pulmonary asbestosis was the principal physical defect found on examining the 541 persons. This disease, a form of pneumoconiosis caused by long continued inhalation of asbestos dust, is characterized pathologically by diffuse interstitial pulmonary fibrosis and the presence of asbestos bodies in the lungs." *Asbestosis. R.R. Sayers and W.C. Dreessen. American Journal of Public Health. Vol. 29: 205-214. 1939.*

"The paper describes the clinical and radiological signs of asbestosis. The chief complications are (1) purulent bronchitis, (2) broncho-pneumonia, (3) pulmonary tuberculosis, (4) carcinoma." *Asbestosis. Sparks, J.V., Journal of Industrial Hygiene and Toxicology 21: 54. 1939.*

"It has been possible to correlate the response of peritoneal tissue to certain dusts with the results of X-ray examination or of post-mortem study of workers exposed by inhalation to high

concentrations of the same dusts for protracted periods of time. These records are far from complete, because medical and roentgenographic surveys are available for only a limited number of the dusty trades. Nevertheless, the preliminary results of such comparisons can be summarized: (a) No cases of pneumoconiosis have been reported and confirmed among workers exposed solely to dusts of the absorptive group; (b) all of the dusts so far examined that fall into the proliferative group are known to produce a nodular, pulmonary fibrosis (silicosis); (c) pneumoconioses caused by dusts of the inert group (asbestos, anthracite, mine dusts, bisque ware, mica, pyrophyllite, and talc) have been reported as a result of X-ray examination of industrial workers. Where autopsy material is available, certain of the dusts of this group are known to produce a diffuse, interstitial, pulmonary fibrosis, or a mixed nodular and diffuse fibrosis, such as is produced by anthracite coal containing free silica." *The Response Of Peritoneal Tissue To Industrial Dusts. J. Miller. Public Health Report. No. 56. 264., 1941.*

"Asbestos opening consists chiefly in separating crushed asbestos fiber preparatory to mixing with cotton. The work produces large quantities of asbestos dust, which is known to be injurious to health." *How to Design Exhaust Hoods. J.M. Dalla Valle. Heating And Ventilating. July 1943. p.68.*

"The 'Minimum Requirements for Safety and Industrial Health' identified any job in which asbestos dust is breathed as a source of risk to asbestosis, e.g., handling, sawing, cutting, molding, welding rod salvage. The Minimum Requirements recommended segregation of dusty work, special ventilation, use of respirators, and periodic medical examinations." *Minimum Requirements for Safety and Industrial Health in Contract Shipyards. Washington, DC., Government Printing Office, 1943. p. 9.*

"Asbestos dust is second only to free silica in the magnitude of health hazard which it represents. The lung condition resulting from the inhalation of this dust is known as asbestosis and resembles silicosis in its main clinical aspects, but differs due to the enhanced rate of development.

It is estimated that there are in the United States approximately 10,000 men exposed to the hazard as a result of work in the insulating, asbestos cloth, and similar industries. As is true of the silicosis exposure estimates, this figure does not take into account the number of persons exposed as a result of employment in the process industries where asbestos finds use under various trade names, as a filler aid." *Dust as an Industrial Health Hazard. Hutchinson. Heating and Ventilation, Vol. 41. No. 6. 1944. pp. 60-61.*

"An industrial health inspection of an important U.S. Navy Contract Yard indicated that the dustiness from miscellaneous pipe covering operations was considerable and that a few of the employees had what appeared to be asbestosis. This is a well-known industrial disease caused by only one thing - prolonged breathing of asbestos dust.

It seems likely to us that if the pipe covers studied had worked steadily at any of the above operations where the amount of asbestos dust in the air was consistently high, the incidence of asbestosis among these workers would have been considerably greater. In view of the varied

character of the environmental dust exposure in the pipe covering industry on naval vessels, it is manifestly impossible to set a threshold." *A Health Survey Of Pipe Covering Operations In Constructing Naval Vessels. W. Fleischer et al. Journal of Industrial Hygiene. 28: 9-16, 1946.*

"The literature on talc dust is reviewed. Writers both in Europe and in the U.S.A. have reported the existence of pneumoconiosis, consisting of a diffuse generalized fibrosis, among talc workers. A marked similarity is indicated between tremolite-talc pneumoconiosis and asbestosis. The author concludes that this dust carries a definite risk and that its control is necessary." *The Dust Hazard in Tremolite Talc Mining. Greenburg, L., Yale J. Biol. Med. 1947. In Abstracts of British Journal of Industrial Medicine.*

An article in LeDevoir, the January 12, 1949 issue, entitled "A village of Three Thousand Suffocates in Dust", described an epidemic of asbestosis in mine workers and residents around the mine (from D.S. Egilman MD, MPH.).

"Research on the problem of industrial dust inhalation has indicated that, insofar as their fibrosis-producing qualities are concerned, dusts may be divided into three groups: (1) Those composed completely of combined silica, that is, silicates, such as pure asbestos; (2) those containing free silica in the crystalline form known as quartz; and lastly, (3) dusts containing free silica in a noncrystalline form, such as diatomaceous earth." *Studies of Health Hazards in Industry. J. Bloomfield. Industrial Hygiene News Letter. Volume 10, Number 12. December 1950. pp. 22-24.*

"For reporting purposes, an occupational disease is any abnormal physiological condition due to a specific industrial hazard or hazards, other than traumatic injuries. It is a disease entity, or a group of symptoms and signs, which in most circumstances will fit into the categories listed below.

II. Occupational Diseases Due to Dusts, Fumes, Gases, Vapors, or Mists

Examples: Silicosis, asbestosis, or other pneumoconiosis;" Ten Eastern States to Participate in Study of Occupational Disease Reporting. Industrial Hygiene News Letter. Volume 10, Number 5. May 1950. p. 3.

"Although in man asbestosis is a chronic disease with diffuse pulmonary fibrosis which requires years to develop, it is possible to reproduce in one or more species of animal characteristic tissue changes which are similar to the lesions of human asbestosis.

Tremolite: Fibrosis about bronchioles." *Experimental Studies Of Asbestosis. A.J. Vorwald. Archives of Industrial Hygiene and Occupational Medicine. Volume 3. January 1951. pp. 1-2.*

"C. The mode of action of the long asbestos fiber in the production of asbestosis is primarily mechanical rather than chemical in nature.

D. Typical experimental asbestosis was produced by the inhalation of an atmospheric suspension containing an average of 138 million asbestos particles per cubic foot of air by light field count, of which less than 1 per cent consisted of fibers longer than 10 microns. The evidence presented

shows at least that an atmospheric concentration of asbestos dust containing less than 1 million (0.6 per cent x 138 million) fibers longer than 10 microns per cubic foot of air is capable of producing experimental asbestosis in guinea pigs. The actual lower limit of concentration of long fibers necessary to produce asbestosis in animals cannot be established from these studies.

E. The duration of exposure required to develop the pulmonary reaction to inhaled asbestos dust is inversely proportional to the concentration of long fibers in the atmosphere; as the concentration is increased, the reaction develops in shorter time." *Experimental Studies Of Asbestosis. A.J. Vorwald. Archives of Industrial Hygiene and Occupational Medicine. Volume 3. January 1951. p. 42.*

"List of Occupational Diseases Which in Social Insurance are Considered Equivalent with Occupational Accidents.

29 Asbestosis with diminished capacity to breath and impaired circulation associated with cancer of the lungs." *Report On Industrial Hygiene In The Western Zone Of Germany. Tabershaw, I.R., Archives of Industrial Hygiene and Occupational Medicine. 3: 298-315. 1951.*

"Pneumoconiosis due to asbestos dust (Asbestosis) - (a) where the clinical functional disorders are confirmed by typical radiological indications; (b) in conjunction with cancer of the lung." *Third International Conference Of Experts On Pneumoconiosis, Sydney, February-March 1950, Record Of Proceedings. In International Labour Office: Geneva 1953. p. 235.*

"New Jersey eliminated the special restrictions relating to silicosis and asbestosis, thus making these diseases subject to the same benefits as other injuries." *Industrial Hygiene News Letter. April 1954. p. 50.*

"Moreover, susceptibility to asbestos is not a matter of being able to clear material from the lungs more rapidly in the least susceptible cases and more slowly in the more susceptible cases. Our finding that asbestosis was noted at death only in the third decade after the first exposure and the severe form at the end of this decade or later suggests that the cause of the pathological findings may not lie in the mere presence of the raw asbestos fiber but rather in the breakdown of the asbestosis bodies formed around such fibers." *Mineral Content Of The Lungs After Exposure To Asbestos Dust. Knox and Beattie. Archives of Industrial Hygiene and Occupational Medicine 10: 23-29. 1954.*

"As the result of experimental work on the production of asbestosis in animals, Vorwald and associates concluded that typical peribronchiolar fibrosis was produced when the particle length of the inhaled asbestos dust lay between 20 and 50 μ . The asbestos caused fibrosis by the mechanical action of the fiber on the lung tissue. The length of exposure to dust necessary to induce typical fibrosis by inhalation was between one and two years." *Distribution Of Mineral Particles And Fibers In The Lungs After Exposure To Asbestos Dust. Knox and Beattie. Archives of Industrial Hygiene and Occupational Medicine 10: 30-36. 1954.*

“While the asbestos industry may date its beginnings back into antiquity and while the condition now known as asbestosis may have occurred through a long period of time, the industry as we know it is new, and the health hazard related to it is of recent knowledge. In fact, the term asbestosis was not entirely acceptable as recently as about 30 years ago. Asbestosis is the product of the inhalation of asbestos dust in sufficient amount and during a sufficient period of time.” *Pathology of Asbestos. K.M. Lynch. A.M.A. Arch. Ind. Health, 11: 185-188, 1955.*

“In practice, this group of employees with cardiovascular diseases and a minimal or a moderate degree of asbestosis is becoming a serious problem as far as the compensation aspect is concerned.” *Some Clinical Observations of Asbestosis in Mine and Mill Workers. P. Cartier. Arch. Ind. Health, 11: 204-207, 1955.*

“Asbestosis has been described in detail in numerous published articles and texts. The statements and observations reported here concern several thousand men and women employed in the asbestos industry in Canada and the United States. In this industry the various mining, milling, and manufacturing operations create some dust containing asbestos fibers. If the fibers up to 50 μ in length are inhaled continually in sufficient quantities over a period of several years, a typical pulmonary fibrosis will develop.

If increasing quantities of the fibers are continually inhaled, the tissue reaction progresses, and a generalized, diffuse fibrosis gradually appears throughout the lower lobes of the lungs. With additional exposure, this fibrosis will spread to the other lobes, eventually causing respiratory embarrassment and finally cardiac failure.

There is no typical clinical picture for asbestosis. The disease is insidious in its onset and slowly progressive with continued inhalation of the fiber.” *Pulmonary Disability in Asbestos Workers. K. Smith. A.M.A. Archives of Industrial Hygiene and Occupational Medicine. Vol. 12. 1955. pp. 198-203.*

“Inhalation studies have been conducted using a commercial product composed of hydrous calcium silicate and chrysotile on normal guinea pigs, rats, and hamsters and on guinea pigs infected with tubercle bacilli of the R1 strain. The dust caused marked chronic bronchiolitis, with terminal peribronchiolar focal fibrosis, bronchiectasia, and epithelialization of atelectatic alveoli. The final lesions closely resembled those found in experimental asbestosis and included asbestos bodies.” *Effect of Inhaled Commercial Hydrous Calcium Silicate Dust on Animal Tissues. G. Schepers. A.M.A. Archives of Industrial Hygiene and Occupational Medicine. 12: 348-360, 1955.*

“It is asserted that inhaled asbestos dust produces asbestosis only if the inhaled fibers are sufficiently long. Since the larger fibrils are arrested in the bronchioles (Gardner), the granulomatous reactions form peribronchiolar fibrous cuffs with giant cells and asbestos bodies.” *W.C. Hueper, A Quest Into the Environmental Causes Of Cancer of the Lung, Public Health Monograph No. 36, 1955. pp. 35-36.*

“Cases of asbestosis, however, are now appearing in workers who do asbestos lagging of pipes and boilers. In this process, particularly if asbestos is being sprayed, it is difficult to apply adequate protective measures, more especially because the workers are usually peripatetic.” *The Dust Diseases in Great Britain. I. McLaughlin. Archives of Industrial Health. 12: 83-89. 1955.*

“The preceding discussion has shown that the roentgenological appearance of a well-defined asbestosis is quite distinctive and that it differs materially from any of the other pneumoconioses.” *Asbestosis as Differentiated from Other Pneumoconioses. Sander, O.A., Archives of Industrial Health 11: 208-211. 1955.*

“The diseases caused by dust are shown in Table I. It will be seen that they fall into five broad groups; the chronic fibroses, such as silicosis, asbestosis,.....; the cancers caused by arsenic, chromates, radio-active emanations and probably asbestos;...” *The Incidence And Prevention Of Dust Diseases In British Industry. McLaughlin, A.I.G., Journal of the Royal Institute of Public Health and Hygiene 18: 218-239. 1955.*

“During the past few years a group of 57 men who had experienced varying degrees of exposure to air-borne asbestos fiber were studied in the Department of Physiology of the Edward L. Trudeau Foundation. A study of the men in the above-mentioned group shows rather clearly that in the typical asbestotic there is little, and often times no, impairment of ability to ventilate the lungs, as measured by the maximum breathing capacity. There is likely to be, however, a measurable restriction of the degree to which the lung can be expanded, as evidenced by a slight to moderate reduction in total volume. Of course, when the fibrosis is extreme in extent, the impairment to enlarging the lung may cause appreciable loss of maximum breathing capacity.” *Functional Abnormalities of Industrial Pulmonary Fibrosis. Wright, G.W., Archives of Industrial Health 11: 196-203. 1955.*

“Silicosis and asbestosis result from the inhalation of sufficient quantities of free crystalline quartz silica and asbestos fiber. When pulmonary reaction occurs as the result of deposition of either dust, a characteristic, though different, roentgenological pattern is manifested in the chest x-ray.” *Roentgenological Aspects of Silicosis. Bristol, L.J., Archives of Industrial Hygiene and Occupational Medicine 11: 189-195. 1955.*

“Tables 3, 4 and 5 give maximum allowable concentration values for many industrial air contaminants.

Table 5. Limits for Mineral Dusts”

Substance	Threshold Limit Values A.C.G.I.H. 1956 mppcf.
Asbestos	5

Heating Ventilating Air Conditioning Guide 1957. Published Annually By The American Society Of Heating And Air-Conditioning Engineers, Inc. 62 Worth St. New York 13, NY. pp. 151-167.

"Asbestosis is a lung disease caused by inhalation of asbestos fibers. The changes produced are unlike those of silicosis. The fibrosis is diffuse and not nodular, and there is less susceptibility to tuberculosis. However, there is evidence that asbestosis may be associated with lung cancer." *Encyclopedia Americana* 15: 88-90. 1957.

"Long continued inhalation of asbestos dust results in a form of pneumoconiosis known as asbestosis. The primary effect of inhalation is an interstitial pulmonary fibrosis." *Asbestos. American Industrial Hygiene Association, April 1958. pp. 161-162.*

"Going back a few years great progress has been made in the fight against the two main dust diseases in North Carolina - silicosis and asbestosis. The latter one has been almost licked and the incidence of silicosis has been greatly reduced." *Governor Hodges in his address to the 1958 Governor's Conference on Occupational Health in Chapel Hill, NC.*

"Fig. 1 shows a table published in Part 1 of the Report, and shows the incidence of fibrosis relative to length of employment. It will be noted that in the 0-4 years group the incidence percentage is 0 per cent rising to 80 per cent in the group 20 years and over, with an average incidence of 26.2 per cent. This table, we can say, indicates that the risk increased with the length of exposure." Dust control in the asbestos textile industry. *Bamblin, W.P., Annals of Occupational Hygiene* 2: 54-74, 1959.

"Long continued inhalation of asbestos dust results in a form of pneumoconiosis known as asbestosis. The primary effect of inhalation is an interstitial pulmonary fibrosis." *Asbestos. American Industrial Hygiene Association, Hygienic Guide Series. 1960.*

"Under the National Insurance Industrial Injuries Act (1946) 'Pneumoconiosis means fibrosis of the lungs due to silica dust, asbestos dust or other dust and includes a condition known as reticulation [Byssinosis is included in this definition]." *Pneumoconiosis - its Effects and Complications. Sutherland, C.L., Bulletin of Hygiene* 35: 850. 1960.

"Two rival theories of the aetiology of asbestosis have been reviewed. One theory assumes that the disease is due to mechanical irritation set up by asbestos fibres, the other that it is an indirect silicosis due to the liberation of silica acid by the decomposition of asbestos in the lung." *Studies On The Chemical Properties Of Chrysotile In Relation To Asbestosis. Clark and Holt. Annals of Occupational Hygiene* 3: 22-29. 1961.

"But asbestos dust can be a killer, and, in the manufacturing processes of asbestos textiles, it has been deadly in the past." *Health Progress in an Asbestos Textile Works. Jerry Mitchell. Archives of Environmental Health. Vol. 3. July, 1961. P. 43.*

"In the year 1936, the North Carolina State Board of Health set up a procedure for x-ray and medical examinations of employees in North Carolina engaged in the mining of granite and mica, carving tombstones, working in aggregate plants, or working with asbestos." *Health Progress in*

an Asbestos Textile Works. Jerry Mitchell. Archives of Environmental Health. Vol. 3. July, 1961. P. 44.

“A considerable amount of dust was found in the residential districts of the city of Asbest due to discharges to the atmosphere from 3 industrial plants concerned with asbestos production. At collection points 0.5 km. From each of the 3 plants the average dust levels were found to be 23.4, 14.3, and 18.0 mg/m³; The asbestos dust was found to be made up of varied size particles: ... These dusty discharges from the asbestos plants proved to have an unfavorable effect on the health of children in the age range of 7-14 yrs. Of the children living in a dusty area, more than 71.5% had lived in the area for more than 5 yrs. The incidence of pneumonia in this group was 17.3% while for a comparable group of children living in a relatively clean area the incidence was 9.3%. The results of the investigation point to the necessity of more efficient dust control measures for these asbestos production plants.” *The Amount of Dust in Residential Districts of the City of Asbest and Its Effect on the Children's Health. A.T. Bobyleva, et. al., Archives of Environmental Health. 1961. p. 727.*

“Asbestos when inhaled produces fibrous tissue in the lungs of both men and animals. It has been shown that fibers of asbestos must be present for the production of *asbestosis*. Other silicate minerals of the same chemical composition but nonfibrous in form produce no reaction or a relatively mild reaction, but not the severe reaction of fibrous asbestos dust.” *Dust, Fumes, And Mists In Industry. National Safety Council. 1963.*

“Asbestosis, which is a fatal occupational disease is still occurring 30 yr after steps were taken to eliminate the disease. Asbestosis is a fatal disease. It is due to a spreading fibrosis which not only restricts the expansion of the lungs but also interferes with uptake of oxygen into the blood. Eventually it causes death by slow suffocation.” *Some Observations On Asbestosis. Leathart and Sanderson. Annals of Occupational Hygiene 6: 65-74. 1963.*

“A study among insulation workers in a shipyard has revealed several men on disability compensation and one death due to asbestosis. Exposures occur during the fabrication and installation of asbestos insulations and during removal of insulation for repairs or overhaul of ships.” *Asbestos Exposure During Naval Vessel Overhaul. W. Marr. Journal of Industrial Hygiene. 25: 264-268. 1964.*

“That exposure to asbestos is associated with development of a potentially disabling pneumoconiosis in man has been amply demonstrated by industrial experience.” *Present Threshold Limit Value In The U.S.A. For Asbestos Dust: A Critique. Ann. N.Y. Acad. Sci. 132: 316-322. 1965.*

“To obtain as complete a story as possible the record rooms of six hospitals which draw their cases particularly from the area of the asbestos plant were searched for cases where asbestosis was considered during the period between 1956 and 1964. Seventy-five hospital records coded as asbestosis were located. These were people who either were diagnosed on admission, on x-rays,

or at autopsy to have asbestosis or asbestosis was mentioned in the differential diagnosis.” *News & Views. Pennsylvania Department of Health. Vol. 3, No. 4, 1965.*

“Among the occupationally exposed, the use of asbestos has resulted in many cases of disabling pneumoconiosis, known as asbestosis. Epidemiological evidence also shows that persons occupationally exposed have a higher incidence of malignancies of the lungs, pleura and peritoneum.” *Industrial Hygiene for Insulation Workers. L. Balzer. Journal of Occupational Medicine. 10: 25-31, 1968*

“About the same year as Hoffman’s report, the United States Bureau of Labor Standards published the first edition of a guide to occupational hazards and diagnostic signs. Copies of both the first edition (published about 1918) and the second edition of the guide, published in 1922, are unavailable. The second edition was apparently republished, however, in 1922, in the *United States Naval Medical Bulletin*, where it is attributed to Lewis I. Dublin, Ph.D., statistician, Metropolitan Life Insurance Company, and Phillip Leiboff. The guide identified ‘asbestos workers’ as an occupation that ‘offered’ exposure to asbestos, ‘which definitely produces a lung fibrosis under existing industrial conditions’. The guide set forth diagnostic signs and recommended safe work practices, i.e., standards, including wetting, exhaust systems, confinement, and air-fed helmets.” *U.S. Medical Bull 17: 883-914, 1932. In Chronology of Asbestos Regulation in United States Workplaces. Asbestos-Related Malignancy. Grune & Stratton, Inc. 1986. p. 101.*

(2) Industrial Hygiene Text Books. In addition to the above journal publications, the health hazards of asbestos were also discussed in textbooks relating to industrial hygiene including *Industrial Hygiene and Toxicology* by Frank A. Patty (1948, 1958), *Industrial Health Engineering* by Allen D. Brandt (1947), *Industrial Medicine* by W. Irving Clark and Philip Drinker (1935), *Industrial Dust* by Drinker and Hatch (1936 and 1954), *Industrial Hygiene: A Handbook of Hygiene and Toxicology for Engineers and Plant Managers* by Chenoweth and Machle (1938), *Silicosis and Asbestosis* by Lanza (1938), *Industrial Hygiene* by Lanza (1939), *1021 Answers to Industrial Health and Safety Problems* by Weiss (1943), *The Chemistry of Industrial Toxicology* by H. Elkins (1950), *Public Health Engineering* by E.B. Phelps (1950).

“The story of asbestosis is a long one. It was brought prominently before the Committee on Compensation for Industrial Diseases by Dr. Murray of Charing Cross Hospital in 1906. The Minutes of Evidence give details of a fatal case;” *Industrial Maladies. Sir Thomas Legge. Oxford University Press. London. 1934. pp 190-194.*

“Asbestosis. The X-ray picture of the typical asbestotic chest is confusing to the layman. The effect is described as a diffuse fibrosis. The pathology produced by asbestos is not like that of silicosis. The asbestos fibers group about the neck of an alveolus and shut it off, causing what is known as *atelectasis*.” *Industrial Dust, Drinker and Hatch, pp 32-34, 1936.*

“*Asbestos*. Of the true silicates the mineral commonly called *asbestos* is the only one that has been shown to produce a disabling pneumoconiosis. This condition is different from true nodular silicosis but nonetheless it is a distinct entity.” *Industrial Dust, Drinker and Hatch, p.48. 1936.*

“The following table simply contains a list of the compensation enactments in force relative to pneumoconioses, taken from documents in the possession of the International Labour Office at the end of 1937.

Countries	Diseases	Trades, Industries or processes
Germany	(c) Serious pneumoconiosis due to asbestos (asbestosis).	Undertakings, establishments and services subject to accident insurance.
Great Britain	Asbestosis or asbestosis accompanied by tuberculosis.	Asbestos industry: all processes involving manipulation of asbestos, manufacture and preparation of asbestos textiles and other articles made of asbestos.

Workmen's Compensation For Silicosis In The Union Of South Africa, Great Britain And Germany. International Labour Office. Studies And Reports, Series F (Industrial Hygiene) No. 16, 1937. pp. 133-136. Distributed in the United States by: The International Labour Office (Washington Branch).

“Asbestosis has been defined by Merewether as ‘a specific occupational disease of the lungs caused by the inhalation of asbestos dust and characterized by progressive replacement of the essential active functioning tissue of the lung by inactive non-functioning fibrous or scar tissue. It is essentially a pneumoconiosis, a fibrosis of the lungs, caused by the inhalation of dust and, therefore, is in the same category as silicosis, which it resembles in some respects, while differing considerably in others’” *Etiology, symptoms, diagnosis of silicosis and asbestosis. Sayers and Lanza. In Silicosis and Asbestosis. Edited by A.J. Lanza. Oxford University Press, New York. 1938. pp. 57-63.*

“Asbestosis is caused by the breathing of fine particles of asbestos dust. In this disease not only is there a heavy deposit of the asbestos dust in the lungs but a general lung fibrosis follows and disability is marked.” *Industrial Hygiene: A Handbook of Hygiene and Toxicology for Engineers and Plant Managers. Chenoweth and Machle. 1938. p. 175.*

“It seems of importance to first classify the different kinds of dust, as well as the different types of reaction produced by their inhalation. Drinker has recognized four different types of reaction to dusts: 1. *Specific lung diseases*, such as silicosis and asbestosis;...” *Medicolegal Phases Of Occupational Diseases. Sappington, C.O., Consultant, Occupational Diseases and Industrial Hygiene. Industrial Health Book Company, Chicago. 1939. p. 9.*

“The chief health hazard consists in the inhalation of asbestos dust, which is produced abundantly during the preparation of the mineral for spinning process (purification and removal of stony impurities) and during various other phases of the production and manufacturing process of asbestos and asbestos containing goods. The asbestotic pneumoconiosis, resulting from prolonged occupational inhalation of asbestos dusts and fibrils, is a condition more serious than the cutaneous manifestations.” *Occupational Tumors and Allied Diseases*, W. Hueper. Springfield, Ill. Charles C. Thomas. 1942. pp.399-405.

“Where respiratory tissues are not already infected or diseased, all but one of the silicates, and all *non-toxic* mineral dusts, other than free silica, lie inert in the tissues. The sole exception is asbestos, the only silicate known to have any irritating effect on the lungs capable of producing a progressive tissue scarring. Only the fibroses of silica and asbestos at present are considered progressive and dangerous. The fibroses in these two cases are believed to result from the chemical and toxic irritating action of free silica dust particles on the one hand, and on the other from the inability of the lung dust-defense cells (phagocytes) to *ingest* the long, fibrous asbestos dust particles.

Asbestosis is the name given to chronic, incurable, scarring of the lung tissue, said to be caused by the continued inhalation of asbestos.” *1021 Answers To Industrial Health And Safety Problems*. J. Weiss. Published by Occupational Hazards Inc., Publishers of Occupational Hazards Magazine. 1943. pp. 31-34.

“The industrial hygienist is interested in dust because of its effect on the human body. Therefore, a limited classification of dust from this viewpoint may form a basis for relating the chemical composition of dust to the anatomical and physiological reactions which occur in injury from dust.

(1) *Dust causing extensive pulmonary fibrosis*. This group includes all dust containing free silica or asbestos.” *Industrial Hygiene and Toxicology*. Patty, F.A. Interscience Publishers, Inc. New York. 1948. p. 470.

“Minerals that contain combined silica (silicates) but no free silica are incapable of causing silicosis. Asbestos, however, causes a fibrotic lung condition known as asbestosis, which resembles silicosis in many respects and can be almost as serious.” *The Chemistry of Industrial Toxicology*. H. Elkins. John Wiley & Sons, Inc. 1950. p. 173.

“Asbestos, a magnesium silicate, is extensively mined and worked into fireproofing materials and fabrics. Its inhalation leads to another lung disease, asbestosis. Other silicate dusts appear to lack the peculiarly harmful effects of asbestos and of silica.” *Public Health Engineering. A Textbook of the Principles of Environmental Sanitation*. E.B. Phelps. New York. John Wiley & Sons, Inc. 1950.

“The pathologic changes produced by asbestos are not like those of silicosis. The asbestos fibers group about the neck of an alveolus and stimulate the formation of a diffuse fibrosis.” *Industrial Dust*. Drinker and Hatch. McGraw-Hill. 1954. pp. 45-47.

Abstracts of the following publications on asbestosis appeared in *Pneumoconiosis Abstracts, Vol. II, London. Sir Isaac Pitman & Sons, LTD. 1954:*

Saupe, E., Further Contribution to the Radiological Diagnosis of Pulmonary Asbestosis (1939).
 "In the present paper he gives further details on the radiology of the disease, his series of workers examined having now reached 420. Four stages of radiological appearances are described."

Vigliana, E.C., Two Fatal Cases of Pulmonary Asbestosis. (1940).
 "Two cases are described in considerable detail and in particular the post-mortem findings. A valuable list of references cited is given."

Mottura & Fagiano. Pathogeny and Pathology of Pulmonary Asbestosis. (1940).
 "Though the subject of asbestosis is dealt with, as the title shows, purely from the pathological and the morbid anatomy and histology aspect and not from that of public health, attention is drawn to the article here because, for those interested, it gives an excellent account of the changes set up and of the relations between asbestosis and silicosis, gained from personal observations and from a study of the literature."

Stone, M.J., Clinical Studies in Asbestosis. (1940).
 "This is a clinical record of 180 patients who had been employed for three years or more in a factory manufacturing brake lining for cars, and who had worked in the carding, spinning and weaving rooms. Many of them were also engaged in the more dangerous work of crushing the crude asbestos."

Ehrhardt, W., Experiments upon the Importance of the Dust Filtration Capacity of the Nose in Asbestosis. (1940).
 "The author, however, found in his investigation of asbestos workers, that this dividing line of 40 per cent between the normals and abnormals did not hold good. The group below 40 per cent contained healthy workers as well as some with asbestosis; on the other hand there were workers suffering from severe asbestosis with readings above this figure."

Hannesson, H. A Case of Pulmonary Asbestosis Accompanied by Tuberculosis. (1941).
 "Pulmonary tuberculosis is found complicating asbestosis less often than it complicates silicosis, and appears later. Of ninety cases of death from asbestosis reported between 1933 and 1939, tuberculosis was present in thirty-two."

Kuhn, J., Investigations on Asbestos Dust and Asbestosis Lungs. (1941).
 "...the author has made a comparison of the asbestos fibres and asbestosis bodies in lungs exposed to serpentine (chrysotile) and hornblende (amosite)."

Bohme, A., Examination of Workers in an Asbestos Factory. (1942).
 Correlating these findings with exposure, it is stated that there were in workers with less than three years of exposure 5 per cent of cases, in those with three to five years of exposure 12 per

cent, in five to ten years 56 per cent, and in over ten years 79 per cent.”

Nora, L., On the Histology of Asbestosis (1946).

“This article gives a short account of the histology of asbestosis as seen in two workers in Finland who had been exposed to the amphibole asbestos of that country. This variety of asbestos is harder and more elastic than others and therefore is considered to be especially dangerous.”

Luton, P., et al., The Significance of the Presence of the Asbestosis Body in the Expectoration of Workers in Asbestos. (1947).

“After a detailed historical introduction to the subject, the authors give their experience of four years’ observation of workers in the asbestos industry with special reference to the study of the significance of the asbestosis body.”

Board of Trade. German Industry. F.I.A.T. Fina Report No. 1070. Technical Developments related to the Asbestos Industry in Germany. (1947).

“This report is a description of the machinery and installation of the German asbestos industry which is considered to be of interest to American industry,... The use of respirators was recommended only in extreme cases, reliance being chiefly placed on efficient dust control organization. It was forbidden to eat, or to remain, in dust-endangered rooms during rest periods. Outdoor clothes were not to be kept in workrooms and work clothes had to be cleaned at regular intervals.”

Wegelius, C., Changes in the lungs in 126 Cases of Asbestosis observed in Finland. (1947).

“There were ninety-four (75 per cent) instances of mild asbestosis of stages I and I-II (with an average mean exposure of 3.4 years), twenty-three (18 per cent) of medium stages II and II-III (with an average mean exposure of 7.9 years), and nine (7 per cent) of advanced stage III (with an average mean exposure of 11.5 years).”

Franchini and Canepa. A Contribution to the Study of the Pathology of Pulmonary Asbestosis. (1949).

“The only previous publication on this subject in Italy was on two fatal cases described by Mottura and Fagiano in 1940.”

Wyers, H., Asbestosis. (1949).

“Asbestosis was first reported in this country in 1906, but was not officially recognized as an industrial disease until 1930. The condition is thought to be due to the blocking of the finer bronchioles by relatively long (about 20 μ) fibres which appear to irritate the bronchial wall and cause fibrosis.”

Livingstone and Street, A Case of Pulmonary Asbestosis. (1950).

“The interest in this case is that asbestos bodies were found in the sputum some twenty years after the end of exposure to dust containing asbestos...”

Prockat and Windel. Protection against Asbestosis. (1939).

“Brief reference is made to a previously published paper in which it is pointed out that the asbestosis-hazard depends not only on the chemical nature of asbestos but also on the fineness of the individual fibres.”

“In 1927 Badham (19) in Australia coined the word *silicatosis* to cover the pulmonary disabilities resulting from breathing the various silicate dusts (113)(*Dreessen, W.C.: Effects of certain silicate dusts on the lung, J. Indust. Hyg., 15: 66 (1933).* In 1933 McCord (307) reviewed the subject which is considered at each of the first four Saranac symposiums. The recent summary by Koelsch (251) shows clearly that the problem is recognized all over the industrial world”. *Industrial Dust. Drinker and Hatch. 1954. McGraw-Hill Book Company, Inc. p. 52.*

“The most probable explanation of their occurrence is that they are due to obstruction of the bronchioles by asbestos fibres, and this is supported by the simultaneous appearance of altered fibres in the sputum. In Great Britain the risk of contracting the disease occurs in the asbestos manufacturing industries, and to a small extent in heat-insulation work, pipe and boiler covering (lagging) and the other incidental processes, such as stripping the old composition. The risk varies, of course, with the dustiness of the process and, in the absence of efficient dust suppressing and collecting devices, the most dusty operations are (1) preparatory processes of crushing, opening, sieving, mixing and blending, (2) sack filling and emptying and all handling of loose asbestos.....” *Industrial Medicine and Hygiene. Merewether, E.R.A., Vol. 3. Butterworth & Co. (Publishers) LTD. London. 1956. pp. 113-224.*

“Lanza, McConnell, and Fehnel concluded from their study of asbestosis that prolonged exposure to asbestos dust causes pulmonary fibrosis different from that produced in silicosis and demonstrable by roentgenogram. Clinically it resembles silicosis in that it is not disabling in the early stages, but it may be markedly disabling when advanced, and frequently leads to death by right heart failure.” *Patty's Industrial Hygiene and Toxicology. F. Patty. 1958, pp. 397-399.*

“With the development of the asbestos industry, contamination of the air by small asbestos fiber particles produced health problems. Hygienic measures were not well advanced when the first mining operations were developed. Inasmuch as the dry processing method is used in mining and milling asbestos, small fiber particles are picked up by air currents and distributed throughout the manufacturing plants and in the neighborhoods. The asbestos particles or dust which developed could become harmful to the people who were constantly exposed to it.” *Asbestos: Its Industrial Applications. D. Rosato. New York Reinhold Publ. Corp., 1959. pp. 21-22.*

“Safe concentrations for 8-hour exposure of healthy persons to toxic gases and dusts have been established. These are published periodically by the American Medical Association and the American Association of Governmental Industrial Hygienists. (See Table 1.2)

Table 1.2

<u>Substance</u>	<u>Mppcf</u>	
Asbestos	5	"

Air Pollution Control. W.L. Faith. New York. John Wiley & Sons, Inc. 1959. pp. 23-26.

"*Mineral Dusts*. The non-metallic mineral dusts, i.e., silica and the silicates, are divisible into four categories indicated in Table 1-7. Free silica particles when inhaled over long periods of time may result in the lung disease, silicosis. Some forms of asbestos dust may cause a superficially similar lung disease, asbestosis." *Plant and Process Ventilation*. W. C. Hemeon. Industrial Press Inc. 1963. pp. 12.

"Dusts containing silica, which are incident to stonecutting, sandblasting, rock drilling, and certain processes in coal mining, are especially dangerous. Asbestos dust has the same effect as silica, the resulting disease being known as 'asbestosis', with pulmonary tuberculosis as the aftermath." *Municipal And Rural Sanitation*. V.M. Ehlers. McGraw-Hill Book Co. 1965. pp. 510.

"In the Canadian and American asbestos industries the various mining, milling, and manufacturing operations create some dust containing asbestos fibres. If the fibres up to 50 μ in length are inhaled continually and in sufficient quantities over a period of several years, a typical pulmonary fibrosis will develop. It has been stated that this fibrosis is due not to the chemical but rather to the mechanical action of the fibres." *The Pneumoconioses*. Lanza, A.J., New York: Grune and Stratton. 1963. pp. 13-24.

B. Lung Cancer And Asbestos

(1) Industrial Hygiene, Public Health, Engineering, Trade Journals, Periodicals And Text Books. The first reports of cancer in association with asbestos appeared in 1934 (Wood, W.B. and Gloyne, S.R., *Lancet*, 2: 1383-1385) and 1935 (Lynch, K.M. and Smith, W.A., *Amer. J. Cancer*, 24: 56-64). Cancer of the lung in association with asbestos exposure was officially recognized in Germany in 1943 (Fourth Schedule of Extension of Compensation for Industrial Accidents and Diseases. Reichsgesetzblatt, Part 1, No. 14; Tabershaw, I.R., *Arch. Indust. Hyg.* 3: 298-315, 1951). In addition, in the early 1950's, German researchers recognized mesothelioma as being causally associated with asbestos exposure (Weiss, A., Cancer of the Pleura with lung Asbestosis in Vivo Morphologically Ascertained, *Medizinische* 3: 93-94, 1953; Leicher, F., Primary Epithelial Tumor of the Peritoneum in Asbestosis, Abstract in *Bull. Hyg.* 30: 324, 1955). In the U.S., Dr. Hueper, writing the first book on occupation and tumors in 1942 (*Occupational Tumors and Allied Diseases*), associated lung cancer with asbestos exposure. In 1944 (*J.A.M.A.* 126: 836) and 1949 (*J.A.M.A.* 140: 1219-1220), the Journal of the American Medical Association published editorials that stated that asbestosis resulted in lung cancer. During this time frame, approximately 80% of all physicians in the U.S. received these publications (Burrow, J.G. *AMA: Voice of American Medicine*. Baltimore: Johns Hopkins Press, 1963, pp. 52-53). By 1942, there were enough pathological data to support a causal link between asbestos exposure, asbestosis and

lung cancer. It is important to note, as shown in the quotations from the literature below, that the industrial hygiene literature was discussing asbestos exposure and its association with lung cancer in the 1940's and 1950's. In *Industrial Dust* (Drinker and Hatch, 1954), the association of asbestos and lung cancer is discussed. This is the same publication cited to the management of Zonolite by the State of Montana in the 1956 sampling report. The following citations on asbestos and lung cancer come from reports published in industrial hygiene journals, periodicals and text books. Again, excluded from the following summary are hundreds of publications from the medical literature pertaining to asbestos and lung cancer.

“The author reports on 2 cases of lung cancer of which he made the pathological-anatomical examination. He reports likewise on the clinical aspects of Hornig’s case (see following abstract) and on a 55 yr. old man who had worked in asbestos from his 36th to 43rd years. The author mentions 4 additional cases of cancer with asbestosis in the literature and one must agree with him that, in view of the small number observed and the very few cases of asbestosis autopsied (12 cases in Germany), the number of cancers found is a very high one. After all, the author seems quite right in seeing a causal relation between asbestosis and lung cancer.” *Occupational Cancer in Asbestos Workers*. M. Nordmann. *Ztschr. F. Krebsforsch.*, vol. 47, pp. 288-302 (1938). In *Supp. To Journal of Industrial Hygiene and Toxicology*. 20: 184. 1938.

“A 35 year old woman who worked in an asbestos factory from 1919-1928 fell ill of asbestosis; in 1937 a sharply defined shadow was seen roentgenologically in the upper left lobe. This shadow was considered by the author to be a carcinoma and in the decision on the case, a causal relation between the presence of asbestosis and the development of carcinoma was accepted.” *Clinical considerations on the question of industrial cancer of asbestos workers*. F. Hornig. *Ztschr. F. Krebsforsch.*, vol. 47, pp. 281-287 (1938). In *Supp. To Journal of Industrial Hygiene and Toxicology*. 20: 184. 1938.

“Gloyne (1935) records two cases of squamous carcinoma of the lungs in association with asbestosis and Lynch & Smith (1935) one case of cancer of the lungs in ‘asbestosilicosis’. *Silicosis and Carcinoma of the Lung*. Anderson and Dible. *Journal of Hygiene* 38: 185-204. 1938.

“The paper describes the clinical and radiological signs of asbestosis. The chief complications are (1) purulent bronchitis, (2) broncho-pneumonia, (3) pulmonary tuberculosis, (4) carcinoma.” *Asbestosis*. Sparks, J.V., *Journal of Industrial Hygiene and Toxicology* 21: 54. 1939.

“A summary regarding pneumoconiosis is promised for another report; but mention is made that out of 943 fatal cases of silicosis, cancer of the lungs was present in 23 instances, while cancer of the lungs was associated with 12 out of 103 fatal cases of asbestosis.” *Home office. Annual Report of the Chief Inspector of Factories for the year 1938. Abstract in Bulletin of Hygiene* 15: 69-70. 1940.

“It is only in very recent years that serious consideration has been given to the possibility of a

cancerogenic action of asbestosis upon the lungs. The incidence of lung cancer, in whom an asbestosis was found at autopsy is relatively high, ranging from 17.2 out of 17 cases) to 20 percent (Wood: 2 or possibly 3 out of 12 cases). Teleky exists a minimum of 39 and a maximum of 78 autopsies in fatalities from asbestosis, not being clear in this respect. Teleky only knows of 6 cases of pulmonary cancer and feels that this ratio is high in comparison to the number of necropsies. Lynch found among 35 autopsies with asbestosis 2 cases of pulmonary malignancy (six per cent) whereas there was an incidence of only 0.3 per cent of this type of neoplasia among approximately 2,300 autopsies of the general population." *Occupational Tumors and Diseases*, W. Hueper. Springfield, Ill. Charles C. Thomas. 1942. pp.399-405.

"Asbestosis cancer of the lung is the most recent newcomer among the occupational cancers of this organ. First described in 1935, there are now 18 cases of this industrial cancer on record observed among asbestos workers in England, Germany and the United States. The latter contributed five cases. Inasmuch as the asbestos industry is most extensively developed in this country asbestosis cancer of the lung has for us a special hygienic and sociologic significance." *Cancer in Its Relation to Occupation and Environment*. W. Hueper. The American Society for the Control of Cancer. 25: 63-69. 1943.

"This article is a record of two cases of asbestosis complicated by cancer of the lung. The first patient was aged 43, with an exposure of 11 years in an asbestos factory; death was due to squamous cell carcinoma. The second worker had had 30 years' experience in asbestos work and showed at autopsy an atypical epithelial cell new growth. The author suggests there is a causal relationship between asbestosis and carcinoma." *Further Observations On Occupational Carcinoma In Asbestos Workers*. A. Welz. Arch. F. Gewerbepath. U. Gewerbehyg., vol. 11. No. 4, pp. 536-560. 1942. In *Journal of Industrial Hygiene and Toxicology*. Vol. 26, No. 1. 1944. p. 8.

"The substances or agents now known to cause cancer in man include arsenic, tar, pitch, paraffin, petroleum oils and derived products, benzol, aniline dye compounds, roentgen rays, radium rays and ultra-violet rays, possibly asbestos, nickel carbonyl and chromates." *The Epidemiology of Cancer*. M Levin. American Journal of Public Health. 34: 611-620. 1944.

"Attention is called to the association of asbestosis with pulmonary carcinoma, the latter almost always taking the form of carcinoma of the pavement epithelium. It is possible that, in addition to chemical processes, the purely mechanical effects of the asbestos needles are also responsible for the development of carcinoma." *The pathology of diseases due to the inhalation of dust*. Fr. Boemke. Med. Monatsschr. 1, 2-2 (1947). In *Chemical Abstracts*. 42: c 9002-9003. 1948.

"The number of the tumors of the lungs has greatly increased during the last years and many doctors think that this fact is partly due to the increased industrial use of irritant or toxic carcinogenic matter. Clinical, statistical and experimental data in the tumors of the lungs caused by dust and substances in industry are briefly reviewed. The conclusion is that only asbestos dust

and coal tar derivatives possess an undoubted carcinogenic power on the lungs." *Occupational Tumors of the Lung*. Saita, G., *Abstract in Bulletin of Hygiene* 23: 865. 1948.

"There is increasing evidence indicating that exposure to asbestos dust may create an increased liability to lung cancer in the presence of an asbestosis of the lung." *Occupational Cancer Hazards Found In Industry*. *Industrial Hygiene Newsletter*, Volume 9, Number 12, December 1949. p. 7.

"Other agents seem to cause cancer by altering organs so that the organ itself induces a carcinogen, resulting in a cancer. The mechanism of this transformation is little understood. It is known that some radiations and certain metallic compounds including the chromates, the arsenics, nickel carbonyl and possibly asbestos cause cancer in this relatively roundabout way." *Cancer And Environment*. G. Conklin. *Scientific American*. 180: 11-15. 1949.

"Increased attention is being paid to the inanimate pathogenic factors that form a small but important part of our modern industrial environment. Among these are the chemical carcinogens... Known or strongly suspected carcinogens include.....chromates, radioactive substances, and perhaps nickel carbonyl and asbestos." *Chemical Carcinogens*. Heller, J.R., *Industrial Hygiene Newsletter*, Volume 10, Number 7, July 1950. p. 12.

"The large scale use of arsenical dusts as pesticides and the long-continued and formerly uncontrolled release of arsenicals with waste fumes of metal ore smelters may have created potential cancer hazards in many regions. It may be wise to consider the possible existence of similar conditions for the population living near chromate factories, beryllium operations and asbestos mills.

The future control of these potential hazards depends, first, on the reliable qualitative and quantitative demonstration of cancerigenic agents in the air around establishments producing or handling recognized or suspected cancerigenic agents; second, on thorough epidemiologic studies of cancer incidence in the population living in the fume or waste disposal zone of such plants; and third, on the subsequent institution of effective measures preventing further release of cancerigenic agents into the environmental air." W.C. Hueper, *Environmental Cancer Hazards Caused By Industrial Air Pollution*, *Arch. Indust. Occup. Med.* 2: 325-328, 1950. Read at the *United States Technical Conference on Air Pollution*, May 3 to 5, 1950.

"Table 1. Recognized and Suspected Occupational Carcinogens

(b) Inorganic chemicals: Arsenicals, chromates, nickel carbonyl (?), asbestos (?), beryllium (?)"

A Methodology for Environmental and Occupational Cancer Surveys. W.C. Hueper. *Public health Monograph No. 1*. pp. 3. 1950.

"Mention has already been made of cancer produced from the inhalation of chromates and radioactive dusts. Arsenic and even asbestos have been indicated in this connection." *Industrial Hygiene Newsletter*, Volume 11, Number 1, January 1951. p. 9.

“List of Occupational Diseases Which in Social Insurance are Considered Equivalent with Occupational Accidents.

29 Asbestosis with diminished capacity to breath and impaired circulation associated with cancer of the lungs.” *Report On Industrial Hygiene In The Western Zone Of Germany. Tabershaw, I.R., Archives of Industrial Hygiene and Occupational Medicine. 3: 298-315. 1951.*

“The 1947 report of the Chief Inspector of Factories noted the presence of cancer of the lungs or the pleura in 31 (13.2%) of 235 cases of asbestosis recorded in the 23 years from 1924 through 1946. These figures stimulated interest in the question of whether lung cancer is an occupational hazard in the asbestos industry, and, if so, which phases of the industry and what working conditions present such a hazard. The incidence of cancer was thus 10 times greater in asbestotic lungs than in silicotic lungs.

In addition to the material of Table 1, Dr. Gloyne also examined the lungs of 169 persons without pneumoconiosis but employed in the same set of industries as those included in Table 1. Among these, he found 14 who had primary lung cancer (8.3%). The lungs of 11 asbestos workers who had no asbestosis (either in the gross or microscopically) were negative for carcinoma. The 17 cases of cancer in asbestotic lungs (Table 1) were about equally distributed between men and women (10 men; 7 women), whereas in the normal population in England the ratio is said to be 4 men to every women with cancer of the lungs. In addition to the higher incidence of cancer in asbestotic lungs, Dr. Gloyne felt that this difference in the sex ratio afforded evidence for an occupational factor.

TABLE 1

Occupational Group	Persons with Pneumoconiosis		
	Total Number	Number with Primary Lung Cancer	Percentage with Primary Lung Cancer
Iron and steel workers	78	4	5.1
Pottery workers	340	19	5.6
Coal miners	293	19	6.5
Stonemasons	96	8	8.9
Asbestos workers	121	17	14.0

Despite this elevation of the baseline for comparison, the rate in the asbestosis group continued to stand out.

I next visited Prof. E.J. King at the British Post-Graduate Medical School in London, where I had the opportunity to examine protocols relating to the lungs of 11 individuals who had been employed in a plant using Canadian white asbestos.. Varying degrees of asbestosis were noted in 8 of these 11 lungs; there were 3 cancers, all among the 8 asbestotic lungs.” *Survey of Some Current British and European Studies of Occupational Tumor Problems. Smith, W.E., Archives of Industrial Hygiene and Occupational Medicine 5: 242-262. 1952.*

“Unusually high lung-cancer mortality has also been recorded for miners exposed to radioactive ores in Germany, for nickel-refinery workers exposed to nickel carbonyl, and for men and women patients with asbestosis in England.” *Lung Cancer With Special Reference To Experimental Aspects*. Smith, W.E., *Archives of Industrial Hygiene and Occupational Medicine* 5: 209-210. 1952.

“I have been asked to describe our experience at the Thetford Industrial Clinic in Quebec, where we see men engaged in the asbestos-mining industry in Canada. Table 3 presents data on eight cases of primary cancer of the lung which we have detected among 4,000 asbestos workers between 1940 and 1950. In addition to those listed in the table, there was a case in which there was quite a definite clinical and radiological history of cancer of the lung but for which, unfortunately, no autopsy was performed. Also there were three other cases with a strong suspicion in favor of a cancer of the lung but for which no sufficient data are available.” *Abstract of Discussion*. Cartier, P., *Archives of Industrial Hygiene and Industrial Medicine* 5: 262-263. 1952.

“The relation between fibrotic changes caused by asbestos deposits in the lung and carcinoma is discussed. The lower lobe is the site of predilection. Characteristic are the multicentered developments of flat epithelium. *Lung carcinoma caused by asbestos inhalation*. Fr. Boemke. *Med. Monatsschr.* 7, 77-81 (1953). In *Chemical Abstracts*. 47: c 4471. 1953.

“Pneumoconiosis due to asbestos dust (Asbestosis) - (b) in conjunction with cancer of the lung.” *Third International Conference Of Experts On Pneumoconiosis, Sydney, February-March 1950, Record Of Proceedings*. In *International Labour Office: Geneva 1953*. p. 235.

“Thus, chromium and nickel under some conditions, asbestos, and an as yet unidentified factor in isopropyl alcohol manufacture are today most suspect as human pulmonary carcinogens.” *Experimental Lung Cancer*. Eckardt and Drinker. *Archives of Industrial Hygiene and Occupational Medicine* 9: 449-450. 1954.

“Asbestosis and Lung Cancer. The 1947 report of the Chief Inspector of Factories states that, of 235 cases of asbestosis autopsied between 1924 to 1946, 31 or 13.2 per cent were complicated by carcinoma of the lungs or pleura. This figure should be compared with that of their cases of silicosis of whom 6884 were autopsied over the same period and in which 1.32 per cent showed cancer of the lungs. This latter is about the rate reported in the 1946 census in the United States (13 per cent of all deaths were from cancer and 1 per cent from cancer of the respiratory tract).” *Industrial Dust*. Drinker and Hatch. McGraw-Hill. 1954. pp. 46-47.

“Previously published studies have implicated cigarette smoking and certain occupations - especially those involving exposure to radioactive and chromate ores and asbestos - in the causation of lung cancer. Although data from the present study involve small numbers for many of the occupations,... The group of steam fitters, boilermakers, and asbestos workers lies on the borderline of statistical significance when the effect of cigarette smoking is controlled.”

Occupations and Cigarette Smoking as Factors in Lung Cancer. Breslow, M.D., et al. American Journal of Public Health 44: 171-181. 1954.

Abstracts of the following publications on asbestos and lung cancer appeared in *Pneumoconiosis Abstracts, Vol. II. London. Sir Isaac Pitman & Sons, LTD. 1954:*

Weltz, A. Further Observations on Occupational Carcinoma in Asbestos Workers. (1942).
 "The author suggests there is a causal relationship between asbestosis and carcinoma."

Wedler, H., Asbestosis and Pulmonary Carcinoma. (1943).
 "Carcinoma as a complication of asbestosis occurred most frequently in males between 35 and 41 and was generally in the part of the lung most affected with asbestosis. ...the development of the cancer, which, in the author's view, must now be regarded as an occupational cancer."

Homburger, F., The Co-incidence of Primary Carcinoma of the Lungs and Pulmonary Asbestosis. Analysis of Literature and report of Three Cases. (1943).
 "A review of the literature on the association of pulmonary asbestosis and carcinoma revealed that there are at least nineteen known cases (including the three herein reported) of asbestosis associated with primary pulmonary carcinoma. In this laboratory the association of the two conditions is remarkably high. In eight cases of asbestosis there were four instances of primary pulmonary carcinoma."

"The studies of Breslow, Hoaglin, Rasmussen, and Abrams on 518 histologically proved cases of lung cancer in California suggested the existence of an increased liability to lung cancer for members of the following occupational groups: welders, sheet metal workers, steamfitters, boilermakers, crane operators, and nonferrous metal smelter workers,..... asbestos workers...

The respiratory cancers of recognized or strongly suspected occupational origin are important, not only as industrial disease manifestations but also as prototypes of etiologically and topographically identical cancers affecting workers in other, similarly hazardous occupations as well as of those cancers involving an indefinite portion of the general population sustaining for environmental reasons contacts with the same industry-related carcinogens.

During the last 75 years, an increasing number of specific chemical and physical agents have either definitely been recognized or are strongly suspected of being responsible for the appearance of cancers of the nares, paranasal sinuses, larynx, and lung among members of certain occupational groups. These specific occupational exposures are associated with the inhalation of coal tar and pitch fumes and dusts,.....asbestos...

The evidence on hand, at any rate, has convinced the West German Government to make asbestosis cancer of the lung a compensable disease (Tabershaw)."

Whenever a definite identification of a specific causal agent, such as isopropyl oil, asbestos, and chromates, has not yet been attained, the epidemiologic evidence based on an evaluation of cancer incidence of relatively small, occupationally circumscribed total populations at risk is sufficiently reliable to prove the presence of an occupational respiratory cancer hazard causally related to a specific operation. Epidemiological, medical, and experimental data concerning these respiratory

carcinogens attest their high carcinogenic potency under occupational conditions, particularly when acting on humans. It is therefore reasonable to assume that inhalation of the same agents, in a mitigated form as air pollutants, by the general population is responsible for a considerable portion of the lung cancers attributable to such contacts." *W.C. Hueper, A Quest Into the Environmental Causes Of Cancer of the Lung, Public Health Monograph No. 36, 1955.*

"The diseases caused by dust are shown in Table I. It will be seen that they fall into five broad groups; the chronic fibroses, such as silicosis, asbestosis,.....; the cancers caused by arsenic, chromates, radio-active emanations and probably asbestos;..." *The Incidence And Prevention Of Dust Diseases In British Industry. McLaughlin, A.I.G., Journal of the Royal Institute of Public Health and Hygiene 18: 218-239. 1955.*

"The case reported here was that of a man aged 53 who had been employed for 26 years, in the period 1919-51, spinning coarse yarn and asbestos; during 16 years of that time he had been exposed to high concentrations of asbestos dust. Autopsy showed.... a flat tumour, half the size of a hand and 1 cm. In thickness, was attached to the peritoneum on the under surface of the diaphragm. It is uncertain how the asbestos reached the peritoneal cavity; the most probable route was thought to be by direct penetration by the asbestos fibres from the lung through the pleura and thence through the diaphragm." *Primary Cortical-Cell Tumour of the Peritoneum in a Case of Asbestosis. Leicher, F., Abstract in Bulletin of Hygiene 30: 324. 1955.*

"Possible Industrial Causes Of Lung Cancer: Asbestos from Asbestos Mining, Processing and Weaving." *Medical Aspects: A survey of current medical knowledge on the relationship between the smoking of cigarettes and cancer of the lung. Consumer Reports 20: 67-73. 1955.*

"Conflicting opinions and different reports make it extremely difficult to confirm or deny conclusively the causal relationship of asbestosis and carcinoma of the lung." *Pulmonary Disability in Asbestos Workers. Smith, K.W., Archives of Industrial Hygiene and Occupational Medicine 12: 198-203. 1955.*

"At the 1955 Industrial Health Conference, Cook presented a paper in which he identified asbestos as one of three known carcinogens. He said, "Quoting in part from a private communication from Oettel whose publications on "MAK's" include a well-considered presentation of the general subject: "We suggest that consideration be given to indicating the suspected cancerigens with an asterisk with reference to a footnote that the hazard exists and consequently especially effective control measures be instituted. No man can say today which concentration of the several industrial substances is actually required to be cancerigenic..." *Warren A. Cook, Symposium on Threshold Limits, Present Trends in MAC's, Industrial Health Conference, April 26, 1955. Published in the Industrial Hygiene Quarterly, American Industrial Hygiene Association Volume 17. 1956. pp.273-274.*

"Doll has found that the incidence of lung cancer among 105 English asbestos workers employed more than 20 years was tenfold that in the normal population. Cartier studying over a nine-year period 4000 asbestos miners in Canada, involving 128 cases of asbestosis, 40 of them with autopsies, found six of these have bronchogenic carcinoma. Seven cases of lung cancer were found among miners with no asbestosis." *In the Field of Toxicology. Stokinger, H.E., American Industrial Hygiene Quarterly. 17: 340-344. 1956.*

"Until this charge is successfully answered we may for practical purposes regard asbestos or a derivative of asbestos as a probable co-carcinogen in that proportion of cases of diffuse fibrosis of the lung in which the necessary preparedness of the lung has been brought about." *Industrial Medicine and Hygiene. Merewether, E.R.A., Vol. 3. Butterworth & Co. (Publishers) LTD. London. 1956. pp. 113-224.*

"However, there is evidence that asbestosis may be associated with lung cancer." *Encyclopedia Americana 15: 88-90. 1957.*

"For the sake of clarity, the various known and suspected carcinogenic agents in the atmosphere will at the onset be discussed individually. Included in this group would be the radioactive dusts and gases; the metal oxide and metal salt dusts and fumes from such elements as chromium and nickel; asbestos; and the organic material, isopropyl oil. While the relative significance of these various factors is at present the subject of great controversy, epidemiologic and experimental data obtained from broad programs of lung cancer research strongly support the thesis that air pollution provides a source for agents carcinogenic to the lung." *The Chemical and Biological Consideration of Atmospheric Carcinogenic Agents. Falk and Kotin. Journal of Air Pollution Control Association 7: 12-14. 1957.*

"Since the first case of carcinoma of the lung associated with asbestos was cited by Lynch and Smith in 1935, there have been numerous reports in the literature of similar cases. Authors reviewing the literature describe an incidence of carcinoma of the lung associated with asbestosis ranging from 13% to 16%. Individual reports, usually dealing with relatively small numbers of cases, describe an incidence ranging from 7% to 50%. In an editorial in 1955, Hueper stated that 127 cases of asbestosis carcinoma of the lung were on record and described the occurrence of 114 cases of pulmonary carcinoma in 738 autopsies of asbestosis cases collected from the literature (15%).

A increased incidence of pulmonary tumors has been recorded in mice following the subcutaneous injection, intratracheal injection, intravenous injection, and inhalation of a variety of substances, but only one published statement has been found suggesting the induction of tumors in experimental animals by the inhalation of asbestos. We have been unable to demonstrate any proof of the carcinogenicity of asbestos under the conditions of this experiment, but the increased incidence of multiple lung tumors in dusted animals must be regarded as a possible accentuation by the inhalation of asbestos dust of an existing tendency to develop lung tumors. The equivocal nature of this report does not answer the questions raised by accumulating clinical evidence that asbestosis is strongly associated with, and therefore a possible cause of, pulmonary carcinoma in

man." *Pulmonary Tumors in Mice Exposed to Asbestos Dust*. Lynch, K.M., et al., *Archives of Industrial Health and Occupational Medicine* 15: 207-214. 1957.

"Although tuberculosis has been shown to be no more prevalent in persons with asbestosis than in the general population, lung cancer is under suspicion as occurring more frequently with asbestosis, especially in England." *Industrial Hygiene And Toxicology*. F. Patty. 1958. p. 398.

"In 1935, Lynch and Smith reported lung cancers among asbestos workers who had developed asbestosis. Although there are still those who do not agree thoroughly that asbestos was the cause in these cases, most authorities believe that the incidence of lung cancer among asbestosis cases is higher than would be anticipated.

The lung cancers seen in cases of asbestosis are generally squamous cell carcinomas arising from the bronchial epithelium. In addition to the cancers observed, squamous metaplasia of the epithelium in various adjacent and distant regions of the bronchial epithelium is observed. The most complete analysis of a large series of cases is contained in the Annual Report of the Chief Inspector of Factories of England for the year 1954. In this report, a total of 344 asbestosis deaths was analyzed, of which 205 were men and 139 women. Cancer of the lung was observed in 55, or 16%." *Industrial Carcinogens*. Eckardt, A.J., New York: Grune and Stratton, 1959, pp. 4, 99-101.

"We believe there is an association between the conditions [asbestosis and carcinoma of the lung]." *Asbestosis*. Meiklejohn, A. *Bulletin of Hygiene* 35: 851. 1960.

"A case of asbestosis with primary carcinoma of the lung has been reported. The available literature relating these two conditions has been reviewed up to July 1, 1958. Hueper, from the National Cancer Institute, felt rather strongly that asbestosis predisposes to lung carcinoma. He quoted 127 cases of asbestos carcinoma of the lung as being on record (U.S., 21; Canada, 6; Great Britain, 88; Germany, 12) and an incidence from 7.5% to 50% of carcinoma in autopsied asbestosis cases. In order to rule out any nonspecific irritant as a cause, he stated that silicosis has a normal or less than average association with pulmonary carcinoma. He pointed out also that asbestosis carcinoma is a compensable disease in Germany and that at least one case in Canada has been decided similarly.

Isselbacher's survey of the literature, in 1953, is by far the most complete. He summarized the reports of Merewether, Welder, Gloyne, Wyers, and Lynch and Cannon, whose combined deaths from asbestosis total 603. Of these, 83 died from carcinoma of the lung, for an incidence of 13.8%. He also collected the 19 previously autopsied cases of asbestosis carcinoma and added 2 of his own. This incidence is considerably greater than the average necropsy incidence of carcinoma of the lung from 1935-1949, of 24.25% per 100,000 population, quoted by Cohart.

One further point made by Isselbacher deserves comment, as it may afford some help in determining if asbestosis and lung carcinoma are related. He pointed out that 80% of asbestosis carcinomas arise in the lower lobes. This is consistent with the primary disposition of asbestosis where the diffuse fibrosis is in the middle and lower lung fields and the upper lung fields tend to be emphysematous." *Asbestosis and Carcinoma of the Lung*. Anderson and Campagna.

Archives of Environmental Health 1: 27-32. 1960.

"If the total weighted relative risk is determined for the study groups by multiplying the appropriate percentages of Table 3 with the smoking weighting factors as determined above from the pooled data, and the total weighted relative risk for each population divided by that for the controls, the contribution to relative risk provided by smoking patterns will be as follows:

Controls	1
Welders	1.14
Painters	1.15
Cooks	0.97
Plumbers	1.16
Asbestos workers	1.14
Marine engineers	1.25
Printers	1.05
Electric bridge crane operators	1.09"

Lung Cancer Mortality Experience of Men in Certain Occupations in California. Dunn, J.E., et al., *Journal of Public Health* 50: 1475-1487. 1960.

"It is suspected that lung cancer may be induced by asbestos." *Dust, Fumes, And Mists In Industry.* National Safety Council. 1963.

"Some observers in the past few years have associated various conditions such as lung cancer, bronchiectasis, emphysema and bronchitis with the asbestos worker. It is entirely possible that the asbestos fibre may be a carcinogen, or a co-carcinogen." *The Pneumoconioses.* Lanza, A.J., New York: Grune and Stratton. 1963. pp. 13-24.

"Asbestosis, which is a fatal occupational disease is still occurring 30 yr after steps were taken to eliminate the disease. Asbestosis is a fatal disease. It is due to a spreading fibrosis which not only restricts the expansion of the lungs but also interferes with uptake of oxygen into the blood. Eventually it causes death by slow suffocation. In a minority of patients a fatal cancer of the lung develops, and we seem to have been seeing this termination more frequently in recent years." *Some Observations On Asbestosis.* Leathart and Sanderson. *Annals of Occupational Hygiene* 6: 65-74. 1963.

"The data on underlying cause of death as recorded on the death certificate showed notable excesses of observed over expected deaths at ages 25-64 years for two major chronic illnesses, neoplasms and asbestosis, in the cohort group in the years 1940 to mid-1960. Although asbestosis is rare in the general population, 28 of the 128 non-neoplasms deaths were due to asbestosis as an underlying cause.... A study of the association of asbestosis and lung cancer illustrates the importance of considering histological reports in connection with death certificates in the study of multiple causes of death. The cohort group of workers in an asbestos plant under study was found to have higher mortality than expected due to asbestosis and cancer of the lung and of the peritoneum. An association was also found between asbestosis and cor pulmonale in the group of

workers studied.” *Methodology in Industrial Health Studies. Mancuso and Coulter. Archives of Environmental Health* 6: 210-226. 1963.

“The main types of asbestos of commercial interest are amosite, anthophyllite, chrysotile, crocidolite, and tremolite. There is evidence of an association between exposure to asbestos and malignant neoplasia. This has been established mainly on information from Germany, Italy, South Africa, the United Kingdom, and the United States of America.

The types of tumors which have been shown to be associated with exposure to asbestos dust are: 1. Carcinoma of the Lung; 2. Diffuse mesothelioma of the Pleura and Peritoneum. Present evidence indicates that the associated carcinomas of the lung are not limited to exposure to any one type of asbestos fiber.” *Report and Recommendations of the Working Group on Asbestos and Cancer. Annals of the New York Academy of Sciences* 132: 706-721. 1965.

“Dr. Newhouse’s work and observations, and those of Dr. Wagner bring out a striking resemblance between accumulating data on asbestos and those on beryllium. This is brought to mind by recent observations concerning mesotheliomas, made in a sanatorium in South Africa, as reported by Wagner and his co-workers. Dr. Hardy observed berylliosis in household members of the families of beryllium workers, and subsequent studies demonstrated the release of beryllium in the laundering and handling of work clothes of beryllium workers. Similarly, Dr. Newhouse has observed mesotheliomas among the relatives in the household of asbestos workers, who had laundered their work clothes. The resemblance continues with biological effects of air pollution. Berylliosis was observed among resident nonemployees within a certain radius of beryllium manufacturing plants in Ohio and Pennsylvania, and Drs. Newhouse and Wagner have reported mesotheliomas, and Kiviluoto pleural plaques, of residents living within a certain radius of asbestos factory and mining operations.” *Discussion. Mancuso, T. Annals of the New York Academy of Sciences* 132: 589-594. 1965.

“Within recent years and months there has been a considerable amount of material in the literature which indicates that asbestosis is directly related to the incidence of malignant tumors and cancer. This left 68 asbestos workers who had worked in one particular plant. Further study of these records showed that 21 among them not only had evidence of asbestosis but also were suffering from cancer. Twelve of these had lung cancer... Another interesting feature was that among the other cancers, not the lung cancers, there was one case of a malignant mesothelioma.” *News & Views. Pennsylvania Department of Health. Vol. 3, No. 4, 1965.*

II. Established Dust Control Procedures In Mining Involving Asbestos

The state of the art for dust control in mining and milling involving asbestos was generally led by Johns-Manville Corporation and others. The following citations describe some of the procedures for controlling exposure to dust containing asbestos that were available and being used by some companies.

"Johns- Manville Corp. Is currently constructing a 12-story fiber mill, of which the first half is completed and in operation. The mill will be the largest in the world, producing about 30 pct of the world's fiber.

Cyclones

Almost 200 cyclone collectors of various sizes are required for the fiber handling and dust control systems. Considerable engineering and design effort went into the development of cyclone collectors of minimum pressure drop and efficiency high enough to collect asbestos fibers of commercial value. The cyclones developed through this effort collect fiber as well as previous designs and have about 2.5 in. of water less pressure loss. To minimize maintenance due to abrasion, many of the cyclones have been rubber-lined.

Literally miles of large-diameter sheet steel piping have been installed to convey the asbestos fiber and control dust. The material conveying pipes are all welded heavy gage sheet steel. Many elbows have been rubber-lined to resist abrasion.

Dust Control

The milling of asbestos fiber is a dry process. As such it is quite dusty, and a great deal of effort and money has been devoted to controlling this dust. In the early stages dusty machines and processes were carefully redesigned in attempts to enclose the dust and keep it from working areas. In addition, about 500,000 cfm of air have been set aside for dust control purposes in the full mill.

All the hundreds of oscillating screens have been provided with dust covers of a type developed by Johns-Manville's asbestos mine. The confine dust yet allow easy screen inspection and maintenance. About half the screen covers have been fitted with exhaust connections.

About one third to one half of the many thousands of feet of belt conveyors have been covered with a tight-fitting enclosure and exhaust connections added to strategic points. Crushers, packers, rotating screens, and elevators-all points where dust might escape to the mill atmosphere-have been provided with exhaust air.

Results of the first portion of the mill have been gratifying. The new asbestos mill at Johns-Manville's Jeffrey mine is one of the cleanest in the asbestos mining and milling industry." *Air Handling and Dust Control In John-Manville's New Asbestos Mill; by J. Goldfield; November 1955, Mining Engineering, pp. 1029-1034*

" ASBESTOS MILLS

As expected in a dry process, the dust samples taken in the asbestos mills gave higher dust concentrations than wet processes of flotation and cyanidation. The same principle, of catching the dust at its source applied here. In most of the mills, control measures are taken to prevent

high dust concentrations to escape into the atmosphere. Bag type dust collectors are used extensively in our asbestos mills. One mill is equipped with an electrostatic collector. Control measures are also taken to reduce the amount of dust inside the mills to a safe limit. Great work has been done, and is still being done, by our asbestos mines to reduce the dust, in their plants and in underground workings, to a minimum.

VENTILATION

The study of silicosis is closely tied up with ventilation. Bringing down the dust concentration to a safe limit is the first step in the prevention of silicosis. Any other preventive measures can be used after. The most effective method of purifying the air in a mine is by thorough ventilation. Control of the ventilation in mine workings is very important. Co-operation between the mine staff and the miners is necessary if we want those costly ventilation systems to be efficient. Everybody in a mine from the Manager down to the miners must be dust conscious. The miners should be told the reasons for those preventive measures. That way, we would not find so many ventilation doors and air-locks opened when they were designed to be kept closed.

The proper control of the air currents is a problem which must be solved by the engineers working at each mine. Control work is never ended as the conditions change very often during the life of a mine.

Our large mines have gone to great expense to better their ventilation and have trained engineers in this work.

Amongst our younger miners, I am glad to say that more interest is being taken in ventilation than formerly, which is very important as ventilation studies undertaken early in the life of a mine will do much to reduce difficulties later.

CONCLUSIONS

Mechanical ventilation and dust control in the Province of Quebec is becoming very important as our mines are getting deeper and deeper. Dust surveys made in mines in the past four years showed that the use of water and proper ventilation reduce the dust hazard in the mine workings.

Co-operation between management and the workmen is necessary for the effective use of ventilation systems and dust control equipment. Education of the workmen in connection with the proper use of all these preventive measures is necessary. If every workmen knew more about the reasons for these preventive measures they probably would cooperate more fully and would follow the regulations established.

We have to keep in mind that adequate ventilation and dust control help reduce, at the same time, the accident hazards and improve the efficiency of the workmen." *Mine Ventilation and Dust Control in Quebec Mines; Maurice Lachance; A paper read before the Fourth Conference of McIntyre Research Foundation on Silicosis, held in Noranda Quebec, January 28th-30th, 1952.*

"The Lompoc mill closely resembles our dry mill at Libby as far as operation equipment, and dust control is concerned. As one of the leaders in industrial environmental health, JM started in the early fifties to build into its Lompoc Celite operation dust control equipment and limit values that would insure an environment that is not injurious to personnel. Over the past 15 to 20 years \$3 million has been spent only on dust controls at the mine and mill. JM is of the opinion that dust controls are an integral part of the operating process, not something else or something extra.

This was very evident during our tour by the lack of dust-laden air, excellent housekeeping, and good condition of all facilities.

Dust control, safety, preventive maintenance, and efficiency get the same attention at the mine as at the mill. Each vehicle (hauler, loaders, bulldozers) has its operating cab sealed airtight and equipped with a self-contained filter air supply unit. Air is filtered through an oil filter and cloth filter before it is discharged into the cab.

Each day primary and secondary filters are removed from each vehicle and cleaned. Two water wagons operate on the first shift and one on the second shift watering down all roadways and mining areas where there is a possibility of dust being created by moving vehicles. The air supply units installed in the mine vehicles were designed and manufactured by JM at Lompoc at a cost of \$2,000.

It was very obvious that preventive maintenance pays off at Lompoc since we saw no mine equipment down and only one piece of equipment down in the mill. (The piece of equipment that was down in the mill was being started up after routine maintenance.

The last lost-time accident at the mine was June, 1948. This record should speak for itself.

C. Mill

1. General

Since the mill operation at Lompoc is similar to Libby and Enoree, no description of the mill facilities other than dust control will be mentioned. To prevent a dust condition in the tunnel where the person loading cars is stationed, air at the rate of 60,000 cfm is blown into the shaft from west to east keeping dust always away from the operator. The transfer car is sealed and air filtered with an air supply unit similar to those installed in the mine vehicles.

The total installed dust collecting capacity, not including product collection, is between 200,000 and 250,000 cfm. With the exception of exhaust from the main kiln driers, dust collection is by means of cyclones and bag houses. Exhaust from the kilns passes through various phases of mechanical collection and is discharged through abandoned glory holes at approximately 98% efficiency. JM has found that commercial enclosed bag houses are costly to maintain and are not as effective as the air reversal, open bag house. Considerable design goes into each dust collection system, and through the years specific air flows and face velocities have been established for different phases of dust collection.

2. Vacuum System

A vacuum system with detachable hose outlets is installed throughout the mill. The total number of outlets or installed cfm is not known, but nowhere in the mill was there any accumulation of dust on the floor, equipment or structural members. Each man is responsible for keeping his area clean and this is done as part of his primary job. All cleaning is done by vacuum; the use of dust promoting brooms is discouraged.

3. Bagging Operation

Dust control in each area is basically the same. The total air removed at the packer is 2,500 cfm with 1,000 cfm at the packer nozzle and 1,500 cfm from around bag sides. The dust is passed through cyclones and into an open bag house.

4. Bulk Loading

Loading and exhausting of the cars is by an installed air handling system. There are two or three bins containing sections of 3 inch supply and 6 inch exhaust hose, plus necessary adaptors

that are transported by fork truck to the box car to be loaded. The cars are completely sealed except for the doors when received. In the loading operation, product feeds by gravity into one of two 8 cubic foot (approximate) containers. When the container is full it is pressurized and conveyed to the car. Conveying air is 300 cfm.

5. Personnel Cleaning Stations

Located at strategic locations throughout the mill are seven cleaning stations. These consist of a 3 foot diameter by 6 foot high booth with a grill floor. Attached to the bottom of the booth is a 1,000 cfm blower that discharges to a commercial enclosed bag dust collector. In the booth is a 1 inch hose with nozzle for either blowing or vacuuming dust from clothing.

6. Training

An interesting sideline to this tour which has a definite bearing on maintenance, dust control, efficiency, personnel relations, etc. is training. Due to the shortage of skilled operators and craftsmen, JM's Celite plant undertook a two-year project to establish a training program for their operators. In addition to on-the-job training, there are approximately 60 hours of classroom training from the lowest grade to the top grade. Once a person has completed the necessary time and training requirements successfully, he is regarded and paid the higher rate even though he does not perform the work in the next higher grade."

INSITU AND ENVIRONMENTAL DUST CONTROLS FOR VERMICULITE MINING AND EXPANDING OPERATIONS. By: F.W. Eaton; R.J. Kujaw; P. Kostic. W.R. Grace Inc. 1969.

III. INDUSTRIAL HYGIENE STANDARDS

In addition to the procedures for controlling asbestos containing dust associated with mining and milling described in Chapter II above, there are other standards of industrial hygiene pertaining to worker education and training, warning workers about the hazards of asbestos, sanitation, housekeeping, maintenance, wet methods, respiratory protection, and medical control. The standards of industrial hygiene in the above mentioned areas were well established before 1950. The following is a partial synopsis of these industrial hygiene standards that are cited from industrial hygiene journals, periodicals, magazine articles and text books.

A. Industrial Hygiene Importance and Philosophy

“By study, and by eternal vigilance on his part, the employer may lessen the hazard of industry. The employee, likewise, is capable of reducing the hazard. But the employer must not be allowed to forget that he is the captain of industry, and with his rank goes greater responsibility. And he must come to a realization of the fact that he cannot if he would, shift the burden from himself. The captain must select for his soldiers, competent workmen. He must assign them to the proper kind of employment, and must furnish them with safe places of employment. He must surround his workmen with fellow-servants who are competent. He must give to his employees competent foremen, proper instructions, and constant efficient supervision. He must inspect his machinery, his ways, his methods, and his safeguards at every turn. He must not only make reasonable rules for safety, but he must enforce them. Because of the great responsibility imposed upon the employer, he, too, should accept penalty for his failures.” *Diseases of Occupations and Vocational Hygiene. Kober, G.M. and Hanson, W.C. Philadelphia. P. Blakiston's Son & Co. 1916. pp. 872.*

“The hygienic conditions of the workingmen have improved, both on account of the safeguards which the accident insurance organizations require employers to use and because of the special efforts made by the ‘sick funds’ to reduce the sick rate among members to a minimum. The general knowledge in regard to the preservation and promotion of health, which the ‘sick fund organization’ has disseminated by means of circulars, monographs, popular lectures, etc., has exerted a tremendous educational influence in the promotion of health and morals.” *Industrial Health, Kober and Kayhurst, p 89, 1924.*

“The subject of the health of workers in dusty trades has been receiving considerable attention from students of industrial hygiene and others interested in the various phases of this problem. When one realizes that the workmen employed in the dusty traded comprise the largest group exposed to any one industrial hazard, it is quite apparent that the importance of this problem has not been overestimated. Furthermore, it is by now fairly well established that exposure to certain kinds of dust has increased the mortality rate from respiratory diseases.” *Engineering Control Of Occupational Diseases. Bloomfield, J.J., American Journal of Public Health, Nov. 1935. p. 656.*

"It is probably apparent by now from the brief discussion given herein that, in order for an engineer to carry on such work, he will have to be thoroughly trained in industrial hygiene and be familiar with industrial processes. But there is no reason why an individual with basic engineering training cannot in time be metamorphosed into an industrial hygiene engineer. In closing, it is well to emphasize one point; namely, that occupational diseases are in a large measure preventable, and the degree of prevention exercised by a community will be reflected in the general health status of that community." *Engineering Control Of Occupational Diseases*, J.J. Bloomfield, *American Journal of Public Health*, Nov., 1935.

"For the complete evaluation of the industrial dust hazard it is necessary to do more than simply determine the dust concentrations associated with various dust-producing operations. A medical study of the workers, including physical examinations, chest X-rays in certain industries, and medical histories is also necessary. An occupational analysis (number of men and distribution according to occupation) is essential in order to determine the extent of the dust exposures among the workers and a general sanitary survey is also required to measure the effect of intangible factors. For convenience the important factors may be arranged under three major headings, as follows:" *Industrial Dust, Drinker and Hatch*, pp 81-82, 1936.

"In order to carry out a constructive program of industrial hygiene the minimum requirements are:

(A) A physician thoroughly trained in public-health procedure and having a comprehensive knowledge of the effects upon health of the various materials and processes used in industry, in other words, one trained in industrial hygiene.

(B) An engineer who is also trained in industrial hygiene and who is familiar with industrial processes. He should know the following subjects from both a theoretical and practical viewpoint:

1. Microscopy.
2. Gas chemistry.
3. Mechanics of ventilation.
4. Physiology of ventilation.
5. Industrial sanitation.
6. Illumination
7. Industrial-hygiene survey methods.

(C) A completely equipped laboratory for carrying on studies in industry. With such personnel and facilities, the following program could be inaugurated:

1. Reporting of all occupational diseases to the division carrying on industrial-hygiene work. This will definitely establish where and to what extent certain occupational diseases are occurring and suggest corrective measures.
2. In order to acquaint industry, the medical profession, and others interested in such a program, it may be necessary that the personnel carry on an educational campaign, designed to instruct and interest the various groups involved, as to the importance of the problem, in an effort to further the program.
3. Studies of the workroom environment and the health of workers by the industrial-hygiene

personnel as outlined in 2

The additional cost for maintaining industrial-hygiene personnel of the number and type given would not exceed \$10,000 a year, or slightly more than 1 cent per capita in the present case. When one realizes the fact that one case of silicosis often costs more than the \$10,000 needed for a preventive program of the type outlined, the financial phase of the problem should certainly not preclude the establishment of such a vital adjunct of a health department in a large industrial center." *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis.* D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 178-179.

"However, from now on, with the spread of common, or least available, knowledge of the peculiar danger of certain dusts, only 'special care' will safeguard the interests of employer and workman alike. Let us now consider what present steps will constitute 'special care' where dangerous or poisonous dusts are present: in other words, what shop precautions are now known to be absolutely necessary, based on the knowledge of silicosis just made available to us?

Employers in industries where free silica is present in the atmosphere should constantly be alert and watchful, discounting to the fullest extent every possibility of danger. Employers should not conclude that they have entirely eliminated danger of silicosis, or any type of pneumoconiosis, simply because the air is seemingly free from dust. It should be borne in mind that the particles which do the most harm are invisible and that they remain long in suspension in the air. Particles remaining so long in suspension in room atmosphere continue the danger throughout the entire working day; hence, the urgency of postponing sweeping and dusting until work for the day has ceased. Often dust is thrown back into the air during these operations. Furthermore, dust of dangerous character may be so extremely fine in grain as never to settle at all but remain in suspension indefinitely." *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis.* D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 104.

"The field of industrial hygiene is specialized to a certain degree, but it is definitely a part of public health administration. A close study of the principles demonstrates clearly that industrial hygiene is precisely sanitary or public health engineering as we understand them, with a special emphasis on the industrial environment. Industrial hygiene offers a method of attacking general problems of public health administration. Because industrial hygiene establishes contact with a large section of our population, and keeps it under close observation, there is an opportunity to practise preventive medicine at a low cost to the community. Industrial hygiene should not be restricted to the control of occupational diseases. From the standpoint of public health it offers an opportunity to extend the treatment of venereal diseases as well as the determination and control of malnutrition, tuberculosis, and other diseases. If a worker is found to be suffering, say, from tuberculosis, not only are fellow workers protected by treating the individual but also the immediate family, because the discovery of such a case leads the health officer to consider the home environment. Thus, industrial hygiene simplifies the task of the public health administrator, who in the normal course of events must wait until the case comes to the attention of the family physician or a clinic. The opportunity to reach large sections of the population in this manner

cannot be overemphasized.” *Basic Principles of Industrial Sanitation*. Dallavalle, J.M and Jones, R.R. *American Journal of Public Health*. Vol. 30, 1940, pp. 369-384.

“How may the importance of safety material and information be stressed? A thorough physical examination with attendant stressing of the subject of health and related safety in work at the hands of the plant physician will make the part played by safe physical condition of obvious importance.

As early as possible in the job training program, the following points should be covered by the safety department:

1. The safety department should conduct a discussion of the plant’s safety rules and policies, giving the employee an opportunity to ask questions and clarify any doubts he may have.
2. A description of the use and care of existent safety guards and protective material furnished by the company should be supplied.
3. Typical plant hazards and previous accidents should be demonstrated.
4. There should be a demonstration of the specific hazards to be met by each employee.

1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. *Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine*. pp. 285-286. 1943.

“The chairman, safety engineer and central organization should delegate as much responsibility as is practicable to the safety committee members. The work should consist of more than reporting unsafe conditions; it should be more extensive and allow the committee member to be active in formulating safety programs. The workmen can be spurred on to greater safety interest through the use of educational techniques. Safety posters, pamphlets giving accident statistics, monthly news letters to which members can contribute articles and suggestions.... *1021 Answers To Industrial Health And Safety Problems*. J.E. Weiss. *Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine*. pp. 291-292. 1943.

“The dust problem arising from dust in industry is one of increasing seriousness. Socially, economically and legally it has become evident that immediate steps must be taken to combat the hazard represented by wholesale industrial exposure to the pneumoconiosis-producing dusts. Pneumoconiosis, in many of its forms, is incurable. This consideration of the problem which it represents is based largely on methods of dust reduction and removal and is therefore as much the responsibility of the engineer as it is of the physician.

Recent interest in dust diseases has built up an extensive literature; theories have been confirmed with experimental evidence and innumerable case histories of individuals and of entire groups are available. In contrast to the widespread ignorance of ten years ago, it would probably be difficult at the present time to find a worker in the dusty industries who has not at least heard of silicosis, or an employer who is unaware of the crippling damage suits which will face him if his employees, through failure on his part to take necessary preventive measures, contract the disease.” *Dust as an Industrial Health Hazard*. Hutchinson. *Heating and Ventilation*, Vol. 41. No. 6. 1944. p. 57.”

“Montana

Lecture course.- Through arrangements with the President of the Montana School of Mines, a 10-hour lecture course on industrial hygiene has been made compulsory for all senior students taking mining, metallurgy or petroleum engineering. This course will include a resume of various types of dust, metals, gases, and other toxic materials found in mining, metallurgical operations, and in the petroleum industry, as well as the effects these metals have on the human body. Sanitation, abnormal temperature and humidity, and illumination will also be discussed. Demonstrations of air sampling devices and discussion of engineering control methods will complete the lecture. The course will be conducted by the Director of the Division of Industrial Hygiene.” *State and Local News, Industrial Hygiene Newsletter, February 1949.*

“Although the vital role played by the physician in controlling occupational disease is duly recognized, it is not amiss to point out that the most important single step in the prevention of many occupational illnesses is control of fumes and dust. Measurement of the effectiveness of such control, in the long run a medical problem, can best be made initially by chemical methods. Furthermore, responsibility for the protection of workers rests primarily with industry; and those most intimately acquainted with the industrial processes and materials involved are industry’s own chemists and engineers.” *The Chemistry of Industrial Toxicology, p v., Hervey B. Elkins, Ph.D., 1950.*

“It is now a generally accepted principle in industry that control of the occupational environment is essential in order to prevent harmful absorption of toxic materials. The control of environment is essentially an engineering problem and follows well-established procedures presenting little difficulty in achievement.” *The Limitation of Exposure to Noxious Gases and Fumes in Industry, Lawrence T. Fairhall, Industrial Hygiene Newsletter, January 1950.*

“Montana

Meeting.- Mr. Henry N. Doyle, chief of the Field Station in Salt Lake City, was one of the main speakers at the December meeting of the Montana Safety Council. Mr. Cyril Ainsworth of the American Standards Association, who gave the keynote address, spent a major portion of his talk in stressing the importance of industrial hygiene.” *State and Local News, Industrial Hygiene Newsletter, April 1950.*

“With an organized health and safety program, you ought to be able to save over 20 percent of the money that injuries and illnesses now cost you. There are many other returns for which definite financial equivalents cannot be assigned so easily, such as:

1. It helps stabilize the labor force. 2. It enables the worker to produce more by properly fitting the worker to the job and by improving health standards. 3. It prevent litigation. 4. It contributes to a sense of security among employees and promotes a feeling of good will toward the management.

Actually, the executive who isn’t deeply interested in eliminating all hazards does not qualify otherwise in this period when human relations are at last getting the recognition due them. With today’s competition for the most intelligent and efficient workers, stockholders cannot long afford

directors who do not realize the importance of top health and safety conditions in their company's plants, nor managements which do not spend whatever money is necessary to give plant people the maximum of health and safety assurance." *Health Programs in Industrial Plants Pay Dividends to Owners and Workers*, Crit Pharris, M.D., *Industrial Hygiene Newsletter*, June 1950.

"In the experience of the Industrial Hygiene Foundation, the problems of occupational disease control are shrinking. Mr. Nelson referred to the fact that in Wisconsin they have largely eliminated silicosis and that lead poisoning was going in the same direction. In varying degrees, I think, that is true throughout the country. The current interest of much of industry is in what you might call positive industrial health.

Occupational disease prevention is usually a matter of improving working conditions. We are currently engaged in working with a large chemical company in the design of a series of new chemical processes with a view to building maximum health protection into the processes themselves. The program even includes the instruction of the plant managers in the operation of those plants.

Studies are also being made for a number of industrial associations, checking the different plants within the same industry, and reviewing the good and the bad practices. The exchange of pertinent information which results helps to improve working conditions on an industry-wide front.

So, the emphasis is on positive industrial health. The Foundation, through the assistance of Dr. C.O. Sappington, has completed a two-year survey of industrial health facilities. Almost three hundred plants were covered in this study, which shows, among other things, that most companies, or most plants, now have some industrial health service. About thirty-three per cent of them had some industrial hygiene service in varying degrees. The reaction was quite uniform, as Mr. Fletcher brought out, that healthful working conditions are just good business. Good working conditions attract a good type of employee and that means a good product.

As Charles Kettering has said, "The better the working conditions, the better the attitude of the individual and the better the work." It's pretty clearly demonstrated that this pays off on the economic side, and it is important to bring this out in order to get action.

To emphasize the positive approach further, we found in this study that, in more than half of the plants visited, the preplacement physical examination is no longer regarded simply as a measure to determine whether the man has an occupational disease disposition, a rather negative approach, but is used to help in the successful job placement of the individual.

We think this adds up to this basic concept: there is no longer a question of whether or not industry will sponsor industrial health, but rather, can a company afford not to engage in industrial health activities." *Mr. McMahon. Discussion. In The pneumoconiosis*, edited by A. Vorwald, p. 569. Paul B. Hoeber, New York, 1950.

"Personnel of the industrial hygiene department are always underground with the first day's operation of any new diesel equipment. Extensive tests are made and the results are shown to the workers on the spot. The workers are informed on the different gases and their psychological effects.

It is our primary feeling that most every man is proud of what he knows. He likes to relate to others why a water source is bad, why we are checking the air, or why drill holes should be collared wet in silicious areas. The time for hiding results is past; today all our results of gas, water, ventilation and dust are posted on the bulletin boards at the respective change rooms.” *Dollars and Cents Value of Industrial Hygiene in Industry*, Andrew Fletcher, *Industrial Hygiene Newsletter*, September 1952.

“Just as it is the obligation of any boss to look out for the safety and welfare of his men, it is the moral obligation and responsibility of management to protect the labor force from unforeseen dangers. Most direct of all accident costs is the cost of compensation for death or injury. The load of compensation payments may be deferred in the case of long-term ailments such as silicosis, but in a mine with a long life the eventual drain may become very considerable unless preventive measures are taken early in the game.” *Mine Safety*. *Mining Congress Journal*. J.J. Reed. August, 1955. pp. 58-62.

“...management began to realize that the maintenance of a healthful environment pays dividends from the cost-saving viewpoint as well as in employee satisfaction and reduced turnover of the labor force. More and more industrial concerns have come to the conclusion that industrial hygiene is a necessary adjunct to production and not something to entrusted entirely to overworked government agencies.” *Industrial Hygiene and Toxicology, Volume I*, Frank A. Patty, p 9, 1958.

“One of the outstanding reasons that industrial hygiene has been so successful in controlling adverse environmental conditions and in preventing or controlling occupational disease is that pronounced rivalry has developed between the medical men and the men of the sciences, as well as between the scientific professions involved, for instance, chemists and mechanical engineers..... Industrial hygiene has laid aside its swaddling clothes and entered a vigorous stage of advancement. It is no longer seen by industry as the aimless effort of intellectuals collecting bottles filled with nothing so that they can prepare long and useless discourses that few would read or understand, or, if they did understand, would know what action to take. The safeguarding of industrial health is on a business basis of evaluation and control and is recognized as such by both labor and management. The purpose of the industrial hygienist is no longer merely to ‘lock the stable door after the horse has been stolen’ but to anticipate and prevent harmful situations, or to control them before serious injury results.

Not only harmful exposures but also dirty occupations are on the way out. The workingman has come to expect and demand a safe, healthful, and relatively clean and stress-free workplace, and, having once worked in such surroundings, will not readily return to an excessively dangerous or dirty occupation. Widespread shifting of labor during war production resulted in acquainting many workmen with the fact that control of the work environment is possible. Even the foundry has undergone a transmission from a place with dirty, dusty, smoke and fume filled atmosphere to one of comparative cleanliness. We have some of the cleanest workplaces in the world here in the United States. We also have some that we do not care to talk about - they are the ones upon which we should focus our attention until they have been cleaned up. American industry is aware

of the benefits of more and better production derived from environmental control and health-promotional activities and needs only to be guided in their application. *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, pp. 14- 16, 1958.*

“The usefulness of an industrial hygiene department is greatly augmented by close collaboration with the medical department, mainly through comparison of records compiled by each. Where an industrial hygiene survey shows high dust counts, comparison of results with chest studies, particularly if there are employees with long service records in the department, can help in determining whether the condition should be attacked as a true occupational disease hazard or as a nuisance. If management is approached with all the facts, hysteria is avoided and better confidence is fostered.” *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, p 22, 1958.*

“Colleges offering public health degrees, including I.H. in 1946-47 - Columbia, Harvard, John Hopkins, Toronto, Yale, & state universities of California, Michigan, Minnesota, North Carolina.” *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, p 10, 1958.*

“The technical people involved with the Anaconda Mining Company’s copper mine in Butte, MT were health conscious and were knowledgeable and aware of the hazards of dusty operations, including silicosis. This was communicated to the workers through dust sampling activities and standard operating procedures related to dust control. The Butte mines were regularly sampled for dust by Anaconda Mining Company employees in the 1940's and workers were kept informed of the hazards of generating dust. Work procedures to reduce dust were employed and enforced. Wetting of the dust was a common operating procedure. In the 1940's, 50's and 60's, Butte was a world leader in mine ventilation” *Floyd Bossard, CIH. Retired Mining Engineer.*

B. General Control Methods

“1 Properly adapted buildings, thick walls of separation for dangerous rooms, good lighting, facilities for keeping the workplace clean and for effective ventilation.

2. Apparatus adapted to its special purpose, whenever possible, closing tight in every part.

3. Appliances for accomplishing the arrest of gases and dust at their place of origin, their removal (by exhaust fans), and in a suitable manner rendering them innocuous or collecting them, thus preventing their entrance in the nose and mouth.

4. So far as possible, avoidance of direct contact with poisonous materials or substances injurious to health in working with them, transporting or packing them.

5. The displacement of particularly dangerous labor methods and materials by introduction of less dangerous labor processes and material, as well as by the employment of materials satisfactorily pure chemically.

6. Instruction of workmen, just entering upon an occupation, concerning the properties of the poisonous substances extracted, manufactured, used or otherwise evolved, and, whenever possible, cautionary leaflets should be placed in the hands of the workers.

7. The repetition of these instructions at frequent intervals.
 8. Posting of precautionary regulations and warning placards, containing admonitions for the exercise of special caution, and enjoining the observance of measures for ensuring safety. Constant supervision of all dangerous employments by expert and responsible persons.
 9. Employment of appropriate means for personal protection in the way of suitable work clothes, caps, gloves, and, as necessary adjuncts, mouth and nose shields, respiratory masks and the like, in case the appliances named in rule 3 are inapplicable.
 10. Practice of bodily cleanliness by the use of wash, bath and dressing rooms, the use of special rooms for eating, separate lockers for street and work clothes, and frequent non-hazardous cleaning of the clothing.
 11. Immediate report of symptoms of indisposition, attention to wounds of the skin caused by the handling of corrosive materials, prompt employment of reliable antidote, and summoning at the same time of a physician.
 12. The employment of a healthy working force. Periodical medical examination of the workers in dangerous employments. Temporary or permanent exclusion of unfit workmen from the dangerous departments of the industry. Under certain circumstances there should be a change of work in occupations giving rise to chronic poisoning.
 13. The utmost possible reduction of the hours of labor in dangerous employments.”
- Measures for the Protection of Industrial Workers against the Dangers of Poison; Compiled by Industrial Councillor Dr. Fischer of Berlin. In: Industrial Health, Kober and Kayhurst, pp. 6-7, 1924.*

“Likewise in launching a campaign for the control of industrial exposures, there are some pre-requisites which are necessary for success, and others which are highly desirable:

1. One of the first things to know is what exposures exist in your plants, what is the nature and extent of the exposures, what has been done to control them, how successful is this control. In short, a complete survey of the plant is necessary. The use of the following form is suggested in making this survey:

SURVEY OF POSSIBLE OCCUPATIONAL HAZARDS			
Dept.	Hazardous Operations	Nature of Exposure	
Number of Workers Exposed	Method of Control		
Effectiveness of This Control			
Based on air analysis, etc.		Based on health study of those exposed.	
Recommendations of Improvement			

Such a survey not only gives you a complete picture of the condition of your plant, but also helps in determining the points against which your control campaign should be directed. It can also serve as a record.

2. The second necessary item is a physician of medical department with specific knowledge of the hazardousness of various toxic substances, dusts, etc., from a health standpoint, and also knowledge of the extent to which these exposures have affected and are affecting the health of the

workers.

3. The third prerequisite is a plant engineering force that is interested in the problem and is well versed in the design, installation and maintenance of hoods, exhaust systems and other control mechanisms.

4. A fourth item which is desirable but not absolutely essential, is the necessary equipment for air sampling to determine dust concentration and air contamination. Such equipment is helpful in determining if control is necessary and to check the effectiveness of control used.

5. Another desirable factor is an interested well-informed and cooperative plant supervisory force.

6. In view of the fact that the study and control of industrial exposures is of recent growth, it is often desirable to have one individual charged with this responsibility. He should be able to coordinate the efforts of the existing medical, engineering and plant supervisory forces." *Control of Hygiene Exposures-Practical Methods*-, G.A. Coburn, *Industrial Medicine*, June, 1937, Vol. 6, No. 6, p 375.

"Smith states that the prevention of silicosis may be aided by such combinations of the following measures as are feasible: Substitution of nonsilicosis-producing material, enclosure and segregation of dusty processes, local exhaust ventilation for the removal of dust at point of origin; suppression of dust by water,....; general artificial ventilation; plant cleanliness, which is as important as upkeep of protective equipment; direct protection of the worker, although masks and helmets have serious operating limitations; alternation of work,....; medical supervision; education (workers need to be impressed with the risks, instructed in the use of equipment, and encouraged to submit to physical examination); and dust counting to check the efficiency of the measures should be a part of prevention programs." *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis*. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 130.

"In March 1932 a comprehensive Code of regulations designed to suppress the dust produced in all processes to at least the level of that "arising from flyer spinning carried on without exhaust under good general conditions" came into force.

These regulations apply the following principles to achieve this standard: (1) Application of efficient localised exhaust ventilation at dust producing points. (2) Substitution of enclosed mechanical methods for hand conveyance and for dusty hand work generally. (3) Effective enclosure of dust-producing machines and plant. (4) Substitution of wet methods for dry. (5) Elimination of certain dust-producing appliances. (6) Effectual separation of processes to prevent unnecessary exposure to dust. (7) Use of sacks of close texture for internal work in the factory, and cleaning of them by machinery. (8) Efficient cleaning system. (9) Precautions to prevent dust from asbestos in storage chambers or bins entering the workrooms. (10) Regular examination and testing of ventilating plant, dust settling and filtering apparatus not to be allowed in workrooms. (11) Breathing apparatus of approved type to be provided for persons employed in certain operations.

Other preventive measures in force in Great Britain include the control of the disease by periodic medical examination of the workers, by which those unfitted by health reasons are

prevented from entering the industry and cases of asbestosis and of pulmonary tuberculosis are detected at the earliest possible moment.” *Asbestos. I.L.O.: Occupation and Health. January 1938. pp. 1-15.*

“Dust control is a living thing. It is a policy and a procedure devised and carefully checked by the plant’s operating personnel, and instituted and enforced by the plant’s management whereby clean, healthful, dust and fume-free atmospheric conditions are provided and maintained at all times within the plant. If, in order to secure such conditions, one or more exhaust systems are necessary, then it is to be remembered that these systems are only some of the tools necessary in order to achieve a full result. If respirators are necessary for certain operations, and there are many operations where they are fully justified, then again we must remember these are only tools, and as such should be kept in proper shape and used only when they are most applicable. Even a system of lung x-ray examinations is only a tool, but if used properly and in junction with the other necessary tools, it contributes its share toward real dust control.” *Dust Control, F.F. Kravath, Heating and Ventilating, June, 1941.*

“...it is imperative that economies desired be not attained at the expense of design. Where the plant’s own men are unable to furnish an adequate design, it is urged that a competent consultant be called in to furnish complete specifications and designs, after a thorough study is made of the various problems in company with one of the plant operating personnel.” *Dust Control, F.F. Kravath, Heating and Ventilating, June, 1941.*

“State laws in effect at present in most states, and Federal laws most assuredly to follow, will fix compensation schedules, as well as prescribe methods for the affixing of responsibility. Hence, it behooves management not only to do all in its power to protect its employees’ health, but to protect itself by the adoption of a real set of common-sense policies in dust control.” *Dust Control, F.F. Kravath, Heating and Ventilating, June, 1941.*

“*Sanitary Measures.* The following measures may be taken to eliminate or reduce the existing hazard caused by the inhalation of asbestos dust: humidification of the asbestos matter and the air to decrease the production of dust; introduction of a closed production system, wherever possible; establishment of an extensive and efficient exhaust ventilation; frequent cleaning of the workrooms to remove the accumulated dust; prevention of air currents caused by moving machinery parts; construction of rooms, machinery, and pipelines offering little opportunity for deposition and accumulation of dust; separation of operations in which the production of dust can be eliminated entirely from those in which this is not possible; wearing of respirators by workers engaged in dusty operations; and mechanization of operations under elimination of human labor to reduce the number of workers exposed.” *Occupational Tumors and Allied Diseases, W. Hueper. Springfield, Ill. Charles C. Thomas. 1942. pp.399-405.*

“OCCUPATIONAL DISEASE SURVEY

1. Business Operations
2. Occupational Disease Exposures and Control

Each process operation or department in which there is an occupational disease exposure should be reported separately and should be captioned by the name of the process, operation, or department. Under each such caption the following information should be reported regarding exposure and control:

- a. Description. Describe the process, operation or department. State exactly what constitutes the occupational disease exposure,...
- b. Personnel. Give number, sex, and color of employees exposed to the process. State the number of hours per day they work in the exposure.
- c. Engineering Control. Describe the methods of controlling the exposure, such as physical separation, enclosure, or isolation, natural draft or exhaust ventilation.... Describe the condition of and care given to control devices and protective equipment.
3. General Information. Give any information applying to the risk as a whole, such as shower and washroom facilities, changes of clothing provided, housekeeping conditions, etc.
4. Medical Control.
5. Atmospheric Pollution Study.
6. Summary. Briefly summarize the occupational disease situation. The factors to be considered are: nature of exposures, opinion of how well they are or will be controlled...,
7. Recommendations. In listing the recommendations for control of occupational disease hazards, consideration should be given to the advisability of improving existing ventilation equipment or installing new or additional equipment; the use of personal protective devices; the possibility of substituting less harmful materials or changing processes or methods to reduce or eliminate the hazard; enclosing, isolating or separating processes or equipment; maintenance and care given protective devices or equipment; requests for atmospheric pollution studies; and the use of educational programs for management and personnel.” 1021 *Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. pp. 277-278. 1943.*

“Dust ordinances and control codes exist in many industrial areas for the guidance of the individual employer. The following general rules of prevention are fundamental to a successful control program:

1. Avoid exposure. Permit work only in air clean enough to allow the worker’s system to protect and cleanse itself.
2. Limit exposure time. Reduce working hours where dust concentrations cannot be made safe.
3. Substitute a safer exposure.
4. Substitute a safer method.
5. Cover the machine. Local exhaust systems can be installed close to the source of air pollution with vents opening into a dust collector.
6. Measure existing exposures. Periodical counts of air samples to check the need of further preventive methods should be made.
7. Protect the work room. The floors, walls, benches and other places where dust lodges should be cleaned regularly by vacuum or by wet brushing preferably after working hours.
8. Protect the worker. This important procedure usually supplements other control methods. Special protective equipment and clothing should be worn by the workers exposed to a hazard.

Personnel should be rotated wherever possible and full information on the hazard should be provided, as well as complete instructions regarding protection. *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. pp. 41-42. 1943.*

“Measures for preventing the inhalation of excessively contaminated air have been discussed by many authors, and there are about as many different classifications of these methods as there are papers on the subject. The principles expounded, however, are always essentially the same. They may be divided conveniently into three main groups as follows, depending upon the avenue of approach:

1. Eliminating the source of contamination or reducing the amount.
 - a. Building and equipment design, alteration, and maintenance.
 - b. Substitution of less-toxic materials.
 - c. Process or operation changes.
 - d. Housekeeping.
2. Prevention of contaminant dispersion.
 - a. Segregation of hazardous processes.
 - b. Enclosing the hazardous processes.
 - c. Wet methods.
 - d. Local exhaust ventilation.
 - e. Equipment maintenance.
 - f. Worker education.
 - g. Housekeeping.
3. Protecting the worker.
 - a. Equipment alteration.
 - b. General ventilation.
 - c. Respirators.
 - d. Worker Education.

Industrial Health Engineering. Allen D. Brandt, p 50, 1947.

“Enclosed processes, exhaust ventilation, wet methods, and other engineering techniques can be used to insure safe concentrations of dust in the air breathed by workmen. Personal protective equipment such as filter respirators and air-line or supplies-air respirators will under some circumstances afford protection, but such devices are poor substitutes for air sufficiently free of dust to prevent the development of pneumoconioses.” *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, p 509, 1948.*

“These recommendations or guiding principles apply to trades and industries in which insured persons are endangered by asbestos dust. They apply to asbestos-mines or pits, factories producing asbestos and asbestos cement, asbestos-spinning works, works where asbestos is worked up into various products.

(2) *General measures.* (a) In all operations involving considerable dust an effective dust extraction plant must be installed.

(4) In the conveying of asbestos the raising of dust must be avoided. Pneumatic conveyors or other enclosed arrangement should be used. If hand conveying is unavoidable it should be done in closed, dust-tight containers.

(19) Feeding in rooms with a dust-hazard is forbidden as is also remaining in them during rest pauses.”

Protection against Asbestosis. Prockat and Windel. (1939). In Pneumoconiosis Abstracts. Volume II. London. Sir Isaac Pitman & Sons, LTD. 1954. pp. 409-410.

“1. Industrial dusts, mists, and fumes, their hazards and their control, are discussed in this data sheet. The general principles presented can be applied to evaluate most industrial situations involving these air contaminants and to determine the need for controls. This data sheet is intended to guide employers, plant safety engineers, personnel managers, and supervisors.

2. A plant manager who believes that he has a toxic or irritating dust problem should consult a competent industrial hygienist. Such help may be obtained from his own company, insurance carrier, private consultants, or state health or labor agency.

3. To protect the health of employees who work where a dust, fume, or mist created by a manufacturing process is released into the atmosphere, a control program may be required. In such a case, three steps must be taken:

a. The properties of the specific dust, fume, or mist and its possible physiological effects on employees must be ascertained.

b. The particular exposure must be evaluated by dust counts or by chemical analysis of air samples, and a step-by-step analysis of the operations must be made to find the areas where employees are exposed to hazardous amounts of the material. The operational analysis also should determine how the dust, fume, or mist is dispersed.

c. Appropriate methods of control must be provided where indicated. The type and extent of controls will depend upon the physical, chemical, and toxic properties of the dust, fume, or mist, the evaluation made of the exposure, and the operation that disperses the contaminant.”
Dust, Fumes, And Mists In Industry. National Safety Council. 1963.

C. Medical Control

“By direct invitation and by advertisement word was spread around the district that miners and their families would be examined free of charge at the office and would be advised as to their physical condition. In this manner there was collected a considerable amount of information as to the physical condition, not only of the men themselves, but also their families. More than this, however, there was thus created an opportunity for doing considerable effective work among these people by direct personal advice and instruction. Every man examined was informed fully as to his physical condition. When necessary he was advised of the proper means for caring for himself and how to prevent the spread of infection to his family. He was encouraged to return for further examination or advice and was urged to bring his wife and family for examination when there was any reason to suspect that they might not be in good health. Educational literature was distributed freely at the office.” *Siliceous Dust in Relation to Pulmonary Disease Among Miners*

in the Joplin District, Missouri. Higgins, E. et al. Department of the Interior, Bureau of Mines, Bulletin 132, 1917, pp. 63.

“The employment of a healthy working force. Periodical medical examination of the workers in dangerous employments. Temporary or permanent exclusion of unfit workmen from the dangerous departments of the industry. Under certain circumstances there should be a change of work in occupations giving rise to chronic poisoning.” *Measures for the Protection of Industrial Workers against the Dangers of Poison; Compiled by Industrial Councillor Dr. Fischer of Berlin. In: Industrial Health, Kober and Kayhurst, pp. 6-7, 1924.*

“The silicosis problem is not a pleasant spectacle for those of us concerned with industrial hygiene and safety measures. Painful as the cure may be, it consists of two definite steps: (1) medical examinations of new employees and routine examinations of all persons exposed to dangerous dust concentrations; (2) reduction of dust concentrations breathed by the worker to what are considered safe limits.” *Protecting the Worker Against Dust Inhalation. Drinker, P., National Safety News, March, 1933. pp. 25-26.*

“For the complete evaluation of the industrial dust hazard it is necessary to do more than simply determine the dust concentrations associated with various dust-producing operations. A medical study of the workers, including physical examinations, chest X-rays in certain industries, and medical histories is also necessary.” *Industrial Dust, Drinker and Hatch, p 81, 1936.*

“In outlining the program which he followed in examining workers in dusty trades Sanders said that the purpose of the examination was not so much to eliminate the unfit as to place workers in positions in which they seemed best suited. He emphasized that during the course of such an examination the worker’s viewpoint on safety might be changed materially by taking advantage of the personal contact to inform him regarding the purpose of the examination program and what he himself could do to curb dust dissemination.” *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 147.*

“McConnell believes that thorough physical examination at the time of employment and at regular periods thereafter is the best method of eliminating diseases caused by dust in industrial establishments. The effectiveness of dust-control measures in preventing dust diseases can be determined only by careful physical examination of the worker so exposed under guidance of competent medical supervision. He states further:

The diagnosis of the diseases resulting from industrial hazards and the extent of disability incurred obviously should be entrusted to medical men specially qualified for this work with facilities for adequate radiological examinations. Disputed cases should be referred to a board composed of trained personnel capable of coordinating the medical, radiological, and pathological examinations as well as the results of scientific investigations. The action of such a board of specialists should be final.

McConnell outlines a plan for medical control of all phases of the dust hazard as follows:

1. Establishment of a medical department adequately equipped.
2. Routine examination of all applicants for employment.

3. Rating and placement of applicants.
4. Periodic physical examinations.
5. Provision for the disabled”

Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 153-154.

“Complete information concerning the type of work to be done by the employee under consideration should be furnished to the physician. It will be best provided on a job specification sheet which should include the following items: 5. Exposure to toxic dusts, fumes, gases, vapors or mists. 1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. pp. 297. 1943.

“The control of occupational diseases is the joint responsibility of the engineer and the physician. It is best accomplished by controlling the exposure and the worker. By pre-employment and routine periodic medical examinations, by rotation of workers, by supervision of nutrition, diet, and personal hygiene, and by education, the physician plays an important part in the prevention of occupational diseases through controlling the worker. Important as these measures may be, it is generally agreed that they are secondary to the control of the hazard.” *Industrial Health Engineering, Allen D. Brandt, p 49, 1947.*

“The purpose of medicine in industry is to promote the health and physical well-being of industrial employees. These objectives may be accomplished by:

- (a) Prevention of disease or injury in industry by establishing proper medical supervision over industrial materials, processes, environments and workers.
- (b) Health conservation of workers through physical supervision and education.
- (c) Medical and surgical care to restore health and earning capacity as promptly as possible following industrial accidents or disease.

There is no industrial establishment too small to have an organized medical service. ...it may be advisable to state the functions which are required in such a program. These can be broadly classified as follows: (1) the prevention and treatment of occupational disabilities and treatment of emergency cases; (2) the prevention of nonoccupational disabilities and treatment of emergency cases; (3) investigations; and (4) professional education.

The medical department should take a very active part with other departments in the health and safety education of workers.” *Studies of Health Hazards in Industry, J.J. Bloomfield, Industrial Hygiene Newsletter, February 1952.*

“The daily and accumulated occupational disability statistics provide the definitive picture of the occupational health problems of the plant at any given time for comparison with the experience at a previous time or for another plant or group of plants. In this way, an evaluation of the effectiveness of the plant health and safety program can be made.” *Studies of Health Hazards in Industry, J.J. Bloomfield, Industrial Hygiene Newsletter, February 1952.*

“The components of an adequate industrial health service are: Preplacement examinations; Periodic health examinations, especially of those exposed to occupational disease hazards and of those who need special follow-up; Treatment of all occupational injuries and diseases; Reasonable care and advice for nonindustrial injuries and illnesses occurring while on the job. For further care, employees should be referred to their own physicians; Adequate records and analysis of health experience to point out future objectives; Collaboration with management in the provision of healthful working environment; Collaboration in an active safety program; Health education for employees; and Coordination with community health activities.” *Small Plant Can Afford A Health Service, Industrial Hygiene Newsletter, August 1952.*

“To summarize, no plant is too small for a health education program if it is thought of as the sum of all experience that would influence the employee’s health habits, attitudes and knowledge. These experiences are found in: (1) Preplacement and periodic physical examinations, (2) the treatment of injuries and illnesses, (3) health and safety posters, leaflets, pamphlets, employee magazine articles, (4) participation in community health campaigns, (5) the service of industrial health consultants, (6) good housekeeping and sanitary facilities, (7) elimination and control of occupational hazards, and (8) carefully planned and supervised in-plant feeding facilities.” *No Plant Is Too Small For Employee Health Education, Bernardine Striegel, R.N., Industrial Hygiene Newsletter, August 1952.*

“Where there is no industrial physician or nurse in the plant, a health and safety committee can assume some of the health education responsibilities. If possible, each department should be represented on this committee. Members of the committee, then, are in a strategic position to recognize health needs, to refer employees to the right sources for guidance, and to make health and safety recommendations to management.” *No Plant Is Too Small For Employee Health Education, Bernardine Striegel, R.N., Industrial Hygiene Newsletter, August 1952.*

“Four Essential Requirements. - Such part-time health service is presently in use in many small industries and has proved to be effective if it meets four essential requirements: (1) The medical personnel must come into the plant for enough hours, daily or weekly, to meet the medical needs of the particular plant, (2) the medical personnel must be sincerely interested in developing a preventive medical program, not one limited solely to the curative aspects of plant injury treatments, (3) the primary aim must be the good of the employees, and (4) the program must have the full interest and support of management.” *Small Plant Health Programs- Types, Costs And Results, R.B. O'Connor, M.D., Industrial Hygiene Newsletter, August 1952.*

“Workers, management, and communities have recognized the advantages of comprehensive industrial health services in large plants for a long time. These same advantages of early treatment of plant injuries, minor before they become major, proper job placement, periodic health examination, and early recognition of illness, can and should be available to the workers in small plants.” *The Community Benefits From A Small Plant Health Service, Edward C. Holmblad, M.D., F.A.C.S., Industrial Hygiene Newsletter, August 1952.*

“Basically, prevention is a responsibility of management which by law is obliged to provide and maintain healthful working conditions. In the operation at the plant level, both the industrial hygiene Engineer and the Industrial physician carry the burden of responsibility. The former supervises working conditions, the latter supervises the individual worker. ‘Prospective employees in all dusty industries should have adequate pre-employment examinations. In addition, follow-up examinations should be repeated at regular intervals varying from six months to one year depending upon the particular dust hazards involved.’ *The Pneumoconioses*. Lanza, A.J., New York: Grune and Stratton. 1963. pp. 126-127.

“To emphasize the positive approach further, we found in this study that, in more than half of the plants visited, the preplacement physical examination is no longer regarded simply as a measure to determine whether the man has an occupational disease disposition, a rather negative approach, but is used to help in the successful job placement of the individual. Mr. McMahon. Discussion.

In The pneumoconiosis, edited by A. Vorwald, p. 569. Paul B. Hoeber, New York. 1963.

D. Worker Education

“Education of the worker to exercise the highest degree of care is necessary. This can be done. It has been done. It is being done every day. *Diseases of Occupations and Vocational Hygiene*. Kober, G.M. and Hanson, W.C. Philadelphia. P. Blakiston's Son & Co. 1916. pp. 874.

“Results of Educational Work and Publicity

Early in the investigation it became apparent that, in order to effect a permanent betterment of sanitary conditions, it would be necessary to obtain the cooperation of both the mine operators and the miners; and that such cooperation could be obtained if sufficient publicity were given to the ill effects of unsanitary conditions, especially the prevalence of siliceous dust in the mines. The matter was given much publicity in daily newspapers. Miners and their families, to the number of 2,700, were addressed at three moving-picture shows. At these gatherings, in addition to films pertaining to sanitation and safety, slides made from photomicrographs of rock dust were shown.

At the start few miners gave evidence of interest in better sanitary conditions. However, as they began to acquire a knowledge of the ill effects of siliceous dust their attitude changed, and the miners as a whole became interested in the abatement of siliceous dust and the general improvement of conditions underground and on the surface. There were many instances of miners quitting their working places if they were not supplied with means of allaying the dust.

Many of the mine operators, without waiting for the passage of the laws requiring improved sanitary conditions, inaugurated improvements in and about the mines, such as the building of new and commodious change houses, the equipment of the mines with separate water lines and sanitary drinking devices, and the regulation of the practices of squibbing and the blowing of dry holes.” *Siliceous Dust in Relation to Pulmonary Disease Among Miners in the Joplin District, Missouri*. Higgins, E. et al. Department of the Interior, Bureau of Mines, Bulletin 132, 1917, pp. 56.

“By direct invitation and by advertisement word was spread around the district that miners and their families would be examined free of charge at the office and would be advised as to their physical condition. In this manner there was collected a considerable amount of information as to the physical condition, not only of the men themselves, but also their families. More than this, however, there was thus created an opportunity for doing considerable effective work among these people by direct personal advice and instruction. Every man examined was informed fully as to his physical condition. When necessary he was advised of the proper means for caring for himself and how to prevent the spread of infection to his family. He was encouraged to return for further examination or advice and was urged to bring his wife and family for examination when there was any reason to suspect that they might not be in good health. Educational literature was distributed freely at the office.” *Siliceous Dust in Relation to Pulmonary Disease Among Miners in the Joplin District, Missouri. Higgins, E. et al. Department of the Interior, Bureau of Mines, Bulletin 132, 1917, pp. 63.*

“Among the recommendations of means that should be employed for the improvement of existing conditions outlined in the conclusion of the preliminary report was the following: ‘Through intensive educational campaigns in the public schools, and among the miners themselves, disseminate information as to the harmful effects of insanitary practices and conditions, such as crowded living quarters, overwork, exposure, dissipation, the breathing of air polluted by powder fumes and siliceous rock dust, and the use of common drinking devices’.” Higgins, E., et. al., *Siliceous Dust In Relation To Pulmonary Disease Among Miners In The Joplin District, Missouri, Department of the Interior, Bureau of Mines, Bulletin No. 132, 1917.*

“Sometimes special instructions are necessary in order that workers may adapt themselves to their jobs or safeguard themselves against hazards that cannot be wholly avoided. Physicians may reasonably be expected to offer instruction of this nature at the time of examination, which is an opportune time, and to do so they must be (a) familiar with hazards of their plants, (b) prepared to offer necessary instruction, and (c) supplied with pamphlets for those employees who are given hazardous process work.” *Industrial Health, Kober and Kayhurst, p 120, 1924.*

1. “Instruction of workmen, just entering upon an occupation, concerning the properties of the poisonous substances extracted, manufactured, used or otherwise evolved, and, whenever possible, cautionary leaflets should be placed in the hands of the workers.
 2. The repetition of these instructions at frequent intervals.
 3. Posting of precautionary regulations and warning placards, containing admonitions for the exercise of special caution, and enjoining the observance of measures for ensuring safety.
 4. Constant supervision of all dangerous employments by expert and responsible persons.”
- Measures for the Protection of Industrial Workers against the Dangers of Poison; Compiled by Industrial Councillor Dr. Fischer of Berlin. In: Industrial Health, Kober and Kayhurst, pp. 6-7, 1924.*

“The recently issued Home Office report on the danger to employees in the asbestos industry caused by the inhalation of dust, emphasizes, as preventive measures, ‘the education of the individual, as in other dangerous trades, to a sane appreciation of the risk, and to his personal

responsibility in the prevention and suppression of dust'." *Notes and Memoranda. The Engineer.* 149:379. 1930.

"The most erroneous and expensive policy any employer can adopt is to minimize to his workmen the dangers of free silica dust; no true observance of dust protection can be expected from the workman unless he is fully acquainted with the dangers of his occupation." *Dust in Industry. Federick Willson. American Society of Mechanical Engineering Journal. Vol. 55. 1933. pp. 80-82.*

"As stated by Harrington, the outstanding remedy for a bad situation...with respect to dust disease is education - education of workers in the necessity of taking available precautions; of employers in recognizing the seriousness of the situation and in providing devices and methods to reduce or prevent the incidence of disease and, if necessary, in forcing their adoption on the workers; of doctors in correctly diagnosing disease, giving publicity to its prevalence, seriousness, preventive remedies, etc., and assigning in death certificates dust disease as the cause if such is the case, and of merchants, newspapers, and other influences in the community in trying to prevent the disease rather than to hide its existence." *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 102-103.*

"The most erroneous and expensive policy any employer can adopt is to minimize to his workmen the dangers of free silica dust; no true observance of dust protection can be expected from the workman unless he is fully acquainted with the dangers of his occupation.

It cannot be assumed that workmen in our American factories are so unintelligent as to wish to ignore dangers about which they have been fully informed. Rather they, like the rest of us, are apt to scoff at occasional warnings, preferring to doubt that dangers exists. It is essential, then, that the management should know the truth first of all. Supervisors should be told the whole story, and workmen, severally and individually, in season and out of season, week in and week out, should be educated, warned, and even cajoled into full observance of the rules." *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 105.*

"Workers should be warned of the danger they face and told just what symptoms they must look out for, and report to the management. They must have the protective devices explained to them, so that they can use them intelligently and take their part of the responsibility for their own safety. It is a great mistake for the management to deny and try to conceal the presence of harmful dust or poisons, for the men know the danger is there, but they do not know how it will show itself, they do not know whether some form of bodily distress is to be traced to the job or not, and they cannot protect themselves efficiently." *Protecting Plant Manpower. Practical Points on Industrial Sanitation and Hygiene. U.S. Department of Labor. Special Bulletin No. 3. 1941. pp. 1-50.*

“Education of the Worker.-The education of the worker comprises two distinct subjects: (1) why something should be done, and (2) how it should be done. Such information is essential to the proper accomplishment of the workers’ regular duties as well as to the proper operation and use of the various control devices. A worker cannot be expected to wear his respirator or goggles, or to turn on an exhaust blower, or open a damper unless he knows why he is doing it. Consequently, his education is of utmost importance and cannot as a rule be left entirely to the foreman. Frequent safety meetings and other meetings are necessary for the education of the worker in the proper use of his various safety and health equipment. Only by incessant instruction will the task of educating the worker be accomplished successfully.” *Engineering Control Of Air Contamination Of The Working Environment*, Allen D. Brandt, p 212. 1943.

“As cited in other health hazards, education of the workers to the potential danger and an efficient first aid set-up are of paramount importance. *1021 Answers To Industrial Health And Safety Problems*. J.E. Weiss. *Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine*. p. 119. 1943.

“A small plant, employing fewer than 150 men, may incorporate the legislative, executive and educative safety activities under one safety committee... the committee should:

1. Study the safety engineer’s reports of weekly plant inspection.
2. Determine the practicability of all recommendations made.
3. Study and become familiar with all causes of accidents and consider preventive measures designed to lessen the severity of the hazards.
4. Arrange and schedule educational programs for the employees. These programs should aim at instructing the individual as to the occupational hazards of his work....*1021 Answers To Industrial Health And Safety Problems*. J.E. Weiss. *Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine*. p. 289. 1943.

“All employees shall be instructed in their specific duties by their immediate supervisor and they shall be made familiar with the hazards of the job and instructed carefully in how to avoid them..” *Minimum Requirements for Safety and Health in Contract Shipyards*. Washington DC, Government Printing Office, 1943. p. 25.

“The education of employees regarding chemical hazards is, and must remain, the direct responsibility of their employers. However, such hazards are not confined to employees alone, and information concerning them should, so far as practicable, reach every person using, transporting, or storing chemicals. The most practical means for the seller to disseminate this information appears to be by labels affixed to containers of hazardous chemicals, bearing appropriate precautionary statements and instructions stated as simply and briefly as circumstances permit.” *Manual from Manufacturing Chemists’ Association*., 1946.

“A cooperative, interested, and well-trained worker can accomplish much with any control equipment, whereas the indifferent, lackadaisical, untrained worker produces the maximum amount of atmospheric contamination with any control device. The solution lies in the *education of the worker*. Therefore, proper education of the worker is the first step in a chain of events

which lead to a satisfactory educational program. (The properly instructed worker produces less atmospheric pollution, which results in less labor turnover, which in turn results in a more satisfactory educational program.) To be successful the education of the worker must begin the day he is employed. On the other hand the educational program must not cease as soon as the worker has been trained in the correct procedure of doing his job. It must be continued throughout his period of employment to keep him on his toes and to prevent him from falling into a faulty routine." *Industrial Health Engineering, Allen D. Brandt, p 56, 1947.*

"The *education of the worker* for his own protection is fully as important as to prevent the creation of unnecessary dust, fumes, mist, gases, or vapors. He must be told which contaminants are harmful and sold on the idea of avoiding the higher concentrations. Careful and continuous education is necessary to get workers into the habit of standing upwind of all operations which produce or release considerable material, such as spray painting, welding, cleanout and other maintenance operations, and handling bulk materials; also to keep his face as far from the point of operation, or out of the line of throw or movement of the contaminant." *Industrial Health Engineering, Allen D. Brandt, p 57, 1947.*

"It was necessary to draw the attention of the worker to these rules of personal hygiene, in order to convince him of their necessity and to get his cooperation. As the first step to gain this interest and to teach him which protective measures were the responsibility of his employer and which ones he must himself observe, the earliest laws and regulations required that copies or excerpts of the laws be posted in conspicuous places in the factory." *History of Factory and Mine Hygiene. Teleky, L., Columbia University Press. New York: Morningside Heights. 1948. pp.29, 126.*

"The medical department should take a very active part with other departments in the health and safety education of workers." *Studies of Health Hazards in Industry, J.J. Bloomfield, Industrial Hygiene Newsletter, February 1952.*

"I think the only successful programs that I have observed elsewhere, outside of our organization, are those in which the employee has some knowledge of why he follows certain operating procedures regardless of what the end effect is of the material or the end effect might be in the materials that he handles. Therefore, I would say that we must give the employee that knowledge so that he can understand and use it in coming to a conclusion as to why he must do certain things to protect himself. I think the same statements apply to organized groups and safety committees and union leaders." *Dr. McGee, 21st Annual Meeting of the Industrial Hygiene Foundation, November 1956.*

"I would like to comment in reference to earlier questions. To maintain safety awareness you must say that a company has to tell its employees what the nature of the materials is which they are handling, whether they are toxic or carcinogenic, because you can never have a safety program unless you give the people working with toxic or carcinogenic materials such information." *Dr. Bachman, 21st Annual Meeting of the Industrial Hygiene Foundation, November 1956.*

“All employees coming into contact with toxic materials should be trained to know these materials, and how to handle them safely, as well as how to maintain cleanliness and good housekeeping. All this implies a planned educational program which is a responsibility of both the engineer and the physician. Each has his contribution to make. Unless employees and also the *foreman* understand *why*, for their own good, it is essential for them to cooperate in such a program, efforts at prevention will fall short.” *The Pneumoconioses*. Lanza, A.J., New York: Grune and Stratton. 1963. pp. 127.

“Instruction of workmen as to the hazards of the process they are working in, with frequent repetition of such instructions. The workmen should be instructed in the signs of the poisoning or other injury that may be expected and in the importance of consulting with the plant physician when suspicious signs appear. They should be taught the precautions that should be taken to avoid poisoning or other injury. Warning placards should be used to supplement other instructions.” *Municipal And Rural Sanitation*. V.M. Ehlers. McGraw-Hill Book Co. 1965. pp. 506.

E. Local Exhaust Ventilation

“From the standpoint of cleaning efficiency and capacity to work against widely varying dust loads and great ranges in particle size the cloth filter has many advantages. The design of industrial cloth filters with respect to compactness, tight construction, effectiveness of cloth cleaning, ease of inspection and maintenance and other details, has been highly developed by manufacturers and for most problems it is only necessary to select a stock unit of the proper size to give satisfactory operation.” *Determination of Cloth Area for Industrial Air Filters*, C.E. Williams, T. Hatch, L. Greenburg, *Heating, Piping and Air Conditioning*, April, 1940.

“While the design of a good hood involves many considerations, the following specific rules should be kept in mind at all times

(1) Enclose the source of contamination as much as possible, (2) locate the hood in line with the natural direction of movement of the contaminant or contaminated air, (3) locate hoods, which do not enclose source of contamination, as close to the source as possible, and (4) for hoods which must be located at some distance from the source of contamination, use as large hood openings as practicable and flanges, if possible.” *Engineering Control Of Air Contamination Of The Working Environment*, Allen D. Brandt, p 200. 1943.

“Local exhaust ventilation is used primarily to reduce the concentration of air contaminants to safe and hygienic limits. A knowledge of the velocity characteristics of hoods does not immediately determine whether the air volumes chosen will be effective in removing the contaminant. In other words, although the installation and use of a correctly designed hood is essential in maintaining a safe environment, it is not in itself a solution of the problem. To determine the effectiveness of a given hood, it is necessary to evaluate the concentration of the substance being collected which remains in the air and is constantly breathed by the worker. The amount present must be kept below the limit considered safe for continuous exposure. Whenever hoods are installed to eliminate a health hazard, tests should be conducted to establish

their effectiveness. ... Hoods are of no value in the prevention of occupational disease unless they eliminate the hazard.

Threshold limits act as benchmarks in determining whether the hood is functioning effectively. In any case, the air volumes handled by hoods should always be more than sufficient to produce a hygienic atmosphere." *How to Design Exhaust Hoods, J.M. DallaValle, Heating and Ventilating, June, 1943.*

"Local exhaust ventilation is probably the most important single method of preventing industrial atmospheric pollution. Like all other types of equipment, that employed to control health hazards requires constant checking and maintenance." *Industrial Health Engineering, Allen D. Brandt, p 55, 1947.*

"In general, collectors are used only for one or more of the following reasons:

1. To recover valuable material.
2. To eliminate or prevent a neighborhood nuisance.
3. To eliminate or prevent a health hazard.

If none of the foregoing circumstances are present, the contaminated air may be discharged to the outside at a point where it will not re-enter any building in sufficient quantity to create a nuisance or health hazard."

According to Alden* the following characteristics are desirable in air-cleaning plants for process ventilating or local exhaust systems:

1. The concentration of the contaminant in the cleaned air should be below the predetermined permissible limit. *Alden, John L., *Design of Industrial Exhaust Systems, 1939.*

Types of collectors which are of most interest to industrial hygiene engineers may be divided into five main groups, 1. Settling chamber. 2. Inertial or centrifugal collectors. 3. Filters. 4 Wet collectors. 5. Electrostatic precipitators.

Industrial Health Engineering, Allen D. Brandt, pp 132-135, 1947.

"Consequently, it is a routine duty of the engineer to measure air velocity and air quantity; he must measure the velocity toward the hood at a source of contamination, the face velocity at a partially enclosing hood, such as a paint booth, and the volume rate of air flowing into or out of a hood, in a branch pipe, or in any part of a ventilating system.

Measuring devices or meters in common use by engineers are of two general types- velocity meters and quantity meters.

While not quantitative devices, the smoke tube, smoke bomb, and cigaret serve a very important purpose in air flow studies. These devices show visually what is happening to the air." *Industrial Health Engineering, Allen D. Brandt, pp 179, 194. 1947.*

"So much depends upon the correct design and construction of hoods and exhaust systems that they should be laid out well by well-trained engineers and maintained with great care. In recent years, a tremendous amount of basic engineering data on this type of control has accumulated. Data are available on the quantity of air that must be removed in order to control hazards or nuisances, as well as on the necessary entrance velocities to hoods having certain size and shape characteristic." *Studies of Health Hazards in Industry, J.J. Bloomfield, Industrial Hygiene*

Newsletter, June 1952.

ASA Z9.2, 1960. 3. Plant Construction and Layout. 3.1 Purpose. Consideration of plant layout and construction shall include exhaust ventilation requirements for the purpose of incorporating such requirements in an over all plan resulting in the optimum combination of capital investment and operating economy for all factors within the control of the designer. Layout based only on production or materials-handling considerations per se may prove uneconomical when necessary exhaust or ventilation requirements are superimposed upon a layout not originally including such considerations.

ASA Z9.2, 1960. 3.4 Walls and Floors. Walls and floors should be constructed so as to permit easy cleaning and draining. Horizontal surfaces and ledges on which dust may collect should be kept to a minimum.

ASA Z9.2, 1960. 4. Exhaust Hoods. 4.1 Purpose. It is the purpose of the exhaust hoods to enclose, as effectively as practical, the points where the contaminant is released, or to create air flow through the zone or zones of contaminant release of such magnitude and direction as to carry the contaminated air into the exhaust system, or both. Exhaust hoods and enclosures may also serve the important function of keeping materials in process by preventing their dispersion.

ASA Z9.2, 1960. 4.9.1 Enclosure of Process. The process should be enclosed as much as possible. The practical necessities of operating the process must, of course be taken into account.

(1) The air velocity through all openings must be great enough to prevent the escape of contaminated air, and the air volume must be sufficient to carry away all air or gas introduced into or created within the enclosure. In the design of the hood, special attention must be paid to the fit around rotating shafts, etc, and to the selection of air volume so that there will be an adequate flow of air into the hood at these points.

(2) The air velocity within the enclosure should be high enough to remove the contaminant from the hood, except that the velocity should not be high enough to carry away valuable products unless these are recovered later. In some applications the velocity in the enclosure need not be high enough to prevent settling; in this case, provision should be made for the easy removal of settled dust.

ASA Z9.2, 1960. 4.13 Access Doors for Enclosing Hoods. Where access doors are provided for enclosing or partially-enclosing hoods, it is of considerable importance that such doors be so constructed and arranged that reclosure of the door is quick and easy. Doors should preferably be hinged or otherwise permanently fixed to the housing. If practical, they should close by gravity or spring action. Simple, strong, quick-operating latches should be used.

ASA Z9.2, 1960. 4.6 Control of Air Motion. The primary purpose of an exhaust hood is to confine or capture contaminated air, or both, rather than to remove the contaminating material from the air. To prevent the dispersion of atmospheric impurities, it is necessary to eliminate or reduce stray or secondary air currents of the proper magnitude and direction about the zone of dispersion. These preliminary measures include: (6) Eliminating unnecessary vibration of

machinery.

ASA Z9.2, 1960. 5.6 Future Expansion 5.6.1 No addition should be made to an existing exhaust system which causes a reduction in the flow through any hood to a value below the estimated minimum requirement.

ASA Z9.2, 1960. 6. Air-Cleaning Equipment 6.2. Purpose. Air cleaning is required for one or more of the following reasons:

(1) To prevent the creation of a hazard or nuisance in the area exposed to the effluent of the local exhaust system.

6.3.2 Air cleaning equipment is ordinarily necessary in exhaust systems handling organic and inorganic dusts and fibers. Such contaminants, if discharged directly to the atmosphere, are likely to settle out rapidly to an extent which may constitute a hazard or a nuisance to the neighborhood.

6.4.1 Degree of Cleaning. The concentration and mass rate of emission of contaminant in the cleaned air shall be sufficiently low that neither hazard nor nuisance is created inside or outside the plant.

6.4.2 Legal Requirements. The concentration and mass rate of emission of contaminant in the cleaned air should be below that specified by existing state or local codes, or below that which might reasonably be anticipated in future codes.

ASA Z9.2, 1960. 8. Construction and Installation 8.1 Criteria of Construction and Installation. Exhaust systems should be constructed so that they may be operated safely and efficiently, and maintained easily.

8.3.5 Airtightness. Regardless of the method used to make them, all joints should be made airtight by soldering or other equally effective method.

8.3.21 Location of Cleanouts. Cleanout openings should be provided in horizontal runs of pipe carrying dust-laden air, and especially near elbows, junctions, and vertical pipe runs. The spacing of cleanout doors should not exceed 12 feet for pipes of 12 inch diameter and less, but may be greater for larger pipes.

ASA Z9.2, 1960. 9. Operation and Maintenance 9.1 General. Satisfactory operation of an exhaust ventilating system requires that it be maintained in good condition.

9.2 Instruction of Employees. Employees who work at operations equipped with local exhaust systems should be instructed as to the proper operating method and as to the reason for the installation. Maintenance personnel should receive similar instruction and the necessary additional training to "trouble-shoot" the system in the event of malfunction.

9.4 Maintenance of System. In order that an exhaust system may perform its designed function, a periodic maintenance schedule is necessary.

9.4.3 Items which should be included in the maintenance schedule are as follows:

(1) The air quantity exhausted through each hood should be measured periodically.

(4) When toxic materials or flammable gases or vapors are handled, atmospheric concentrations should be measured at least annually at each significant operation and compared with similar measurements made when the system was first installed and approved.

- (5) Periodic air samples should be taken at the discharge of air-cleaning devices where air pollution, toxicity of effluent, or value of materials in the effluent indicate a need for it.
- (6) A complete inspection of the entire system should be performed at least once each year. This should include checking all piping and other equipment for external damage, abrasion, and corrosion.

F. Wet Methods

"A fourth preventive method, which has been widely applied in the mining, metallurgical, and ceramic industries, is the substitution of wet methods for the original dry screening, grinding, milling, and mining processes." *Industrial Medicine*, W. Irving Clark and Philip Drinker, p 210. 1935.

"Wet Methods.- The use of water or other suitable liquid at operations producing dust or fumes, or both, will generally allay the particulate matter satisfactorily. However, this method of control is necessarily limited to a small number of different operations such as grinding, drilling, and sweeping." *Engineering Control Of Air Contamination Of The Working Environment*, Allen D. Brandt, p 205. 1943.

"Wetting dust with water or other liquids is probably the oldest method of control. It was practiced in the pottery industry in Great Britain as early as 1713. Wet drilling and water sprays have been widely employed in mining operations in recent years. Even though wetting of the dust must be recommended with discretion, it has been found an effective dust control aid in rock drilling, blasting, crushing, screening, materials transfer, foundry shakeout, core knockout, and abrasive blasting," *Industrial Health Engineering*, Allen D. Brandt, pp 54-55, 1947.

"Wetting is primarily an adsorption phenomenon in which the surfaces of the particles become covered with a film of water. Most liquids tend to spread on plane surfaces, but great force must often be used to wet dust, probably because the particles are already surrounded by a film of air. Wetting is of importance in dust sampling and in control of dust.

Three factors have been described by Drinker and Hatch as of importance in the wetting of dust. First, it is necessary to maintain intimate and vigorous contact of long duration between the dust and liquid. Second, it is advantageous to apply the liquid immediately at the dust source, because the heat usually generated in producing dust by drilling or grinding hampers air adsorption and because continuous flooding at the source excludes air. Third, wetting agents may be used to increase the wetting power of water." *Industrial Hygiene and Toxicology, Volume I*, Frank A. Patty, pp 468-469., 1948.

"Another, and very effective, means for dust control is the use of wet methods. This measure has been employed with great success in drilling operations in mines. Sprinkling of floors and dusty materials is another simple wet method which is often feasible to use." *Studies of Health Hazards in Industry*, J.J. Bloomfield, *Industrial Hygiene Newsletter*, June 1952.

G. Sanitation

“A sanitary workshop, apart from good management, demands sufficient air-space for each inmate, a suitable temperature, proper ventilation, general cleanliness, sanitary conveniences, separate toilet rooms for men and women, facilities for personal cleanliness, wash rooms, shower baths, dressing-rooms, clothes lockers, lunch rooms, etc,... The employer must furnish working clothing, gloves, respirators, and sometimes head coverings, and lockers in which to keep them. There must be dressing rooms, and wash rooms supplied with hot and cold water, soap, towels, nail brushes, and bathing facilities; a dust-free room, warmed in cold weather and in some cases provided with means for warming the workmen's food, must be set aside as a lunch room. Notices of the law must be posted, and sometimes must also be distributed to the employees.” *Diseases of Occupations and Vocational Hygiene. Kober, G.M. and Hanson, W.C. Philadelphia. P. Blakiston's Son & Co. 1916. pp. 453, 807.*

“Now the mines have erected, or are erecting, change houses with concrete floors and concrete or galvanized-iron walls, with plenty of windows and adequate ventilation. These change houses have shower baths with hot and cold water, wash basins, and individual lockers for clothes, are ventilated, and are heated by steam pipes. Also most of them have a separate room, with benches and tables, for eating.

The new change houses have been received with enthusiasm, and most of the men use them in the manner intended. A recent visit to a change house showed nearly every locker containing clean street clothes as evidence that the men changed when coming off shift.” *Higgins, E., et. al., Siliceous Dust In Relation To Pulmonary Disease Among Miners In The Joplin District, Missouri, Department of the Interior, Bureau of Mines, Bulletin No. 132, 1917.*

“10. Practice of bodily cleanliness by the use of wash, bath and dressing rooms, the use of special rooms for eating, separate lockers for street and work clothes, and frequent non-hazardous cleaning of the clothing. *Measures for the Protection of Industrial Workers against the Dangers of Poison; Compiled by Industrial Councillor Dr. Fischer of Berlin. In: Industrial Health, Kober and Kayhurst, pp. 6-7, 1924.*

“Miscellaneous Sanitary Provisions.- In this connection it is desirable to point out certain sanitary requisites, which are important in all dusty occupations, especially in those involving exposure to toxic dust and fumes.

1. Suitable Work Clothes and Caps.- There is a great variety of suitable patterns in the market, of which the snug-fitting duck union suit, without many folds, properly buttoned and adjusted is the best. Such suits and caps should be furnished at the expense of the employer and washed once a week.

Dressing-rooms, Lockers, Bath and Wash Rooms.- It is desirable, in all dusty occupations, that the workmen should take off all their street clothing before beginning work, and this is absolutely essential when the occupation involves exposure to poisonous dust. For this purpose suitable dressing-rooms, provided with lockers for street suits and separate compartments for overalls, are necessary. Facilities for washing and bathing, brushes, soap and individual towels should be furnished. In most of the civilized countries statutory provisions have

been made for these sanitary requisites, in all establishments in which poisonous substances are manufactured or used, and the result has been most beneficial.”

3. Pure Drinking Water and Lunch Rooms.- The health and safety of employees exposed to industrial poisons demand that no food shall be taken, or tobacco in any form used, in the workrooms.” *Industrial Health, Kober and Kayhurst, p 24-25, 1924.*

“In some instances it is necessary to require that employees change their clothing completely before they leave the plant, and it may be necessary to launder their clothing at frequent intervals. Of course such procedure is always accompanied by regulations in connection with bathing.” *Protective Equipment Lessens the Risk. Barth, A.L., National Safety News. January, 1931.*

“Employers should see that workmen are not exposed to the danger of tubercular infection from one another, that every facility in the way of dressingrooms, lunchrooms, and washrooms is provided, and that every piece of protective equipment is kept in perfect working order.” *Review of the Literature on Effects of Breathing Dusts With Special Reference to Silicosis. Harrington and Davenport. U.S. Bureau of mines Bulletin 400. 1937. p.133.*

“The following suggestions were made to further diminish the dust danger in South African mines: 3. The daily removal of all dust (by vacuum cleaners) from clothing worn underground.” *Review of the Literature on Effects of Breathing Dusts With Special Reference to Silicosis. Harrington and Davenport. U.S. Bureau of mines Bulletin 400. 1937. p.107.*

“It must be remembered that all people do not react in the same way when exposed to chemicals. Some may be quite seriously affected by quantities which are harmless to others. Hence, it follows that any one using paint and allied products should provide adequate ventilation and should observe ordinary sanitary measures such as washing of the hands and face before eating and keeping the clothes clean. Dirty work clothes, including shoes, can be an important source of skin absorption.” *National Paint, Varnish and Lacquer Association, Inc. 1939.*

“Daily change of work clothes for all employees working with slip or wet caly.” *Silicosis And Lead Poisoning Among Pottery Workers. R.H. Flinn, et. al. Public Health Bulletin No. 244. 1939. pp. 37-43.*

“Wash thoroughly before going home, preferably in a shower bath using plenty of hot water and soap.” Recommended Safe Practices. Owens-Corning Fiberglas Corporation. 1940. *From Egilman, M.D. MPH.*

"For the purposes of discussion, we may consider industrial hygiene as organized along the lines shown in Figure 1.

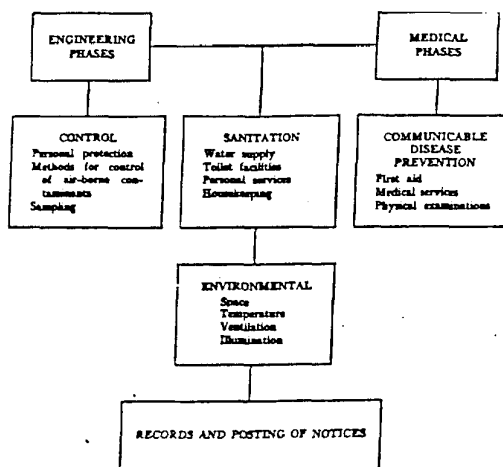


FIGURE 1.—Relationship of engineering and medical phases of industrial hygiene

The principles of sanitation applied to the industrial environment do not differ from those forming a part of community sanitation. Their primary purpose is to control the causative factors of disease. However, in accordance with the accepted definition of sanitation, the principles are interpreted as applying to the prevention of diseases other than occupational.

One shower bath with ample supply of hot and cold water from one fixture should be provided for every 15 workers or less exposed to skin contamination with poisonous, infectious, or irritating material. Dressing rooms should be provided for men whenever the type of work performed involves exposure to excessive dust, dirt, heat, fumes, vapor, or moisture of such degree as is declared by the enforcing authority to require the same. Two-compartment lockers should be provided in a separate room from the place of work for employees whose clothes are exposed to contamination with poisonous, infectious, or irritating material, and well separated facilities should be provided for street and working clothes. Where the process in which the worker is engaged is such that his working clothes may become wet or have to be washed between shifts, they should be so cared for that dry clothes are assured for the return to work. Whenever the nature of the work is such that the employees' clothing becomes covered with or permeated with industrial poisons, the employer should provide necessary equipment and help to cleanse such clothing as often as may be necessary." *Basic Principles of Industrial Sanitation*. Dallavalle, J.M. and Jones, R.R. *American Journal of Public Health*, Vol. 30, 1940, pp. 369-384.

"Give any information applying to the risk as a whole, such as shower and washroom facilities, changes of clothing provided, housekeeping conditions, etc." *1021 Answers To Industrial Health And Safety Problems*. J.E. Weiss. *Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine*. p. 277. 1943.

"Where dust, grease, oil and grime are prevalent, these procedures should include the maintenance of separate lockers for work clothes, apart from street clothes (both within easy access of showers).

For example, in processes where irritant chemicals, dusts, gases, fumes, mists, vapors or sprays come in contact with the worker, complete washing, with suitable cleansers, under showers should be compulsory at the end of each shift. Facilities should be adequate, light, sanitary and kept free from athlete's foot fungus by live steam treatment or other methods, and by facilities for medical foot baths." *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. p. 13-14. 1943.*

"The Police, Factories, etc. (Miscellaneous Provisions) Act of 1916 authorized the Secretary of State to compel the employer by 'welfare orders' to provide for the health and comfort of workers: to make available facilities for preparing, heating, or taking meals and to provide protective clothes, first aid arrangements, seats, eating and dressing facilities, and an adequate supply of drinking water. In the older literature there were directions for personal care, most of them recommending certain medicines or foods. From the beginning of the 19th century on, the rules and regulations contained instructions on cleanliness, washing, bathing, and work clothes, and prohibited smoking and taking of meals in the workrooms. It was necessary to draw the attention of the worker to these rules of personal hygiene, in order to convince him of their necessity and to get his cooperation. As the first step to gain this interest and to teach him which protective measures were the responsibility of his employer and which ones he must himself observe, the earliest laws and regulations required that copies or excerpts of the laws be posted in conspicuous places in the factory." *History of Factory and Mine Hygiene. Teleky, L., Columbia University Press. New York: Morningside Heights. 1948. pp.29, 126.*

"In connection with the prevention of nonoccupational diseases, the medical department should assume supervision of the general health aspects of the plant. This will involve periodic checks on the adequacy, functioning, and sanitary conditions of all eating, drinking, washing, bathing, and toilet facilities, as well as such environmental factors as air conditioning and lighting." *Studies of Health Hazards in Industry, J.J. Bloomfield, Industrial Hygiene Newsletter, February 1952.*

"Mining, in any of its phases, is inherently dirty work. This means that the miner usually wears clothes specifically adapted to the work he is doing. Frequently these clothes are not suitable for use away from the mines. Dust and water introduce their own particular problems as to comfort and cleanliness.

It used to be custom for miners to wear their dirty clothes home and change there. This custom no longer prevails though, and change houses or bath houses are provided at most mining operations nowadays.

Health is man's greatest asset and should be guarded at all times. Properly designed change rooms not only protect the health and welfare of the employee, but cut down labor-turnover and promote better employee-employer relationships. This has been proven many times.

For ease of maintenance and economy of construction, it is advantageous to have one large central change house with complete shower and toilet facilities. There are three common ways to store employees' clothes and personal effects: hooks or ladders hanging on the wall; in floor lockers; and in overhead basket lockers. Showers should be supplied in a ratio of one shower head for each 10 men on shift. The change room should be cleaned thoroughly after each shift.

A clean worker is a healthy happy one, and a happy worker is a good, steady efficient one. The intelligent placing, design and furnishing of industrial change rooms is perhaps one of the most direct and certain methods of increasing workers' morale. Don't neglect it." *Modern Change Houses for the Mining Industry. Mining Congress Journal. November, 1954. pp.45-47.*

"These recommendations or guiding principles apply to trades and industries in which insured persons are endangered by asbestos dust. They apply to asbestos-mines or pits, factories producing asbestos and asbestos cement, asbestos-spinning works, works where asbestos is worked up into various products.

(19) Feeding in rooms with a dust-hazard is forbidden as is also remaining in them during rest pauses."

Protection against Asbestosis. Prockat and Windel. (1939). In Pneumoconiosis Abstracts. Volume II. London. Sir Isaac Pitman & Sons, LTD. 1954. pp. 409-410.

"This is a very comprehensive article and valuable in pointing out, as the title indicates, the basic principles of industrial sanitation. It does more than that. It touches on water supply, conservancy, water closets and privies, washing facilities, and housekeeping and catering, temperature and ventilation, lighting, control of dusts and fumes and keeping of records. A very helpful list of references for each of these subdivisions is appended to the article". *DallaValle, J.M., and Jones, R.R., Basic Principles of Industria Sanitation. American Journal of Public Health. Vol. 30. 369-384. 1940. In Pneumoconiosis Abstracts. Vol II. London. Sir Isaac Pitman & Sons, LTD. 1954. p. 380.*

"The areas that may be considered the province of industrial sanitation are: (5) provision of adequate sanitary facilities and other personal services; (6) maintenance of general cleanliness of the industrial establishment." *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, p 117, 1958.*

"The revised American Standard Minimum Requirements for Sanitation in Places of Employment states (10.1.1) that: 'In all places of employment where employees are permitted to lunch on the premises, an adequate space suitable for that purpose shall be provided for the maximum number of employees who may use such space at one time. Such space shall be separate from any location where there is exposure to toxic materials.' It further states (10.1.3) that: 'No employee shall be permitted to store or eat any part of his lunch or eat other food at any time where there is present any toxic material or other substance that may be injurious to health.'" *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, pp 130-131, 1958.*

"Where the employee is exposed to toxic materials, or if he is a food handler, the need for the optimum in clean, well-lighted, and well-ventilated washing and locker facilities becomes imperative from the point of view of both protecting the health of the individual employee and minimizing the possibility of his transmitting infections to others. In industries where work clothes of the employee are exposed to contamination with poisonous, infectious, or irritating, materials, separate storage for street and work clothes should be provided. Cash suggests the following arrangement for such a 'change house':

'A good arrangement is a room or building divided into two sections - a street clothes section and a work clothes section, with bathing and toilet facilities between. The street clothes section has an outside entrance and lockers for street clothes, toilets and wash basins or wash fountains, and changing facilities for supervisors. The work clothes section has rooms for work clothes, toilets and wash basins or wash fountains, showers, and laundry. Three connections between the street clothes section and the work clothes section are (1) through the supervisors change room, (2) through the main shower room, and (3) a hall with 'one way traffic doors' from street to work clothes sections' (F.E. Cash, *Suggested standards for change houses. Presented at American Public Health Association Annual Meeting, October, 1951*).'' *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, pp 136-137, 1958.*

"Requiring of body cleanliness on the part of workers. This includes bathing and changing of clothing at the end of the working day. Work clothing must be frequently cleaned in nonhazardous ways. This requirement places upon the industry the responsibility of furnishing suitable clothing lockers, washrooms, and shower baths.

A well-ventilated locker should be furnished to every employee. An alternative to lockers is the ceiling hook, an arrangement which allows complete drying and airing of clothing. Each workman is allotted a combination of two hooks and a wire basket for shoes, etc., all of which are attached to a chain which runs over a pulley suspended close to the ceiling. After the clothing is raised to the ceiling, the chain is locked to a device below. This system has been widely used at steel plants, mines, and chemical works." *Municipal And Rural Sanitation. V.M. Ehlers. McGraw-Hill Book Co. 1965. pp.507-518.*

"Sanitation was important to the Anaconda Mining Company, Butte, MT and lockers and showers were provided to its employees in the 1940's. Most of the workers would wash their work clothes in the shower at the end of the shift and hang them in their lockers to dry." *Floyd Bossard, CIH. Retired Mining Engineer.*

"William Spear began work for the ACM in Butte in 1939. He worked in the underground mines until 1942 when he began work as an oiler and then a brick layer. He worked approximately 40 years for the company. He said that every mine in Butte had its own dry, with showers and lockers for the workers. These dries were large structures with plenty of lockers and large shower rooms. When he started work, he estimates that there were at least 20 different mines with their own dries. There was also a dry associated with the machine shops on the hill. He said many of the men, including himself, would wash their work clothes in the shower and then hang them on hooks on the inside of their lockers. He had separate work boots which he left at work. He remembers seeing clothes washing machines in the heating plant on the hill in the 1940's."

H. Housekeeping

"Hygiene, on the other hand, approves of hard wood floors or impermeable floors, curves instead of corners and angles, smooth and non-absorbent walls - in brief of everything which will prevent the collection of dust and germs and facilitate their removal.

Workshops should be swept daily after cessation of work, the sweeping should be done when practicable with damp sawdust, with the upper windows opened. In certain industries, cleaning

and dusting by the vacuum system has been employed and should be encouraged, especially where there is exposure to poisonous dust. In a number of occupations, cement floors, with suitable incline for drainage, so as to facilitate washing with hose, have been found useful." *Diseases Of Occupation and vocational Hygiene. G.M. Kober and W.C. Hanson. Philadelphia. P. Blakiston's Son & Co. 1916. pp.442.*

"(f) Cleaning of Workshops. - A number of states provide by laws that 'all factories shall be kept clean.' Hygiene demands that there should be no accumulation of dust in any part of the premises, and therefore condemns all interior finishes, such as exposed girders, cornices, mouldings, cubby holes, unnecessary shelves and inaccessible spaces, which will serve as dust and germ traps.

Workshops should be swept daily after cessation of work, the sweeping should be done when practicable with damp sawdust, with the upper windows opened. In certain industries, cleaning and dusting by the vacuum system has been employed and should be encouraged, especially where there is exposure to poisonous dust." *Industrial Health, Kober and Kayhurst, pp 23-24, 1924.*

"Good housekeeping is, after all, one of the major considerations in the protection of workmen where there is dust of a hazardous nature. Dust-exhausting systems are of no use unless they are so applied to the work as to really carry off a large part of the dust and deposit it in receptacles where it cannot again work harm." *Dust in Industry. Frederick Willson. American Society of Mechanical Engineering Journal. Vol. 55. 1933. pp. 80-82.*

"Good housekeeping is an important aid in reducing dust concentrations. The dust collected on floors, benches, rafters, etc., should be removed at frequent intervals. Either wet sweeping or vacuum cleaning should be used. Good housekeeping not only serves to remove sources which contribute to the general dustiness of a plant, but also adds an important psychological factor. A clean workplace not only tends to keep clean, but frequently compels some method of control to be applied to those sources which are dustiest." *The Determination And Control Of Industrial Dust, J.J. Bloomfield and J.M. Dalla Valle, Public Health Bulletin No. 217, p 130. April, 1935.*

"The daily cleaning of all flat surfaces, both floors and benches, by methods that do not produce dust. The advantages of vacuum cleaners in potteries have been well expressed by the air hygiene committee of the United States Potters Association. The committee reported in part:

Keeping the plants clean by sweeping has never been satisfactory, due to the fact that it is almost impossible to wet down the floors sufficiently to prevent the sweepers from raising a cloud of fine dust with the brooms. If it were possible to thoroughly dampen the dust so as to eliminate this dust cloud, it would be later found that while the heavy accumulations of dust, clay, and pieces of ware have been removed, the fine dust which causes most of the trouble is still on the floor - after all, sweeping with brooms simply removes the heavy material, leaving the cracks and crevices filled with fine dust. In plant where heavy plank or board floors are used, the cracks between the boards are filled with dust, so that every time a truck is moved, a cloud of dust is raised.

The only successful method today of cleaning the plants and entirely eliminating the dust is by vacuum cleaning. This method not only removes the surface dust, but also removes that which is deposited in the cracks and crevices. A properly designed system is one in which the equipment is of sufficient size to enable the cleaners to use 50 feet of hose and reach any part of the plant; one which will permit the required number of operators to work simultaneously; one which will permit the operators to pick up anything that will readily pass through the hose and tools." *Silicosis And Lead Poisoning Among Pottery Workers. R.H. Flinn, et. al. Public Health*

Bulletin No. 244. 1939. pp. 37-43.

“All places of employment, passageways, storerooms, and service rooms should be kept in a sanitary condition. So far as practicable, sweeping and cleaning should be done outside of working hours and in such a manner as to avoid the dissemination of dust.” *Basic Principles of Industrial Sanitation. Dallavalle, J.M. and Jones, R.R. American Journal of Public Health, Vol. 30, 1940, pp. 369-384.*

“Quality of plant housekeeping, while not directly related to the manufacturing process itself, influences the extent of the hazard. Direct benefits result from good housekeeping in certain industries. Some foundry operations and lead storage-battery manufacturing processes, for example, disseminate dust generally on the floors and beams. Without a regular cleaning program the dust accumulates and is thrown back into the air by every passing truck or vibration of the building. Indirectly an effective housekeeping program also improves working conditions since undesirable situations, such as equipment in need of repair, are brought quickly to the attention of the maintenance official. A well-kept plant constitutes the best evidence of a basic effort to maintain safe and healthful working conditions.” *Protecting Plant Manpower. Practical Points on Industrial Sanitation and Hygiene. U.S. Department of Labor. Special Bulletin No. 3. 1941. p. 14.*

“7. Protect the work room. The floors, walls, benches and other places where dust lodges should be cleaned regularly by vacuum or by wet brushing preferably after working hours. *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. pp. 41-42. 1943.*

“Good Housekeeping.-Dust and other particulate matter in the air of industries is settling out continuously at a rate dependent upon the physical characteristics of the material and the air currents. As a result, the dusts or fumes are depositing constantly on the floor; ledges; stationary machinery; workers’ arms, faces, and clothing; and other objects. Vibration, shock, or unusual air currents will tend to dislodge and redisperse some of this material into the air, thereby increasing the workers’ exposure needlessly. All of this may be avoided by good housekeeping. The floors, ledges, overhead structures, stationary machines, and other objects should be cleaned frequently and routinely. This should be done by means of suitable vacuum systems. Blowing the dust off of machines and ledges is taboo since it is merely redispersed into the air; in other words, the atmospheric concentration is increased since more dust is kept in the air than if it were permitted to settle out. Dry sweeping is also not recommended; it should be done wet. As a general rule, more good can be accomplished per dollar invested by good housekeeping than by any other single method.” *Engineering Control Of Air Contamination Of The Working Environment, Allen D. Brandt, p 205. 1943.*

“The employee should be taught general safety policies and good housekeeping procedures.” *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. p. 285. 1943.*

"The following two types of vacuum cleaning units are in common use: 1. The built-in type, having a central filtering unit to which are connected convenient outlets to the various points of the plant, and 2. The portable unit, built on the household cleaner principle, but in much greater dimensions.

The use of vacuum cleaning insures a less hazardous plant, and promotes employee cooperation. Also, air-borne dusts often have as their source uncleaned rafters, or are deposited on pipes, etc. which can be reached and eliminated by vacuum cleaning systems.

Where hazardous dusts are present, dry broom sweeping has been practically prohibited as heavy, injurious dust concentrations may be produced." *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. pp. 275. 1943.*

"More can be done by *good housekeeping* to eliminate sources of contamination, particularly dusts and fumes, than is commonly realized. In dusty industries or workrooms where dust is continuously settling on all surfaces which approach the horizontal, and collecting on vertical surfaces, good housekeeping in the form of vacuum cleaning, wet washing, and sometimes brushing prevents this material from being redispersed into the air. The amount of dustiness which is contributed to the air of dusty industries by the continual redissemination of the settled material is sometimes more than 50% of the total dust concentration. Yet this dust can be prevented from getting into the air very readily by constant cleaning. While good housekeeping alone is seldom sufficient to control existing hazards, experience has shown that the housekeeping in most plants is a good index of the industrial hygiene program." *Industrial Health Engineering, Allen D. Brandt, p 52, 1947.*

"Good housekeeping is a fundamental part of any safety and health program and is an essential in efficient plant operation. It is of special importance in the control of dust hazards. In many plants where there is a limited budget for dust control, more results on a dollar-for-dollar basis can be achieved by good housekeeping than almost any other method. Good housekeeping means much more than sweeping of floors. It includes orderly storing of equipment; good maintenance of machinery to prevent unnecessary vibration or escape of material; placing of operations in such a manner as to limit the area of number of workers exposed to hazards; prevention of unnecessary accumulation of dust and dirt on windows, light fixtures, and beams; and cleaning methods which do not in themselves result in stirring up of greater dust concentrations. The execution of a good housekeeping program requires careful planning and sustained effort, coupled with educational activities to enlist the cooperation of every employee." *Studies of Health Hazards in Industry, J.J. Bloomfield, Industrial Hygiene Newsletter, June 1952.*

"These recommendations or guiding principles apply to trades and industries in which insured persons are endangered by asbestos dust. They apply to asbestos-mines or pits, factories producing asbestos and asbestos cement, asbestos-spinning works, works where asbestos is worked up into various products.

(3) Where considerable dust is evolved the walls must be washable and the flooring dust-tight, (i.e. no accumulation of dust between floor boards). Everything on which dust can accumulate

should be avoided as far as possible. The work rooms must be regularly cleansed outside working hours, protection being arranged for the cleaners.” *Protection against Asbestosis. Prockat and Windel. (1939). In Pneumoconiosis Abstracts. Volume II. London. Sir Isaac Pitman & Sons, LTD. 1954. pp. 409-410.*

“Much dust can be kept out of the air of a workroom by ordinary methods of cleanliness by seeing that the floors, walls and ledges in a workroom are cleaned regularly, preferably with a vacuum cleaner.” *The Incidence And Prevention Of Dust Diseases In British Industry. McLaughlin, A.I.G., Journal of the Royal Institute of Public Health and Hygiene 18: 235. 1955.*

“VI. Maintenance of General Cleanliness of the Industrial Establishment

The industrial plant that processes hazardous or potentially hazardous materials that cannot be prevented from escaping into the general atmosphere has a double responsibility to provide the utmost in housekeeping and plant cleanliness.

It is no longer sufficient to delegate responsibility for cleanliness of the plant and surroundings to a foreman or supervisor whose primary duties, interests, and training lie elsewhere. The complexity and cost of housekeeping machinery and supplies, the technical knowledge required for their proper use, and the extensiveness of the workload make the establishment of a housekeeping department in large plants a virtual necessity. Working standards, schedules, and quality controls are also required in this routine plant operation.” *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, p 140, 1958.*

I. Maintenance

“When holes appear in the piping or some other part of the system begins to deteriorate or operate in an inferior way, repair should be immediate. Since this is a matter of health, it should take precedence over other repairs.” *Dust Control, F.F. Kravath, Heating and Ventilating, June, 1941.*

“Maintenance, Housekeeping, and the Education of the Worker

Even though these three items are discussed individually in this section, they are interdependent. It is impossible to have good maintenance unless the housekeeping is good and the worker has been informed of the need for the control measures and the proper operation thereof. Any attempt to maintain working equipment in good condition and to keep the work place in good order, is doomed to failure unless the worker is given the necessary instruction. It is the duty of management to provide the necessary personnel or instruct the proper personnel to inspect, lubricate, clean out, and repair the equipment routinely. Improper maintenance is evidenced by such indications as badly dented or collapsed hoods or ductwork; torn bags in bag-type collectors; ducts clogged with waste of all kinds, paper, or articles of clothing; collectors not functioning because they are not cleaned; dirty respirator filters; exhalation valves or filter missing from respirators; holes in ductwork; ductwork badly corroded.” *Engineering Control Of Air Contamination Of The Working Environment, Allen D. Brandt, p 210-211. 1943.*

“Under the jurisdiction of the safety engineer comes the problem of keeping all ventilating systems working effectively and efficiently. Regular inspection tours are of paramount importance. In addition, maintenance procedure, such as cleaning, lubricating and replacing worn parts, should be under his strict control.

As previously cited, the only way a ventilating system can be judged as working correctly and adequately is by an actual plant survey which includes the regular sampling of work room air.” *1021 Answers To Industrial Health And Safety Problems*. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. pp. 276. 1943.

“Like all other types of equipment, that employed to control health hazards requires *constant checking and maintenance*. It should be included with other equipment in the cleaning and maintenance schedule. Dust collectors, fans, and in many instances ductwork require periodic cleaning to obtain satisfactory operation. Bent hoods and leaky or damaged ductwork and enclosures should be repaired promptly.” *Industrial Health Engineering*, Allen D. Brandt, p 55, 1947.

“Fan maintenance is extremely important. It should be done on a scheduled, periodic basis, not hit or miss. The maintenance must be the responsibility of a designated individual or department if it to be done satisfactorily.” *Industrial Health Engineering*, Allen D. Brandt, pp 167-168, 1947.

“In order to carry on a systematic maintenance program of an exhaust system it is necessary to assign to individual employees, and to schedule daily, weekly, monthly, and semiannual or annual tasks.

At the beginning of each work period- day, shift, or part shift, some individual should have the responsibility of seeing that the system is set into operation; that all dampers or gates are properly opened; and that all hood openings are free and exhausting air. Similarly at the end of each work period, it should be someone’s assigned responsibility to see to it that the dust collectors or other air-cleaning equipment are cleaned out according to the maintenance schedule. Each week, static pressure or velocity pressure should be taken at each hood and checked against similar readings taken after original installations.” *Exhaust System Maintenance*, W.B. Harris, *Industrial Hygiene Newsletter*, December 1949.

“Perhaps the best assurance that mechanical ventilation is functioning properly is a scheme of periodic inspection and testing. Volume III outlines the practical methods of observing and measuring air flow. Successful maintenance departments have learned to ensure first-class performance.” *Industrial Hygiene and Toxicology*, Volume I, Frank A. Patty, p 341, 1958.

J. Respirators

Respirators have never been considered by the industrial hygiene community as the method of choice for protecting workers from exposure to asbestos or other chemical agents. Merewether and Price (*Report on Effects of Asbestos Dust on the Lungs and Dust Suppression in the Asbestos Industry*, 1930) made some of the earliest recommendations pertaining to the control of dust

exposures in asbestos plants. In their recommendations, respiratory protection was “only recommended as a second line of defense, and not in substitution for other preventive measures specifically directed to the control of dust as near as possible to its point of origin.”

Respirators were considered by the industrial hygiene community in the 1950's, as they are considered by industrial hygienists today, as the least preferred method of protecting workers from exposure to chemical agents, including asbestos.

“It should be remembered that even the best respirators, so far designed, are far from satisfactory, and none fulfil the indications fully.” *Diseases Of Occupation And Vocational Hygiene. G.M. Kober and W.C. Hanson. Philadelphia. P. Blakiston's Son & Co. 1916. p. 442.*

“The observations included in the report show, for instance, that the majority of particles of asbestos dust floating in the air are not larger than a five-hundredth of a millimeter, and many are as small as a two-thousandth. It is said, therefore, that respirators, apart from their discomfort and the difficulty in inducing workers to wear them for any length of time, are unable to arrest the finest particles of dust, and at best can only be regarded as a second line of defense.” *Mineral Dust in Factories. Engineering. 129: 577-578. 1930.*

“The recently issued Home Office report on the danger to employees in the asbestos industry caused by the inhalation of dust, emphasizes, as preventive measures, ‘the education of the individual, as in other dangerous trades, to a sane appreciation of the risk, and to his personal responsibility in the prevention and suppression of dust’. The protection afforded by respirators was, it is said, only partial, and there was a real danger that the use of them might give a sense of false security.” *Notes and Memoranda. The Engineer. 149:379. 1930.*

“Mechanical filter respirators provide efficient protection against certain forms of dust, but they do not provide a complete seal against the finest and most dangerous dust, especially the dust containing silica. Obviously, equipment such as respirators should be properly supervised. It should be remembered that respirators as protective devices are considered the minimum requirement for dusty operations. It is always a good practice to make their use unnecessary, if it can be done.

Breathing through a mask is naturally more laborious than ordinary breathing, and employees who use this equipment should be thoroughly instructed in its use.” *Protective Equipment Lessens the Risk. Barth, A.L., National Safety News. January, 1931.*

“More often than not employers urge that their workmen are not willing to wear respirators, or that they wear them only occasionally. It must be evident to any one that if this neglect of personal protection is actually practiced, the situation from a protective standpoint could not possibly be much worse. Part-time protection can hardly be considered as protection at all - rather it is only a form of deception. If workmen will not wear respirators because of alleged discomfort, an effort must be made to provide them with devices that really can be worn during full-time employment; but full cooperation will probably not be attained without acquainting the worker with the danger to which he will be exposed if totally or partially unprotected.” *Dust in Industry. Frederick Willson. American Society of Mechanical Engineering Journal. Vol. 55.*

1933. pp. 80-82.

"It is important first of all to hold in mind the limited use of personal protection devices. Because a worker cannot with comfort wear a mask or helmet continuously, such devices must be employed intermittently. As a consequence, their use is generally extended to those operations where all other methods have failed or supplementary to them,.... Respirators and helmets are in a sense the last resort in dust protection.

The fit of a respirator or mask is important. They should in every case be fitted to the wearer. Otherwise leaks will interfere with the effective use of the device" *The Determination And Control Of Industrial Dust*, J.J. Bloomfield and J.M. Dalla Valle, *Public Health Bulletin No. 217*, p 155-163. April, 1935.

"A simple practical test that anyone can run to determine whether a respirator facepiece is making a tight seal, is to wear it in a high concentration of coal dust. The time of the test can be shortened by blowing a stream of air containing a high concentration of coal dust around the edges of the facepiece." *Respiratory Protective Devices*, Carlton E. Brown, *Journal of Industrial Hygiene and Toxicology*, Feb., 1937.

"Although some form of respirator has been in use for generations to protect against dust it has not proved satisfactory because it is uncomfortable to wear and the filtering medium clogs rapidly with dust and exhaled moisture, which greatly increase resistance to air flow and impose extra and often excessive effort in breathing. Some of the discomforts may become pronounced, such as the pressure at the edge in contact with the face; the heat caused by the face cover; the warm humid, exhaled air contact with the face; rebreathing the trapped exhaled air; and prevention of cooling by evaporation and radiation. Some respirators fit the face so poorly that much of the air is inhaled through openings between the face and respirator without removing the dust. One reason that respirators have not proved successful is that workmen will not wear them for any length of time, probably because of the discomforts." *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis*. D. Harrington and S.J. Davenport. *U.S. Bureau of Mines. Bulletin 400*. 1937. pp. 123-124.

"In 1926 the United States Bureau of Mines summarized the results of an investigation of the construction and filtering efficiency of dust respirators as follows:

...

2. The efficiencies against silica dust floated in air range from about 9 to 70 percent for the dust respirators,...
3. As the dust most injurious to miners, stoneworkers, and many others engaged in dusty trades is about 1 micron in diameter the respirators, if worn, can prevent a considerable amount of dust, but not all of it, from being inhaled.
6. The discomfort caused by respirators covering the face - the heat engendered thereby, the irritation of the skin at contact with the respirators, and the resistance to the flow of the air breathed - are the most serious disadvantages of respirators.
20. Although the use of respirators should be encouraged among workers in dusty trades, a respirator cannot be considered a final safeguard. In mining and in other industries effort to

prevent the formation of dust and its distribution by the air by the use of hollow drill steel and water and by sprays on the undercutting machines should be continued ” *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 124-125.*

“Drinker points out that all mechanical filter-type or dust respirators are poor substitutes for dust control and that supplying workmen with air line or dust respirators instead of installing proper dust-control equipment is poor economy, although respirators have a place in industry and are an important aid in preventing inhalation of dust. He believes that the time is not far off when courts and compensation boards ‘will make short shrift of the employer who lets his men work in dense clouds of dust regardless of what the dust is’ and suggests that the employer try some of the dust jobs himself, wear the men’s respirators, and then decide whether or not it would be better to install dust-control equipment instead of respirators.” *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 126.*

“ RESPIRATORS, GAS MASKS, AND BREATHING APPARATUS

Most of these devices cannot be relied upon to give complete protection from hazards of long duration and they are essentially supplementary to other control measures. In spite of the fact that constant supervision is required wherever such devices are used and although they are not in all cases satisfactory, there is nevertheless a definite field for respirators, mainly in situations where exposure is intermittent and the hazard, though definite, is not of a severe type.” *Industrial Hygiene: A Handbook of Hygiene and Toxicology for Engineers and Plant Managers. Chenoweth and Machle. 1938. pp. 179-188*

“Respirators, the reports states, should not be considered part of the workman’s own apparel but should be provided by the employer. Nor does the employer’s duty stop there. He must see that respirators are distributed to all who need them and workmen ‘must be educated in their proper use - a difficult task which is accomplished only by incessant instruction’.

Only too frequently good respirators are purchased, distributed carefully, and then forgotten. In a short time they are very dirty and function ineffectively, if at all. The worker will object to wearing a dirty or unsightly respirator. A defective respirator is worse than none because the wearer is given a false sense of security, and will not take the precaution which he would take if he had no respirator.” *New Bulletins Describe Hygienic Measures. National Safety News, May, 1938.*

“Workers should be instructed in the use of and the necessity of using the personal protective equipment, and employers should take steps to require the employees to use such equipment. Masks and respirators should not be used in lieu of exhaust ventilation or other methods for controlling dust, gas, fume, vapor, or mist hazards.” *Basic Principles of Industrial Sanitation. Dallavalle, J.M. and Jones, R.R. American Journal of Public Health, Vol. 30, 1940, pp. 369-384*

“Respirators, especially the facepieces, should be cleaned at the end of each day in which they are used and sterilized at least once (preferably twice) each week if the same respirator is issued to the same person each day, and always before they are given to another person to wear. It is good practice to insist that everyone that works in or enters a department where respirators are generally required also wear a respirator. This should include foremen, supervisors, and even visitors.” *Protecting Plant Manpower. Practical Points on Industrial Sanitation and Hygiene. U.S. Department of Labor. Special Bulletin No. 3. 1941. p. 27-43.*

“In no instance should respirators be employed as a substitute for other more satisfactory methods of control of air contamination. It is the duty of management to decide whether respirators are needed. In no instance should they be selected as the control measure merely because they cost less than other appropriate control systems. If, after all the pertinent factors have been considered, it is concluded that respirators are needed, good respirators of the proper type should be purchased; they should be given to the workers with adequate instruction as regards the need for and proper wearing thereof, and a satisfactory system of maintenance should be set up.” *Engineering Control Of Air Contamination Of The Working Environment, Allen D. Brandt, p 210. 1943.*

“The following considerations must control the selection of respiratory equipment:

1. The process and conditions that create the actual or potential exposure.
2. The chemical, physical, toxicological, or hazardous properties of the substances from which protection is required.
3. The nature of the duties to be performed by the person who wears the equipment and the permitted encumbrance or restrictions to movement in the working environment.
4. An understanding of the principles of the protection, the general design, scope of use, advantages, and limitations of available kinds of equipment for respiratory protection.
5. An understanding of the degree of hazard, actual or potential, in which the equipment is to be used, especially whether the conditions are of a non-emergency or emergency nature.
6. Whether the protective equipment has Bureau of Mines' approval.
7. A consideration of the intelligence and experience of the persons who will wear the equipment.
- 8 The facilities for maintenance, upkeep and supervision of use.” *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. p. 319. 1943.*

“The abomination of most supervisors is the filter respirator. The order is given that the men must wear respirators and then the trouble begins. The first thing most workers do with a respirator is to take it off. And the obvious course for the supervisor appears to be an eventual indifference.” *Industrial Dust Control. Cook W.A. The Industrial Supervisor. October, 1944. p. 14.*

“Proper use, care, and maintenance require a thorough knowledge of the device and should be performed by, or at least under the supervision of, a responsible and capable person. All respirators should be inspected periodically whether used or not and should be serviced completely after each use.

When a respirator is given to a worker, he should be told why he needs to wear it, he should be shown how to wear it, he should be told what provisions are in effect to clean the respirator daily and to insure that he will always get the same device. All respirators used routinely should be collected at a central point at the end of each shift for cleaning. Clean cabinets are needed at convenient locations for storing respirators while not in use, for example, during the lunch period." *Industrial Health Engineering, Allen D. Brandt, p 276, 1947.*

"For pneumoconiosis-producing and nuisance dusts, air-line respirators, pneumoconiosis-producing and nuisance-dust respirators, or all-dust respirators could be chosen. If the dust concentration is exceedingly high, air-line respirators would be preferable." *Industrial Health Engineering, Allen D. Brandt, p 275, 1947.*

"Respiratory protective devices are used to support other methods of control and are more frequently used as an emergency measure.

To say that they are comfortable is stretching the imagination, and where control by other means is feasible, control by personal respiratory protection is not the method of choice. Rather, mechanical-filter respirators are to be considered as either temporary or last-resort measures; *Industrial Hygiene and Toxicology, Frank A. Patty, p 456, 459. 1948.*

"In the selection of a respirator careful consideration should be given the chemical, physical, and toxicological properties of the contaminating material; possible secondary or by-products that may occur; whether the exposure is immediately dangerous, or whether injuries might arise only after prolonged exposure; the nature and amount of work to be done by persons wearing devices; whether the exposure will be brief or prolonged; whether sufficient consideration has been given to other possible control measures. The person making the selection should know the principles, design, scope, use, limitations, advantages, and disadvantages of the respiratory protective equipment available.

It is essential that the provision of respirators be under competent supervision; and that not only the correct respirator be provided, but that it be clean, sterilized, and maintained in good condition, and that the wearer be properly instructed in its purpose, use, and care." *Industrial Hygiene and Toxicology, Frank A. Patty, p 463-465. 1948.*

"Respiratory protective devices are commercially available. Their use, however, should be confined to emergency or intermittent exposures and not relied upon as primary means of hazard control." *Asbestos. American Industrial Hygiene Association Journal, April, 1958. pp 161-162*

"Respirators. The choice of a respirator, its use and care may be supervised by the industrial physician or nurse but often these activities are performed by a layman. Too often a respirator represents false security.

The fit of the respirator is extremely important, especially the half mask type. Facial contours vary and therefore the best face fit will not be obtained unless individual fitting is done. The so-called universal fit fails to make allowance for the narrow face or for one who must wear prescription glasses. Frequently the wearer is not aware of leakage around the mouth or edges of the facepiece. There are several methods for testing the efficiency of the facepiece.

At the end of each work day, all respirators in use should be turned in to a person, or persons, charged with their maintenance. They should be scrubbed with soap and water and stored in a clean place. The filter must be cleaned or renewed. All such equipment should be inspected regularly for defects.

Finally, all persons concerned with the selection, fit, use, and care of respiratory protective devices should have indoctrination followed by periodic training courses. At this writing, a Joint AIHA-ACGIH Committee on Respiratory Protective Equipment is preparing a technical manual on this subject." *Johnstone and Seward, Occupational Diseases and Industrial Medicine, W.B. Saunders Company, Philadelphia, pp. 245-247, 1960.*

"Face masks, respirators, helmets or other protective devices have a limited value, and their use should be mainly restricted to emergencies." *The Pneumoconioses. Lanza, A.J., New York: Grune and Stratton. 1963. pp. 127-128.*

"Respiration filters often clog after an hours work removing insulation." *Marr, W.T., Asbestos exposure during naval vessel overhaul. J. Ind. Hyg. 25: 264-268, 1964.*

K. Warnings and Labeling

"It cannot be assumed that workmen in our American factories are so unintelligent as to wish to ignore dangers about which they have been fully informed. Rather they, like the rest of us, are apt to scoff at occasional warnings, preferring to doubt the danger exists. It is essential, then, that management should know the truth first of all. Supervisors should be told the whole story, and workmen severally and individually, in season and out of season, week in and week out, should be educated, warned, and even cajoled into full observance of the rules." *Dust in Industry. Federick Willson. American Society of Mechanical Engineering Journal. Vol. 55. 1933. pp. 80-82.*

"The vital factor concerning toxic materials is to intelligently safeguard the public. People may feel safer in buying materials whose danger they know rather than materials unknown to them. Each manufacturer can ably cope with the toxic material situation by constantly safeguarding the public through the products he manufactures and by the repetition of instructions to salesmen, service men and others who can intelligently instruct the consumer of the advantage of providing adequate ventilation and of maintaining personal hygiene.

Manufacturing Chemists' Association Legal Principles

1. A manufacturer who puts out a dangerous article or substance without accompanying it with a warning as to its dangerous properties is ordinarily liable for any damage which results from such failure to warn.
2. A manufacturer or dealer who erroneously labels a dangerous drug with the name of a harmless substance is liable for any injury which may be caused thereby.
3. Failure to comply with a statute, e.g., with respect to labeling poisons, is usually held to be negligence per se or at least evidence of negligence.
4. The name of the product alone may be sufficient warning, if its nature is very widely known or its sale is restricted to those who are presumed to know its nature, but even in such cases the advisability of a specific warning is indicated.

5. Technical accuracy may not be sufficient protection for the manufacturer if he uses words which may give the purchaser the impression that his product is not what it actually is.
6. A nonwarranty of results is not a warning against possible dangerous results.
7. The consumer is entitled to rely on positive representations or directions appearing on the label unless he knows them to be incorrect.
8. The manufacturer is ordinarily not liable if his product is put to a use for which it is not intended and an injury results which could not reasonably have been foreseen. It is often difficult, however, to know whether a particular result should have been foreseen, and the courts are apt to differ on this point.
9. The manufacturer or one who holds himself out to be the manufacturer must know the qualities of his product and he cannot escape liability on the ground that he did not know it to be dangerous.
10. The general rule that a manufacturer is not liable to those not in privity of contract with him does not apply when his product is imminently or inherently dangerous."

National Paint, Varnish and Lacquer Association, Inc. 1939.

"The keeping of records and posting of notices must be regarded as much a part of industrial hygiene as many of the requirements previously listed. Not only do records measure progress in the control of specific hazards, but also if such items as labor turnover, injuries received, or illnesses treated, to mention a few are available for analysis, they may often reveal significant facts pertaining to unsuspected hazards. Posters when properly prepared and displayed are valuable adjuncts for the education of employees in matters of personal hygiene and accident prevention.

Posting Notices

1. Every industrial establishment should provide one or more bulletin boards for posting notices located so as to attract the attention of every employee at some time during the working day.
2. All employees should be instructed in the hazards to the work engaged in, both with regard to the individual and fellow workers. Workers who are transferred to other unaccustomed work should be instructed as to the hazards incidental to the new occupation.
3. The employer should place warning signs and instruct all employees who are required to work where industrial poisons of a hazardous nature are used, stored, or carried, regarding the danger connected with them." *Basic Principles of Industrial Sanitation. Dallavalle, J.M. and Jones, R.R. American Journal of Public Health, Vol. 30, 1940, pp. 369-384*

"From a humanitarian point of view, no company can afford to subject its' employees to an unknown hazard. From a cold business point of view, no company can afford to jeopardize its own existence by subjecting itself to the liability of unknown hazards that may be encountered by those to whom it supplies the material." *Draft of Interim Report by E.C. Ames, 1941. From D.S. Egilman MD, MPH.*

"Controls of processes by enclosures or by exhaust systems should be accompanied by informative warning posters. The company doctor should examine all workers in possible exposures regularly." *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. pp. 116-*

117. 1943.

"The education of employees regarding chemical hazards is, and must remain, the direct responsibility of their employers. However, such hazards are not confined to employees alone, and information concerning them should, so far as practicable, reach every person using, transporting, or storing chemicals. The most practical means for the seller to disseminate this information appears to be by labels affixed to containers of hazardous chemicals, bearing appropriate precautionary statements and instructions stated as simply and briefly as circumstances permit.

A precautionary label does not take the place of safety equipment such as suitable goggles, airline respirators, gas masks, clothing, shoes, etc.

VI. Harmful Dusts

CAUTION: HARMFUL DUST

Avoid repeated breathing or skin contact

Wash thoroughly before eating or smoking

Keep away from feed or food products"

Manual from Manufacturing Chemists' Association., 1946.

"ACGIH Resolves to Aid in Labeling Dangerous Substances

RESOLUTION-Adopted by the American Conference of Governmental Industrial Hygienists at its annual meeting, April 22, 1952, Cincinnati, Ohio.

Whereas, the content, dangers and protective measures necessary for the handling of potentially dangerous substances is not limited by geographic areas, and

Whereas, the appropriate label on such substances can help to preserve and protect the public health; and

Whereas, the storage, transportation and use of these substances may need specific precautions for the protection of the public; and

Whereas, in the past the U.S. Public Health Service and the Manufacturing Chemists' Association have cooperated towards this end;

Now, therefore, be it resolved, that the American Conference of Governmental Industrial Hygienists approve the following principles:

- (1) That adequate labels for warning and identification of harmful substances are necessary for the prevention and control of a public health problem,
- (2) That requirements for adequate warning labels should be as uniform as possible, and
- (3) That the American Conference of Governmental Industrial Hygienists work together with other official and non-official groups as well as with the Manufacturing Chemists' Association toward the development of an adequate uniform guide for the labeling of potentially harmful substances.

And be it further resolved, that the Executive Committee assign to the Chairman of one or more appropriate standing committees the responsibility for immediate action to implement these principles." *Industrial Hygiene Newsletter*, April 1952.

"The workmen should be instructed in the signs of the poisoning or other injury that may be expected and in the importance of consulting with the plant physician when suspicious signs appear. They should be taught the precautions that should be taken to avoid poisoning or other injury. Warning placards should be used to supplement other instructions." *Municipal And Rural Sanitation. V.M. Ehlers. McGraw-Hill Book Co. 1965. pp.506.*

IV. The Use of Exposure Limits in the Practice of Industrial Hygiene

Occupational exposure guidelines (including TLV's) for toxic agents such as asbestos are *not now, nor ever were*, fine lines between safe and dangerous concentrations nor are they a relative index of toxicity. Industrial hygienists and the medical community began to establish thresholds or permissible dust concentrations for dusty processes in the early 1900's (*Higgins, E. et al., Siliceous dust in relation to pulmonary disease among miners in the Joplin District, Missouri, U.S. Bur. Mines Bull. 132, 1917*) (*Mavrogordato, A.: Contributions to the study of miners' phthisis, Publ. S. African Inst. Med. Res., Johannesburg, 1926*). From their inception, these threshold levels for dusts and other toxic materials were intended as guides for the routine industrial hygiene control of health hazards.

"It is to be emphasized that the intent in presenting these maximum allowable concentrations is to provide a handy yardstick to be used as guidance for the routine industrial control of these health hazards-not that compliance with the figures listed would guarantee protection against ill health on the part of exposed workers, nor should the maintenance of the suggested concentrations be considered a substitute for medical control." *Cook, W.A., Maximum Allowable Concentrations of Industrial Atmospheric Contaminants, Industrial Medicine, 14: 926-947, 1945.*

It should be noted also that part of the NCGIH's (later ACGIH) MAC's were compiled from the above mentioned reference (*Cook, W.A., Maximum Allowable Concentrations of Industrial Atmospheric Contaminants, Industrial Medicine, 14: 926-947, 1945*). The mere fact that NCGIH published these values from Cook's list as MAC's does not change the interpretation of the values as described above. A review of the literature makes it clear that early industrial hygienists and doctors interpreted these limits as suggestions or guides, and they were not so naive as to think that these limits represented an absolute safe level of exposure to all workers in all occupations.

"It is only with a few poisons, those known for many years, that we have experience enough to fix the 'allowable concentration' or 'toxic limits', that is, the concentration which may be inhaled by men over a long period without damage. But even for such poisons the figures are not yet exact. The inestimable value of such data, if they are exact, for working out means of prevention and elimination of damaging amounts of poisons has induced men to set up tables of such allowable limits. Provided they are used with caution and with an awareness of their unreliability, they can be very useful, especially if a safety coefficient is taken into account. But such tables are certainly out of place in rules and regulations (California, Connecticut, Oregon).

It should not be forgotten, however, that with every test we get only, as it were, a snapshot, and we do not know what happens before and after. We need therefore to have those tests repeated. In addition, we need a control to indicate whether the contamination of the air is permanently below the allowable limit in all sections of the workshop and how the workers react to it. The concentration of the air, changing often and differing very much, permanently influences the health of the worker and is in most cases to be recognized on examination of the workers.

Therefore a combination of the old method - regular periodical examination of the workers by a reliable physician - with the most modern method developed first by Americans - chemical analysis of the air, repeated in regular periods by a reliable chemist - may afford the best protection. This combination gradually will give us also the correct figures for 'toxic limits'." *History of Factory and Mine Hygiene. Teleky, L., Columbia University Press. New York: Morningside Heights. 1948. pp.29, 138-139.*

"A number of these values are soundly founded on a combination of animal experimentation and experience with workers under actual industrial conditions. Others of these values have a basis only in animal experimentation, some of which is so limited as merely to give an indication of the approximate concentrations which should be permitted. Still others of these values are based on judgment which has its foundation in sensory response of persons to known concentrations of the atmospheric contaminant or in human experience under occupational conditions of insufficient extent to be truly significant.

The final column of accepted and tentative values is offered with the hope that further work both in the experimental laboratory and under industrial conditions may be stimulated. Only through further correlated activity of this type can we arrive at more complete dependable information on these maximum allowable concentrations. It is advised that there be medical observation of workers whose exposure to an atmospheric contaminant may be close to the allowable concentration especially where it may be one of those values based on such limited data as to be of questionable reliability." *Maximum Allowable Concentrations of Industrial Atmospheric Contaminants, Industrial Medicine, 14: 926-947, 1945.*

"Dr Sterner has discussed the great difficulties attendant on developing adequate data for threshold limits, the many imponderables in their interpretation, and their unsatisfactory and necessarily always incomplete nature. All these considerations should certainly be thoughtfully considered and strongly stressed, because errors in judgement cannot be afforded." *Stokinger, H.E., Industrial Hygiene Quarterly, pp. 284-286, Sept. 1956.*

"such standards may be of value in estimating the relative efficiency of the methods used for suppressing dust in a single industry, but it would be wrong to adopt any of these standards as a measure of safety under different conditions and in other industries." *Home Office (British): Memorandum on the industrial diseases of silicosis and asbestosis, H.M. Stationary Office, London, 1935.*

"It is as yet impossible to determine, even for a specific industry under unchanging conditions, at what concentrations workers will invariably begin to develop cases of lead poisoning, silicosis, fever, etc." 1021 *Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational*

Hazards Inc. Publishers of Occupational Hazards Monthly Magazine. 1943. p. 40.

"Hatch emphasizes, however, that present-day standards of safety are only estimated values and reduction in dust exposure below the estimated threshold value does not give absolute assurance of complete control of the disease. Moreover, a potential hazard always exists in basically dusty industries, and a constant guard therefore must be maintained. Routine determination of dust concentrations provides a measure of operation of the dust-control system, but the efficacy of the control program must be measured by periodic medical examination, since only by this means can the presence or absence of silicosis be determined.

As no definite, absolutely reliable standards of allowable dustiness are known, obviously the aim in the prevention of dust diseases should be elimination of all dusty in the atmosphere where people work." *Review Of The Literature On Effects Of Breathing Dusts With Special Reference To Silicosis. D. Harrington and S.J. Davenport. U.S. Bureau of Mines. Bulletin 400. 1937. pp. 56-57.*

"Limitations in Standards of Permissible Dustiness. The idea of adopting standards of permissible dustiness for each harmful dust has a medicolegal appeal that is not at all justified by the data available today. Having had no compensation laws covering silicosis until recently, certain states are now drafting regulations defining permissible dustiness in precise figures which will not stand the most elementary analysis.

In none of the original studies was there a single suggestion that the threshold figures were useful as legal standards. In the report on the cement study (231), for example, it is emphasized that '...the variations in dustiness were so great as to make impractical an attempt to study the sickness rate in relation to dosage except in a general way.' In spite of this, there is a strong temptation to plot a curve with permissible concentrations and content of free silica as coordinates and then to interpolate or extrapolate freely from this curve to obtain the standard of dustiness for any industry. We cannot admit the soundness of this practice from a medicolegal standpoint, but, on the other hand, there is much to recommend the use of figures thus obtained as basic criteria in the design and operation of dust-control equipment and as general guides in the appraisal of working conditions. It is essential, however, to consider the limitations of these threshold values when applying them to industries not included in the original studies. Some of the limiting factors are discussed below.

2. *Dust Floods.* A plant in which dust of any kind is heaped upon rafters or a dry mine in which dust is lying about is in ideal condition for the freeing of dust floods. Undue vibration in the plant, such as occurs in starting motors and belts, or a misdirected blast of air from a hose or the exhaust of a rock drill will dislodge this dust, with the consequent development of unusually heavy dust concentrations in the neighborhood.

Referring to the effect of dust floods upon workers in quartz dust, Mavrogordato (176) writes: 'Lesions of silicosis in a mild degree can be produced in an animal by 30 hr. exposure to intense dust clouds, and one is inclined to suspect that it is intermittent exposure to relatively dense clouds that is the deciding factor in producing the disease in susceptible human subjects.' Analogous arguments apply with equal force to toxic dusts like lead and manganese.

Unfortunately, it is impossible to evaluate dust exposures medically with the arithmetic nicety that we would like. Yet it is commonly claimed-by laymen- that prolonged exposure to low

concentrations is just as serious as short exposures to heavy concentrations. This claim is contrary to a fundamental law of physiology. In discussing the subject Clark and Drinker (40) remark that '...a sub-threshold stimulus (dust inhalation) for a long time produces no reaction whereas a relatively brief super-threshold stimulus may cause a reaction.' There is little excuse for dust floods since they can usually be prevented by ordinary methods of good housekeeping. If workers are to be exposed, however, to sudden heavy concentrations, we believe that the threshold values suggested previously will be seriously weakened." *Industrial Dust, Drinker and Hatch, pp.72-78, 1936.*

"To engineers engaged in industrial hygiene, threshold limits provide the reference line or bench mark upon which all considerations and calculations for control of air contamination are based." *Engineering and Chemical Application of Standards. Brandt A.D., American Industrial Hygiene Quarterly. 17: 286. 1956.*

"Adequate data have not yet been published to justify the determination of threshold limits for dustiness which will produce asbestosis in any definite period of time. In the absence of such threshold values it is not possible to determine permissible limits of dustiness on a medical basis. Nevertheless, any appreciable decrease in the amount of asbestosis dust will cause a decrease in the incidence and severity of the resulting asbestosis." *A Study Of Dust Control Methods In An Asbestos Fabricating Plant. Page and Bloomfield. Public Health Report, Vol. 52, No. 48, 1937. pp. 1713-1727.*

"While in our efforts to establish protection of the health of industrial workers we have set up certain standards concerning atmospheric dust concentrations, these are of a general nature rather than specific, and may have given a false sense of security." *Pathology of Asbestos. K.M. Lynch. Arch. Ind. Health, 11: 185-188, 1955.*

"Obviously, and by its very definition, the threshold value is a difficult quantity to establish. What may appear to be a safe working concentration now may later on be shown to be hazardous. On the other hand, some values may be needlessly low and may pose a burden on management that is wholly unnecessary.

It is apparent therefore that the evaluation of working conditions, so far as toxic contaminants are concerned, should be based upon most careful and conscientious investigation. This point requires emphasis because all too frequently insufficient care has been used in determining environmental working conditions in industry.

In summarizing, I would like to point out (1) that threshold limit values should be used only as guides in an evaluation of the working environment; (2) that appraisal of the working environment, so far as toxic aerial contaminants are concerned, requires special care; and (3) that present threshold limit values are subject to change and therefore should not be considered as fixed standards." *The Limitation of Exposure to Noxious Gases and Fumes in Industry. L. Fairhall. Industrial Hygiene News Letter. Volume 10, Number 1. January 1950. pp. 3-5.*

"It must be emphasized that these limits in the great majority of instances are only *suggested maximum working levels* since they are estimates based in many cases upon incomplete environmental and medical studies. The values are not fixed, but are subject to revision, upward or downward, with the development of new information. There is by no means complete agreement regarding these values among responsible industrial hygienists.

In applying these guide limits, the following factors must be considered:

1. The duration of exposure is 8 hr a day for 5 or 6 days a week.
2. The measurements are indicative of the concentration in the breathing zone of the exposed person.
3. The M.A.C. is usually accepted as the average exposure value when the upper limits do not greatly exceed the M.A.C. value. For example, it cannot be assumed that if 100 ppm is considered *safe* for 8-hour exposure, that 800 ppm for one hour will be permissible.
4. Two substances with similar M.A.C. values may be quite different as to physiological effects at other concentrations.
5. These values are *upper* limits; it is desirable to operate well below the levels if the engineering and economic factors permit. The prudent engineer will incorporate a reasonable margin of safety in his estimates of ventilation capacity." *Heating Ventilating Air Conditioning Guide 1957. Published Annually By The American Society Of Heating And Air-Conditioning Engineers, Inc. 62 Worth St. New York 13, NY. pp. 151-167.*

"Levels set for industrial practice have been variously labeled as threshold limits, maximum safe concentration, maximum allowable concentration, toxic limit, maximum permissible concentration, and maximum safe practice. What is, of course, the most desired value is the maximum concentration to which an individual may be exposed throughout his or her working day, for an indefinite period of time, without suffering any ill effects. Unfortunately this has been established satisfactorily for extremely few single substances.

With very few exceptions all of our so-called "safe" limits are educated guesses. At their best they are estimates rather than actual safe limits. We should call them hygienic standards, recommended good practice, tentative threshold limits, or suggested maximum concentration standards until we learn through experience, or research, the true maximum safe limit, and then, if necessary, change our standards accordingly." *Industrial Hygiene and Toxicology, Patty, F.A., Second Edition, Volume I, 1958. pp. 163-164.*

Once asbestos was recognized as a hazardous agent, a guideline for excess asbestos exposure was explored in an attempt to protect workers. The first value for the asbestos guideline for dust control arose by analogy to silica (*Brown, V. Discussion. In The Pneumoconiosis, edited by A. Vorwald, p. 569. Paul B Hoeber, New York, 1950).*

The silica guideline was based on engineering feasibility, not on the prevention of adverse health effects (*Higgins, E. et al., Siliceous dust in relation to pulmonary disease among miners in the Joplin District, Missouri, U.S. Bur. Mines Bull. 132, 1917).* The adequacy of the proposed asbestos guidelines was first challenged in 1935 (*Clark and Drinker, Industrial Medicine, pp. 145-146. National Medical Book Company, New York, 1935).* Clark and Drinker indicated that the safe exposure limit for asbestos was not known, but that Metropolitan Life "prefers to see the

dust count below 5 million (ppcf) and welcomes still lower figures." Clark and Drinker went on to say, in this same publication : "The only justifiable conclusion to be drawn from such apparent inconsistencies is that generally we lack data for defining rigidly permissible dustiness. The application of medical and engineering knowledge and common sense to dust control is highly commendable but the point has not been reached where a manufacturer can be told with certainty that his plant will have no silicosis, no asbestosis, or no lead poisoning if he keeps dustiness down to some definite figure. He can be told only that the maintenance of certain degrees of air cleanliness represents the best present practice. ... a sub-threshold stimulus for a long time produces no reaction whereas a relatively brief super threshold stimulus may cause a reaction. It is not enough to find that the average dust concentration is below a desired figure: occasional exposure to excessive dustiness should be avoided." (*Clark and Drinker, Industrial Medicine*, pp. 149-150. *National Medical Book Company, New York, 1935*).

Unaware of the unpublished Metropolitan Life data, in 1938 the U.S. Public Health Service proposed a **tentative** Maximum Allowable Concentration for asbestos of five million particles per cubic foot (5 mppcf) (*Dreessen, W.C., et al., A study of asbestosis in the asbestos textile industry. Public Health Bulletin, No. 241, 1938*). One of the authors of this study recognized the inadequacy of the proposed guideline in a second 1938 publication (*Sayers, R.R., and Lanza, A.J., Etiology, symptoms, diagnosis of silicosis and asbestosis. In Silicosis and Asbestosis, edited by A.J. Lanza, p. 60. Oxford University Press, New York, 1938*).

In 1942, NCGIH (later ACGIH) began to develop a list of proposed guidelines for chemical substances, including asbestos. Without any review of research or data, the Subcommittee on Threshold Limits of NCGIH presented a table of "Maximum Permissible Concentrations" for various atmospheric contaminants. "The table was prepared from lists furnished by the various State units. It is not necessarily complete because some States did not reply. Others indicated that they used a list furnished by the U.S. Public Health Service. Inquiry revealed that the U.S. Public Health service now considers that list not 'applicable in the light of present knowledge'. The table is not to be construed as recommended safe concentrations." (*Transactions of the Fifth Annual Meeting of the National Conference of Governmental Industrial Hygienists*). The principal source for the table was a survey of various state industrial health units. The value of 5 mppcf for asbestos had been accepted by at least seven states. Some of these states used values from a list furnished by the U.S. Public Health Service, which stated that its own values were "not applicable in light of present knowledge." The Subcommittee on Threshold Limits of NCGIH recognized the inadequacy of the "Maximum Permissible Concentrations" when they wrote, "The table is not to be construed as recommended safe concentrations." (*NCGIH. Transactions of the Fifth Annual Meeting of the National Conference of Governmental Industrial Hygienists. Cincinnati, 1942*).

In discussing the level of protection provided by their guidelines, Manfred Bowditch said this at the 1943 NCGIH meeting: "What you mean by toxic seems to me relatively unimportant to the discussion. We don't talk about toxic limits in our standard. We simply say that there are maximum allowable concentrations. We don't even say why they are maximum or why they are allowable." (*NCGIH. Transactions of the Sixth Annual Meeting of the National Conference of*

Governmental Industrial Hygienists. Cincinnati, 1943).

The 1948 Report of the committee on threshold limits states the following: "It must be borne in mind that these values are not indices of toxicity and are not intended to approach that value. Accordingly, the comparative toxicity of these compounds cannot be established on the basis of their numerical maximum allowable concentration value. People vary greatly in response to drugs and toxic substances. Therefore, it is a figment of the imagination to think that we can set down a precise limit below which there is complete safety and immediately above which there may be a high percentage of cases of poisoning among those exposed."

The first proposed preface for the MAC values appeared in 1953. *"Values are given in the following tables for the maximum average atmospheric concentration of contaminants to which workers may be exposed for an eight-hour working day without injury to health. These values are based on the best available information from industrial experience, from experimental studies and, when possible, from the combination of both. They are not fixed values, but are reviewed annually by the Committee on Threshold Limits for changes, revisions or additions as further information becomes available. Threshold limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations. They represent conditions only within which it is felt that workers may be repeatedly exposed, day after day, without adversely affecting their health. It is felt, at the present time, that workers should not be exposed to a working environment containing any of these substances in excess of the value indicated."*

In 1954 a statement pertaining to air pollution was added to the preface to the MAC values. "These values are not intended for use, or for modification for use, in the evaluation or control of community air pollution or air pollution nuisances."

Although the asbestos guideline was adopted in 1946, the first documentation concerning the guideline was not produced until 1961. In that documentation, ACGIH recognized that the guideline measured the wrong thing. "While chemical analysis of collected samples of airborne dust correspond to those of settled dust samples, it is believed that dust counts of particulates by conventional methods can be expected to give only an indirect measure of the risk of asbestosis because of the great relative importance of long fibers." (*ACGIH. Transactions of the Twenty-Third Annual Meeting of the American Conference of Governmental Industrial Hygienists. Cincinnati, 1961*).

"The ACGIH itself, as late as 1958, adopted a resolution condemning laws equating concentrations above the recommended TLV as *prima facie* evidence of a serious health hazard. In effect, the ACGIH itself repudiated the notion that its own threshold limit values could be used as "standards":

'The American Conference of Governmental Industrial Hygienists condemns the improper and dangerous misuse of the threshold limit or MAC list or a similar list by incorporation in any code, law, rule or regulation as a sole criteria of a health hazard.'

Nowinski, P.A., Chronology of asbestos regulation in United States workplaces. In Asbestos-Regulated Malignancy, edited by K. Antman and J. Aisner, p. 114. Grune and Stratton, Inc.

1987.

The asbestos guideline had been criticized by Patty on the basis of fiber size in 1958. "Allowable concentrations. Dreessen, DallaValle, Edwards, Miller, and Sayers have found evidence to indicate that 5 million particles per cubic foot of air is a satisfactory figure for the maximum atmospheric concentration of asbestos to which workers may be exposed. However, in setting up this figure, only fibers less than 10 μ in length were counted and the longer ones were disregarded. It now appears that the shorter fibers may have to be disregarded and permissible concentrations of long fibers established, which has not been done." Patty, F.A. (ed.) *Industrial Hygiene and Toxicology*, 2nd Rev. Ed., p.399. Interscience Publishers, New York, 1958.

In 1964, Lynn Schall, Chairman of ACGIH in 1963, emphasized major shortcomings in the scientific basis for the asbestos guideline (Schall, L., *Present threshold limit value in the U.S.A. for asbestos dust: A critique. Ann. N.Y Acad. Sci.* 132: 316-321, 1965). In this critique Schall said "It is important to stress that the five mppcf value is based upon dust counts of all particles, fibrous and particulate, asbestos or not. Therefore, it cannot be presumed to represent a safe limit of asbestos in all applications. Finally, note should be made that Dreessen and his colleagues regarded the figure they gave of 5 mppcf as simply a working figure for that time. On the basis of their studies, they concluded that '5 million particles per cubic foot may be regarded tentatively as the threshold value for asbestos-dust exposure until better data are available'"

In 1968, ACGIH said this about their 5 mppcf TLV for asbestos: "A conference on the biological effects of asbestos in 1965 called attention to the very real probability that the 5 mppcf limit recommended by Dreessen is inadequate to give complete working-life-time protection against all forms of asbestos. Medical data on which the limits had been based were inadequate; more than half of the asbestos workers studied were under 30 years of age and thus provided an insufficient exposure time for asbestosis to develop. Of the 105 workers exposed to < 5 mppcf, 82 had worked < 5 years; 101, < 10 years; only 4 had > 10 years exposure. Seven of 36 workers exposed to 5-9.9 years had asbestosis; 3 of 50 workers exposed to 10-19.9 mppcf for < 5 years had asbestosis. Moreover, it was a "point-in-time" study; many of the ill were missing and the dead uncounted, hence not considered in the over-all evaluation of the limit."

Other limitations of the asbestos TLV related to insulation workers. "In view of the varied character of the environmental dust exposure in the pipe covering industry on naval vessels, it is manifestly impossible to set a threshold." Fleischer, W., et. al., *A health survey of pipe covering operations in constructing naval vessels. J. Ind. Hyg. Toxicol.* 28: 525-539, 1946.

A study by Marr in 1964 also indicated that the asbestos TLV was not applicable to insulation work. "Dust counts, taken with the Bausch and Lomb Dust Counter, appear in Table 1. The low counts on sampling do not appear to give a adequate indication of the actual hazard. During sawing of blocks and pipe sections and removal of old insulation, the work environment appears extremely dusty. Respiration filters often clog after an hours work removing insulation." Marr, W.T., *Asbestos exposure during naval vessel overhaul. J. Ind. Hyg.* 25: 264-268, 1964.

In 1968, Balzer also demonstrated that insulation work routinely exceeded the asbestos guideline. “Anyone looking at the present basis for the threshold limit value (TLV) of 5 mppcf as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) in 1946 realizes that it is no based on solid evidence.” *Balzer, J.L. Industrial hygiene for insulation workers. J. Occup. Med. 10: 25-31, 1968.*

As the above discussion points out, there was a lot of skepticism concerning the validity of the asbestos guideline. An attorney for Johns-Manville, Vandiver Brown, questioned the validity of the asbestos guideline. “Maximum limits are prescribed for a great variety of materials with which I have no familiarity, but it is my earnest hope that these limits have been arrived at on the basis of a better factual and scientific background than exists in the case of asbestos. The allowable limit for industries using this material is a “mandatory” requirement of not more than five million particles per cubic foot, 10 microns or less in longest dimension. So far as I have ever been able to ascertain, no one can state with certainty what is the maximum allowable limit for asbestos dust.” *Brown, V. Discussion. In The pneumoconiosis, edited by A. Vorwald, p. 569. Paul B. Hoeber, New York, 1950.*

In response to the uncertainty surrounding the asbestos guideline, some asbestos companies adjusted downward their internal guideline for asbestos-containing dust. In 1954, Johns-Manville recognized that the pathogenesis of asbestos-induced disease emanated from the fibrous component of the asbestos and they established an internal guideline of one million asbestos fibers per cubic foot (*Johns-Manville Corporation. Answers to interrogatories. Reprinted in Stockholders and Creditors News Re. Johns-Manville Corp., et al., Andrews Publications, Edgemont, Penn., January 22, 1990.*

The final point regarding the asbestos guideline is that it was not intended to protect against the carcinogenic effects of asbestos. In a 1954 paper by Mayers, he identified asbestos as a probable carcinogen and stated, “the maintenance in a factory workroom of Maximum Allowable Concentrations will not necessarily insure safe working conditions if a potential carcinogen happens to be present.” *Mayers, M. Industrial cancer of the lungs. Compens. Med. 4: 11-18, 1952.*

At the 1955 Industrial Health Conference, Cook presented a paper in which he identified asbestos as one of three known carcinogens (“known cancerigenicity of arsenic, chromates and asbestos”). He said, “Quoting in part from a private communication from Oettel whose publications on “MAK’s” include a well-considered presentation of the general subject: “We suggest that consideration be given to indicating the suspected cancerigens with an asterisk with reference to a footnote that the hazard exists and consequently especially effective control measures be instituted. No man can say today which concentration of the several industrial substances is actually required to be cancerigenic...” *Warren A. Cook, Symposium on Threshold Limits, Present Trends in MAC’s, Industrial Health Conference, April 26, 195; Published in Industrial Hygiene Quarterly, AIHA, Vol.1, 1956.*

“There is still one group of substances for which some method should be devised for establishing safe air standards-the industrial cancerigens. How shall we establish the limits for this type of substance? Thus far the question has been sidestepped completely. As a suggested method of approach, the following is offered: To the level judged safe for other types of systemic injury add a safety factor for carcinogenicity. The magnitude of the safety factor is suggested to be from 100 to 500.” *Herbert E. Stokinger, Industrial Hygiene Quarterly, pp.284-286, Sept. 1956.*

V. Community Exposure to Toxic Materials Including Asbestos

The fact that air pollution or toxic agents brought home from industrial processes could present health hazards to the general public has been recognized for centuries (Ramazzini 1773. In *Asbestos: Medical and Legal Aspects*, Castleman, B.I., p.406, 1986). Industrial contaminants such as asbestos can come into contact with people near an industrial process through plant emission sources (vent stacks or fugitive emissions from road dust or waste piles) or through workers carrying contaminants from work into their homes.

“Dust and fume, begriming agents as they are, have therefore done something to socialize mankind, to promote health, and to advance civilization, for those nations are leading in the path of progress to-day whose workers not only require soap and water for themselves, but who, by the factory dust and smoke they create, oblige all of us to resort to similar usages.” *Mortality From Respiratory Diseases In Dusty Trades (Inorganic Dusts). F. Hoffman. U. S. Department Of Labor. Bureau Of Labor Statistics. Industrial Accidents And Hygiene Series, No. 17. 1918. p. 21.*

“In the interest of public health and for economic reasons, in certain industries, the dust and fumes extracted by the preceding methods should be collected, treated and disposed of in a suitable manner. In the case of dust which has no special value, it is usually made to pass through a tower and precipitated by means of a fine spray of water. The collection of large particles of dust is usually accomplished by means of so-called cyclone separators in which, by means of centrifugal force and cone-shaped metallic drum, the dust is deposited. In addition to these methods successful attempts have been made to precipitate dust and smoke by strong electric currents.” *Diseases of Occupations and Vocational Hygiene. Kober, G.M. and Hanson, W.C. Philadelphia. P. Blakiston's Son & Co. 1916. pp. 440-441.*

“Dr. Newhouse’s work and observations, and those of Dr. Wagner bring out a striking resemblance between accumulating data on asbestos and those on beryllium. This is brought to mind by recent observations concerning mesotheliomas, made in a sanitorium in South Africa, as reported by Wagner and his co-workers. Dr. Hardy observed berylliosis in household members of the families of beryllium workers, and subsequent studies demonstrated the release of beryllium in the laundering and handling of work clothes of beryllium workers. Similarly, Dr. Newhouse has observed mesotheliomas among the relatives in the household of asbestos workers, who had laundered their work clothes. The resemblance continues with biological effects of air pollution.

Berylliosis was observed among resident nonemployees within a certain radius of beryllium manufacturing plants in Ohio and Pennsylvania, and Drs. Newhouse and Wagner have reported mesotheliomas, and Kiviluoto pleural plaques, of residents living within a certain radius of asbestos factory and mining operations.” *Discussion. Mancuso, T. Annals of the New York Academy of Sciences 132: 589-594. 1965.*

A. Contaminants Released From Emission Sources

As early as 1929 medical authorities were commenting on “asbestos bodies” in the lungs of an asbestos factory neighbor who never went inside the plant.

“Dr. A. C. Haddow (Leeds) described the clinical aspects of asbestosis, and quoted a case in which the curious bodies were found in a man who was not employed in the industry, but who lived next door to an asbestos factory. This result was confirmed by Prof. J.M. Stewart (Leeds).” *Reviews and Notices of Books, The Lancet*, p. 231, August 3, 1931. “An article in *The Lancet* (London), July 9, 1932 (pp. 92, 93), gives a brief account of recent German reports of pulmonary asbestosis among factory workers. It is stated in the article that although before the war the German physicians had noted that there was something unusual in pneumoconiosis as seen in asbestos workers no extensive studies of such cases had been made until quite recently. In 1931, however, 8 cases occurring in 2 factories in the vicinity of Dresden were described, and shortly after 52 cases occurring in and around the same city were reported.” *Health and Industrial Hygiene. Monthly Labor Review. U.S Dept. Of Labor, Bureau of Labor Statistics. July, 1932. p. 541.*

“We have encountered “bodies” in the sputum of persons whose occupation has only entailed their occasional presence in the asbestos factory and in one instance we found them in the lungs, *post mortem*, in a man who lived close to a factory for many years but who had never been inside it.” *On the Occurrence of Clumps of Asbestosis Bodies in the Sputum of Asbestos Workers, M.J. Stewart, et. al., J. Path. Bact., Vol. XXXV., pp.737-741. 1932.*

An article in *LeDevoir*, the January 12, 1949 issue, entitled “A village of Three Thousand Suffocates in Dust”, described an epidemic of asbestosis in mine workers and residents around the mine (from D.S. Egilman MD, MPH).

“Regardless of the mechanism by which air pollution control is administered, the ultimate responsibility for limiting the release of pollutants to tolerable quantities must rest with the operators of the units from which the pollution comes.” *Air Pollution Handbook. P.L. Magill; F.R. Holden; C. Ackley. McGraw-Hill Book Company. 1956. p. 2-19.*

“As a general rule, the material collected and transported by an exhaust system yields no economic return. Nevertheless, its proper disposal is an item of considerable importance for three reasons: (1) To prevent reentrance of dust-laden air into a building thus contaminating working places, (2) to avoid public nuisances, and (3) to conserve, especially in winter, warm indoor air

for recirculation.

Unless dust-laden air collected by the exhaust system can be eliminated through a stack of considerable height, it is undesirable to exhaust directly to the atmosphere. In some States, codes prevent direct discharge. Such methods, if practiced, may with strong contrary winds cause the dust to be swept back into the plant or to adjoining buildings and cause a general nuisance." *The Determination And Control Of Industrial Dust. J.J. Bloomfield and J.M. Dalla Valle. Public Health Bulletin No. 217. April, 1935. pp. 133.*

"Immediately after taking the dust counts within the plant, the technician should take about three counts at varying distances from the plant and always in a direction counter to the prevailing wind (which should be recorded). At least one count should be taken in an admitted residential neighborhood, while the remaining counts should be taken in busier locations, one being a well-known business center relatively free from visible dust." *Dust Control. F.F. Karavath. Heating and Ventilating, June 1941. pp. 31.*

"May dust-laden air be discharged directly through stacks? No. Before such contaminated air is discharged into the free air around the plant, primary dust separators should first remove the dust particles large enough to settle out immediately. This step is necessary because such large particles released into the open air tend to fall immediately to the ground, creating an atmospheric nuisance. This procedure may also frequently permit the salvaging of useful materials.

What types of disposal or collecting systems for air-borne fumes and dusts are commonly employed? Such systems depend entirely upon the waste to be removed and the location of the plant in relation to other plant buildings or to residences. Cyclone collectors, electrical precipitators, cloth arresters, water sprays, vapor condensers, water absorption chambers, dynamic precipitators, impinger collectors, chemical neutralizers and various other forms of gravitational settling chambers are all used successfully in air contaminant disposal of one type or another, according to the waste product. Often, collected waste can be reclaimed to provide an economical gain." *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. pp. 270-271. 1943.*

"In general, collectors are used only for one or more of the following reasons:

1. To recover valuable material.
2. To eliminate or prevent a neighborhood nuisance.
3. To eliminate or prevent a health hazard.

If none of the foregoing circumstances are present, the contaminated air may be discharged to the outside at a point where it will not re-enter any building in sufficient quantity to create a nuisance or health hazard." *Industrial Health Engineering. Brandt, A.D., pp. 132-135, 1947.*

"The large scale use of arsenical dusts as pesticides and the long-continued and formerly uncontrolled release of arsenicals with waste fumes of metal ore smelters may have created potential cancer hazards in many regions. It may be wise to consider the possible existence of similar conditions for the population living near chromate factories, beryllium operations and asbestos mills.

The future control of these potential hazards depends, first, on the reliable qualitative and quantitative demonstration of carcinogenic agents in the air around establishments producing or handling recognized or suspected carcinogenic agents; second, on thorough epidemiologic studies of cancer incidence in the population living in the fume or waste disposal zone of such plants; and third, on the subsequent institution of effective measures preventing further release of carcinogenic agents into the environmental air." *Environmental Cancer Hazards Caused By Industrial Air Pollution*, W.C. Hueper. Read at the United States Technical Conference on Air Pollution, May 3 to 5, 1950.

"Increased attention is being paid to the inanimate pathogenic factors that form a small but important part of our modern industrial environment. Among these are the chemical carcinogens... Known or strongly suspected carcinogens include.....chromates, radioactive substances, and perhaps nickel carbonyl and asbestos. Where chemical carcinogens may have polluted air, water or soil, the surveys might well include the general population living in the fume or waste disposal zone. Surveys of environmental cancer require team work among plant managers, industrial physicians, the medical profession, and Federal and State health agencies." *Chemical Carcinogens*. Heller, J.R. *Industrial Hygiene Newsletter*, Volume 10, No. 7. July 1950. p. 12

"The air pollution in urban or industrial areas affords another source of widespread exposure to carcinogenic material, but the epidemiological studies have failed to establish whether exposure is significant." *Lung Cancer With Special Reference To Experimental Aspects*. Smith, W.E., *Archives of Industrial Hygiene and Occupational Medicine* 5: 209-210. 1952.

"At the International Symposium on the Endemiology of Lung Cancer held last year at Louvain, however, it was agreed that "a significant part of this increase is absolute and represents a real increase in the number of people suffering from cancer of the lung".

Factors which have been considered are (1) atmospheric pollution with (a) the waste products of domestic chimney and factory smoke, (b) the exhaust fumes of vehicles, and (c) the dust from tarred roads." *Bronchial Carcinoma: Incidence and Aetiology*, Doll, R. *British Medical Journal*, Sept. 5, 1953.

"Gone are the days when they could dump all such materials freely into the atmosphere and depend on nature for their removal or a tolerant people to endure silently. The vast extent of today's industrialization, together with the fatal London smogs and the Donora tragedy's sudden highlighting of its potential health dangers, has created a general demand for effective relief.

Engineers already have at hand a great variety of devices for cleaning exhaust and flue or stack gases. To the credit of a vast number of industrial concerns, it must be said that their voluntary installation of these devices is bringing about great improvement in many cities. Public concern over the situation is now serving notice that the few recalcitrant ones can no longer go on operating with their past callous disregard of the communities' basic right to clean air and liveable surroundings." *Air Pollution and Community Health*. C.A. Mills. The Christopher Publishing House. 1954. p. 147.

"Many segments of American industry have taken strong measures to keep their wastes out of the neighborhood atmosphere..... Statistics showed a close relation between death rates and atmospheric conditions. There was also good ground for believing that the tarry matter of smoke was at least partly responsible for the increase of cancer of the lung....

It is fair to generalize and say that there is sufficient silica, carbon, tar and sulfur dioxide in the air of most industrial areas to cause some degree of pulmonary fibrosis, to irritate the respiratory mucous membranes, and to predispose to respiratory disease." *Air Pollution and Community Health*. C.A. Mills. The Christopher Publishing House. 1954. pp. 10-17.

"Since , at least in former years, industrial asbestos effluents caused local environmental air pollution, the possibility exists that in the absence of a history of specific employment of the deceased individual, asbestosis might be observed at autopsy because of former residence near an asbestos plant. Since asbestosis, like berylliosis, presents a characteristic histologic lesion, there should be no serious difficulty in identifying "neighborhood" cases of asbestosis and asbestosis cancer of the lung." *Silicosis, Asbestosis, and Cancer of the Lung*, W.C. Hueper. *Am. J. Clin. Path.*, Vol. 25, 1955.

"The marked and growing predominance of males among lung cancer victims seems to be due largely to the following factors:

2. Males predominate in outdoor occupations, especially in urban areas, where they become exposed to carcinogenic pollutants in the general atmosphere (effluents of domestic and industrial furnaces, exhaust from gasoline and diesel engines, dust from rubber tires and from asphalted and oiled roads).

4. Males more often than females work through the entire span of their occupational life within urban areas with proved carcinogenic atmospheric pollution, while females stay for larger portions of their lives in the cleaner suburban dormitory communities.

These considerations provide substantial support to the concept that local differences in general and occupational industrial air pollutants may more plausibly account for an appreciable portion of the observed differences in attack rates for the two sexes rather than do local variations in their smoking habits."

Since environmental carcinogens have been shown to produce cancers wherever they operate in adequate intensity and duration, and considering the fact that many of the occupational respiratory carcinogens occur as industry-related general atmospheric pollutants, it may justly be assumed that these pollutants represent the cause of a significant portion of lung cancers among members of the general population, especially those who live and work in highly industrialized areas.

The respiratory cancers of recognized or strongly suspected occupational origin are important, not only as industrial disease manifestations but also as prototypes of etiologically and topographically identical cancers affecting workers in other, similarly hazardous occupations as well as of those cancers involving an indefinite portion of the general population sustaining for environmental reasons contacts with the same industry-related carcinogens.

It is therefore reasonable to assume that inhalation of the same agents , in a mitigated form as air pollutants, by the general population is responsible for a considerable portion of the lung cancers attributable to such contacts." *A Quest Into the Environmental Causes Of Cancer of the Lung*, W.C. Hueper *Public Health Monograph No. 36*, 1955.

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Table 1-10. Dust Sources	
Solids Handling and Processing	Loading and unloading raw materials; mixing and packaging solids; size reduction (crushing and grinding ores . . .)
Earth-Moving Operations	By construction and mining;..

Thus, for every chemical contaminant or group of contaminants there is a maximum threshold concentration which can be exceeded only at the risk of nuisance or damage. This threshold varies widely, depending upon chemical type and sensitivity of the persons, animal, or plant at ground level near the contaminant source.” *Air Pollution Handbook*. P.L. Magill; F.R. Holden; C. Ackley. McGraw-Hill Book Company. 1956. p. 1-8 - 1-23.

“The industrialist seeking to improve plant operation and maintain good public relations needs to know the dangers of air pollution. He needs to know what methods are available for the control of stack emissions, for example, and which are the best and most economical.

Control of air pollution sources can be practiced in old and new installations. A blend of research, development, and application of improved technology is the nation’s traditional method of raising living standards. This method has been used on past air pollution problems and will continue to be used.

Existing plants and processes usually can be altered to decrease air pollution by adding new abatement equipment. Additions of electrical precipitators, cyclones, scrubbing towers, high stacks, and similar equipment are only a few general possibilities.” *Air Pollution Handbook*. P.L. Magill; F.R. Holden; C. Ackley. McGraw-Hill Book Company. 1956. p. ix-1-9.

“Some dust control falls into the class of good housekeeping. Prevention of dust recycle by street cleaning and flushing, by oiling, and by paving of roads and cleared areas are constructive steps. Little new research is needed to direct these corrective steps.” *Air Pollution Handbook*. P.L. Magill; F.R. Holden; C. Ackley. McGraw-Hill Book Company. 1956. p. 1-24.

“For the sake of clarity, the various known and suspected carcinogenic agents in the atmosphere will at the onset be discussed individually. Included in this group would be the radioactive dusts and gases; the metal oxide and metal salt dusts and fumes from such elements as chromium and nickel; asbestos; and the organic material, isopropyl oil. While the relative significance of these various factors is at present the subject of great controversy, epidemiologic and experimental data obtained from broad programs of lung cancer research strongly support the thesis that air pollution provides a source for agents carcinogenic to the lung.” *The Chemical and Biological Consideration of Atmospheric Carcinogenic Agents*. Falk and Kotin. *Journal of Air Pollution Control Association* 7: 12-14. 1957.

“With the development of the asbestos industry, contamination of the air by small asbestos fiber particles produced health problems. Hygienic measures were not well advanced when the first mining operations were developed. Inasmuch as the dry processing method is used in mining and milling asbestos, small fiber particles are picked up by air currents and distributed throughout the

manufacturing plants and in the neighborhoods. The asbestos particles or dust which developed could become harmful to the people who were constantly exposed to it.” *Asbestos: Its Industrial Applications*. D. Rosato. New York Reinhold Publ. Corp., 1959. pp. 21-22.

“A considerable amount of dust was found in the residential districts of the city of Asbest due to discharges to the atmosphere from 3 industrial plants concerned with asbestos production. At collection points 0.5 km. From each of the 3 plants the average dust levels were found to be 23.4, 14.3, and 18.0 mg/m³; The asbestos dust was found to be made up of varied size particles: ... These dusty discharges from the asbestos plants proved to have an unfavorable effect on the health of children in the age range of 7-14 yrs. Of the children living in a dusty area, more than 71.5% had lived in the area for more than 5 yrs. The incidence of pneumonia in this group was 17.3% while for a comparable group of children living in a relatively clean area the incidence was 9.3%. The results of the investigation point to the necessity of more efficient dust control measures for these asbestos production plants.” *Abstracts From Current Literature*, A.T. Bobyleva, et. al., *The Amount of Dust in Residential Districts of the City of Asbest and Its Effect on the Children's Health*. *Gig. Sanit. (Moscow)* 23: 9-12, 1958. In *Archives of Environmental Health*. Vol. 2, 1960. p. 189.

“ASA Z9.2, 1960. 6. Air-Cleaning Equipment 6.2. Purpose. Air cleaning is required for one or more of the following reasons:

(1) To prevent the creation of a hazard or nuisance in the area exposed to the effluent of the local exhaust system.

6.3.2 Air cleaning equipment is ordinarily necessary in exhaust systems handling organic and inorganic dusts and fibers. Such contaminants, if discharged directly to the atmosphere, are likely to settle out rapidly to an extent which may constitute a hazard or a nuisance to the neighborhood.

6.4.1 Degree of Cleaning. The concentration and mass rate of emission of contaminant in the cleaned air shall be sufficiently low that neither hazard nor nuisance is created inside or outside the plant.

6.4.2 Legal Requirements. The concentration and mass rate of emission of contaminant in the cleaned air should be below that specified by existing state or local codes, or below that which might reasonably be anticipated in future codes.”

“Turning the dust which may have been sucked out by the few fans into the open air, to be carried by the prevailing southerly breezes into nearby homes, was also accepted as part of the price for having industries providing payrolls. Homes also were as close as possible to the mills.” *Health Progress in an Asbestos Textile Works*. Jerry Mitchell. *Archives of Environmental Health*. Vol. 3. July, 1961. P. 44.

“There are a number of criteria relative to the question as to what is a tolerable dust or fume discharge rate. The simplest situation is where local government regulations specify maximum permissible stack dust concentrations in the discharged gases. In circumstances and locations where there are no official regulations, one or more of the following criteria should be referred to: (1) Prior experience with the particular process emission and with the performance of known dust

separating apparatus.

(2) Good industrial practice, referring to the same process elsewhere and commonly accepted control measures.

(3) Appearance of the residual emission of dust or fume in relation to the character of the locality.

(4) The dustfall emission rate.

Measurement of dustfall emission rate can be made by a technique described by Haines et al.

If particle separation is inadequate, the effect will be in an offensive situation in the vicinity due to sedimentation of dust particles onto surfaces, causing an annoyance either to neighboring portions of the given plant or to residents in the neighborhood.... Note that concentration of particulates in the open atmosphere is directly proportional to quantity rate emission, and this rule may therefore be re-stated in these terms: a small percentage of large particles in a dust mixture passing out into the open atmosphere contributes to a major degree to any fallout nuisance in the vicinity of the source." *Plant and Process Ventilation. W.C. Hemeon. Industrial Press Inc. 1963. pp. 465-472.*

"Industry is frequently an important contributor to air pollution. It should therefore assume responsibility for prevention. Industry can contribute by (1) measuring and evaluating its emissions that contribute to air pollution; (2) providing means of eliminating or reducing them to acceptable levels; (3) engaging in or sponsoring research; and (4) supporting and participating in all phases of the air-pollution-control program." *Municipal And Rural Sanitation. V.M. Ehlers. McGraw-Hill Book Co. 1965. pp.97.*

B. Contaminants Brought Home By The Worker

Industrial hygienists have recognized since the early 1900's that toxic contaminants such as asbestos could be carried home on the clothes of a dirty worker.

"The provision of adequate washing facilities, water closets and opportunities for removing overalls so that they do not have to be worn home when impregnated, for example, with lead dust or dyes, are other factors of much importance in influencing general health.

The workman who goes home to a scanty meal, wearing clothing steeped in perspiration and fumes, dust or solutions of toxic materials in which he has been working, and who sleeps in a close, dirty apartment in which he hangs his reeking clothes, carries much of his occupational hazard with him, if it be of toxic nature. These are not all conditions which can be controlled by legislation, but are largely to be remedied through education of the workman in personal and home hygiene, and by such moral and social influences as may be brought to bear upon the situation." *The Occupational Diseases; Their Causation, Symptoms, Treatment and Prevention. Thompson, W.G. New York and London. D, Appleton and Company. 1914. pp. 47-48.*

"He also cites the case of a woman who acquired double 'drop-wrist' from washing the overalls of a house painter. Oliver recovered lead from the washtub water." *The Occupational Diseases; Their Causation, Symptoms, Treatment and Prevention. Thompson, W.G. New York and London. D, Appleton and Company. 1914. pp. 233*

"The Ohio state board of health has large legal powers: supervisions of all matters relating to the preservation of life and health of the people. 'It may make special or standing orders or regulations for preventing the spread of contagious or infectious diseases.... and for such other sanitary matters as it deems best to control by a general rule.' Provisions are made for local boards of health in cities and villages." *Diseases of Occupations and Vocational Hygiene*. Kober, G.M. and Hanson, W.C. Philadelphia. P. Blakiston's Son & Co. 1916. pp. 860-861.

"The inhalation of lead dust from dirty drop cloths and overalls is doubtless a frequent cause of plumbism among house painters and decorators. And for obvious reasons the men should be careful not to expose their street clothing to lead-containing dust.

Eating should not be permitted in the smelters and as an additional general precautionary measures the help should be required to wash the hands and to take a bath daily before leaving the smelter. It is also important that the help wear clothing made of close-meshed fabrics for the purpose of preventing the penetration of the underwear with soot and mercurial vapors. Where this precaution is not taken the workmen are apt to carry mercury into the home. In doing this the workman jeopardizes not only his own health, by being continuously in an environment of mercury, but also that of the other occupants of the same house. At Idria cases of poisoning are often noted among members of a mercury worker's family." *Diseases of Occupations and Vocational Hygiene*. Kober, G.M. and Hanson, W.C. Philadelphia. P. Blakiston's Son & Co. 1916. pp. 518, 523-524.

"1. Eleven persons showing chronic beryllium poisoning (berylliosis) have been reported among residents in the vicinity of a beryllium producing plant. None gave a history of occupational exposure to beryllium.

2. The distribution of the cases of berylliosis with respect to the plant indicates that the incidence of disease was a function of the concentration to which the residents were exposed.

3. The eleventh patient resided almost 2 miles from the plant and was a member of the household of an employee of this beryllium plant. This patient's disease is believed to have resulted from atmospheric contamination introduced to the household by work clothes of the employee. Based on air analyses made during simulated home cleaning of work clothes, a daily laundering can result in the inhalation of 17 micrograms of beryllium." *Non-Occupational Berylliosis*, Eisenbud, M. et. al., *J. Ind. Hyg. Toxicol.*, Vol 31, No. 5, pp. 282-294, 1949.

"At the present time, environmental cancer appears as an industrial problem, although it extends into many nonindustrial occupations. Such industrial carcinogens not only provide a serious hazard to the exposed workers but may possibly also affect the health of the general population through various routes of contact. Carcinogenic agents produced or handled in industrial operations, workshops, and laboratories may enter the air, water supply, or soil after being discharged as waste. Persons living or working in the fume or waste disposal area may thus come into contact with the carcinogens. Contaminated clothing worn by workers in carcinogenic operations may also create a hazard when laundered without proper precautions in the factory, home, or commercial laundry. Another possible extension of industrial hazards to the general population is the incorporation of carcinogens into goods for general consumption either as essential parts or as contaminants." *A Methodology for Environmental and Occupational Cancer*

Surveys. W.C. Heuper. Public Health Technical Monograph No. 1. 1950.

“We have no time to lose. While all the calculations are being made and all the various kinds of studies are in progress, it is largely the women of the country who will have to patiently take care of all the dirty work caused by air pollution. It is the women, primarily, who will be wondering whether there is any connection between the dirty air and her children’s sickness. It is she who will notice that the clothes she launders are often stained gray or black; who will notice that the collars on her husbands shirts are ringed with black, despite his faithful participation in the American ritual of the daily bath. Even if we fail to educate her in an understanding of air pollution, she will be constantly reminded of its effects - in the amount of clothes she has to wash; in the depressing effects of air pollution on the interior walls of her home.” *Impact of Air Pollution on Our Economics (2) - The Homemaker’s Viewpoint. Miss Chloe Gifford. In Proceedings National Conference on Air Pollution. November, 1958. Washington, D.C. Public Health Service Publication No. 654. 1959. pp. 248-251.*

In order to prevent this from occurring, the workers and their family members must be warned of the hazards of the toxic material they work with and educated in the proper sanitary control measures. The need for companies to warn of the hazards of their products was recognized by the Chemical Manufacturing Association in 1945. They produced a manual called “A guide for the preparation of warning labels for hazardous chemicals”. This guide included a warning label for harmful dusts.

(1) Warning.

“In order to interest workmen in care of the general health as a means of self-protection against occupational hazards, I have adopted the plan of distributing to them printed circulars of information and precautions. A sample circular follows, devised by my chief of clinic, Dr. W.H. Sheldon, and we have found them much appreciated by the workmen, who take them home and often discuss them with their friends, whereas they are very liable to forget or fail to comprehend mere verbal directions given them at the time of examination. Many minds, too, are much more impressed by anything which is in print. Another means of educating the workman in special dangers of occupation is by placards posted conspicuously in the workrooms where danger exists. Such placards of warning have proved valuable in the prevention of accidents, as well demonstrated by Illinois Steel Company. The objection to their use is that they are either overlooked or read more superficially than the circular which the workman takes home with him and regards as a personal message. In summary, the workman should be educated through the means of printed circulars, posted warnings, free illustrated lectures, and personally by visiting physicians whenever feasible.” *The Occupational Diseases; Their Causation, Symptoms, Treatment and Prevention. Thompson, W.G. New York and London. D, Appleton and Company. 1914. pp. 79-81.*

“The recommendations offered as the result of this investigation are of such exceptional practical importance that they may safely be considered as a first requirement for the effective sanitary control of health-injurious conditions in the practice of metal mining in general. 6.

Through intensive educational campaigns in the public schools and among the miners themselves disseminate information as to the harmful effects of insanitary practices and conditions, such as crowded living quarters, overwork, exposure, dissipation, the breathing of air polluted by powder fumes and rock dust, the use of common drinking devices, etc.” *Diseases of Occupations and Vocational Hygiene*. Kober, G.M. and Hanson, W.C. Philadelphia. P. Blakiston's Son & Co. 1916. pp. 784-785.

“Results of Educational Work and Publicity

Early in the investigation it became apparent that, in order to effect a permanent betterment of sanitary conditions, it would be necessary to obtain the cooperation of both the mine operators and the miners; and that such cooperation could be obtained if sufficient publicity were given to the ill effects of unsanitary conditions, especially the prevalence of siliceous dust in the mines. The matter was given much publicity in daily newspapers. Miners and their families, to the number of 2,700, were addressed at three moving-picture shows. At these gatherings, in addition to films pertaining to sanitation and safety, slides made from photomicrographs of rock dust were shown.

At the start few miners gave evidence of interest in better sanitary conditions. However, as they began to acquire a knowledge of the ill effects of siliceous dust their attitude changed, and the miners as a whole became interested in the abatement of siliceous dust and the general improvement of conditions underground and on the surface. There were many instances of miners quitting their working places if they were not supplied with means of allaying the dust.

Many of the mine operators, without waiting for the passage of the laws requiring improved sanitary conditions, inaugurated improvements in and about the mines, such as the building of new and commodious change houses, the equipment of the mines with separate water lines and sanitary drinking devices, and the regulation of the practices of squibbing and the blowing of dry holes.” *Siliceous Dust in Relation to Pulmonary Disease Among Miners in the Joplin District, Missouri*. Higgins, E. et al. Department of the Interior, Bureau of Mines, Bulletin 132, 1917, pp. 56.

“While industrial managements cannot be expected to take over the responsibilities of individuals, private doctors, or community health and safety authorities, there most certainly is an opportunity, if not a definite responsibility for industries to be interested in not only the so-called occupational diseases and accidents, but also in the non-industrial diseases and accidents *off* the job. The practice of good health and safety habits on the part of employees, and the practice of good plant sanitation and safety on the part of management, should be objectives of prime importance in any and every program of industrial hygiene.” *First Aid and Its Relation to Accident Prevention*. L.D. Bristol. *Industrial Medicine*. Vol. 4, No. 5. 1935. pp.261-262.

“Posting Notices

1. Every industrial establishment should provide one or more bulletin boards for posting notices located so as to attract the attention of every employee at some time during the working day.
2. All employees should be instructed in the hazards to the work engaged in, both with regard to the individual and fellow workers. Workers who are transferred to other unaccustomed work should be instructed as to the hazards incidental to the new occupation.

3. The employer should place warning signs and instruct all employees who are required to work where industrial poisons of a hazardous nature are used, stored, or carried, regarding the danger connected with them.” *Basic Principles of Industrial Sanitation. Dalluvalle, J.M. and Jones, R.R. American Journal of Public Health, Vol. 30, 1940, pp. 369-384*

“From a humanitarian point of view, no company can afford to subject its’ employees to an unknown hazard. From a cold business point of view, no company can afford to jeopardize its own existence by subjecting itself to the liability of unknown hazards that may be encountered by those to whom it supplies the material.” *Draft of Interim Report by E.C. Ames, 1941. From D.S. Egilman MD, MPH.*

“The education of employees regarding chemical hazards is, and must remain, the direct responsibility of their employers. However, such hazards are not confined to employees alone, and information concerning them should, so far as practicable, reach every person using, transporting, or storing chemicals. The most practical means for the seller to disseminate this information appears to be by labels affixed to containers of hazardous chemicals, bearing appropriate precautionary statements and instructions stated as simply and briefly as circumstances permit.

A precautionary label does not take the place of safety equipment such as suitable goggles, airline respirators, gas masks, clothing, shoes, etc.

VI. Harmful Dusts

CAUTION: HARMFUL DUST

Avoid repeated breathing or skin contact
Wash thoroughly before eating or smoking
Keep away from feed or food products”

Manual from Manufacturing Chemists’ Association., 1946.

In addition to the Chemical Manufacturing Association, additional recommendations on the need for warnings were produced by both the National Paint, Varnish and Lacquer Association and the American Conference of Governmental Industrial Hygienists (ACGIH) in 1939 and 1952 respectively.

“The vital factor concerning toxic materials is to intelligently safeguard the public. People may feel safer in buying materials whose danger they know rather than materials unknown to them. Each manufacturer can ably cope with the toxic material situation by constantly safeguarding the public through the products he manufactures and by the repetition of instructions to salesmen, service men and others who can intelligently instruct the consumer of the advantage of providing adequate ventilation and of maintaining personal hygiene.

Manufacturing Chemists’ Association Legal Principles

1. A manufacturer who puts out a dangerous article or substance without accompanying it with a warning as to its dangerous properties is ordinarily liable for any damage which results from such failure to warn.
2. A manufacturer or dealer who erroneously labels a dangerous drug with the name of a harmless substance is liable for any injury which may be caused thereby.
3. Failure to comply with a statute, e.g., with respect to labeling poisons, is usually held to be

- negligence per se or at least evidence of negligence.
4. The name of the product alone may be sufficient warning, if its nature is very widely known or its sale is restricted to those who are presumed to know its nature, but even in such cases the advisability of a specific warning is indicated.
 5. Technical accuracy may not be sufficient protection for the manufacturer if he uses words which may give the purchaser the impression that his product is not what it actually is.
 6. A nonwarranty of results is not a warning against possible dangerous results.
 7. The consumer is entitled to rely on positive representations or directions appearing on the label unless he knows them to be incorrect.
 8. The manufacturer is ordinarily not liable if his product is put to a use for which it is not intended and an injury results which could not reasonably have been foreseen. It is often difficult, however, to know whether a particular result should have been foreseen, and the courts are apt to differ on this point.
 9. The manufacturer or one who holds himself out to be the manufacturer must know the qualities of his product and he cannot escape liability on the ground that he did not know it to be dangerous.
 10. The general rule that a manufacturer is not liable to those not in privity of contract with him does not apply when his product is imminently or inherently dangerous."

National Paint, Varnish and Lacquer Association, Inc. 1939.

"ACGIH Resolves to Aid in Labeling Dangerous Substances

RESOLUTION-Adopted by the American Conference of Governmental Industrial Hygienists at its annual meeting, April 22, 1952, Cincinnati, Ohio.

Whereas, the content, dangers and protective measures necessary for the handling of potentially dangerous substances is not limited by geographic areas, and

Whereas, the appropriate label on such substances can help to preserve and protect the public health; and

Whereas, the storage, transportation and use of these substances may need specific precautions for the protection of the public; and

Whereas, in the past the U.S. Public Health Service and the Manufacturing Chemists' Association have cooperated towards this end;

Now, therefore, be it resolved, that the American Conference of Governmental Industrial Hygienists approve the following principles:

- (1) That adequate labels for warning and identification of harmful substances are necessary for the prevention and control of a public health problem,
- (2) That requirements for adequate warning labels should be as uniform as possible, and
- (3) That the American Conference of Governmental Industrial Hygienists work together with other official and non-official groups as well as with the Manufacturing Chemists' Association toward the development of an adequate uniform guide for the labeling of potentially harmful substances.

And be it further resolved, that the Executive Committee assign to the Chairman of one or more appropriate standing committees the responsibility for immediate action to implement these principles."

Industrial Hygiene Newsletter, April 1952.

Owens-Corning Fiberglas (OCF) established the corporate standard for companies to warn the users of their products of potential health hazards. OCF demonstrated the way to warn product users of insulation products by producing a forty page manual called "Health Aspects of Fiberglass". The following excerpt from an OCF letter establishes the minimum duties of a corporation producing products that may injure users.

"Since May, 1941 our health program has been built on these premises:

1. Find out the facts. (Our files have been centralized, complete related data have been assembled on insurance experience, investigations have been carried out).
2. Get out facts into medical literature. (Articles have been published in Industrial Medicine, American Journal of Surgery, Journal of the American Medical Association, Industrial Hygiene Digest, etc.).
3. Take the mystery out of the subject by making the facts available to members of our own organization and to the general public. ("Health Aspects" has been published and reprints of articles in medical journals made available for general distribution).
4. Handle inquiries prompt and fully.
5. Concentrate on professional and technical "influence centers" - Medical groups, safety engineers, industrial hygienists, plant physicians, and nurses, public health authorities. These contacts have been and are being cultivated.

Johns Mansville placed warnings on bags of diatomaceous earth in 1952. This was the first product warning of an ingredient of insulation products.

"The longer we wait to educate the public to the necessity for solving this problem the greater becomes the risk of some unsuspecting city becoming another Donora. If this should happen, the public's tolerance may end with a bang and it will be too late to whimper. It will be too late to explain that we don't know all about the things that cause air pollution. It will be too late to apologize for the fact that we failed to let the public know that there are methods of controlling many air pollutants and that we did not have enough public support to find out soon enough about the others. I believe everybody in town and city, regardless of whether the citizens face a recognized air-pollution problem and regardless of whether they seem to care, should know the facts of air pollution." *Impact of Air Pollution on Our Economics (2) - The Homemaker's Viewpoint. Miss Chloe Gifford. In Proceedings National Conference on Air Pollution. November, 1958. Washington, D.C. Public Health Service Publication No. 654. 1959. pp. 248-251.*

"Education should not be confined to informing the general public of the menaces of air pollution, but should also be designed to inform the contributors of the damages which they are causing the communities, and of ways and means by which they may reduce pollution resulting from their operations. *Impact of Air Pollution on Our Economics (3) - Agricultural Considerations. Charles Butler. In Proceedings National Conference on Air Pollution. November, 1958. Washington, D.C. Public Health Service Publication No. 654. 1959. pp. 251-255.*

(2) Sanitation. The general principles of sanitation have been known for over a century.

“Now the mines have erected, or are erecting, change houses with concrete floors and concrete or galvanized-iron walls, with plenty of windows and adequate ventilation. These change houses have shower baths with hot and cold water, wash basins, and individual lockers for clothes, are ventilated, and are heated by steam pipes. Also most of them have a separate room, with benches and tables, for eating.

The new change houses have been received with enthusiasm, and most of the men use them in the manner intended. A recent visit to a change house showed nearly every locker containing clean street clothes as evidence that the men changed when coming off shift.” *Higgins, E., et. al., Siliceous Dust In Relation To Pulmonary Disease Among Miners In The Joplin District, Missouri, Department of the Interior, Bureau of Mines, Bulletin No. 132, 1917.*

“Miscellaneous Sanitary Provisions. - In this connection it is desirable to point out certain sanitary requisites, which are important in all dusty occupations, especially in those involving exposure to toxic dust and fumes.

1. Suitable Work Clothes and Caps. - There is a great variety of suitable patterns in the market, of which the snug-fitting duck union suit, without many folds, properly buttoned and adjusted is the best. Such suits and caps should be furnished at the expense of the employer and washed once a week.

Dressing-rooms, Lockers, Bath and Wash Rooms. - It is desirable, in all dusty occupations, that the workmen should take off all their street clothing before beginning work, and this is absolutely essential when the occupation involves exposure to poisonous dust. For this purpose suitable dressing-rooms, provided with lockers for street suits and separate compartments for overalls, are necessary. Facilities for washing and bathing, brushes, soap and individual towels should be furnished. In most of the civilized countries statutory provisions have been made for these sanitary requisites, in all establishments in which poisonous substances are manufactured or used, and the result has been most beneficial.”

3. Pure Drinking Water and Lunch Rooms. - The health and safety of employees exposed to industrial poisons demand that no food shall be taken, or tobacco in any form used, in the workrooms.” *Industrial Health, Kober and Kayhurst, p 24-25, 1924.*

“The following suggestions were made to further diminish the dust danger in South African mines: 3. The daily removal of all dust (by vacuum cleaners) from clothing worn underground.” *Review of the Literature on Effects of Breathing Dusts With Special Reference to Silicosis. Harrington and Davenport. U.S. Bureau of mines Bulletin 400. 1937. p.107.*

“It must be remembered that all people do not react in the same way when exposed to chemicals. Some may be quite seriously affected by quantities which are harmless to others. Hence, it follows that any one using paint and allied products should provide adequate ventilation and should observe ordinary sanitary measures such as washing of the hands and face before eating and keeping the clothes clean. Dirty work clothes, including shoes, can be an important source of skin absorption.” *National Paint, Varnish and Lacquer Association, Inc. 1939.*

“The principles of sanitation applied to the industrial environment do not differ from those forming a part of community sanitation. Their primary purpose is to control the causative factors of disease. However, in accordance with the accepted definition of sanitation, the principles are interpreted as applying to the prevention of diseases other than occupational.

One shower bath with ample supply of hot and cold water from one fixture should be provided for every 15 workers or less exposed to skin contamination with poisonous, infectious, or irritating material. Dressing rooms should be provided for men whenever the type of work performed involves exposure to excessive dust, dirt, heat, fumes, vapor, or moisture of such degree as is declared by the enforcing authority to require the same. Two-compartment lockers should be provided in a separate room from the place of work for employees whose clothes are exposed to contamination with poisonous, infectious, or irritating material, and well separated facilities should be provided for street and working clothes. Where the process in which the worker is engaged is such that his working clothes may become wet or have to be washed between shifts, they should be so cared for that dry clothes are assured for the return to work. Whenever the nature of the work is such that the employees' clothing becomes covered with or permeated with industrial poisons, the employer should provide necessary equipment and help to cleanse such clothing as often as may be necessary.” *Basic Principles of Industrial Sanitation. Dallavalle, J.M. and Jones, R.R. American Journal of Public Health, Vol. 30, 1940, pp. 369-384.*

“Give any information applying to the risk as a whole, such as shower and washroom facilities, changes of clothing provided, housekeeping conditions, etc.” *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. p. 277. 1943.*

“Where dust, grease, oil and grime are prevalent, these procedures should include the maintenance of separate lockers for work clothes, apart from street clothes (both within easy access of showers). For example, in processes where irritant chemicals, dusts, gases, fumes, mists, vapors or sprays come in contact with the worker, complete washing, with suitable cleansers, under showers should be compulsory at the end of each shift. Facilities should be adequate, light, sanitary and kept free from athlete's foot fungus by live steam treatment or other methods, and by facilities for medical foot baths.” *1021 Answers To Industrial Health And Safety Problems. J.E. Weiss. Occupational Hazards Inc., Publishers of Occupational Hazards Monthly Magazine. p. 13-14. 1943.*

“3. Wherever occupational cancer occurs in industry, serious and determined efforts should be made by the plant management to eliminate entirely the hazardous aspects of the respective operations by technical improvement in the production methods, by the observation of extensive sanitary measures and the introduction of a close medical supervision of the endangered workers.” *Cancer in Its Relation to Occupation and Environment, W.C. Hueper, Bulletin of the American Society for the Control of Cancer, American Cancer Society, pp. 63-69, 1943.*

“The agents known or suspected to cause occupational cancer are arsenic, chromates, nickel carbonyl, radium, mesothorium, asbestos, crude and processed mineral oils, pitch, tar, soot,

paraffin, anthracene oil, creosote, aromatic amino compounds (aniline, naphthylamine, benzidine), benzene, ultraviolet rays, roentgen rays, radioactive materials and substances from certain parasitic worms.

The public health importance of industrial cancer undoubtedly will increase not only with respect to the number of workers, male and female, exposed to industrial cancerogenic agents but also with respect to the variety of plants and operations in questions. Public health authorities will wish to institute effective technical and sanitary supervision of such establishments as well as medical control of the workers, present as well as past." *Environmental Cancer, J.A.M.A., Nov. 25, 1944.*

"The Police, Factories, etc. (Miscellaneous Provisions) Act of 1916 authorized the Secretary of State to compel the employer by 'welfare orders' to provide for the health and comfort of workers: to make available facilities for preparing, heating, or taking meals and to provide protective clothes, first aid arrangements, seats, eating and dressing facilities, and an adequate supply of drinking water. In the older literature there were directions for personal care, most of them recommending certain medicines or foods. From the beginning of the 19th century on, the rules and regulations contained instructions on cleanliness, washing, bathing, and work clothes, and prohibited smoking and taking of meals in the workrooms. It was necessary to draw the attention of the worker to these rules of personal hygiene, in order to convince him of their necessity and to get his cooperation. As the first step to gain this interest and to teach him which protective measures were the responsibility of his employer and which ones he must himself observe, the earliest laws and regulations required that copies or excerpts of the laws be posted in conspicuous places in the factory." *History of Factory and Mine Hygiene. Teleky, L., Columbia University Press. New York: Morningside Heights. 1948. pp.29, 126.*

"Mining, in any of its phases, is inherently dirty work. This means that the miner usually wears clothes specifically adapted to the work he is doing. Frequently these clothes are not suitable for use away from the mines. Dust and water introduce their own particular problems as to comfort and cleanliness.

It used to be custom for miners to wear their dirty clothes home and change there. This custom no longer prevails though, and change houses or bath houses are provided at most mining operations nowadays.

Health is man's greatest asset and should be guarded at all times. Properly designed change rooms not only protect the health and welfare of the employee, but cut down labor-turnover and promote better employee-employer relationships. This has been proven many times.

For ease of maintenance and economy of construction, it is advantageous to have one large central change house with complete shower and toilet facilities. There are three common ways to store employees' clothes and personal effects: hooks or ladders hanging on the wall; in floor lockers; and in overhead basket lockers. Showers should be supplied in a ratio of one shower head for each 10 men on shift. The change room should be cleaned thoroughly after each shift.

A clean worker is a healthy happy one, and a happy worker is a good, steady efficient one. The intelligent placing, design and furnishing of industrial change rooms is perhaps one of the most direct and certain methods of increasing workers' morale. Don't neglect it." *Modern Change Houses for the Mining Industry. Mining Congress Journal. November, 1954. pp.45-47.*

“The revised American Standard Minimum Requirements for Sanitation in Places of Employment states (10.1.1) that: ‘In all places of employment where employees are permitted to lunch on the premises, an adequate space suitable for that purpose shall be provided for the maximum number of employees who may use such space at one time. Such space shall be separate from any location where there is exposure to toxic materials.’ It further states (10.1.3) that: ‘No employee shall be permitted to store or eat any part of his lunch or eat other food at any time where there is present any toxic material or other substance that may be injurious to health.’” *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, pp 130-131, 1958.*

“Where the employee is exposed to toxic materials, or if he is a food handler, the need for the optimum in clean, well-lighted, and well-ventilated washing and locker facilities becomes imperative from the point of view of both protecting the health of the individual employee and minimizing the possibility of his transmitting infections to others.

In industries where work clothes of the employee are exposed to contamination with poisonous, infectious, or irritating, materials, separate storage for street and work clothes should be provided. Cash suggests the following arrangement for such a ‘change house’:

‘A good arrangement is a room or building divided into two sections - a street clothes section and a work clothes section, with bathing and toilet facilities between. The street clothes section has an outside entrance and lockers for street clothes, toilets and wash basins or wash fountains, and changing facilities for supervisors. The work clothes section has rooms for work clothes, toilets and wash basins or wash fountains, showers, and laundry. Three connections between the street clothes section and the work clothes section are (1) through the supervisors change room, (2) through the main shower room, and (3) a hall with ‘one way traffic doors’ from street to work clothes sections’ (F.E. Cash, *Suggested standards for change houses. Presented at American Public Health Association Annual Meeting, October, 1951*).” *Industrial Hygiene and Toxicology, Volume I, Frank A. Patty, pp 136-137, 1958.*

“Work clothing must be frequently cleaned in nonhazardous ways. This requirement places upon the industry the responsibility of furnishing suitable clothing lockers, washrooms, and shower baths.” *Municipal And Rural Sanitation. V.M. Ehlers. McGraw-Hill Book Co. 1965. pp.507.*

“Miners, sorters or dressers of asbestos ore in open pit mines, but particularly in underground mines, are exposed to the inhalation of rock dust containing asbestos. Similar exposures exist for the loaders of the mined rock and for the truckers and railroad personnel who haul the material and deliver it to the crushing mill. The crushing and screening of asbestos rock (comminution), carried out in mills for separating the asbestos fibers from the adherent rock, is associated with the production of a great deal of dust and thus entails a heavy exposure to asbestos unless stringent technologic precautionary measures are taken for protecting the workers employed in these mills. The amount of dust produced in these operations and escaping the mill buildings can, moreover, cause a marked pollution of the intraplant and periplant environment with asbestos dust and thereby create not only an intraplant asbestos hazard for workers employed in the yard and offices located on the premises but also a periplant hazard endangering individual and animals working and living in the vicinity of such plants (industrial neighborhood and household hazard).” *Occupational and Nonoccupational Exposures to Asbestos. Hueper, W.C., Annals New York Academy of Sciences 132: 184-195. 1965.*

“Epidemiological investigations have moreover shown mesotheliomas not due to occupational exposure but to possible contamination with asbestos in a family setting or in the neighborhood of asbestos factories.” *H. Bohlig, et al., Epidemiology of Malignant Mesothelioma in Hamburg. Environmental Research 3, 365-372 (1970).*