Threshold Limit Values

This defense is multi premised and goes thusly: "The asbestos manufacturing industry was deluded by reliance on the Threshold Limit Values in that we assumed that the construction environment differed markedly from the mining and manufacturing environment in that the former workers were exposed to admixtures of asbestos while the latter were exposed to 100% asbestos. We further assumed that the TLV's established a level of safe exposure to asbestos dust and that an insulation worker, whom we considered to be exposed to less than 5 million particles of dust per cubic foot, was, therefore, not at risk to contract disease."

a. History of Establishment of a TLV for Asbestos

The 1935 Metropolitan Life Insurance Company study conducted at the behest of a law suit plagued asbestos industry under the benign guidance of Dr. A. J. Lanza about which more will be said below concluded that the "experience so far does not warrant an attempt to define a standard of dustiness for asbestos dust."[84]

The U. S. Public Health Service was requested by the health and compensation authorities in North Carolina to make an engineering and medical study of the conditions in that state's asbestos textile industry. The results were published in detail as a Public Health Bulletin in August, 1938, and in more concise form in the American Journal of Public Health in 1939.[89, 90]

In all, 242 dust counts were made to measure workers' exposure. The counts employed standard methods for that time, and all particles in the air were counted, not just asbestos fibers.[90A, 92] The unit of measurement of airborne dust concentration was million particles per cubic foot (mppcf), and the maximum value observed was 74.3 mppcf.

> Medical examinations were made of 511 men and women representing practically all of the employees at the time of the study....The three factories studied had been in operation 6 to 16 years. About 15 months before the study, approximately 150 workers were replaced by new ones with little or no asbestos experience. As a consequence, there was an abnormally large percentage of workers with less than 5 years' employment in the asbestos textile industry and an abnormally small percentage who had worked 10 years or more in the industry.

In fact, [illegible] less than 5 years exposure; only [illegible] had 10 years of exposure, and 14% had less than 1 year of exposure.[90A] The Public Health Service reported,

> The percentage of persons with asbestosis increases greatly with increasing length of employment....[A]lmost three-fourths of the workers employed for more than 15 years have the early stages, at least, of a disabling disease, asbestosis. Since there is no satisfactory way of locating and examining persons who drop out of an industry because of disability incurred therein, the percentage values of the foregoing tables are necessarily minimal evidence of the prevalence of asbestosis.
>
> ...16.3 per cent of the 69 former asbestos workers [who had been traced] and 378 men and women employed at the time of the study in three asbestos textile factories had asbestosis. (Persons who were not exposed to appreciable quantities of asbestos dust have not been included.)

The non-exposed persons were office workers and other non-production personnel and applicants for employment. Eight per cent of the 378 workers employed at the time of the study had asbestosis. This does not completely represent the incidence of asbestosis because about 150 employees were discharged from these factories 15 months before the present study was made. Many of the discharged workers had asbestosis, as the reports of Doctors Shull, Donnelly and McPheeters show. Although an attempt was made to examine as many as possible of these discharged cases, only 69 could be examined, 43 persons of whom had asbestosis according to the diagnostic standards employed in this study.

The investigators went on to estimate that another 50 cases of asbestosis among the recently discharged workers had "escaped observation". In other words, there were 30 cases of asbestosis in the factories by the time they were inspected by the Public Health Service, and an estimated 93 more asbestotics had been fired by the mill owners shortly before the Public Health Service conducted its survey. The wholesale replacement of tenured workers was so dramatic that it resulted in the average age of the workers being lower than any other group previously studied by the USPHS.

By differential employee with long term exposure, especially in the least dusty processes, the companies wiped out most of the data base the Public Health Service needed in order to develop any good dose-response data on asbestosis.[96] Only 5 workers in the study who were considered at risk of disease had been exposed to levels under 5 mppcf for over 10 years.

> None of the 19 persons exposed to dust concentrations below 2.5 million particles per cubic foot had a case of asbestosis, although, as a matter of fact, only 6 persons had been employed more than 5 years.[88]

There were 3 "doubtful" or borderline cases of asbestosis found among the workers exposed to 2.5 to 4.9 mppcf. Despite the paucity of data on the risk among workers exposed to less than 5 mppcf, a tentative threshold value for asbestos dust exposure of 5 mppcf was designated. Despite much criticism in the literature, this value stood as the recognized TLV in the United States for the next 30 years although it was given short shrift by some United State and foreign manufacturers.[92A]

The Public Health Service investigators were assigned the difficult task of prescribing a limit that would be safe and demonstrably attainable with available process controls. They cited a 1935 Pennsylvania study[97] that showed that incidence of asbestosis increases with the concentration of airborne dust and that found no safe threshold:

> In their report of a similar study carried on in Pennsylvania asbestos textile factories, Fulton, Dooley, Matthews, and Houtz found that 8 per cent of the workers exposed to an average dust concentration of 5 million particles per cubic foot had asbestosis; 22 per cent of the 17 million particle group; and 57 per cent of the 44 million particle group had asbestosis.[98]

dose relat

The conflict between the Pennsylvania findings and the 5 mppcf threshold set by the Public Health Service study was not resolved in the Service's report. Nonetheless, the Public Health Service proposed a TLV based solely on its own health and engineering study ignoring the Pennsylvania study and British studies

> Because of the importance of the problem, it seems to be desirable to use such data as are at hand to define tentative safe working conditions that may serve as standards for the guidance of factory managers and engineers until more complete data are available....
>
> Because clear-cut cases of asbestosis were found only in dust concentrations exceeding 5 million particles per cubic foot, and because they were not found at lower dust concentrations, 5 million particles per cubic foot may be regarded tentatively as the threshold value for asbestos dust exposure until better data are available.
>
> In order to find out the levels to which asbestos dust concentrations have been reduced in practice, an engineering study was made in an asbestos textile factory in which dust control equipment has been recently installed. This shows that means are already available for reducing the dust exposure of a majority of asbestos textile workers to less than 5 million particles per cubic foot.[89]

The investigators were optimistic that no new cases of asbestosis would appear if asbestos dust concentrations in workplace air were kept below 5 mpocf--and followed by describing 5 mppcf as a "tentative threshold" that could be achieved with available methods of dust control. This grievous and unwarranted conclusion suffered from an additional limitation. Like all cross sectional studies, Dreessen surveyed only the working and less than half the fired population thus excluding the disabled sick and the dead.[90A]

As generous and ill-founded as Dreesaen's tentative dust conclusions were to the industry, his paper was not joyously embraced by all. Wrote Sumner Simpson, President of Raybestos-Manhattan, to Asbestos Magazine on March 22, 1939:

> I think that when we get through with our Saranac investigation, we will show that this paper is considerably distorted although he does say at last that where the air can be kept down to 5 million microns, there is no danger and I can tell you confidentially, but am not willing to make it public, that the air can be kept below 5 million microns with proper controls, but I am not willing to start a controversy with my competitors.[91]

The American Conference of Governmental and Industrial Hygienists adopted Dreesaen's tentative proposal of 5 mppcf of total dust as the maximum allowable concentration standard in 1946 and this standard sadly remained in effect for more than twenty years.[92]

b. The 100% Asbestos-Plant Exposure Myth

Protestations of industry apologists notwithstanding, the thesis that asbestos insulation manufacturing facility workers are exposed to virtually pure asbestos and end product users to admixtures is pure hokum. Common sense dictates that plant workers who are engaged in production line processes the end result of which was to produce a thermal insulation product composed of 15% asbestos and 85% magnesia have a kindred percentage exposure to insulators who apply these products. Common sense aside, the early investigators unanimously agreed. Fulton,[93] Lanza[68] and Dreessen[89] all found manufacturing worker exposures to admixtures of asbestos dust and other dusts running the gamut from 1 to 100% asbestos dust. As observed by Nicholson regarding the inherent limitations of Dreessen's approach:

> The instrument of choice in defining asbestos air concentrations was the impinger in which all particles having dimensions greater than one micron were counted, including many non-asbestos particles. Estimates were made of the number of asbestos and cotton fibers in the samples. The percentage of fibers ranged from 26% in weaving to 7% in carding, 5% in twisting and to as low as 1% in crushing operations.[92]

Amer. Conf. Gov. and Industrial Hygienists

The Dreessen and ACGIH standards required the counting of all atmospheric dusts including non-asbestiform particles.[92, 89, 94] It has been stated that while work practices among insulators remained fairly constant between 1946 and 1966 with few, if any, controls implemented, insulation materials probably contained twice the asbestos content in the prior decade.[92]

c. The TLV is a Safe Level Myth

While the asbestos insulation manufacturing industry prior to 1967 conducted no research to determine the levels of asbestos exposure encountered by insulators[92, 95], they in retrospect contend that the TLV of 5 mppcf was presumed to be a safe level below which disease did not occur and that they assumed insulation work created exposures below said level.

A TLV is Not a "Safe Level"

Threshold Limit Values are not fine lines below which disease is guaranteed.[96] Threshold limit values and their predecessors, Maximum Allowable Concentrations, attempted to assay only what uniform concentration of a toxic substance was tolerable in the majority of cases for forty hour weeks for a working lifetime. The TLV-MAC standard ignored peak exposure considerations.[97] The preface to the 1948 ACGIH MAC list explicitly declares the limitations of such standards.

> While it will doubtless be very advantageous to have what might be called permanent or standard maximum allowable concentration values, it must be borne in mind that all our values at the present time are fluid and subject to annual revision. They should not be adopted as fixed or legal values, but merely as guides to assist us in defining more or less safe working conditions. 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 their 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 or poisoning among those exposed.
>
> With these facts in mind the Committee has set values below which it is fair to expect reasonable protection and above which it is reasonable to expect that we can have occasional cases of poisoning.

Neither the scientific community nor the asbestos industry considered adherence to a TLV to constitute failsafe assurance that disease would not occur below such a level. The results of a survey of the combined membership of the ACGIH and the American Industrial Hygiene Association, reported in 1956, which, inter alia, sought to quantify the degree of confidence in TLV's are revealing:

Confidence	Number of Replies
100%	53
80%	173
50%	37
Less than 50%	9
Qualified	54
Total	326 [97]

With specific reference to asbestos, the captains of that industry were not misled by the asbestos TLV of 5 mppcf. As was so eloquently stated by Vandiver Brown, Secretary of Johns-Manville in 1947:

> 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. I am certain no study has been made specifically directed toward ascertaining this figure and I question whether there exists sufficient data correlating the disease to the degree of exposure to warrant any determination that will even approximate accuracy.[98]

And the Phillip Carey Manufacturing Co. was told by an industrial hygienist consultant in January, 1963, upon completion of a dust survey of one of its asbestos manufacturing facilities: "They (TLV's) are guides for the control of health hazards - not fine lines between safe and dangerous concentrations."[99]

Assuming, for the sake of argument, that insulators were exposed to lower levels of asbestos contaminants than manufacturing employees, concern over the effects of long term low level exposure to asbestos is not of recent vintage. In a 1947 unpublished Dust Investigation conducted by the Industrial Hygiene Foundation at the request of the Asbestos Textile Institute, the asbestos manufacturing industry was clearly apprised of the inherent deficiencies of the Dreessen inspired TLV and the potential hazards resulting from long term low level exposure:

> The maximum permissible dustiness for asbestos is commonly taken to be 5 mppcf. This represents good attainment in the dust control program. It is emphasized, however, that dust elimination to this extent does not positively insure that no asbestosis will develop in some workers after a long working life. (greater than 20-25 years) Scientific evidence is obscure on this point.[100]

The IHF study's concern was predicated in substantial part on the limitations of the Dreessen study:

> 1. What is the expectation of asbestosis in workers exposed more than 15-20 years to low concentrations of asbestos dust? Among the 500-odd workers who composed the subjects in the USPHS study, there were abnormally few who had been exposed for more than 15 years and practically none over 20 years. These facts seriously affected the conclusions that could be drawn.[101]

Hemeon advocate ... industry to sponsor studies to determine the effect of low level long term exposure stating that the information available does not permit committee acceptance that 5 million ppcf is thoroughly safe nor has information been developed permitting a better estimate of safe dust ... Unfortunately while the INP proposal to conduct such a long range study was proposed to the ATI in 1947,[101] it was rejected in 1948.

The scientific literature is replete in the 1950's and early 1960's with references to the fact that TLV's do not provide rigid guides below which disease does not exist. Dr. Kenneth Dunner in 1955 expressed the prevailing view that individual susceptibility and peak exposures rendered TLV's valuable merely as general and not specific yardsticks.[102A] By January, 1963, the limitations of the TLV were so well established that the ultra conservative Committee on the Pneumoconioses of the Council on Occupational Health of the AMA (whose 7 man membership included 2 fulltime and 2 parttime consultants to the asbestos industry) was moved by mountains of data to acknowledge that "brief and intermittent exposures to extremely large amounts of dust are capable of ultimately producing the same pulmonary pathology as longer and continuous exposure to more moderate concentrations."[102B] Any lingering illusions about the total efficacy of the asbestos TLV were certainly shattered by the late 1963 report issued by the Committee on Occupational Diseases of the Chest of the American College of Chest Physicians which included, inter alia, the observation that:

> There is no agreement on safe limits for asbestos dust and the best evidence for this is that several governmental agencies have recommended 5,000,000 asbestos particles (of any length) per cubic foot of air as the m.a.c., some industries have adopted 1,000,000 asbestos fibers of 5 microns and greater length per cubic foot, and a third group of hygienists considers a count of 10,000,000 total dust particles per cubic foot as a safe level.[102C]

Predicted as 1947 by Hemeon[100] blind adherence to an ill-founded Threshold Limit Value which ignored entrenched peak exposure concepts and failed to calculate the effects of long term low-level exposures produced a continually increasing number of diseased asbestos workers in the 1950's[102D] and spawned an epidemic of disease in the allied non-insulating construction trades in the 1960's[102E] and conjugal disease in the 1970's.[102F]

In addition to knowledge that the TLV did not ensure safety, the industry was acutely cognizant of the fact that it was measuring the wrong thing--total dust rather than fibers. Thus, Vandiver Brown of Johns-Manville in his 1947 Saranac speech[158] and the ATI on numerous occasions discussed the need to count fibers rather than dust. In an unpublished preliminary report to his industry sponsors, Gardner advised that the long rather than the short fibers were disease inducing and urged the dust engineers to direct their efforts toward the fibrous material in the air.[103A]

Concern over the adequacy of the TLV prompted at least one major manufacturer to employ a dual measurement approach. In the 1963 Phillip Carey Dust Investigation[99] it was reported that one large manufacturer (J-M) employed a TLV of 5 mppcf for all dust below 10 microns and 1 mppcf for all fibers greater than 10 microns in length.[99] And Dr. William T. Marr reported the same information in his 1964 article.[79Y] This practice was stated by the Asbestos Information Association to have been implemented shortly after 1938.[104]

d. Exposure Levels of Insulators and Shipworkers (Laggers)

Historical analysis of asbestos exposure in insulators and laggers is made difficult for two reasons: (1) Excepting the Fleischer[79C] survey, exposure level data were either not published nor accumulated prior to the mid to late 1960's; (2) Correlation between impinger dust count samples and modern fiber analysis methodology is diff cult.[92]

The Fleischer study found alarming fiber concentrations in all four shipyards ranging from a low of 1.6 mppcf to a high of 141 mppcf. The authors also counted asbestos fibers and while the counts are exceedingly difficult to average and to compare the asbestos dust counts reached or exceeded the J-M TLV for asbestos dust in two shipyards. Nicholson, in his analysis of the Fleischer survey and the Murphy sequel[105] has estimated exposures ranging from 15 to 20 f/ml for average asbestos concentrations in insulation work during this period.[92] Fleischer erroneously contrasted textile operations with insulation operations on an asbestos percentage basis and concluded that the dust concentrations differed markedly. As discussed above, asbestos production workers, not unlike insulation workers, were exposed to admixtures of asbestos of considerable disparity. Murphy found a time weighted average of total dust exposure of 5.2 mppcf in his analysis of shipyard insulation work.[105] Nicholson estimates insulators past exposure to asbestos to be 10 to 15 f/ml for construction workers and 15-20 f/ml for marine work.[92] A survey of a naval off-ship insulation facility conducted in 1947 revealed dust counts upward of the TLV prompting recommendations for dust suppression.[106] Airborne dust samples taken for Armstrong Cork in 1968 of an insulation function revealed quite disturbing results. "The dust deposit on the membrane filter was so thick that the deposit came off during the transport." Dust counts for this spraying operation grossly exceeded 5 mppcf.[107]

In unpublished 1970 data[107A] obtained in litigation discovery the results of fiber concentrations created during simulated insulation operations dramatically underscore the tremendous past exposures created in the course of these activities and concomitant fallout hazard. Performing sawing application and tearout procedure on one amosite (60% asbestos) and three calcium silicate (10 to 15% asbestos) products commonly utilized by thermal insulation workers,

the 8 boilermakers employed by [illegible] asbestos fiber concentrations longer than 8 man-months per milliliter of air gross, in excess of the 1968 standard of 12 f/ml, and asbestos in excess of the subsequently reduced standards. Thus, pre-formed (calcium silicate) yielded a mean of 29.163 f/ml (5mm) at the personal monitor level, and in excess of 9 f/ml (5mm) in the room measurement; the pounding (application) task produced a mean in excess of 14 f/ml (5mm) at the personal and 8 f/ml (5mm) at the room monitoring stations and the tearout operation (not assessed by Fleischer in 1967)[79C] resulted in counts approaching 50 f/ml (5mm) at the personal monitoring station and 8 f/ml (5mm) at the room levels. Product B's (amosite) performance was even more dismal with tearout levels approaching 270 f/ml (5mm) and 70 f/ml (5mm) at the personal and room stations respectively. The author's conclusion that manipulation and commination of all four of these products "within confined spaces may result in airborne asbestos fiber concentrations orders of magnitude greater than the present ceiling value of the ASA-107A was well justified by these alarming data.

Harries undertook in a 1971 publication to compare mass and fibre concentrations in shipyard insulation processes and by both measurements found remarkable dust counts. Total dust counts taken during removal of sprayed crocidolite asbestos, removal of pipe lagging and application of pipe lagging produced mean concentrations of 17.3 mppcf, 36.47 mppcf and 6.17 mppcf, respectively.[107B]

Dust counts reported in an obscure U. S. Navy 1961 publication yielded the following data:

Operation	Dust Count-mppcf
[illegible] asbestos cloth	5.5
[illegible] laying insulation block	20.0
[illegible] insulation block	3.9
[illegible] block	27.0
[illegible] block insulation	11.7
[illegible] magnesia cement	5.6
[illegible] after coating asbestos on boiler	92.5
Ripout of pipe insulation	6.8

The author of this naval publication recommended that insulators "be required to wear respirators" and that wetting down procedures be implemented. The astronomical values achieved during sweeping operations and the location in the near proximity of non-insulating shipyard workers should have foretold the flood of disease cases being reported in the 1970's in the allied shipyard trades.

Both the law of public liability and a sense of corporate fair play should have promoted the sponsorship of testing and analyses such as were systematically but belatedly conducted in the late 1960's; such curiosity would have prevented thousands of deaths.

Whatever the true average level of asbestos exposure was historically, it is widely accepted that peak exposures were excessive and the measurements employed crude. The state of the art respecting the inadequacies of the TLV with regard to peak exposures,[97] effects of long term low level exposure [98,100] and dust rather than fiber counting[103] were well known by the early 1960's and coupled with the case reports in the literature should have constituted signal notice of a hazard to insulators.

e. The Fallacy of an Effective TLV for Carcinogenic Substances

Nicholson[92] has extensively analyzed the inapplicability of a TLV concept to known carcinogens. Criticism of using TLV's for carcinogenic substances is not a modern phenomenon. Hueper in 1952,[80K] and Cook in 1956[108] both addressed the fallacy of attempting to establish a TLV for suspected cancer causing substances including asbestos. Therefore, by 1956 with the evidence of an overwhelming association between asbestos and lung cancer in asbestos workers[79,109] reliance on a tentative TLV established by Dreessen as a safe level of exposure constitutes gross negligence and inattention to a major public health problem.

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AL 102

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AL102 38 [illegible]

3. State of the Art: The History of Knowledge of Asbestos Disease

The defendants contend that until Dr. Irving Selikoff orchestrated the conference on the Biological Effects of Asbestos at the New York Academy of Sciences in New York City in October, 1964, they were unaware that insulators were at risk to contract asbestos related diseases. Thus, they argue, there was no duty to warn or test or find substitute products prior to this conference as the state of medical knowledge did not indicate a problem to users of insulation products containing asbestos. It is interesting to note that Johns-Manville, the leading manufacturer, decided to implace caution labels in September, 1964 although not on all products prior to the October meeting. In addition, although Dr. Paul Kotin, current medical director of Johns-Manville, described the conference as a "bombshell", only two manufacturers began labelling in 1964 and some did not label before 1970. Dr. Selikoff actually first publicly presented his preliminary findings indicting asbestos as a cancer agent and describing asbestos diseases in insulators in June, 1963, at a medical meeting. The defendant manufacturers who were members of the Asbestos Textile Institute were advised of and received a copy of Selikoff's paper at the June 6, 1963, meeting of the ATI Air Hygiene Committee.

I. Asbestosis

a. Ancient History

The earliest recorded historical recognition of the hazards of asbestos dates to the time of Christ.

Strabo, the Greek geographer and historian (63 B.C. - A.D.), described the dangers of asbestos weaving. [illegible] the Younger (61-113 A.D.), in his description [illegible] of slaves, called asbestosis an [illegible]. Both writers stated that [illegible] manufacture of handkerchiefs, [illegible] cloth was common, and that the [illegible] articles was equal to the pearls of [illegible].

[illegible] referred to the use of respirators to avoid inhalation of the dust by the slaves.[2] The Romans instituted

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the use of respirators in order to extend the lives of these slaves, much as one might oil a machine to keep it from wearing out too quickly. The Romans did not have pathologists with microscopes or the science of radiology available to them, but nonetheless they saw the gross effects of asbestos inhalation on their workers. It is stated that Charlemagne's tablecloth was composed of asbestos and it was cleaned by torch.[2]

The modern asbestos industry began in the 1870's, and commercial production of asbestos insulation products was recorded as of 1874. Selikoff and co-workers wrote in 1965:

> Asbestos, as a mixture of fiber and sodium silicate, was first used as an insulating material in 1866 and as asbestos cement about 1871. Magnesia and asbestos as a binder soon followed and air-cell covering, made with corrugated asbestos paper, was introduced in 1898. These materials are still in use, with others.[3]

b. Initial Recognition of a Hazard

The first modern reports of asbestosis were in asbestos textile workers in England and France.[4,5] One of these, Murray's case, was not published in the general medical literature, but it was referred to in a 1918 bulletin published by the U. S. Department of Labor's Bureau of Labor Statistics (Hoffman).[6] Hoffman said that the mining and "dressing" of asbestos

> unquestionably involve a considerable dust hazard, but the hygienic aspects of the industry have not been reported upon. 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.

He continued,

> It is [illegible] that there should be no further information available regarding the asbestos industry in its various branches, including the utilization of by-products of manufacture, on account of the self-evident injuriousness of asbestos dust as a predisposing cause of pulmonary tuberculosis. (Emphasis added).

Hoffman's Department of Labor bulletin contained numerous pleas for research on health hazards in the growing asbestos industry

The rapidly increasing developme[illegible]
using asbestos, as ascertained from [illegible]
of foreign sources, suggests the [illegible] of more
qualified medical considerat[illegible] to prepare a
Dem[illegible] given the subject.

Hoffman also noted that there was no [illegible] literature at
on asbestos-related diseases from the Surgeon General's Library,
the U. S. Geological Survey, or the state of Georgia where asbest[illegible]
was mined.

"There is evidently an urgent need for a more qualified and extensive investigation of the health effects of asbestos manufacture," he said, in the paragraph describing Murray's case report. "It is therefore to be anticipated that the conditions of asbestos workers will attract more qualified attention in this country in the future than it has in the past."

Also in 1918, Pancoast and co-workers reported finding fibrosis in the chest x-rays of 15 asbestos workers.[7]

The first report of asbestosis in the British medical literature was by Cooke in 1924.[8] In 1927, Cooke published additional details of his case, a 33 year old woman.[9] Another case of asbestosis in Britain was reported by Seiler in 1928.[10]

In 1929, Haddow reported four fatal cases of asbestosis with average age at death was 41.[11] He also had four "advanced" cases under treatment whose average age was 35.

In 1928-1929 Merewether and Price of the Factory Department in Great Britain investigated the health of workers exposed to asbestos. The asbestos textile industry was a logical place to [illegible] the study, because these workers' exposure was to [illegible] only one of which was fibrogenic - asbestos. [illegible] sters of relatively large groups of [illegible] employed for long periods of time, thus giving [illegible] opportunity to observe the effects of prolonged [illegible]

Mereweather and Price examined 361 workers and found that 91 (26%) had asbestosis and 21 others had "precursive signs" of it.[12] Based on these findings, the authors wrote,

> ...it appears that the general incidence rate of fibrosis of the lungs amongst those employed in these sections of the industry is rather less than 1 in 8, or, excluding those employed under 5 years, rather less than 1 in 3.

These investigators analyzed the workers' exposure by lengths of time and dustiness of job, and summarized their findings thusly:

> While it seems necessary for the production of generalized fibrosis of the lungs that a definite minimal quantity of dust must be inhaled, the lower the concentration of dust in the air breathed, the longer the lapse of time before the fibrosis is fully developed, and within a certain limit, the higher the concentration of dust, the sooner the fibrosis becomes fully developed and the more intense the involvement of the lung tissue.
>
> If this hypothesis is correct, and the evidence points to it, the practical inferences are of very great importance, since it follows that the application of measures resulting in the reduction of the concentration of dust in the air in the neighbourhood of dusty asbestos processes will cause, first a great increase in the length of time before workers develop a disabling fibrosis, and secondly, the almost total disappearance of the disease, as the measures for the suppression of dust are perfected.

J. C. McVittie, of Great Britain's Ministry of Pensions and National Insurance, described the reaction to this report, which contained specific recommendations for improved ventilation and dust suppression.[13]

> Under Section 79 of the Factory and Workshops Act of 1931 the Secretary of State issued a certificate to the effect that 'the manipulation of asbestos and the manufacture and repair of articles composed wholly or partly of asbestos and processes incidental thereto are dangerous.' The section in the Workmen's Compensation Act of 1925, which provided for the application of that Act to workmen suffering from silicosis was extended to certain processes involving exposure to asbestos dust, and in 1931 asbestosis became a compensable disease. Compensation cover was fairly wide and the compensatable disease was defined as 'fibrosis of the lungs due to asbestos dust or that disease accompanied by tuberculosis.'

Regulations for exhaust ventilation, dust control and housekeeping measures in asbestos plants were made effective on March 1, 1933.

and related to manufacture and repair of materials composed wholly or partly of asbestos. Thus, it was recognized that it was not necessary to be exposed to "pure" asbestos in order to be liable to the disease. Mereweather's findings were subsequently reported in the American literature.[14]

At the end of 1930, Dr. W. B. Soper published a case report of asbestosis from Connecticut, in the American Review of Tuberculosis.[15] Noting the dearth of American medical literature on asbestosis and acknowledging the flurry of British publications on the subject, he wrote:

> Just as certain other dusts took their toll over a long period before the medical profession awoke to the true facts, so asbestos dust to a lesser degree appears to be taking its toll without sufficient recognition of the fact on the part of physicians.

In 1926 radiologists Pancoast and Pendergrass of Philadelphia reported x-ray abnormalities among asbestos workers they examined.[16] They published "A Review of Pneumoconiosis" in 1931.[17] In addition to some cases mentioned above, they described asbestosis case reports from 1927 to 1929 by Oliver and by Wood and Page, as well as the extensive study by Mereweather and Price. They noted the progressive nature of asbestosis:

> The condition is apparently progressive even after cessation of occupation. Mereweather and Price state that with continued exposure to high concentration dust fibrosis may be fully developed in from seven to nine years, and death may result in about thirteen years. With less concentration, fibrosis may not be fully developed for 15, 20 or 25 years. Inhalation of dust in high concentration results in a more marked degree of fibrosis in a shorter time than when the concentration is lower. (Emphasis added).

Another case report of asbestosis was published in 1931 by Lynch [illegible] Charleston, South Carolina.[18] A literature review and [illegible] followed. In their survey of the available literatu[illegible] the authors counted a total of 172 cases of pulmonary asbestosis. Stewart and co-workers in Philadelphia reported two more cases of asbestosis in 1931, one after only nine months of exposure[19] and the authors concluded by calling for further study.

Plaintiff has not surveyed the entire considerable body of medical literature in the late 1920's and early 1930's. Suffice it to say that a plethora of case reports and surveys appeared in the literature.

c. The First Insulator Cases

Doctors Wood and Gloyne reported a case of asbestosis in an asbestos "sawyer" (presumably one who saws asbestos as does an insulator) in 1931.[20]

In the July, 1933, issue of the Journal of Industrial Hygiene, Dr. Phillip Ellman described the first case of asbestosis in an insulation worker to appear in the American medical literature:

> A typical lesion of mild activity, with an early stage of pulmonary asbestosis, was present in one of my cases who had been exposed to asbestos dust for ten years; but the work, which consisted in coating lead pipes, did not entail exposure to high dust concentrations.[21]

In a 1932 British Government publication, industries and processes in which asbestosis occur were described and included "the making and repairing of insulation mattresses composed wholly or partly of asbestos and the saving of articles composed wholly or partly of asbestos..."[22]

In 1934 Dr. Ellman again described a case of asbestosis in an insulation worker in a paper published in the British Journal of Radiology.[23]

In 1934, Wood and Gloyne published a review of the first 100 cases of asbestosis they had seen. Among the 67 women in their [illegible] the shortest exposure was six months (2 cases)..." [illegible] of the men and all of the women in this series worked at [illegible] the men the shortest exposure was 11 [illegible] reported seeing at least 3 cases [illegible] year of occupational [illegible] individuals worked at [illegible] fibers. [illegible] is also interesting:

That even serious damage to the lungs is not incompatible with many years of tolerably comfortable existence is proved by such an example as that of a patient who was still able to carry out administrative duties at a factory when nearly 40 years' exposure to the dust had caused a fibrosis involving [illegible] of the lungs.

It is reasonable to consider the import of this case with regard to the asbestosis risk of insulation workers. This case is described later in the paper as having had "about 40 years (clerical and administrative work)" at an asbestos factory, as of 1934.

The authors provided brief, individual discussions for only a handful of cases. They noted two that resulted from outdoor exposure to asbestos:

> ...a van boy, aged 18, whose spare time during two and a half years' employment had been spent in mixing powdered asbestos in an open yard...
>
> ...a man who had been employed handling asbestos mattresses in the open air at an aerodrome.

Again, one wonders how these exposures compared with the exposures of insulators. Insulators worked in the open air at times, but at other times worked in very confined enclosures where the airborne dust concentrations could "accumulate" in the course of doing a job.

The authors next described asbestosis in "...a middle-aged boiler riveter who had served his apprenticeship as a youth in a shop where asbestos was used for lagging pipe..." It was not stated that this man ever applied insulation to pipes himself, but if he did it could have been only intermittently during his (several year?) apprenticeship for the boiler riveting trade. He did work in close proximity to insulation workers during his apprenticeship and thus was exposed to the dust this work created.

This report further mentions that two of the asbestosis cases in the series also had carcinoma of the lung. The following year

Wood 6 lung
100 cases
2 Ca
1934

7

Doyne issued a separate report on these two cases of lung cancer.

d. Early Studies of Asbestos Textile Plants

The asbestos industry produced a study of its workers in [illegible] conducted by Lanza and co-workers of the Metropolitan Life Insurance Company: 1930

> In 1929, the Metropolitan Life Insurance Company was approached by officials representing the asbestos industry in the United States, who were desirous of ascertaining whether asbestos dust was an occupational hazard in their establishments and, if so, what was the nature of this hazard and what should be done to prevent or control it.[25]

Dr. Lanza reported that the industry appeared to be "quite uninformed" of the hazard and observed that in many departments the exposure was to an admixture of asbestos and other substances and in some operations, the exposure was to materials containing only 25% asbestos. Dr. Lanza (later a consultant to Johns-Manville) recommended that the industry face up to the problem of dust control, and "sponsor studies on known cases of asbestosis as well as studies on effects of asbestosis on the heart."

e. The Hazard Intensifies as the Industry Grows

In 1935, D. S. Egbert of the Yale University Medical School reported a fatal case of asbestosis in a 30 year old man. The author noted that

> The asbestos industry is growing rapidly and that, as a result, pulmonary asbestosis will continue to become more important is seen from the fact that total world production of asbestos has increased from 96,490 tons from 1910 to 434,938 tons in 1929.[26]

He included a table, "Summary of reported fatal cases of pulmonary asbestosis", in which the reference, age of the victim, time exposed before onset of symptoms, total time exposed, and principal findings were recorded. Total time of exposure was only 9, 12, 15, 24 and 28 months for some of the cases which Dr. Egbert listed.

In 1938, Donnelly of the Mecklenburg Sanatorium in Huntersville, North Carolina, presented another paper at an annual meeting of

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the Industrial Hygiene Section of the American Public Health Association in Milwaukee. It was published the following year.[27] Donnelly's opening remarks called attention to the public health implications of the rapidly rising demand for asbestos products:

> That the serious industrial hazard of this type of work has not previously received sufficient attention is becoming more apparent. The manufacture of asbestos products has increased more than four-fold in the last 20 years, and hence, because of the greater number of workers exposed, and the more frequent recognition as a pathological entity of the resulting pulmonary condition, the subject of asbestosis has rapidly assumed greater importance.

In the same issue of the Journal of Industrial Hygiene and Toxicology, S. B. McPheeters of Charlotte, North Carolina, reported on the clinical examination of 210 asbestos textile workers seen at work.[28] None of the workers had been exposed for more than 20 years. In his opening paragraph, the author wrote:

> While it employs a relatively small number of persons the asbestos industry has had a remarkably rapid expansion and by reason of the widespread and varied uses of its products which include 'matches, filter pads, paints, roofing, high-pressure jointing, electrodes, brake linings, clutch rings and insulating material in a great variety', the industry occupies an important, increasing and permanent place in our economic establishment.

f. Case Reports of Insulators Contracting Asbestosis Increase with the Accelerating Use of the Products

As previously stated, asbestosis is a lung disease which is caused only by the inhalation of asbestos dust and particles - asbestosis is agent specific related to asbestos. Thus, any reports in the literature describing an insulation worker patient with asbestosis or other asbestos related diseases demonstrates [illegible] could be and were being contracted by insulators. [illegible] reports found in the literature describing asbestos related diseases.

Year	Author	Nature of Disease	Type Employment and Number of Cases	[illegible] Disease
1931	Wood and Gloyne	Asbestosis	1 sawyer	don't know
1933	Ellman	Asbestosis	1 insulator	no
1934	Wood and Gloyne	Asbestosis	1 insulator	no
1942	Holleb and Angrist	Asbestosis and lung cancer	2 insulators	yes
1946	Fleischer and Drinker	Asbestosis	3 insulators	yes
1946	Skavlem	Asbestosis	sawyer	don't know
1949	Franchini	Asbestosis	insulator	yes
1950	Frost	Asbestosis	insulator	no
1951	Stoll, Bass and Angrist	Asbestosis and lung cancer	insulator	yes
1952	Hardy	Asbestosis and lung cancer (citing Stoll)	insulator	no
1953	Sander (Medical consultant to an asbestos mfg. co.)	Asbestosis	plumbers helper	no
1953	Isslebacher	Asbestosis and lung cancer	insulator	no
1956	Pendergrass	Asbestosis	insulator	don't know
1959	Hertz and Feinwein	Asbestosis and cancer	insulators	no
1960	Anderson and Campagna	Asbestosis and lung cancer	insulator	yes
1960	Eisenstadt	Asbestosis and mesothelioma	oil refinery - worked with insulation materials	don't know
[illegible]	Teliachi [illegible] Limestone	Asbestosis and lung cancer	plaster mixer	don't know
1962	[illegible]	Asbestosis	automobile undercoater	yes
1962	Eisenstadt	Asbestosis and mesothelioma	3 oil refinery workers who worked with insulation	yes
1962	McCaughey	Asbestosis and mesothelioma	insulator	don't know
1962	Smither	Asbestosis and mesothelioma	insulator	no

Year	Author	Nature of Disease	Type Employment and Number of Cases	IHF* Disease
1963	McCaughey	Asbestosis and mesothelioma	Insulator	yes
1963	Case Report - Mass. General Hospital	Asbestosis and mesothelioma	Insulator	no

*Denotes whether the article was abstracted in the IHF Digest, a monthly publication which was received by members of the Industrial Health Foundation (membership included Johns-Manville and Owens-Corning

In addition to the above listed case reports, there were an additional substantial number published in 1964.

One of the defenses interposed by the defendants is that case reports are not highly significant as they merely describe an isolated incidence of one patient with a disease. The defendants contend that only surveys and epidemiologic studies of large population groups are significant. Below is a table of pre-1964 surveys and epidemiologic studies indicating hazards to insulators.

and 1 case reports vs surveys & epidemiologic

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TABLE 2

Year	Author	Nature of Survey	Disease	IH?
1932	British Home Office	Lists dusty occupations and includes repair of mattresses and sawing asbestos	Asbestosis	no
1942	Hueper	Lists asbestos as a carcinogen and surveys case reports	Lung cancer	no
1946	Fleischer-Drinker	Epidemiologic survey. Finds 1 cases of asbestosis in shipyard but concludes trade isn't hazardous	Asbestosis	yes
1947	U. S. Navy Safety Review	Surveys a shop operation at Naval Base and concludes that insulation work is hazardous	Asbestosis	yes
1947	Kennaway	Autopsies of cancer victims. Included an insulator	Asbestosis and lung	no
1948	British Ministry of National Insurance	Insulators are made eligible for Workmen's Compensation	Asbestosis	no
1949	British Home Office - Annual Report of Chief Inspector of Factories	Discusses hazards in insulation work	Asbestosis	no
1954	Breslow	Epidemiologic survey of lung cancer victims citing insulators as being at risk	Lung cancer	don't know
1955	Hueper	Surveys environmental causes of cancer, cites use of asbestos as an insulation material and lists asbestos as carcinogenic	Lung cancer	no (but cites ATI)
1955	[illegible]	Traces history of dust diseases and lists insulators at risk	Asbestosis	don't know
1956	[illegible]	Survey and study of insulators at a shipyard and finds extensive asbestosis	Asbestosis	yes
1960	[illegible]	Epidemiologic survey of miners, civilians and insulators	Mesothelioma	don't know
1960	Keal	Survey of cancer and asbestosis in asbestos workers including	Asbestosis and lung cancer and	yes

AL102 3C 1986

Year	Author	Nature of Survey	Disease	IMP
1962	Cordova	Survey and study of cases including insulators	Asbestosis and lung cancer	yes
1962	Song Hi Cin	Survey of lung cancer in asbestos workers including 6 insulator reports	Asbestosis and lung cancer	don't know
1963	Selikoff	Initial paper presented on epidemiologic survey of insulation workers	Asbestosis and lung cancer and mesothelioma	ATI
1964	McVittie	Retrospective study (1955-63) of insulators who filed for Workmen's Compensation showing large number of claims	Asbestosis	no
1964	Selikoff, Hammond and Ehticknap	Epidemiologic studies	Asbestosis and lung cancer and mesothelioma	yes

In addition to the numerous case reports, survey and epidemiological studies above discussed, general articles and editorials appeared in the literature indicting asbestos as a carcinogenic substance or an environmental health hazard to civilians and calling for testing or for development of substitute products or for expenditure of funds for dust suppression. (Table 3).

The British Government was ahead of the United States Government in recognizing insulators as a group at risk and taking definitive action to deal with the problem. In the 1932 Memorandum to the British Home Office[12] discussed briefly above, the hazards associated with making and repairing of insulation mattresses and the sewing of admixtures of asbestos was cited. By 1946 insulators were specifically made eligible for occupational disease Workmen's Compensation benefits[13] and in a 1964 retrospective study of occupational disease compensation claims for the years 1955-61, McVittie reported that the largest increase was noted in asbestos insulation workers.[13]

In his annual report for the year 1949, the British Chief Inspector of Factories stated:

> It is very necessary to keep an ever watchful eye for the new case of asbestos in some manufacturing or other process, for example on ships or buildings where the work may be undertaken by someone not fully realizing the necessity of preventing as far as possible the inhalation of asbestos fiber and dust.[14]

In his 1949 Report, the Chief Inspector also described in detail the hazards resulting from the use of asbestos spraying machines for insulation purposes on ships and buildings. Unlike their American counterparts, the Chief Inspector observed that the manufacturer which leased such machines took steps to advise the contractors and insulators as to the dangers resulting from such operational and [illegible] in its proper use:

> In view of the risks to health unless proper precautions are taken in the application of asbestos by means of these [illegible] the firms from which they are hired out [illegible] operatives of various insulation contractors are given a course of training in their proper use and manipulation, lasting about 14 days, and representatives attend these courses from overseas as well as from the British Isles.[14]

The Chief Inspector concluded by condemning the practice of shipping raw asbestos fibre in impermeable bags (a practice banned within British factories).

A. R. Fisher, then President of Johns-Manville, in an address in 1955 before the Twentieth Annual Meeting of the Industrial Health Foundation, praised the free enterprise approach to industrial health practiced in the United States. Comparing the voluntary but enlightened attitude of United States industry's approach to industrial health and consumer safety with the "cradle to grave security" of Great Britain, Fisher opined

> It is only in our Western Civilization that real progress has been made. And the greatest progress has been recorded in the United States and Canada. Perhaps there is a definite reason for this. Ours is the middle approach. We do not leave the problem of the nation's health entirely to the Government. We do not leave it entirely to private groups. Nor do we neglect it or merely pay lip service to it....Our approach to the health of the nation is different from that of England. Ours is neither a Government controlled health program nor one dominated completely by private enterprise.... [P]rivate industry promotes the well-being of the individual. Indirectly, we have our so-called cradle-to-grave security without the heavy hand of Government....[I]ndustry today is directed by enlightened professional managers who realize their obligations and responsibilities to their employees, customers, stockholders and the public.[75]

Fisher directly addressed himself to the question of industry's responsibility to the consuming public. "Every effort is made nowadays to protect the consumer with safer products and better methods of handling them." Having touted industry's enlightened attitude toward the health and safety of consumers of their products Fisher compared 1955's attitude with the past.

> Years ago industrial research was unconcerned about problems of health and safety that might be involved in [illegible]. While the product was developed, it was [illegible]. Today our industrial research [illegible] probes into every health hazard. And every safeguard is insisted upon before the product is marketed to the consumer. (Emphasis added).

Fisher praised the establishment by some companies of research organizations whose "sole purpose" was the elimination of "health hazards that might injure the consumer."

Fisher concluded his praise of industrial responsibility to the consuming public by observing that industry has inspired to a very great extent the movement to label properly certain types of products that might harm the consumer if he were not forewarned."

In abrupt contrast to Fisher's eulogy to industry, his own company, as verified by Answers to Interrogatories:

1. Never prior to 1964 contributed a dime to or sponsored or encouraged medical research designed to determine whether or not insulation products containing asbestos might harm insulation workers.

2. Never prior to 1970 conducted field tests to determine whether the use of their products in the field by insulators exceeded the TLV.

3. Placed no warning labels on asbestos insulation products prior to the fall of 1964.

The record of other major manufacturers is even more dismal.

Had the American asbestos industry heeded the "heavy hand" of the British Government's concern over the health of insulators or implemented Fisher's ideology of responsibility to the consuming public, these lawsuits would not have occurred.

TABLE 3

Year	Author	Subject and Disease	IHF or ATI
1942	Hueper	Brands asbestos as cancer agent and calls for use of substitute products	no
1944	Journal of the American Medical Assn. editorial	Lists asbestos as a cancer agent and calls for more research	don't know
1947	U. S. Navy Safety Review	Cites insulators as being at risk and recommends that dust suppression measures be undertaken. Finds TLV exceeded in an insulation operation	IHF
1949	Conklin	Brands asbestos as cancer agent and calls for testing and search for substitute products	ATI
1949	Kenneth Smith and Johns-Manville officers	Health survey of mill and request for funds to improve dust inside and outside the mill.	no
1949	Journal of the American Medical Assn. editorial	Cites asbestos as cancer agent and threat to workers in asbestos consuming industries	yes
1951	Stoll	Case report of asbestosis and lung cancer and cites need for "careful preventive measures".	IHF
1952	Hueper	Article exhorting industry to concern itself with cancer risks to consumers and to general public and to seek substitutes for known cancer causing substances	no
1952	Hardy	Article calling for more testing of cancer causing agents and cites several case reports of insulators who had asbestosis and lung cancer	no
1954	[illegible]	[illegible] epidemiological survey citing asbestos as a cause of lung cancer and calling for further "intensive investigation"	don't know
[illegible]	[illegible] (President of Johns-Manville)	Presentation before IHF in November, 1955, comparing past "unconcern" over testing with current "insistence on every safeguard prior to marketing a product"	IHF

Year	Author	Subject and Disease	IMF or ATI
1955	Hueper	In a book written by this pioneer, Dr. Hueper again indicts asbestos as a cancer agent and suggests that the general population is at risk from atmosphere pollution and specifically lists insulators as being at risk. Dr. Hueper again calls for the use and development of substitute products.	ATI. This was specifi discussed a all meeting including a discussion risk to gen public and

The above tables and discussion graphically demonstrate that there was a distribution of scientific writings specifically describing health hazards of asbestos.

5. Fleischer-Brinker

The defendants premise their main state of the art defense on this survey of shipworkers which was published in 1946. They contend that they were misled by this survey into believing that insulators were not at risk.

1. The survey's deficiencies

In 1945 U. S. Navy doctors took x-rays of 1,074 men who were working as pipe coverers in Navy yards.[29] They also found that exposure to asbestos dust was below 5 mppcf in most of these workers' tasks, but that level was exceeded in some measurements. This study had several deficiencies in its methodology. First, they did not monitor the dustiest job of all in ship insulation work--the removal of old insulation. Second, only 51 of the men had been doing insulation work for more than ten years, and only three cases of asbestosis were identified. All of the diseased workers had been exposed for over twenty years to asbestos products. The vast majority of scientists recognized in 1946 that clinical or x-ray evidence of asbestosis was generally non-existent absent fifteen years or more of exposure. Thus, slightly less than 10% of those still working who were generally thought capable of manifesting symptoms of the disease were, in fact, sick, a not insignificant percentage. Third, the authors ignored the experience of many previous investigators who found that a complete clinical examination is necessary to diagnose asbestosis accurately -- no such examinations were conducted in Fleischer-Brinker. Symptoms of cough and shortness of breath may be pronounced in cases where the x-ray shows little sign of disease.

The main shortcoming of the study was that very few workers had been exposed long enough for cases of asbestosis to "mature". Only 12% of workers had worked for 5 to 10 years in the pipe covering industry; only 176 had been exposed for 5 or more years. Yet, in spite of these limitations, the authors cited a ridiculous statistic and concluded that the trade was safe.

> The incidence of asbestosis among pipe coverers in the shipyards studied was low, 0.29 per cent or three cases out of 1074...
>
> Since each of the three cases of asbestosis had worked at asbestos pipe covering in shipyards for more than 20 years, [illegible], he concluded that such pipe covering is not a dangerous occupation.

Furthermore, only active workers were surveyed, thus distorting the statistics by the absence of workers who may have been disabled due to asbestos related diseases.

2. Lack of reliance by Johns-Manville

Dr. Kenneth Smith has testified that he had never heard of the Fleischer-Drinker survey before 1976. Clifford Scheckler, former Industrial Hygienist for Johns-Manville, testified in the Borel case that he was unaware of Fleischer-Drinker prior to 1960.

If, in fact, Johns-Manville relied on Fleischer-Drinker, they utterly failed to follow through on its recommendations. While Fleischer-Drinker recommended that dust suppression measures be taken to prevent disease in insulators, none of these recommendations were implemented by Johns-Manville with their own insulator employees until 1964.

The U. S. Navy obviously did not rely greatly on Fleischer-Drinker. In the January, 1947, issue of the Safety Review, official organ of the Navy's Safety Branch, it was reported that dust levels in one shipyard insulation operation "approached" the TLV and recommendations were forwarded to all Naval operations to implement dust suppression measures including: isolation of asbestos operations in shops from other operations; use of exhaust ventilation; instructions to workers as to [illegible] for and use of respirators.[30] (This Safety Review article [illegible] March, 1947, issue of the IHF Digest).

[illegible] Tables I [illegible] show the multitude of case reports and surveys demonstrating health hazards to insulators, the 1956 Danish survey published [illegible] of shipyard insulators deserves analysis.[31] In contrast to Fleischer-Drinker, the Danish authors, recognizing the established principle that asbestosis does not manifest itself clinically or radiographically until 15 or more years exposure, [illegible]

The researchers, who were radiologists, found "definite signs of pulmonary asbestosis" in 9 of the 31 workers (29%), usually in association with pleural abnormalities.

> In no less than 19 cases abnormalities of the pleura were found. These changes ranged from obliterated sinuses and pleural adhesions to extensive thickening of the pleura with calcification...

Some workers' chest x-rays were so whited-out by pleural calcification that there was no way to get a look at the condition of the man's lungs.

> In a few cases the abnormalities of the pleura were so widespread that no definite diagnosis could be made regarding the conditions of the lungs.

The authors considered the pleural damage to be a reliable sign for judging asbestosis among these insulators. In their introduction, they referred to a 1950 Danish case report of asbestosis in an insulation worker. The Frost-Georg survey was abstracted in the June, 1957, IHF Digest.

II. Lung Cancer

The two earliest reports of lung cancer associated with asbestosis were made by the British pathologist, Gloyne. He wrote at length of the damage to the pleura and lungs in asbestosis, and reported the first published case of pleural cancer with asbestosis in 1931.[32] In 1935 he reported two cases of lung cancer in female workers with asbestosis.[33] He considered the pleural cancer a complication unrelated to asbestosis. He suggested the possibility of industrial origin of the lung cancer, though he realized that there was insufficient evidence to "make out a case for an aetiological association of these two diseases".

One of Gloyne's cases was a 35 year old woman who had worked as a spinner for eight years and had not worked with asbestos for nine years since, making 17 years from onset of exposure until death. The other woman died at 71, 15 years after periods of 6 and 13 months' exposure "in the mattress and opening departments of the factory". These lung cancers were not recognized during the lives of the patients, but were discovered at autopsy

So Carolina
first case of Ca
in 1935

Also in 1935, Lynch and Smith of South Carolina published the first case of asbestosis lung cancer in the American literature.[34] The victim was an asbestos textile mill worker. Lung cancer was an uncommon disease in 1935, and the occurrence of even one case of asbestosis with lung cancer was noteworthy.

Egbert and Geiger at the Yale University School of Medicine published another case report of asbestosis with lung cancer in July, 1936.[35] The patient was a man who worked as a weaver in an asbestos factory for 18 years. He had to leave his job when he developed a disabling pain in his back; he died shortly afterward with lung cancer.

In 1938, Nordmann in Germany published a paper entitled, "The Occupational Cancer of Asbestos Workers".[36] He reported two new cases of lung cancer with asbestosis, in a 35 year old woman and a 55 year old man. Both victims were asbestos textile workers. Nordman reviewed the cumulative literature and was the first to propose that lung cancer be recognized as an occupational disease among asbestos workers, tabulating statistics from all of the earlier reports.

Finally, Nordmann assembled the scant autopsy data on asbestosis cases to reveal that an unusually high fraction of these cases had cancer. Referring to Wood and Gloyne's report of 100 cases of asbestosis, he noted that of 12 autopsied cases 2 (17%) had lung cancer. In Germany, he knew of 12 autopsied cases of asbestosis and 2 of these also had lung cancer.

In England, the Senior Medical Inspector of Factories reported that a total of [illegible] cases of cancer of the lung had occurred in 10[illegible] autopsied [illegible] on record as of 1938 (11.6%).[37]

[illegible] reported another [illegible]osis with lung cancer in a 50 year old [illegible] with asbestos 15 years before he [illegible] with asbestos for 13 years. The malignancy

of the lungs was so extensive that no definite point of origin could be positively determined. The authors reviewed other literature on lung cancer with asbestosis, noting that Merewether considered lung cancer with asbestosis an occupational disease.

In 1942, the lengthy book Occupational Tumors and Allied Diseases was published in the United States by Dr. Wilhelm Hueper.[3] Hueper had begun his research on cancer in 1925 in Chicago. By 1942, he had established himself as one of the leading American authorities on experimental toxicology and carcinogenesis with dozens of studies and books on a wide range of substances used in industry. Hueper assayed the evidence on asbestosis and lung cancer and concluded that the evidence was "suggestive of an occupational origin".

Dr. Huepar acknowledged that there was not a plethora of case reports of asbestosis-lung cancer but he drew an analogy to "previous experience" with other occupational cancers and concluded that: "such isolated cases may represent the first warning of a subsequent appearance of large numbers of similar tumors of undeniable occupational derivation". This prediction regrettably was, if anything, an understatement of the extent of the asbestos-cancer problem. Hueper went on to discuss medico-legal and social aspects of the problem and urged wide ranging studies of the cancer risks of asbestos work:

> Asbestosis carcinoma of the lung is not included in any group of occupational tumors recognized by any country. The evidence presented is sufficiently serious, and the number of persons exposed to the suspected causative agent large enough to indicate a thorough and extensive clinical, statistical, and experimental investigation of the incidence and causative interrelation of asbestosis and pulmonary carcinoma.

The first case report of asbestosis-lung cancer in insulators was reported by Holleb and Angrist in New York.[4] The deceased were men aged 52 and 58 and both had worked applying insulation to pipes for over twenty years. The authors observed that these insulators were exposed to relatively low concentrations of dust and reasoned that long term low exposure probably had a cumulative effect in

On January 29, 1943, the German government declared "asbestosis in combination with lung cancer" a compensable occupational disease, acknowledging that lung cancer occurs in relatively [illegible] cases of asbestosis as well as in advanced asbestosis.[41] Thus, the citations of this health hazard in the medical literature since 1938 by Nordmann, et al, resulted in the German government formally recognizing this occupational disease within a period of 5 years. Germany's tradition of industrial disease compensation stretches back to 1884 (German Industrial Insurance Act).[19] In contrast in the United States, Hueper wrote in 1942 that 24 states in this country still did not hold employers liable for diseases workers contracted as the result of conditions of their employment.

In 1943, Hueper was no longer uncertain about the occupational origin of lung cancers with asbestosis. He wrote the following in the Bulletin of the American Society for the Control of Cancer:

> Asbestosis cancer of the lung is the most recent newcomer among 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.[42]

In the same article, Hueper urged that industry take action to control occupational cancer and implored that research be undertaken and substitute products be found:

> Industry should devote considerably more effort than heretofore in determining the cancerous or noncancerous [illegible] their numerous products which may be suspected [illegible] grounds in cancerigenic respects...
>
> Industry should make serious attempts to eliminate all potentially cancerigenic agents from further use by the development of suitable substitutes.

JAMA 1944 Ed.

The Journal of the American Medical Association carried an editorial, "Environmental Cancer", on November 25, 1944.[43] The editorial warned that

> The largest and most important group of environmental cancers is represented by occupational cancer elicited by exposure to chemical and physical agents in the course of regular occupations... The agents known or suspected to cause occupational cancer are... asbestos.

The Editorial called for a search for substitute products:

> The benefits from such efforts will be not only the early detection and improved prognosis of cases of occupational cancer but also the prevention of industrial cancer by the elimination of exposures to cancerigenic agents.

In 1947, Kennaway and Kennaway published a report on lung cancer in Great Britain.[44] From a search of death certificates of lung cancer in males between 1921 and 1938, they found 8 with asbestosis listed as well. They were unable to obtain satisfactory figures on the number of persons occupationally exposed to asbestos but believed the number of lung cancers was probably greater than would be expected for the number of workers exposed. One of the cases they reported was a "boiler and pipe asbestos coverer".

The following year the British pathologist Cureton reported a case of lung cancer with asbestosis in a woman who died at the age of 37.[45] This woman had worked for 7 years in "a factory making asbestos pipe covers", starting at the age of 15.

Merewether, Chief Inspector of Factories, produced cumulative statistics for autopsied cases of asbestosis in England from 1924 to 1946 in his annual report for the year 1947.[46] In a total [redacted] cases, "cancer of the lungs or pleura" was present in 31. This was contrasted with the incidence [redacted] and the general adult population (1%). In other words the expected number of lung cancers in a series of 235 would be 2 or 3 (0.01 x 235) and instead it occurred. The chance that as many as 31 lung cancer cases in 235 would occur if their real likelihood were only the same as that of the general population (1%) is remote — less than 1 in a million!

This Mereweather report was often cited in later papers. The large number of asbestosis cases with lung cancer pointed unmistakably and unwaiveringly to [illegible] occupational origin of these cancers.

A 1949 Editorial in the Journal of the American Medical Association ("Asbestosis and Cancer of the Lung") discussed Mereweather's findings.[47] The Editorial cited epidemiological and experimental evidence suggesting that asbestos workers were at increased risk of lung cancer. It characterized this risk as "probable", and stated that workers in asbestos-consuming industries should be considered at risk along with manufacturing plant workers:

> Since some 20,000 workers are employed in the asbestos-producing industries of this country and Canada and many additional thousands in various asbestos-consuming industries, increased attention to this probable occupational hazard of cancer of the lung by the medical profession is desirable.

Wyer's, later medical director of an asbestos producer, report on 115 deaths from asbestosis in England also offered statistics on the incidence of accompanying lung and pleural cancer.[48] Lung and pleural cancer were referred to as one entity: "The proportion of pulmonary cancers in the series was therefore 14.8 per cent."

Another case of asbestosis-lung cancer in an insulator was reported in 1951.[49] The authors concluded that there was definite association between industrial exposure to asbestos and lung cancer and urged that this relationship mandated the undertaking of "careful preventive measures".

Hardy of the Massachusetts Institute of Technology referred to prior case reports of asbestosis with lung cancer in an insulation worker and in a man who "worked for seven years sorting and carding asbestos fibers intended for insulation and manufacturing" She concluded,

> These cases have particular significance since there are nearly 10,000 workers exposed to varying amounts of asbestos in American industry, many of them in some operations not properly safeguarded against a potential carcinogen.[50]

Subsequently, Isselbacher and Hardy and co-workers reported another case of asbestosis with lung cancer in a contractor's helper who worked with asbestos insulation products in 1951.[51]

Weiss in Germany also in 1953 reported a case of pleural cancer with asbestosis in a man who had been an asbestos insulation worker.[52]

Thus, by 1953, five different reports (Holleb and Angrist 1942 - Kennaway 1947 - Stoll, et al 1951 - Isselbacher 1953 - Weiss 1953) had appeared describing asbestosis-lung cancer in insulators and two leading researchers, Hueper and Hardy, had expressed specific concern for users of asbestos insulation products.

In additon, Dr. Breslow of the California Department of Public Health in early 1954 in an extensive epidemiologic survey listed insulators as an occupational group excessively at risk to contracting lung cancer and called for further intensive investigation.[53]

In 1955, Doll in England reported that of 105 asbestos textile workers examined at necropsy from 1935-1953, 18 had lung cancer.[54] Follow-up study of 113 men with at least 20 years' exposure showed that 39 deaths had occurred, whereas only 15.4 would have been expected based on general mortality rates. The excess was entirely due to lung cancer (11 against 0.8 expected) and other respiratory and cardiovascular disease (22 against 7.6 expected). Doll noted that all of the workers with 20 years or more exposure had been first exposed before the implementation of the asbestos industry regulations. Though he had no data on the fate of workers with [illegible] exposure under the improved conditions, Doll believed the [illegible] asbestos workers had become greatly reduced [illegible] by Dressen and co-workers in 1938, the British asbestos textile mills used the same asbestos that was predominantly used in the American asbestos industry: chrysotile asbestos from Canada.

Tables 1 and 2 list additional post-1955 pre-1964 case reports and surveys of insulators with asbestosis-lung cancer.

The asbestos industry, even if it neither conducted independent research nor kept current with medical literature, can not plead ignorance of this proliferation of literature demonstrating the carcinogenicity of asbestos. As is revealed in Tables 1, 2 and 3, many of these articles were either abstracted in the IAF Digest shortly after the articles were published, and thus delivered on the doorsteps of various of the defendants, or were discussed at ATI meetings. In addition, on three different occasions in the mid 1950's, the ATI rejected proposals to fund cancer studies once citing a fear that such a study "would stir up a hornets nest and place the whole industry under suspicion." Dr. Hueper's 1955 publication received considerable attention at an ATI meeting in 1955, and Hueper's contention that asbestos users and the general population were at risk was emphasized.

III. Mesothelioma

1960

Most scientists hold the view that the seminal survey linking asbestos with the dread mesothelioma tumor was published in 1960. In that year, Wagner of South Africa reported 33 cases of pleural mesothelioma.[55] A history of occupational or environmental exposure to crocidolite asbestos in the North West Cape Province, where it was mined, was established for 32 of the 33 cases. Most of these people had not been occupationally exposed to asbestos, but had lived near the mines and roads where asbestos was hauled and mine tailings were used in road construction. Several insulators with asbestosis and mesothelioma were included in the group surveyed.

Late in 1960, [illegible] reported on 23 women and 19 men treated as in-patients with asbestosis in one hospital in London.[56] Of the 19 men known [illegible] with lung cancer and 1 was thought to have had [illegible]. The man with lung cancer [illegible] coverers". The 4 women [illegible] were all non-smokers. The [illegible] had cancer of the

Wagner and Neal in 1960 sounded the opening of the floodgates of mesothelioma-asbestos exposure reportage. In 1962, the British

began to develop a register of mesotheliomas of the pleura and peritoneum.[57] In calling for information, Smither and co-workers acknowledged that:

> There appears to be no correlation between the severity of any pulmonary asbestosis and the occurence of these tumors. In a number of cases the exposure to asbestos dust appears to have been minimal, and the only histological evidence of asbestos exposure is the presence of a few asbestos bodies and fibres in the lung tissue. However, a detailed occupational history has, in nearly all cases, revealed some contact with asbestos fibre.

McCaughey in Belfast had first reported 15 cases of pleural mesothelioma in 1958, which he investigated further in 1962.[58] Lung sections revealed numerous asbestos bodies in only one of these cases. Detailed occupational histories were obtained for 9 of the 12 cases in which asbestos bodies were present in the lungs. In 4 of the 9 there was "a clear cut history of intermittent exposure to asbestos". In the other 5 there was no known asbestos occupation, but

> all had jobs in the shipyard which inevitably brought them into intermittent contact with asbestos work -- for example, shipyard plumbing and furnace repairing.

In the United States, Dr. Eisenstadt first reported two cases of asbestosis-mesothelioma in a non-plant worker exposed to asbestos insulation products in 1960.[59] He followed this with a description of an additional similarly exposed worker with asbestosis - mesothelioma in 1962.[60]

This was followed in 1963 by the initial publication by Dr. Selikoff of his epidemiologic survey of United States insulation workers in a paper entitled "Asbestos Exposure and Neoplasia".[61] While this study was [illegible] 1964, copies of the paper were circulated at the [illegible] Annual meeting.

While Wagner's 1960 study was the first extensive review of the association between asbestos and mesothelioma, other scientists had been reporting cases of asbestos workers with pleural tumors since 1943.[62] In 1949 Wyers, supra, reported in his series of cases

in asbestos workers, one patient with endothelioma of the pleura (an early nomenclature for mesothelioma).[63] In 1951, Smith, medical director of an asbestos producer, reported mesothelioma in two Canadian asbestos mining employees (one of whom was an office worker).[62]

In 1954, Leicher in Germany reported a case of peritoneal mesothelioma with asbestosis in an asbestos factory worker.[64] The man began asbestos work in 1919 and died 33 years later. Asbestos dust was positively identified in the tumor. Leicher considered the cancer to be of occupational origin, noting that such tumors were very rare in the general population.

Earlier reports had listed "metastatic tumors" in the pleura and peritoneum in cases of asbestosis with lung cancer. Reports of primary tumors of these sites suggested that some of these earlier cases may have been misdiagnosed primary tumors, not metastases.

Bonser and co-workers, reporting in 1955 on post-mortem examination of 72 factory workers with asbestosis in the United States, found 2 pleural and 4 peritoneal cancers.[65]

Eisenstadt, supra, cites several other earlier suggestions of an association between asbestos and mesothelioma, and Selikoff in 1965 cited a 1953 article by Weiss in which the author described a case of asbestosis and mesothelioma in an insulator and suggested a causal relationship.[52]

As was the case with early reports of an association between asbestos and lung cancer, industry did nothing to disseminate such information to insulators and expended no funds to sponsor research [illegible] or deny the association prior to 1968.

[illegible] Wagner's study in 1960, it became accepted [illegible] that para occupational and even casual exposure to asbestos could lead to health hazards. It is now generally conceded that persons with as limited an exposure to asbestos as washing their insulator husband's clothes may precipitate mesothelioma.[66]

Indeed, the occupational hazards of handling asbestos are so great that even one month or less of work in an asbestos plant has been shown to cause mesothelioma.[67]

As is reflected in the memoranda accompanying Dr. Kenneth Smith's 1949 health survey and in Dr. Smith's depositions, Johns-Manville was aware of health hazards to the general population living near asbestos producing facilities as early as 1949.

IV. Threshold Limit Values

The defendants, as an adjunct to their "we didn't know" state of the art defense are likely to also argue that they relied on the TLV (earlier called maximum allowable concentration or MAC) for asbestos and concluded that insulators were not at risk because they supposed that insulation work did not entail exposure to levels above the TLV. Of course, no one tested the level of emission at insulation job sites prior to 1970 to determine whether the TLV was being exceeded and no defendant sponsored research, such as that undertaken by Selikoff, which has demonstrated conclusively that asbestos diseases can be produced at levels significantly lower than the post-1938 TLV.

1. Definition.

The Threshold Limit Value is promulgated by the American Conferenc of Governmental Industrial Hygienists an unofficial body with no legislative powers. As defined by the ACGIH: "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 The TLV for asbestos from 1938 to 1969 was 5 million particles per cubic foot. The TLV required a count of dust particles rather than fibers.

[redacted] establishment of a TLV for asbestos.

[redacted] Health Service was requested by the health [redacted] North Carolina to make an engineering [redacted] medical study of the conditions in that state's asbestos textile industry. The results were published in detail as a Public Health Bulletin in August, 1938, and in more concise form in the American Journal of Public Health in 1939.[68, 69]

In all, 242 dust counts were made to measure workers' exposure. The counts employed standard methods for that time, and all particles

in the air were counted, not just asbestos fibers. The unit of measurement of airborne dust concentration was 1 million particles per cubic foot (mppcf), and the maximum value observed was 74.3 mppcf

> Medical examinations were made of 541 men and women representing practically all of the employees at the time of the study...The three factories studied had been in operation 6 to 16 years. About 15 months before the study, approximately 150 workers were replaced by new ones with little or no asbestos experience. As a consequence, there was an abnormally large percentage of workers with less than 5 years' employment in the asbestos textile industry and an abnormally small percentage who had worked 10 years or more in the industry.

The Public Health Service reported,

> The percentage of persons with asbestosis increases greatly with increasing length of employment....[A]lmost three-fourths of the workers employed for more than 15 years have the early stages, at least, of a disabling disease, asbestosis. Since there is no satisfactory way of locating and examining persons who drop out of an industry because of disability incurred therein, the percentage values of the foregoing tables are necessarily minimal evidence of the prevalence of asbestosis.
>
> ...16.3 per cent of the 69 former asbestos workers [who had been traced] and 378 men and women employed at the time of the study in three asbestos textile factories had asbestosis. (Persons who were not exposed to appreciable quantities of asbestos dust have not been included.)

(The non-exposed persons may have been office workers and other non-production personnel).

> Eight per cent of the 378 workers employed at the time of the study had asbestosis. This does not completely represent the incidence of asbestosis because about 150 employees were discharged from these factories 15 months before the present study was made. Many of the discharged workers had asbestosis, on the reports of Shull, Donnelly [illegible]. Although an attempt was made to [illegible] possible of these discharged cases [illegible] examined, 43 persons of whom had [illegible] to the diagnostic standards [illegible] study.

The investigators went on to estimate that another 30 cases of asbestosis among the recently discharged workers had "escaped observation". In other words, there were 30 cases of asbestosis

in the factories by the time they were inspected by the Public Health Service, and an estimated 93 more asbestotics had been fired by the mill owners shortly before the Public Health Service conducted its survey.

By firing employees with long-term exposure, especially in the least dusty processes, the companies wiped out most of the data base the Public Health Service needed in order to develop any good dose-response data on asbestosis. Only 5 workers in the study who were considered at risk of disease had been exposed to levels under 5 mppcf for over 10 years.

> None of the 39 persons exposed to dust concentrations below 2.5 million particles per cubic foot had a case of asbestosis, although, as a matter of fact, only 6 persons had been employed more than 5 years.

There were 3 "doubtful" or borderline cases of asbestosis found among the workers exposed to 2.5 to 4.9 mppcf. Despite the paucity of data on the risk among workers exposed to less than 5 mppcf, a <u>tentative</u> threshold value for asbestos dust exposure of 5 mppcf was designated. This value stood as the recognized TLV in the United States for the next 30 years.

The Public Health Service investigators were assigned the difficult task of prescribing a limit that would be safe <u>and</u> demonstrably attainable with available process controls. They cited a 1935 Pennsylvania study that showed that incidence of asbestosis increases with the concentration of airborne dust and that found no safe threshold:

> In their report of a similar study carried on in [illegible] asbestos textile factories, Fulton, Dooley [illegible] found that 8 per cent of the work[illegible] average dust concentration [illegible] particles per cubic foot [illegible] of the [illegible] million [illegible] of the [illegible] asbestosis.

The conflict [illegible] Pennsylvania findings and the 5 mppcf threshold [illegible] Health Service study was not resolved in the [illegible] report. Nevertheless, the Public Health Service proposed a TLV based solely on its own health and engineering study ignoring the Pennsylvania study and British studies:

Because of the importance of the problem, it seems to be desirable to use such data as are at hand to define tentative safe working conditions that may serve as standards for the guidance of factory managers and engineers until more complete data are available...

Because clear-cut cases of asbestosis were found only in dust concentrations exceeding 5 million particles per cubic foot, and because they were not found at lower dust concentrations, 5 million particles per cubic foot may be regarded tentatively as the threshold value for asbestos dust exposure until better data are available...

In order to find out the levels to which asbestos dust concentrations have been reduced in practice, an engineering study was made in an asbestos textile factory in which dust control equipment has been recently installed. This shows that means are already available for reducing the dust exposure of a majority of asbestos textile workers to less than 5 million particles per cubic foot.

The investigators were optimistic that no new cases of asbestosis would appear if asbestos dust concentrations in workplace air were kept below 5 mppcf—and followed by describing 5 mppcf as a "tentative threshold" that could be achieved with available methods of dust control.

Unfortunately, nothing was published after 1938 that led to the determination of a threshold for worker exposure that would protect against asbestosis for the next 30 years. Worldwide sales of asbestos fiber from 1939-1969 rose from 492,000 tons per year to 3,315,304 tons per year, with the U. S. in 1968 consuming about 25 per cent of world output.[70, 71]

D. Industry dissatisfaction with the TLV.

The minutes of the ATI are replete with evidence of dissatisfaction [illegible] 5 mppcf suggested by Dreesen in [illegible] reference is made to the fact that the [illegible] dust control and this is attributed [illegible] 1953, March 10, 1954, and [illegible] June 9, 1954, the TLV is criticized for requiring a dust rather than fiber count. (G) The June 9, 1954, minutes reflect that the State of New Jersey had specifically rejected the TLV because of its insistance on counting dust rather than fibers.

Dr. O. A. Sander, medical consultant to an asbestos producer, wrote in 1953 that companies should emphasize dust suppression rather than achievement of levels consistent with the TLV.[72]

Dr. Smith testified in his deposition that Johns-Manville in the early 1950's attempted to achieve dust levels in their various operations below the TLV and set operating standards below such a level.

In sum, the TLV was never intended to be a "fine line" below which disease never appeared and was not considered to be such by industry.