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REPORT OF BARRY I. CASTLEMAN

Re: Wayne Knight (D/O/B 10/18/1943)

In Re: Knight v. Huntington Ingalls Incorporated, et al – 2:18-cv-09421

I. QUALIFICATIONS

My name is Barry I. Castleman. I live at 4406 Oxford Rd., Garrett Park, Maryland 20896. My education consists of a Bachelors Degree in Chemical Engineering from Johns Hopkins University 1968. I have a Masters Degree in Environmental Engineering, which was mainly in areas related to air pollution control from Johns Hopkins University, 1972. I have a Doctor of Science Degree in Health Policy from Johns Hopkins School of Hygiene and Public Health, 1985.

My professional experience goes back over 40 years in the area of asbestos and other occupational and environmental health problems. My field is occupational and environmental health policy, which is a branch of Public Health, mainly oriented towards the recognition of risk factors and the prevention of disease from industrial activities.

The Doctoral degree was awarded for two years of course work, various examinations, and the writing of a doctoral dissertation. The course work was mainly in the areas of toxicology, epidemiology, biostatistics, physiology, and public health policy. These are the tools that are used to understand how the body works and can be damaged by toxic substances, how these effects can be identified by means of various studies of people, studies of animals experimentally exposed and so on.

My Doctoral thesis was, Asbestos: An Historical Case Study of Corporate Response to an Industrial Health Hazard, and is largely identical to a book published in 1984 by Prentice Hall Law and Business called Asbestos: Medical and Legal Aspects (now in its 5th Edition, 2005). The doctoral thesis is an historical review of the asbestos problem as a public health problem in society worldwide, but mainly in the United States. It encompasses a comprehensive review of medical literature of all kinds, as well as other literature available in libraries and published

sources such as government publications, safety magazines, engineering journals, trade magazines, insurance publications, encyclopedias, popular magazines, and newspapers. The doctoral thesis also involved research based on unpublished government records. The government records included workers' compensation claims files where claims had been made by individuals alleging that they had asbestos-related diseases of the lungs, claims against various companies that were their employers, some of which companies were also manufacturers of asbestos insulation products these individuals has used in the course of their work.

In addition to published information of all kinds, I examined files, unpublished information available from the U.S. government archives, the archives of scientists and the archives of institutions that had worked for and with asbestos companies. I also looked at unpublished information which was obtained in legal discovery. This included trade association minutes, corporate documents, and testimony of corporate officials who were associated with asbestos hazards over the years -- doctors, plant managers, executives, and other people who were aware of events that transpired.

In addition to published information and corporate knowledge that came out of mainly legal discovery, I have also interviewed a bunch of old-timers in the field of industrial medicine and hygiene. They included physicians who were active in the field of occupational medicine, such as Harold Stewart, who first published on asbestosis in 1931, and Alfred Angrist, who first published on asbestos and lung cancer in 1942. They are both pathologists. Another, Dr. Wilhelm Hueper, was a leading United States authority in the field of occupational cancer and first director of the environmental cancer section of the National Cancer Institute. Dr. Irving J. Selikoff was the leading epidemiologist and asbestos authority in the US. Dr. Hueper, Dr. Harriet Hardy, Dr. Thomas Mancuso, Dr. Gerrit Schepers, Dr. Richard Doll, Dr. Morris Greenberg, and others I have interviewed were involved in the area of asbestos and health over the past decades.

II. THE BODY OF KNOWLEDGE THAT EXISTS

A. Asbestosis

First let us consider what was available in published sources and how the published knowledge base developed. The originally published reports in the era of the modern asbestos industry came at just before the turn of the century, and the first reports in the English language were included in the annual reports of the chief inspector of factories and workshops in Great Britain. The reported published in 1899, the report for the year 1898, talked about the observation of lung disease in individuals who had worked in asbestos manufacturing plants and about the "evil effects of asbestos dust."

The medical literature of asbestos disease mainly developed after the publication of a case report in the British Medical Journal by Dr. Cooke, a pathologist in Britain in 1924. This was called, "Fibrosis of the Lungs Due to the Inhalation of Asbestos Dust." Dr. Cooke reported on the death of a 33-year-old woman who had worked off and on in asbestos plants from the age of 13. According to Cooke, the scarring of her lung tissues was largely attributable to the inhalation of asbestos in the course of her work. There followed a number of other reports in British sources, and this is reflected as well in the United States in editorials of the Journal of the American Medical Association. In one on January 14, 1928, called "Pulmonary Asbestosis," reference is made to Cooke's case and other reports on the disease now called asbestosis. The Journal of the American Medical Association recommended that further attention be paid to this disease, as it may well be occurring in the United States. The Journal of the American Medical Association issued another editorial in 1930 about asbestosis, this time noting the asbestosis had become a compensable occupational disease in Great Britain under the workers' compensation law. The Journal of the American Medical Association was believed to have been read by 80% of American physicians in those years, medical historians have written.

In the meantime, there were additional reports of asbestosis published in the British Medical Journal, which is in every medical library I have ever walked into. The reports mainly involved deaths of individuals who were verified as having asbestosis by autopsy.

In 1930, a report was published by a physician, Dr. E.R.A. Merewether, and an engineer named C. W. Price. Merewether and Price reported a survey that had been conducted by the Factory Inspectorate in England, including 363 asbestos workers who were actively employed. Of these individuals, 26% were found to have asbestosis. Merewether and Price reported that the people longest exposed had the highest prevalence of the disease: 80% in workers with 20 years or more in the industry. There were no cases of asbestosis in individuals with less than five years, and Merewether referred to that phenomenon that the disease was delayed in appearance and developed gradually over a period of years. It could in seven years be substantially developed in the most severe cases, but more often 11 years or more would elapse before the disease had become largely developed in exposed individuals. This is the time from the onset of exposure. Merewether urged that workers be educated to a sane appreciation of the risk to health posed by asbestos dust. Merewether's 1930 writings on asbestosis are among those most often cited in the literature on asbestosis.

There were reports also of the progression of disease caused by asbestos fibers trapped in the lungs, including a report by the radiologist, Sparks, called "Pulmonary Asbestosis", published in the United States in 1931. Sparks talked about the fact that the disease progressed in some individuals after the cessation of exposure. This was demonstrated by the chest x-rays of the individuals who had been removed from exposure but who had continued to go downhill in terms of their lung conditions.

There are also publications by Dr. Harold Stewart, whom I mentioned, and his coworkers in 1931, describing two cases of asbestosis in the Archives of Pathology, published in the United States. One of these individuals had been exposed for only nine months to uncontrolled asbestos dust conditions and nine years later had developed a severe degree of asbestosis when seen at autopsy.

Other sources were also remarking on the disease, asbestosis. A journal called National Underwriter, a publication of the insurance industry, in a 1932 article called AOccupational Diseases are Not Generally Understood,@ repeatedly called attention to asbestosis and referred to

asbestos industries as dangerous industries from the standpoint of insurers who might be prevailed upon to sell coverage of various kinds for the health of workers in such industries.

In this connection, I would mention that back in 1918 there was a United States publication authored by Frederick Hoffman called Mortality from Respiratory Diseases in Dusty Trades. This made reference to the annual reports of the Chief Inspector of Factories in England and the reports of asbestos disease there. This 1918 report, written by an insurance company actuary, noted that it was the practice of American and Canadian life insurance companies to not sell life insurance to asbestos workers on account of the assumed deleterious conditions in the industry.

By 1932 there were 60 or more publications in print on asbestosis. These were noted by way of reference in a bibliography published by the International Labor Organization in 1932. These publications continued to emerge from many countries. The first cases of asbestosis in the United States were reported in 1930. Asbestosis was also described in an article in the trade magazine Asbestos in the United States in the March 1930 issue, amid numerous advertisements from asbestos mining and manufacturing companies.

In 1932, the first case of asbestosis in an asbestos product user was reported at a conference held by the Industrial Commission of Wisconsin, proceedings of which were published. Here, Dr. Albert Russell of the United States Bureau of Mines described an individual who had worked maintaining the insulations on pipes in a government hospital and had been diagnosed as having asbestosis and had been compensated by the government for disability sustained from this asbestos condition. This is the first published product user case. There were other cases reported in the United States in 1933 by Philip Ellman and also reported by Ellman in 1934 in The British Journal of Radiology. Wood and Gloyne reported in 1934 reported on cases of asbestosis including a boiler riveter who would have been exposed to asbestos because it was used as an insulation material on boilers. Wood & Gloyne's report was called "Pulmonary Asbestosis: A Review of 100 Cases." That was published in The Lancet, the world's oldest medical journal, in 1934. The Lancet is, like the British Medical Journal, a general medical journal published in England and available very widely in medical libraries in the English-

speaking world. This article was widely cited in subsequent literature. Of the hundred cases of asbestosis they reported on, the shortest duration of exposure in any case was six months, in the case of two women who had worked in an asbestos plant.

In 1933 and 1934 in the British journal, Tubercle, Dr. Merewether published "A Memorandum on Asbestosis." He emphatically noted that asbestosis shortened people's lives. Merewether showed that, in the British experience, individuals who had died with silicosis, another occupational lung disease, had an average age at death of 54. In the case of asbestosis, the average age at death was only 41. The duration of exposure was similarly very much different. In the cases of silicosis in which death occurred, the average duration of exposure was 40 years. For asbestosis, the average duration of exposure was only 15 years.

In 1935, the Pennsylvania state authorities published a report on asbestosis in the industry in the state. This was called Asbestosis, published by Fulton and his coworkers at the Pennsylvania Department of Labor and Industry. One-fourth of the workers they examined had asbestosis. They included an impressive bibliography of 125 references to asbestos-related disease previously published in journals in the United States, England, France, Italy, Germany and other countries. The Pennsylvania study included an effort to relate dose and response. The authors had sampled the exposure of the workers to dust in four asbestos plants and the found that, overall, average concentrations of dust could be broken down into three groups that varied from 4.64 million particles per cubic foot up to 44 million. Asbestosis was reported in all three groups, with the prevalence and severity of disease greater in the more heavily exposed groups. But no level of exposure was found to be free of the disease. This was one of the first surveys of this kind in the United States similar to that which had been done by Merewether and Price and published in Great Britain and the United States separately in 1930. In all of these studies at least 25% of the workers were diagnosed as having asbestosis.

The study by Lanza and his coworkers at Metropolitan Life, published in 1935 and initiated at the request of representatives of the asbestos industry, found that 53% of the workers examined with three or more years of exposure had asbestosis.

In 1938, a similar study was done by the Public Health Service, including an effort to account for workers who had been discharged before the Public Health Service was admitted to the North Carolina asbestos textile plants to do the study. An estimated asbestosis rate in the workplace was given as 27 1/2%. The report recommended that dust exposure in asbestos plants be limited to 5 million particles per cubic foot. This guideline was recommended as a tentative occupational exposure limit, though it was noted that the Pennsylvania study had found cases of asbestosis at that level of exposure.

Literature on asbestosis was substantially developed by 1935. The disease was shown to have a distinctive pathological appearance with asbestos bodies, types of scarring that would form around the asbestos fibers trapped in the lung tissues. This was commented upon a great deal by pathologists in the 1920s. The disease was shown to have an identifiable radiological appearance on chest X-ray distinctly different from such diseases as TB and silicosis. The disease was also characterized by shortness of breath, which would become more pronounced as the individual became more seriously affected by the disease.

The risk of the disease involved not only mining and manufacturing plant workers but by 1935 it had come to include users of some asbestos products, mainly insulation products such as these used by insulation workers. Also, there were two reports on clerical workers in asbestos manufacturing plants with 30 to 40 years of experience, and these individuals were among the victims of asbestosis described in the medical literature published in Britain and the United States in 1934 and 1935.

The disease was consistently found to affect a large percentage of people who were employed in the industries where asbestos products were manufactured. This was reported in four surveys in the United States and Britain by the mid to late 1930s.

B. Lung Cancer

In 1935, another aspect of the hazard of asbestosis was identified with the publication of medical case reports of asbestosis in combination with lung cancer. The first such reports were published by Lynch and Smith in the United States in 1935 in the American Journal of Cancer

and by Dr. Gloyne in Great Britain in Tubercle in two separate reports in 1935 and 1936. In these reports, the question was raised that chronic irritation of the lung tissues from asbestos might be producing cancer as well as lung scarring already well identified as an asbestos-related phenomenon.

There were additional reports of lung cancer in combination with asbestosis reported by Egbert and Geiger at Yale in 1936, and Nordmann in 1938. An abstract of this last publication appeared in the United States in the Journal of Industrial Hygiene & Toxicology, also in 1938. The article was entitled "The Occupational Cancer of Asbestos Workers." The German author, Nordmann concluded that asbestosis was definitely related to lung cancer, that lung cancer was in fact an occupational disease of asbestos workers. Various features of the six cases Nordmann knew of were tabulated to justify that. Nordmann noted, among other things, that the prevalence of lung cancer among autopsied victims of asbestosis was one in six both in Germany and Great Britain. This was very much higher that the prevalence of lung cancer in the general population, which tended to be more like 1% or several percent at most. The high rate of lung cancer among people dying with asbestosis would be a most consistent finding around the world.

There were additional publications of cases of lung cancer and asbestosis in 1939 in the United States and in 1941 and 1942 in Germany. Holleb and Angrist reported in the American Journal of Pathology on two individuals who had been pipe coverers (users of asbestos products) diagnosed at autopsy as having both asbestosis and lung cancer. These were the first cases of cancer and asbestosis in users of asbestos products published in the medical literature. Holleb and Angrist tabulated a total of 10 cases of lung cancer in combination with asbestosis that had been published in the United States, Britain, and Germany. This gave readers of their articles the benefit of a review of what had come up until that time in worldwide literature on lung cancer and asbestosis. This was a feature of many medical articles on asbestos disease; that is, they make extensive reference to preceding work. So, that if one finds a single article, one has the windows open on a great deal of knowledge that preceded it.

In 1942, Dr. Wilhelm Hueper published a book on occupational cancer called Occupational Tumors and Allied Diseases, nearly 900 pages long. It included a lengthy section

on asbestosis and cancer from asbestos, in which a large number of references from the United States, Great Britain and Germany were cited in support of the view that asbestos most likely did cause occupational cancer. Dr. Hueper made unequivocal statements the next year in the article called, "Cancer in its Relation to Occupational and Environment" published in the Bulletin of the American Society for the Control of Cancer. There, Hueper said that asbestosis cancer of the lung as he called it then, was the newest proved occupational cancer of the lung, to be listed with the ones that were already known up at that time. In the Journal of the American Medical Association (JAMA), there appeared an editorial called "Environmental Cancer" in 1944, in which asbestos was listed among agents known and suspected of causing occupational cancer.

By 1950, there were more than 80 articles and abstracts referring to the lung cancer hazard of asbestos, including writings in newspapers and popular magazines (see D below).

C. Mesothelioma

The disease mesothelioma of the pleura was attributed to exposure to asbestos or asbestosis starting in 1943 with the report of Dr. H.W. Wedler in Heidelberg. There were additional reports in the German literature as well as British literature. The case reports that appeared prior to 1960 are annotated and cited by way of reference in Chapter 2, table 5 of my book. Dr. Wedler was the first to state that he believed the pleural cancers were occupational cancers, and his work was prominently cited in the United States in the 1940s. Other German pathologists starting with Leicher in 1954 would identify peritoneal mesothelioma as an asbestos disease.

A major report of pleural mesothelioma came from South Africa by Wagner and his coworkers, published in the British Journal of Industrial Medicine in 1960. Within a very short time it was widely accepted: that asbestos did cause mesothelioma; that levels of asbestos exposure present from environmental exposure as well as occupational exposure were sufficient to cause mesothelioma; and that mesothelioma was affecting a considerable number of workers in shipyards. Reports, such as those in the British Medical Journal in 1962, described the different types of workers who were being affected by mesothelioma in shipyards.

In 1964, Dr. Irving Selikoff and his coworkers published a mortality study in JAMA showing that there was a substantial excess of occupational cancer and deaths from asbestosis among people involved in the insulating trades. A group of workers who installed insulation and removed it regularly was found to have 45 deaths from pulmonary cancer in a group where only six or seven such deaths would have been expected. There were four deaths from peritoneal and pleural mesothelioma in this cohort, and this was described as a very rare disease and a substantial excess over what would have been expected. There were also 12 deaths from asbestosis in this work force.

Subsequently, later in 1964, at an international conference held in New York and published in 1965, Selikoff and coworkers reported that around 80% of the people who were in the insulating trade had developed asbestosis by the time they had been in trade for 20 or 30 years or more. At the conference in New York, British researchers Newhouse and Thompson presented a report on 76 deceased mesothelioma patients and an equal number of "controls", based on interviews with relatives. Their report showed strong evidence that mesothelioma patients were far more likely to have had occupational, household, or neighborhood exposure to asbestos than the comparison patients who died from other causes at the same hospital.

D. Other Sources of Knowledge

The subject of asbestosis was receiving attention in other types of circles. The Encyclopedia Britannica first noted the disease asbestosis in the regular publication of the Encyclopedia in 1940.

By this time, The National Safety Council had been established for 28 years as management's response to the industrial safety issue, with its associated problems of disability compensation and labor unrest. Starting in the 1930s the National Safety Council has published numerous articles, pamphlets and other materials concerning the hazards of asbestosis in the 1930s. Many of the annual congresses held forums and discussions about dust disease. The transactions of these meetings were automatically mailed to the industrial members.

During the 1930s there were an increasing number of lawsuits for dust diseases contracted in the workplace. To confront this dust disease threat, a meeting of about 250 people representing over 50 industries with industrial disease problems was held on January 15, 1935. The meeting covered the hazards of asbestos and silica dust, and one focus of the meeting was on "the menace of ambulance chasing lawyers in combination with unscrupulous doctors." During this and subsequent meetings of the association, which was initially called the Air Hygiene Foundation, lawyers outlined a plan to limit dust disease lawsuits and compensation. This included eliminating the right to trial and limiting workers' ability to claim workers compensation.

The refractories industry played a major role in this meeting and subsequent establishment of the Air Hygiene Foundation (renamed the Industrial Hygiene Foundation in 1941). As chairman of the Temporary Organizing Committee, Mr. Hitchens, of the American Refractories Institute, oversaw much of the planning of the structure and outline of purposes of the organization. Through Industrial Hygiene Foundation publications, meetings and conferences, its members have been long aware about dust diseases and the responsibilities of manufacturers to warn concerning hazards associated with their products.

Among the means by which the Industrial Hygiene Foundation disseminated information was the Industrial Hygiene Digest, which published abstracts of articles from hundreds of journals that were being published. The Industrial Hygiene Digest included abstracts of industrial medicine articles that had appeared in the journals included reference to cancers of the lung and pleura reported originally by Dr. Wedler in 1943, in January of 1945. Wedler's article had been published in the German Medical Weekly. Here, we see the first references to cancers of the pleura as well as cancers of the lungs all being counted as pulmonary, asbestos-related cancers in literature.

In 1944, a trade magazine called Heating and Ventilating carried an article called ADust is an Industrial Health Hazard@ by Hutchinson, in which was noted that fatal cases of asbestosis occurred in shorter periods of time than fatal cases of silicosis, and also that the hazard of asbestosis extended to industries including the insulating industry. Hutchinson said at that time there was no known safe level of exposure.

The Journal of the American Medical Association carried an editorial called "Asbestosis and Cancer of the Lung" in August of 1949. This reported British statistics on 235 deaths in which asbestosis had played a part. Of these 235, 31 (13%) of the individuals were also found to have cancers of the lung or pleura. This was considered quite excessive compared to the normal rate of lung cancer in the general population of 1% of all autopsies. This editorial in the Journal of the American Medical Association was promptly summarized in the abstract form in the Industrial Hygiene Digest in 1949.

Reference to cancer from asbestos appeared in the New York Times on Jan. 7, 1948, Business Week Nov. 13, 1948, Washington Post Nov. 21, 1948, and Scientific American in January 1949 in an article called Cancer and Environment. It appeared in Newsweek magazine May 15, 1950. The reference to asbestos in Newsweek was in relation to the rising rate of lung cancer in urban dwellers compared with people in the rural areas. This was partly attributed to the presence of carcinogens like asbestos in urban air, according to Dr. Hueper, Chief of the Environmental Cancer Section, US National Cancer Institute. The Los Angeles Times noted the carcinogenicity of asbestos April 6, 1951, the Chicago Tribune on June 10, 1951. The Encyclopedia Britannica made reference to asbestos as one of the causes of occupational cancer under the title "cancer" in 1952, and asbestos was described as a lung cancer hazard to steamfitters working with asbestos in the Wall Street Journal on April 7, 1959.

D. TLVs

Various guidelines have been recommended to limit asbestosis as a hazard in places where asbestos is used. These guidelines included so-called Threshold Limit Values (TLVs) or maximum allowable concentrations. The Public Health Service in its survey in 1938 recommended 5 million particles per cubic foot for dust in which asbestos was present in the workplace, as a ceiling concentration. This was adopted by non-governmental group, a volunteer professional organization. It was recommended as a guideline in some states prior to the enactment of the Occupational Safety and Health Act in 1970.

Authors in other countries took issue with the idea that one could recommend an occupational exposure limit of dust in the air and thereby completely control health hazards. Under the heading "The Prevention of the Dust Disease" Dr. McLaughlin, of the Factory Inspectorate in Great Britain, writing in The Lancet in 1953, said that people in some countries who recommend these maximum allowable concentrations seem to think that man is a "standardized machine which he clearly is not." McLaughlin noted a number of factors that would distinguish people in terms of their risks in ways that we could recognize as well as the fact that there are also ways that we can't recognize, where one individual exposed to the same things as another working right next to him gets sick and the other one does not.

Others such as that of Dr. May Mayers of New York, in 1952, and Warren Cook, also writing in the United States in 1956, observed that maximum allowable concentrations that were recommended to prevent other effects than cancer could not be considered to be safe if the substances also caused cancer. Asbestos was noted by both of those authors as one such substance that caused cancer.

The Documentation of the Threshold Limit Values published in 1962 and in its second edition in 1966, clearly indicated that the asbestos TLV was based on the 1938 Public Health Service study and was only suggested to protect against the disease asbestosis. The word cancer was not even mentioned in the 1966 Documentation, whose most recent cited reference on asbestos was dated 1955.

With asbestos, as with many other substances, it was infrequent that the TLV or the basis for it were reviewed in the light of recent literature once the substance was on the list. The limited efforts of unpaid volunteers working on the TLV committees appear to have been mainly devoted to adding new substances to the list during the 1950s and thereafter.

E. End-Products Users

There were many articles coming out in the 1940s and 1950s that noted the risk of asbestosis and in some cases cancer in individuals who were exposed to asbestos in the course of using asbestos-containing products; there were more than 50 separate case reports, some involving one or two individuals, some involving as many as ten or more. These case reports were published mostly in the English language in medical journals between 1932 and 1963. These reports are tabulated in Chapter 5, Tables 2 and 3 in my book, Asbestos: Medical and Legal Aspects.

Companies marketing products that could give rise to respirable asbestos dust either were or should have been aware that most dusts can either cause or aggravate problems in the lungs of end-product users. Some specific company knowledge includes the following. Westinghouse's medical director wrote a book in 1947 in which he state that asbestos produced serious effects, including the progressive disease of asbestosis, yet the company did virtually nothing to warn users of its products until required to do so by federal regulations. Mine Safety Appliances Company published several pamphlets outlining the problems associated with dusts and recommending the usage of respirators, yet did not put warnings on its asbestos clothing. In 1964 Eagle-Picher told GREFCO and NARCO that it was putting warning labels on the asbestos products it manufactured for them, but neither company put warnings on its own manufactured asbestos products. These are but a few examples of widespread failure to warn workers concerning the hazards associated with asbestos and other dusts.

F. Household Contact Asbestos Exposure and Disease

In 1897, the first physician in modern times to write about lung disease in asbestos workers also commented on ill health among the workers= family members. The families of asbestos-exposed workers in the 20th century were exposed to asbestos brought home on the clothes, shoes, hair, tool boxes, lunch boxes, and automobiles of the workers.

As far back as 1913, the text, Safety, by W.H. Tolman and L. B. Kendall (p. 249) emphasized the importance of having workers remove work clothes before leaving a factory

where toxic materials are handled, so the poisons would not be carried "into the homes of workers."

Some chemical companies provided work clothes and laundered them in plants using toxic and carcinogenic chemicals as early as the 1920s. "Two-compartment lockers, or preferably two individual lockers, should be provided in dressing rooms for employees whose clothes are exposed to poisonous material," said the U.S. Public Health Service in the Manual of Industrial Hygiene (1943). An article that year in the trade magazine Chemical Engineering advised separate lockers for street clothes and work clothes, separated by showers, in plants handling aluminum powder. Hueper wrote in JAMA in 1946 that workers handling carcinogenic materials such as asbestos be provided with showers and special rooms for storing street clothes.

Corporate physicians advised a number of safeguards that would have protected families of workers at a Chrysler plant being built in 1946. The plant was to use asbestos and chemicals that could cause toxic effects and dermatitis. Protective clothing, laundry, showers, and separate lockers for street and work clothing were recommended by the doctors. In a 1948 document, Roy S. Bonsib, an industrial hygienist for Standard Oil of New Jersey stated: "Appropriate work clothes, properly fitted and maintained, play a prominent part in an industrial worker's health and efficiency. This is especially true when persons are working with more or less toxic or carcinogenic materials or where cleanliness is a factor in the maintenance of product quality. Consequently, many of the more progressive industrial organizations, such as E.I. DuPont de Nemours & Company, the American Cyanamid Company and the Borden Company, have for years supplied their employees with work clothing and have instituted a laundry service."

A 1951 article, "Industrial Hygiene in the Paint Factory", in the trade magazine Paint and Varnish, recommended the provision of work uniforms not to be worn home and separate lockers for work clothes and street clothes.

The United States Department of Labor issued safety and health guidelines in conjunction with contract work for the federal government. A 1952 document entitled Safety and Health Standards for Contractors performing Federal Supply Contracts under the Walsh-Healey Public

Contracts Act required that contractors provide facilities to prevent the communication of harmful substances from work clothes by contact to street clothes. Subsequently, Walsh Healey regulations were published in the Federal Register in 1960. These regulations provided that, "Where employees' work clothes are exposed to contamination by poisonous, infectious, or irritating material, facilities shall be provided in change rooms so that street and work clothes will not be stored in contact with each other."

Retired Monsanto chemist and industrial hygienist Jack Garrett has testified that in the 1950s, that chemical company's employee protection against asbestos from insulation products included showers and daily changes of clothes: "We went down to shoes and socks, underwear and all. We didn't want it at home." (deposition in *Schmidt*, District Court of Jefferson Co. TX, Dec. 16, 1993). In 1967, Shell Chemicals in Britain adopted a code of practice for handling asbestos products, including vacuum hoses for removing dust from clothing and shoes, separate lockers for work clothes and street clothes, and hot and cold showers. Work overalls were vacuum cleaned, bagged with warning labeling, and laundered by the company.

The Occupational Safety and Health Administration (OSHA) was created by Congress in the last days of 1970. In June of 1972, OSHA asbestos regulations were published in the Federal Register, containing rules for laundering of asbestos-contaminated clothing.

The hazard of asbestos exposure to families of the workers, in particular cancer, was scientifically knowable long before it was studied directly, as illustrated by the advice of the Chrysler doctors.

Once it was substantially established in the 1940s that asbestos exposure could cause lung cancer, the consequent public health impact of asbestos use was dramatically increased. Cancer is initiated by the malignant transformation of a single cell which replicates itself until it threatens the life of the affected person. This meant that asbestos exposures insufficient to cause death from asbestosis could clearly cause death by cancer. This had been recognized by German workers' compensation authorities in establishing workers' compensation recognition to lung cancer as occupational in the presence of "slight" asbestosis as early as 1939 (Baader, "Asbestosis" German

Med. Weekly 65: 407-408, 1939). The danger of less-than-occupational asbestos exposure as a cause of lung cancer was noted by Dr. Wilhelm Hueper, Chief of the Environmental Cancer Section of the US National Cancer Institute, in warning in 1950 that urban air pollution including carcinogens such as asbestos was a factor in the rising incidence of lung cancer in the general population ("Environmental Cancer Hazards Caused by Industrial Air Pollution" Arch. Ind. Hyg. Occ. Med. 2: 325-328, 1950; "Small Studies" Newsweek, p. 53, May 15, 1950).

It followed that whatever exposure limits that were considered applicable to limit non-cancer effects of a substance were in no way to be considered protective if the substance also caused cancer. Experts considering this in the mid-1950s recommended that, for a nickel compound believed to be carcinogenic, the occupational exposure limit should be lowered by a "safety factor" from 1/500th to 1/100th the exposure level that would have applied for "other types of systemic injury" the substance caused (H. Stokinger, "Prepared Discussion" Am. Ind. Hyg. Assoc. Quarterly 17: 284-286, 1956).

And it also follows that if a substance is a carcinogen, the population at risk from its use in society has to be broadened to consider environmental exposures such as air pollution, consumer product use, and contamination of workers' homes by carcinogenic dust brought home on the clothes, hair, shoes, lunchboxes, and cars of the unsuspecting workers. This is particularly true in the case of asbestos, a chemically stable solid.

Industry was well aware that asbestos was mineral with high resistance to destructive forces such as heat and that asbestos did not decompose even upon prolonged storage. (One scientist borrowed from the language applied to radiation in stating that asbestos in the environment had a "half-life of infinity"). It was also obvious that, absent any safeguards to prevent it, workers typically exposed to dust from asbestos products would take the contaminant home on them, where it would accumulate in carpets, clothing, window curtains and furniture. It was also known that the very young (the developing organism) would be most susceptible to the action of carcinogenic agents, a fact demonstrated in laboratory testing of carcinogenic agents at least as far back as 1938 (cited in Hueper, Occupational Tumors and Allied Diseases, 1942, p. 758).

Companies that were or should have been aware that asbestos was carcinogenic should have anticipated that allowing workers to return home, unwarned, with cancer-causing dust all over their clothes etc. would have also endangered the lives of their family members. In the 1950s, the type of cancer most associated with asbestos was lung cancer. The additional widespread recognition that asbestos also caused mesothelioma, which was in fact a signal tumor for asbestos exposure, made it possible for epidemiologists and others to confirm that the cancer hazard of asbestos had indeed spread into the homes of the workers and the neighborhoods of asbestos air pollution point sources.

Studies on the occurrence of asbestos disease that included family members of asbestos-exposed workers were not published until the 1960s, and work such as that of Newhouse and Thompson (1965) and Lieben and Pistawka (1967) established that mesothelioma was causing deaths among persons with only household (and not occupational) exposure to asbestos. The contamination of workers' homes and the exposure of their spouses and children was very foreseeable, and with the knowledge that asbestos was carcinogenic came the possibility that household-contact exposures could have disastrous consequences for members of workers' families if not prevented. That these reports also included a number of mesotheliomas in the neighbors of asbestos factories also confirmed the lethality of environmental exposures well below those typical of occupational settings.

G. Brake Repair Workers and Asbestos Disease

Since the beginning of the past century, automotive brake linings, brake shoes and clutch facings have contained asbestos. The type of asbestos used in the United States has been chrysotile, and roughly 50% of the composition of brake linings and brake shoes was chrysotile.

There were four reports of asbestosis in US brake lining manufacturing plants published in the 1935-1940. The British government recognized that the risk of asbestosis arose from grinding and turning in the dry state "motor car brake and clutch linings" (1935). In New York, a state brake lining garage worker brought a disability claim against the state in the early 1940s

(Converse). Not until a conference held by Ford in Britain were actual measurements of brake mechanics' asbestos exposures published (Hickish and Knight, 1970).

Amidst reports identifying environmental exposure to asbestos as a cause of mesothelioma, the Public Health Service analyzed brake linings decomposition products and identified a small fraction of surviving asbestos fiber (Lynch, 1968). Before this report was published, Turner and Newall industrial hygienist Stephen Holmes knew that wear products from brake linings contained very little asbestos (letter to Mrs. D.M. Thorley, Nov. 17, 1967). The brake wear dust had been feared as an urban air pollution hazard, and from that standpoint it was fortunate that most of the asbestos in brake pads wasn't released as asbestos air pollution. But the remaining asbestos in the dust was a danger to mechanics, as was the dust from grinding and beveling brake pads. Work histories of mesothelioma patients published in the literature included automotive brake servicing.

Air sampling in brake shops in the United States showed that with the commonly used technique of blowing out dust from brakes with compressed air jets, peak levels of exposure could exceed the 15-minute ceiling of 10 f/cc allowed by the 1972 OSHA standards. It is evident from visual observation that immense dust exposures are sustained by mechanics blowing out brake drums. In 1972, brake repair workers in Baltimore County were sent a warning of the cancer hazard and advising the use of vacuum methods, which I prepared. The federal government (NIOSH) then sent out a lengthy notice of its own in 1975. This was followed by the publication of additional measurements of brake mechanics' exposures and clinical studies on brake repair workers by the Mount Sinai (N.Y.) research team. Lorimer and co-workers (1976) identified signs and symptoms of asbestosis in a limited survey of workers who had been doing brake repair for than 10 years and were actively employed at the time. Nicholson and co-workers estimated that over the 1982-2027 years, there would be 20,000 excess deaths from asbestos-related cancer among automobile maintenance workers in the United States.

US government regulatory authorities have addressed the hazards of asbestos in brake and clutch work. The US. Environmental Protection Agency (EPA) published Guidance for Preventing Asbestos Disease Among Auto Mechanics, on the hazards of asbestos from brake

repair work and how to reduce them, in 1986. EPA issued an update of this guidance document, Current Best Practices for Preventing Asbestos Exposure Among Brake and Clutch Repair Workers, on April 2, 2007. The 1994 OSHA standard for asbestos has a specific provision for safeguarding mechanics doing brake repairs. On July 26, 2006, OSHA published a Safety and Health Information Bulletin, Asbestos-Automotive Brake and Clutch Repair Work, to acquaint employers with methods to comply with this regulation. These EPA and OSHA documents on brake and clutch servicing warn that unprotected asbestos exposure carries the danger of mesothelioma, lung cancer, and asbestosis.

H. Oil Industry Knowledge of the Hazards of Asbestos

The hazards of asbestos were well known in the oil industry, where tremendous amounts of asbestos-containing thermal insulation were used. Standard Oil of New Jersey industrial hygienist Roy Bonsib wrote an extensive report in 1937, "Dust Producing Operations in the Production of Petroleum Products and Associated Activities", which stressed the hazards of asbestos from insulation work. The American Petroleum Institute had regular meetings of doctors from the oil companies starting at least as early as 1945, with the formation of subcommittees including a subcommittee on carcinogenicity. Among the reports that the doctors' group, the Medical Advisory Committee (MAC), reviewed, was Shell Oil chemist HH Zuidema's "Carcinogenic Hydrocarbons and Related Compounds/ A Literature Review", which named asbestos as having been documented to have cancer-producing ability (1945).

In 1948, the MAC received a memorandum summarizing a presentation by Dr. WC Hueper at the annual meeting of the American Public Health Association, in which Hueper identified asbestos as a material for which a definite correlation with cancer incidence had been shown. Hueper was the Chief of the Environmental Cancer Section, US National Cancer Institute, and the most prolific author of articles on occupational cancer in the US. It was the practice of the committee to circulate memorandums such as this and published papers to its members.

The MAC began to write Toxicological Reviews on specific substances used at oil refineries and circulate them to medical schools and state health departments in 1948. This was

brought to the attention of the API Board of Directors' Safety Committee. Industry managers were alarmed that this practice could trigger government regulation and decided in 1949 that the MAC be directed to not publish or send out such materials without permission of the management higher-ups on the API Board.

In the early 1950s, Dr. Hueper was invited to appear at one of the MAC meetings. In January 1953, one of Dr. Hueper's articles, "Environmental Cancers: A Review", published in 1952 in the journal Cancer Research, was circulated to members and associates of the MAC. This article pointed to asbestos as a cause of lung cancer.

In 1954, Hueper presented a paper to the National Petroleum Association, again describing asbestos as a cause of occupational cancer. This was published in a 1955 article, "Occupational Cancer Hazards", by the US Department of Labor, and was circulated to members of the MAC and others prior to a meeting of the MAC and its Subcommittee on Carcinogenicity in April 1955.

Additional discussion of oil industry knowledge and the knowledge of specific oil companies about asbestos hazards is in the 5th edition of my book, Asbestos: Medical and Legal Aspects (pp. 627-646).

I. Texaco

Previously known as the Texas Company, this firm hired Allan Dooley as its industrial hygienist in 1947 and employed him through the 1960s. Dooley was the second author of a study, *Asbestosis*, published in several parts in 1934-35 by the Pennsylvania Department of Labor and Industry. One fourth of the asbestos factory workers in the study had asbestosis. Average concentrations of asbestos-containing dust were 4.64 to 44 million particles per cubic foot, and no level of exposure was found to be free from risk of disease. The study had 125 references to publications worldwide on asbestos and its hazards (See also "U.S. Reports Relating Degree of Exposure to Degree of Disease Risk," in Chapter 4). The prevalence of asbestosis in the workers examined was consistent with other reports of this kind published previously in the U.K. and the U.S.

A report prepared by the Texas Company for the new American Petroleum Institute Medical Advisory Committee (MAC) evidenced a widespread knowledge of worldwide medical literature (*The Carcinogenicity of Bituminous Compounds/ Literature Review,* Apr. 30, 1945). Citing Hueper's 1943 paper, "Cancer in Relation to Occupation and Environment," the annotated bibliography listed substances as carcinogens including asbestos. The company obtained additional information on carcinogens including asbestos through its involvement in the MAC in the 1940s and 1950s (See "Oil Industry," this chapter).

Dooley conducted an *Industrial Hygiene Survey/Port Arthur Works* in 1949. He wrote that work with 85% magnesia insulation, which was 15% asbestos, could give rise to an asbestosis hazard. Exposures from crushing and bagging of insulation, in particular, were in excess of the 5 MPPCF maximum allowable concentration.

A report on two mesothelioma cases in oil refinery workers was published in 1960 by H. B. Eisenstadt and F. W. Wilson ("Primary Malignant Mesothelioma of the Pleura," *Journal-Lancet* 80: 511-514). Dr. Wilson was a physician employed by Texaco in Port Arthur, Texas. One of the workers was a Texaco employee. The report said that, "the etiologic association of asbestos and mesothelioma has been repeatedly discussed in the literature," citing reports from the Netherlands, Germany, Italy, and the U.S. The patient's history of asbestos exposure "alerted suspicion of the authors in the second case."

When the American Petroleum Institute (API) gathered information from member firms on asbestos in 1965, a "strictly personal and confidential" memorandum was prepared by Texaco (E. W. McNealy, to H. G. Tigh, Mar. 11, 1965). It covered information on insulator employees and those retired within the preceding 5 years, including assessments by Dr. F. W. Wilson. In addition to the foreman who had died and been reported on by Eisenstadt and Wilson in 1960, there was another man in the group dying with peritoneal mesothelioma. Some of the men had pleural plaques and varying severity of diffuse pulmonary fibrosis, the latter judged by Wilson to be non-specific in etiology.

Philips Petroleum Company industrial hygienist Lucian Renes wrote a report, "The Health of Refinerymen Applying Asbestos Insulation" and sent it to his counterparts in other oil companies including Dooley at Texaco. The report contained reference to Selikoff's work and limited data from API member firms suggesting that there could be an asbestos disease problem in the oil companies' insulators (See "Oil Industry," this chapter). Dooley wanted to assess whether there had been changes in the amount of asbestos insulation used in oil refineries; he also wanted to organize presentations by the medical directors of the oil companies on the health status of refinery insulators (letter to fellow members of a subcommittee on health of oil industry insulators, R. Diakum of Humble Oil and L. Levin at Socony Mobil, Nov. 1, 1965). It does not appear than any industry-wide medical study was completed by the API members.

In 1969, Texaco hired another industrial hygienist from the state of Pennsylvania, Ronald Richards. Richards' co-workers at the Pennsylvania Division of Occupational Health included Dr. Jan Lieben, who conducted research showing that the rate of lung cancer in an asbestos factory was excessive (*Arch Environ. Health* 13: 619-621, 1966). Lieben then recorded cases of mesothelioma among asbestos workers, asbestos factory neighbors, and in the families of asbestos plant workers (*Arch Environ. Health* 14: 559-563, 1967). As OSHA moved to develop its asbestos standard in 1972, Richards found that sawing and fitting of insulation and stripping of old insulation yielded exposures above the 5 f/cc limit in the OSHA Emergency Temporary Standard for Asbestos. He recommended continued use of respiratory protection where such work was done (memorandum to F. D. Dorr, May 9, 1972). Richards has testified that in 1972 Texaco adopted a policy of using only non-asbestos insulation for new construction (Deposition in *Jameson*, Superior Court State of Washington, County of Skagit, No. 0202-01069-8, Aug. 19, 2003).

Articles linking asbestos and cancer appeared in *Archives of Industrial Hygiene and Occupational Medicine* in 1952 (Smith, Hueper, Cartier), 1954 (Eckardt and Drinker), and 1955 (then renamed *Archives of Industrial Health* -- McLaughlin, Sander). Volumes of this journal for the years 1951-1955 at Lamar University in Beaumont, Texas, were stamped "The Texas Company/ Research Library/ Port Arthur, Texas."

As a member of the National Safety Council, the company had occasion to learn about asbestos hazards at annual meetings of the NSC and from NSC publications in the 1930s and thereafter. Similarly, Texas Company was a member of the Industrial Hygiene Foundation from Apr. 15, 1949 until Mar. 26, 1959, and thus would thus have received abstracts of papers about asbestosis in insulation workers and cancer from asbestos in the *Industrial Hygiene Digest.*

J. Avondale Shipyards

Companies involved in shipbuilding and ship repair during World War II were subject to the 1943 US Navy and Maritime Commission publication, "Minimum Requirements for Safety and Industrial Health in Contract Shipyards", which warned of asbestosis hazards and included specific control measures to be taken. One of the attendees of the Conference of Gulf Coast Shipyard Physicians held in New Orleans on Sept. 8, 1943 in connection with the Minimum Requirements document was Dr. LJ O'Neill of Avondale Marine Ways.

The Walsh-Healey Public Contracts Act required during the 1950s and 1960s that government contractors provide health protection for workers when doing government contract work; in the 1950s and 1960s this included limiting worker exposures to specific limits of toxic substances in the workplace air including asbestos.

Avondale was a member of the National Safety Council, and in 1967 the Vice Chairman of the NSC Shipbuilding and Repair Division was JR O'Donnell, Avondale's safety director. Founded 1912 and based in Chicago, NSC made abundant information available for corporate members, including a monthly periodical, National Safety News, the annual National Safety Congresses, accident prevention manuals and other publications. From the 1930s on, NSC publications carried information on asbestos, under subjects including occupational diseases, air sampling/analysis, recommended limits for airborne dust exposure, respirators, industrial ventilation, and workers' compensation laws. More general principles were also discussed, including the importance of worker education and training in the prevention of illness and injury that products can cause.

K. Shipbuilders Council of America

Avondale was also a member of the Shipbuilders Council of America, an industry trade association in Washington DC. Council documents show that the trade group was involved in informing and coordinating the industry response to safety and health regulations for the industry in 1966. In January 1968, the Council distributed an addendum to a publication, *The Shipbuilder*, saying, "Asbestos is recognized as one of the most dangerous of all industrial poisons." It went on to note that asbestos inhalation caused asbestosis and cancer, mesothelioma even in people with just household or neighborhood exposure. That year, the Council gathered numerous reports on the dangers of asbestos.

On Feb. 7, 1969, a memo to shipyard members included a critical article (Dec. 4, 1968, *Washington Post*) and suggested that the industry might develop a specialized group to deal with asbestos. It was considered "unwise" for shipyards to refuse access to Dr. Selikoff, given the expected publicity and his association with unions demanding health surveys. The Council president desired to avoid "controversy" such as legislation then being enacted by Congress to compensate coal miners for Black Lung.

Council representatives attended a meeting on asbestos hazards in shipyards hosted by Dr. Selikoff's laboratory in October 1970. Protective measures being adopted by the US Navy and in England were featured. The Mt. Sinai Hospital group then wrote a detailed manual for shipyards and sent the draft to the Council in February 1971. Work practices, local exhaust and other ventilation, isolation of removal work, respiratory protection, worker education, non-asbestos (substitute) product use, and medical monitoring were covered in the 16-page draft. Regarding worker education, it read: "No dust control program can be effective unless workmen and supervisors understand the hazards associated with the jobs, the sources of the hazards and the reasons for following recommended procedures carefully."

In January 1972, the Council circulated the OSHA notice that an asbestos standard was being developed, also referring to the emergency temporary asbestos standard issued December 7, 1971. OSHA was specifically moving to regulate asbestos exposure in shipyards. A US Navy Instruction on asbestos (9 Feb. 1971) circulated by the Council required numerous work practices

for control of asbestos hazards in shipyard work. In testimony at the March 1972 hearings on the OSHA asbestos standard, the Council specifically addressed the posting of warning signs and air monitoring of exposed workers.

The Council organized an Ad Hoc Committee on Asbestos in 1978 as the US Department of Health, Education and Welfare prepared to announce that millions of people who worked in US shipyards during World War II were at risk of developing asbestos disease. Workers' compensation claims and personal injury suits over asbestos were increasing "exponentially" and the Council was interested in pursuing legislation to limit shipyards' liability. This was discussed at a Board of Directors meeting June 14, 1978, attended by Albert Bossier, Jr. or Ogden/Avondale Shipyards. Later that month, the Council distributed a press release preceding the broadcast of a documentary, "ABC News Close-up -- Asbestos: the Way to Dusty Death," featuring asbestos victims who had worked at shipyards. The Council also obtained the transcript of the broadcast from the Asbestos Information Association after it appeared.

The Ad Hoc Committee on Asbestos, including John Chantrey, Jr. of Ogden/Avondale, met Nov. 2, 1978 to discuss "potentially ruinous" asbestos liability the shipyards faced. It was agreed to advise the Board of Directors to pursue indemnification legislation to limit liability. Arguments to support this, included claims that 1) shipyards "could not have known of the dangers of asbestos until the 1960's or later" and 2) the US government was the ultimate responsible party for the use and control of asbestos on ships.

III. CONCLUSION

So, to summarize, the literature had largely established that asbestos was a lethal material by the early 1930s, causing disability and deaths from asbestosis. By the mid-1940s, it was widely accepted by people writing on the matter that asbestos inhalation could also cause lung cancer. There were several dozen reports of cases as well as editorials and other publications referring to the cancer risk of asbestos in the literature. Most of the authors by that time were concluding that asbestos probably or definitely caused cancer of the lungs, and in some cases

cancers of the pleura were counted in as if they were also occupational pulmonary cancers caused by asbestos. The added hazard of cancer from asbestos was sufficiently well-known to start appearing in more general references like the New York Times and Business Week in 1948, Scientific American magazine in 1949, Newsweek in 1950, and the Encyclopedia Britannica in 1952. Further, the hazard of asbestos exposure to families of the workers was scientifically knowable since the 1950s. The risk of mesothelioma especially in individuals with environmental, nonoccupational asbestos exposure became a subject of intense discussion in the early 1960s subsequent to the publication Wagner and his co-workers in 1960.

That was what was available in the medical libraries to anyone who knew how to spell the word asbestosis. You could find the information at any time by using Index Medicus, which is a subject index of worldwide medical literature. The Index Medicus has been published since 1879 and can be used to identify articles that are newly emerging on any medical subject including asbestosis. It is one of the things I used in my research. There were many medical texts on occupational diseases, pathology, internal medicine, cancer, lung diseases, and public health, that spoke of asbestos hazards, published in the 1930s and thereafter. Also, the articles themselves often contained numerous references to prior articles, and so in this way one could easily find in a matter of a few hours in a library a great deal of information about a subject like asbestosis using the classical methods. None of this would require using any kind of a computer search or any other kind of modern technique.

Signed this ___ day of _____, 2020, in Garrett Park, Maryland.

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Barry Ira Castleman, Sc.D.

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Signed this 30 day of July, 2020, in Garrett Park, Maryland.

Barry Ira Castleman, Sc.D.