No Doubt About it! Medical - Scientific Literature Overwhelmingly Proves that Canadian Chrysotile Asbestos Used in the US Causes Malignant Mesothelioma in Americans

The following brief was submitted on March 8, 2002 by our co-counsel Waters & Kraus in *Donald Cipov, et al., vs. ACandS, Inc., et al.,* pending in the 141st Judicial District Court in Tarrant County, Texas, in response to an attempt by defendant Garlock, Inc. to escape liability for its chrysotile asbestos-containing products through what is known as "the chrysotile defense." Garlock claims that there is inconclusive scientific proof that chrysotile asbestos causes mesothelioma. The Waters & Kraus brief well and passionately exposes the chrysotile defense as a sham. On the brief were attorneys Charles S. Siegel and F. Leighton Durham, III of Waters & Kraus, and Jonathan Smith-George.

Introduction

Asbestos is a generic name for a particular type of fibrous rock incorporated into various thermal insulation products. There are two main fiber types of asbestos: "serpentines," of which chrysotile is the only form commercially exploited, and "amphiboles," a group that includes the commercial fibers amosite and crocidolite, and tremolite, a non-commercial form that contaminates all mined Canadian chrysotile ore. Over the last eighty years, the hazards of inhaling asbestos fibers have been copiously documented in the medical and scientific literature. Workers who inhale asbestos fibers of any type have been shown to develop both non-malignant and malignant diseases, the most serious of which is malignant mesothelioma, a fatal cancer of the lining of the lung. Numerous articles and studies in the peer-reviewed medical and scientific literature have concluded that the overwhelming cause of mesothelioma in humans is exposure to asbestos and that all three commercial forms of asbestos - amosite, crocidolite and chrysotile - are capable of causing the disease in workers and in their family members.

Of the three commercial forms, chrysotile asbestos comprised 90 to 95% of all of the asbestos incorporated into products used in the United States. Practically all of the chrysotile asbestos used in the United States was imported from Quebec, Canada Over the course of the last eighty years, the Canadian asbestos mining industry, through its trade organization, the Quebec Asbestos Mining Association (QAMA)(**1**), has tried, relentlessly, but unsuccessfully, to convince regulatory authorities of the supposed safety of its chrysotile asbestos. The latest attempt occurred when the Canadians unsuccessfully petitioned the World Trade Organization ("WTO") to overturn the ban on the use of chrysotile asbestos imposed by the French. Like every other national and international governmental body to have addressed the issue, the WTO rejected this attempt -- in the process rejecting the same claims Garlock makes here.

From the 1960's to the present, the overwhelming scientific consensus has been that *all* types of asbestos fibers cause mesothelioma. Most of the epidemiological studies from which this scientific consensus grew involved mixed dust exposure; i.e., persons exposed to two or more of the major asbestos fiber types. Because all Canadian chrysotile ore deposits are contaminated to some degree with tremolite, even those populations of workers that used only chrysotile asbestos were also exposed to other forms of asbestos

Not surprisingly, researchers backed by the Canadian mining industry have attempted to exonerate chrysotile asbestos as a cause of mesothelioma. Canadian scientists, most of whom have ties to McGill University in Montreal, Quebec and whose research is supported by the Quebec Asbestos Mining Association (QAMA), have published studies attempting to place the blame for mesothelioma in workers exposed to chrysotile on the tremolite contamination, rather than on the chrysotile fiber itself. Despite the Canadian asbestos mining industry's efforts, however, the overwhelming consensus of the scientific community has always been, and remains, that chrysotile asbestos causes mesothelioma. In fact, *every major regulatory agency in the world has rejected the position of the Canadian asbestos mining industry as unproven or bad science, and instead has regulated chrysotile as a substance that causes mesothelioma*.

For 25 years, manufacturers of finished products containing chrysotile asbestos, have seized upon the medical literature dependably generated by the Canadian researchers of McGill University to defend cases throughout the country by contending that chrysotile asbestos at least as it is found in manufactured products, does not cause mesothelioma.

III. History of the "Chrysotile Defense"

A. Government and Public Health Agencies have Concluded that Chrysotile Causes Mesothelioma.

The "chrysotile defense," the claim that chrysotile asbestos is incapable of causing mesothelioma, has been part of the asbestos litigation since the first cases regarding asbestos injuries were filed in the early 1970's. Despite a concerted effort by the asbestos industry to exonerate chrysotile as a cause of mesothelioma, every public health organization and U.S. governmental agency that has investigated this issue agree that *all* forms of asbestos, including chrysotile, can cause mesothelioma. The conclusion of the New York State Asbestos Advisory Board is instructive:

[T]he claim that various types of asbestos differ in their hazard is particularly insidious. It is put forth by the manufacturers of Canadian asbestos (chrysotile asbestos), the type of asbestos most widely used in New York and throughout the United States. The central claim here is that the Canadian product, termed "chrysotile asbestos" is relatively harmless. However, that claim is not based on fact, and it is not supported by the results of epidemiological and toxicological studies conducted in the United States and overseas. These studies show that *all types of asbestos, including Canadian asbestos, are fully capable of producing* the full spectrum of asbestos-related diseases including asbestosis, *mesothelioma*, lung cancer, laryngeal cancer, cancer of the pharynx and cancer of the gastrointestinal tract.

Bold, Bianci DeVito, Landrigan, Pettengil, Second Annual Report, State of New York, Asbestos Advosory Board, February 1990. (Ex. 4)(emphasis added). (Ex. 4).

In 1986, the Occupational Safety and Health Organization (OSHA) "reviewed numerous epidemiological studies concerning the toxicity and carcinogenicity of different asbestos fiber types." OSHA, "Occupational Exposure to Asbestos, Tremolite, Anthophylite, and Actinolite; Final Rules," (1986)(Ex. 5). After reviewing 55,000 pages of medical and scientific articles and testimony, OSHA concluded that "all fiber types, alone or in combination, have been observed in studies to induce lung cancer, mesothelioma, and asbestosis in exposed workers." *Id.*

In 1994, OSHA reiterated that the "evidence submitted in support of the claim that chrysotile asbestos is less toxic than other asbestos fiber types is related primarily to mesothelioma. *This evidence is unpersuasive, and it provides an insufficient basis upon which to regulate that fiber type less stringently."* Department of Labor, Occupational Safety and Health Administration, 29 CFR Parts 1910, et al, "Occupational Exposure to Asbestos; Final Rule," (August 10, 1994)(Ex. 6) (emphasis added). OSHA concluded that "although there is some evidence linking chrysotile to a lower mesothelioma rate than some amphibole fiber types, OSHA believes that there is insufficient evidence to show that chrysotile does not present a significant mesothelioma risk to exposed employees." *Id.*

The International Agency for the Research on Cancer, the Environmental Protection Agency, the United States Department of Health and Human Services, and the National Institute for Occupational Safety and Health *all* reached similar conclusions after their own independent reviews of the literature and scientific evidence. *See* IARC Monographs on the Evaluation of the Carcinogencity of Chemical to Humans (1979)(Ex. 7)("pleural and peritoneal mesotheliomas have been observed after occupational exposure to crocidolite, amosite and chrysotile asbestos"); Environmental Protection Agency, "Asbestos: Manufacture, Importation, Processing and Distribution in Commerce Prohibitions; Final Rule," (July 12, 1989)(Ex. 8)("available information indicates that the combined epidemiological and animal evidence fail to establish conclusively differences in mesothelioma hazard for the various types of asbestos fibers"); "Asbestos Bibliography," U.S. Department of Heath and Human Services (September 1997)(Ex. 9)("both epidemiologic evidence and experimental confirmation indicate that chrysotile, amosite, and crocidolite asbestos are causative agents for mesothelioma"); "Atlas of Respiratory Disease Mortality, United States: 1982-1993," U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, 1998 (Ex. 10).

The current consensus that chrysotile causes mesothelioma is highlighted by two recent publications. In 1997, a multidisciplinary panel of pathologists, radiologists, occupational and pulmonary physicians, epidemiologists, toxicologists, industrial hygienists, and clinical and laboratory scientists held a meeting in Helsinki, Finland. At the conclusion of the meeting, the consensus among the participants who collectively had published over 1000 articles on asbestos and its associated disorders was that, while chrysotile may be less potent than other types of asbestos, it nonetheless causes mesothelioma. *See* Consensus Report, "Asbestos, asbestosis, and cancer: the Helsinki criteria for diagnosis and attribution," Scand. J. Work Environ. Health, 23:311-6 (1997) (Ex. 60).

Moreover, in 1998, the International Progamme on Chemical Safety (IPCS), under the joint sponsorship of the United Nations Environment Program, the International Labor Organization and the World Health Organization, published a monograph devoted exclusively to chrysotile asbestos. After reviewing over 400 medical articles, the IPCS found that "commercial grades of chrysotile have been associated with an increased risk of pneumoconiosis, lung cancer and mesothelioma in numerous epidemiological studies of exposed workers," and concluded that "exposure to chrysotile

asbestos poses increased risks for asbestosis, lung cancer and mesothelioma in a dose-dependent manner." IPCS Environmental Health Criteria 203 - Chrysotile Asbestos, World Health Organization (1998) pp. 7, 168 (Ex. 11).

The chrysotile defense has also been raised and rejected in other contexts. For instance, in 1998, Canada sought redress from the World Trade Organization regarding the French decree to ban the use of chrysotile asbestos. Relying on many of the same authorities and arguments posited by Garlock, the Canadian government sought to overturn the ban by asserting the safety of the chrysotile fiber. In response to Canada's request, a Panel was appointed to investigate and it issued findings in September of 2000.

With respect to the capacity of chrysotile asbestos to cause mesothelioma, the Panel found that:

[T]he carcinogenicity of chrysotile fibres has been acknowledged for some time by international bodies. This carcinogenicity was confirmed by the experts consulted by the Panel, with respect to both lung cancers and mesotheliomas, even though the experts appear to acknowledge that chrysotile is less likely to cause mesotheliomas than amphiboles. We also note that the experts confirmed that the types of cancer concerned had a mortality rate of close to 100 per cent. *We therefore consider that we have sufficient evidence that there is in fact a serious carcinogenic risk associated with the inhalation of chrysotile fibres*. …

World Trade Organization, European Communities - Measures Affecting Asbestos and Asbestos-Containing Products, Report of the Panel, paragraph 8.188 (Sept. 18, 2000)(Ex. 12)(emphasis added). The Panel concluded that:

[Th]e EC (European Communities) has made a prima facie case for the existence of a health risk in connection with the use of chrysotile, *in particular as regards lung cancer and mesothelioma in the occupational sectors downstream of production* and processing and for the public in general in relation to chrysotile-cement products. This prima facie case has not been rebutted by Canada. Moreover, the Panel considers that the comments by the experts confirm the health risk associated with exposure to chrysotile in its various uses.

Id. at paragraph 8.194 (emphasis added).

C. The Overwhelming Consensus of the Medical and Scientific Community is that Exposure to Chrysotile Can Cause Mesothelioma.

For their assertion that chrysotile asbestos is incapable of causing mesothelioma, Garlock and its experts rely almost exclusively on three studies published by the Canadian researchers of McGill University in 1997(**2**). While Garlock's expert Dr. Bruce Case has conceded that any researcher reviewing the medical literature from the early 1960s until the early1980s would properly conclude that chrysotile is capable of causing mesotheliomas in humans(**3**), Garlock asserts that the consensus of the medical community completely changed after the publication of the McGill studies and now everyone agrees that chrysotile is incapable of causing mesothelioma. Despite the fact that the McGill studies were published almost four years ago, however, Garlock does not, and cannot, offer a single article published in the peer-reviewed medical or scientific literature written by sources not connected with McGill University or the Canadian mining industry that supports their conclusion.

To the contrary, the scientific community has overwhelmingly rejected Garlock's contention, and the publications that have occurred *since* the McGill studies in 1997 have uniformly *affirmed* the proposition that chrysotile can cause mesothelioma. Just last year, researchers published an epidemologic study that established that exposure to pure chrysotile asbestos can cause lung cancer and mesothelioma. *See* Yano, Wang, Wang, Wang and Lan, "Cancer Mortality among Workers Exposed to Amphibole-free Chrysotile Asbestos," Am J Epid, 154(6): 538-543 (Sept. 2001)(Ex. 62). Two mesothelioma death cases were found among 132 deaths of employees of a factory using chrysotile asbestos that contained a negligible amount of tremolite, less than .001 percent. The authors stated that they found, "no evidence is support of the amphibole contaminant hypothesis. To the contrary, a strong potential for chrysotile asbestos alone to cause lung cancer and mesothelioma was suggested."

In 1999, Drs. Landrigan, Nicholson, Suzuki and Ladou published a review article entitled, "The Hazards of Chrysotile Asbestos: A Critical Review," Industrial Health, 37:271-280 (1999)(Exhibit 54). After reviewing 40 different studies of workers exposed to asbestos, the authors concluded that, "[c]linical and epidemiologic studies have established *beyond all reasonable doubt that chrysotile asbestos causes* cancer of the lung, *malignant mesothelioma of the pleura and peritoneum*, cancer of the larynx and certain gastrointestinal cancers." They further found that "Canadian chrysotile that is amphibole-free still is associated with mesothelioma." *See also* Nicholson, "The Carcinogenicity of Chrysotile Asbestos - A Review," Industrial Health, 39:57-64 (2001)(Exhibit 56)("*there the is strong support for the proposition that chrysotile is a potent causative factor in producing mesothelioma and that the risk associated with*

exposure to chrysotile in producing mesothelioma is similar to that of amosite on a per fiber exposure basis"); Cullen, "Chrysotile asbestos: enough is enough," Lancet 351:1377-1378 (1998) (Ex. 52); Landrigan, "Asbestos - still a carcinogen," New Eng J Med, 338:1618-1619 (1998) (Ex. 55).

D. Experts in the Field of Asbestos Disease Agree that Chrysotile Causes Mesothelioma.

The reliability of the scientific evidence which supports the conclusion that chrysotile can cause mesothelioma is demonstrated by the quality and quantity of its proponents in the medical community.

- *I think it's quite clear and actually undeniable from the medical literature that chrysotile dust can cause a disease malignant mesothelioma.*

Q. Dr., how widely accepted in the American medical community is it that chrysotile products can cause pleural mesothelioma?

A. I think it's the consensus of opinion, and there are very few dissenters to that opinion that I'm aware of.

Trial testimony of Victor Roggli, M.D., Breaux v. AcandS, Inc., No. 00-08271-I, 162nd Judicial District, Dallas County, TX (July 25, 2001) at pp. 78, 81 (Exhibit 63)

Dr. Victor Roggli, a Board-certified pathologist, is a professor of pathology at Duke University and has been a member of the U.S.-Canadian Mesothelioma Panel since 1987. Dr. Roggli has written the only pathology textbook devoted exclusively to diseases associated with exposure to asbestos and has published 130 articles in the peer-reviewed medical literature.

- The vast majority of epidemiologists, pathologists, ect., who opinions I rely on to form my opinion, is that indeed chrysotile is capable of producing mesothelioma in humans.

Deposition Testimony of Hector Battifora, M.D., Darnold v. Able Supply Co., No. 98-10-04083E, 404th Judicial Dist., Cameron County, TX (July 19, 2001) at pp. 56-57. (Exhibit 64)

Dr. Hector Battifora is Board-certified pathologist and former member of the U.S.- Canadian Mesothelioma Panel. Dr. Battifora has published over one hundred peer-reviewed medical articles and co-authored a text book entitled "Tumors of the Serosal Membrane," most of which deals with mesothelioma.

- Chysotile can cause mesothelioma.

Trial Testimony of Andrew Marc Churg, M.D., Ph.D., Anderson v. Fibreboard, No. 85-2-00438-0, Wash. Super. Ct., Kitsap Cnty (1987) (Exhibit 65).

Dr. Andrew Churg, Board-certified pathologist and member of the U.S.-Canadian Mesothelioma Panel. Dr. Churg has reviewed over 500 case of mesothelioma and is frequently an expert witness who testifies on behalf of asbestos manufacturers. Dr. Churg has written between 70 and 80 peer-reviewed medical articles on occupational lung disease and co-edited a textbook on the pathology of occupational lung disease.

- I believe that there's overwhelming evidence that chrysotile asbestos causes mesothelioma. . . I only know of . . . two people who are living today that are pathologists that do not believe chrysotile causes mesothelioma.

Deposition of Samuel P. Hammar, M.D., Turley v. AC&S, Inc. taken on March 22, 2001 at pp. 50-51. (Exhibit 66).

Dr. Samuel Hammar, Board-certified pathologist and member of the U.S.-Canadian Mesothelioma Panel. Dr. Hammar has seen over 3,500 cases of mesothelioma and has written 103 articles that have appeared in the published medical literature, many of them dealing with asbestos associated diseases. He is the editor of a respected textbook entitled "Pulmonary Pathology" which includes an entire chapter that he wrote on mesothelioma.

- Q. As I understand it, your opinion is that finished chrysotile can in fact be a cause of pleural mesothelioma?

A. Yes.

Deposition Testimony of Joseph K. Wagoner, S.D.Hyg., In Re: All Asbestos-Related Personal Injury, Survival and Wrongful Death Cases in Which Plaintiffs Are Represented by Baron & Budd, P.C., In Dallas County, Texas (March 5, 1992) at p. 912 (Exhibit 67).

Dr. Joseph Wagoner, Senior Epidemiologist for the National Institute for Occupational Safety and Health, who received a Doctor of Science from the Harvard University School of Public Health in Epidemiology and Biostatistics in 1970.

The scientific community, commentators, and the courts have overwhelmingly accepted that mesothelioma is a signature disease for asbestos -- that is, asbestos is the only proven cause of mesothelioma in humans. *See e.g.*, Roggli Affidavit (Ex. C) at p. 2; Battifora Affidavit (Ex. E) at p. 2; D. Faigman, D. Kaye, M. Saks & J. Sanders, 3 *Modern Scientific Evidence § 40-1.1* at 264 (1999) (Ex. 15) ("In spite of the asbestos litigation's enormous size, cases involving the admissibility of scientific evidence have been relatively rare. In part, this is due to the fact that some asbestos related injuries, e.g. Mesothelioma, are 'signature diseases.' That is, they are uniquely related to asbestos exposure and are rarely observed in individuals not exposed."); *In Re Joint Eastern & Southern Dist. Asbestos Lit.*, 52 F.3d 1124, 1130 (2nd Cir. 1995) (referring to "...a mesothelioma-like signature disease arising only when a person of that age is exposed to asbestos."); *Blancha v. Keene Corp.*, 1991 WL 224573 at 3 ("The only known cause of mesothelioma is exposure to, and inhalation of, asbestos dust and fibers."). In fact, the causal relationship between exposure to all forms of asbestos and the development of mesothelioma is as firmly established as the relationship between smoking and lung cancer, HIV and AIDS, or even water in the lungs and drowning.

Tthe scientific community unanimously holds the opinion that there is no known threshold of asbestos exposure below which mesothelioma cannot occur. Mesothelioma has been diagnosed in individuals with brief, low or indirect exposures to asbestos. V. Roggli, *Asbestos,* 3 Modern Scientific Evidence § 40-2.2.3 at 295 (West Supp. 1999)(Ex. 16)(in section setting forth areas of scientific agreement regarding asbestos as to which there are no real controversy). Consistent with this proposition, courts have found that any exposure to asbestos is considered factually and legally sufficient to support causation. *See, e.g., Reserve Mining Co. v. EPA*, 514 F.2d 492, 508-9 and fn. 25 and 26 (8th Cir. 1975) ("It is significant that the witnesses generally agree that no known safe level of exposure exists for mesothelioma."); *Blancha v. Keene Corp.*, 1991 WL 224573 at 3 and 5 (E.D. Pa. 1991) ("Very small amounts of and short periods of exposure to asbestos dust and fibers can cause mesothelioma. . . .Mesothelioma . . . may be caused by a very small amount of exposure both as to time period and concentration. . . . Any exposure to asbestos dust and fibers can cause or lead to mesothelioma."); *Eagle-Pitcher Indus., Inc. v. Balbos*, 578 A.2d 228, 243 (Md. App. 1990), *aff'd in part and rev'd in part on other grounds*, 604 A.2d (Md. 1992) ("...all of Knuckle's exposures to asbestos were 'significantly contributing causal factor[s] to the mesothelioma.'"); *Celotex Corp. v. Tate*, 797 S.W.2d at 203 ("The medical evidence confirmed that inhaling asbestos dust in industrial conditions, even with relatively light exposure, can produce mesothelioma.").

Given the overwhelming scientific consensus regarding the relationship between asbestos and mesothelioma, courts have uniformly adopted the following causation standard in regard to mesothelioma cases:

Thus, it is not essential to establish with any precision the quantity, duration, or percentage of the occupational exposure to asbestos for which any or each particular manufacturer or supplier is responsible in order to establish proximate cause and, therefore, liability. Every such exposure is a substantial factor in bringing about mesothelioma, and may be so found when the latency period is consistent.

Blancha v. Keene Corp., 1991 WL 224573 at 6. *See also Spaur v. Owens-Corning Fiber Glass Corp.*, 510 N.W.2d 854, 861 (Iowa 1994); *Celotex Corp. v. Tate*, supra, at 204. supra 204. ("If there was sufficient evidence presented by appellee showing that Carey supplied **any** of the asbestos to which Tate was exposed, then appellees have adequately met their burden of proof [regarding causation]").

Dr. Yasunosuke Suzuki and his colleague, Dr. Steven Yuen, recently published their findings from their analysis of tissue samples taken from the lungs and pleura of 151 malignant mesothelioma cases. *See* Suzuki & Yuen, "Asbestos Tissue Burden Study on Human Malignant Meosthelioma," Industrial Health, 39:150-160 (2001)(Exhibit 59). The authors broke the cases into three groups, one where they examined both lung and mesothelial tissues, one in which they looked only at lung tissue and one in which they limited their examination to mesothelial tissues. For approximately on quarter of the cases in each group, the only type of asbestos detected was chrysotile asbestos. Based on these findings, the authors concluded that this evidence supports the fact that chrysotile asbestos can induce human malignant mesothelioma.

Similarly, Drs. Langer and Nolan examined the asbestos content of tissues obtained at autopsy or biopsy from 81 workers and 2 household persons, 33 of which had been diagnosed with mesothelioma. *See* "Asbestos in the lungs of persons exposed in the USA," Monaldi Archives of Chest Diseases, 53(2):168-180 (1998)(Exhibit 58). They found that

in 12% of the mesothelioma cases, the only asbestos fiber detected was chrysotile and concluded that exposure to chrysotile, even in the absence of tremolite, can produce mesothelioma. *See also* Rogers, Leigh, Berry, Ferguson, Mulder, Ackad, "Relationship between lung asbestos fiber type and concentration and relative risk of mesothelioma," Cancer, 67:1912-1920 (1991)(Ex. 40)(2 cases with only chrysotile found in the lungs).

Given the undeniable association between exposure to asbestos and the development of mesothelioma, the identification of chrysotile as the only asbestos fiber in the lungs and mesothelial tissues of an individual afflicted with mesothelioma is strong physical evidence of causation obviating the need for the *Havner* statistical significance test.

As is demonstrated below, taking each of these factors in turn, it is clear that the relationship between chrysotile and mesothelioma is based on sound, reliable science. First, the theory has been tested and retested through multiple epidemiologic studies as well as animal and molecular assays. Second, the theory is based on objective scientific and medical facts, not the subjective opinions of the experts. Third, all of the studies and publications recounted in this response and relied upon by the Plaintiffs' experts have been subjected to some form of peer review. Many of the articles appear in prestigious publications such as the New England Journal of Medicine, the American Journal of Industrial Medicine, Cancer, and the British Journal of Industrial Medicine. Moreover governmental regulatory bodies throughout the world have relied upon these studies in setting public health policies.

Fourth, the extensive number of studies and their consistency minimizes the potential rate of error. Given the fact that mesothelioma is a disease specific to exposure to asbestos, and that it very rarely appears in a population that has not been exposed to asbestos, the likelihood that the appearance of the disease in chrysotile exposed cohorts is due to chance is non-existent. Fifth, as demonstrated above, the proposition that chrysotile can cause mesothelioma is widely accepted among scientists. With the exception of a handful of researchers, this proposition is almost universally accepted in the scientific community.

Finally, unlike Garlock's theory that chrysotile cannot cause mesothelioma, the accepted view that chrysotile does cause mesothelioma was not developed for litigation. Instead, this has always been the view of governmental agencies and public health organizations.

One widely accepted methodology for determining cause and effect was published by Sir Austin Bradford Hill in 1965. Hill, "The Environment and Disease: Association or Causation?" 58 Proc. Royal Soc'y Med. 295 (1965)(Ex. 18); *see Havner*, 953 S.W.2d at 718. Hill proposed nine factors to consider in determining the existence of a cause and effect relationship: strength of association, consistency, specificity, temporality, biological gradient (dose response), plausibility, coherence, experimentation, and analogy. It is not necessary that all criteria be met before drawing inferences about causation: "none of the nine factors can bring indisputable evidence for or against the cause and effect hypothesis, and none can be required as a sine qua non." Hill, 58 Proc. Royal Soc'y Med at 295 (Ex. 18); *see Havner*, 953 S.W.2d at 719 n.2.

Analyzing the published data on chrysotile and mesothelioma according to the considerations espoused by Sir Austin Bradford Hill, leaves no doubt that the scientific evidence supports the carcinogenicity of chrysotile alone in the induction of mesothelioma.

B. A Strong Association Exists Between Exposure to Chrysotile and the Development of Mesothelioma.

First, strength of association reflects the regularity with which an injury occurs in a population exposed to a particular agent, compared to the regularity with which the injury occurs in an unexposed population. This measure usually is expressed in statistical epidemiologic terms like relative risk, in morbidity studies, and standard mortality ratios (SMR) in mortality studies. As noted above, mesothelioma is a signature disease for asbestos exposure, but is exceedingly rare among the unexposed population -- at best, one case per million persons per year or less, or 1 in 10,000 autopsies The rarity of the disease, coupled with problems in diagnosis and reporting, make the assessment of the actual risk through of epidemologic studies difficult.

Nevertheless, there are a number of studies of chrysotile exposed populations that have demonstrated a significantly elevated risk for developing mesothelioma:

- In a 25-year longitudinal study covering 11,625 person years of 515 male asbestos plant workers exposed to chrysotile only asbestos in Chongqin, China, researchers found two cases of mesothelioma accounting for 1.5% of the total deaths. Based on an expected rate of one mesothelioma in 1,000,000 person years, this finding documented a risk exceeding 170 times that of the non-exposed population. The authors also reported a third mesothelioma case in a child of a worker but did not include it because the child's father was employed

after the cohort started. Yano, Wang, Wang, Wang and Lan, "Cancer Mortality among Workers Exposed to Amphibole-free Chrysotile Asbestos," Am J Epid, 154(6): 538-543 (Sept. 2001) (Ex. 62).

- In a study of the mortality of 2242 women in two chrysotile asbestos mining areas of the province of Quebec, 7 "pleural cancers," or mesotheliomas, were found. The authors calculated an SMR of 7.63 at a 95% confidence interval of 3.06 to 15.73. Camus, Siemiatycki, Meek, "Nonoccupational Exposure to Chrysotile Asbestos and The Risk of Lung Cancer," NEJM, 338(22): 1565-1571 (1998)(Ex. 19).
- In a study of 1094 chrysotile production workers employed at the mine and mill in Balangero, Italy, two mesothelioma cases, one confirmed pathologically and one based on radiographic findings and an examination of pleural fluid, were discovered among 427 deaths. Piolatto, Negri, La Veccia, Pira, Decarli & Peto, "An update of cancer mortality amoung chrysotile asbestos miners in Balangero, Northern Italy," Br. J. Ind. Med., 47:810-814 (1990)(Ex. 20). Based on an expected rate of one mesothelioma in 10,000 deaths, this finding was equivalent to an SMR well in excess of a doubling of the risk. While no tremolite was detected in any of the samples of chrysotile, the authors did find a trace amount of the silicate balangeroite, a substance that is not known to cause mesothelioma.
- A study of the records of 51 Zimbabwean miners and millers who had been certified as having an occupational lung disease, revealed two cases of mesothelioma, one proven by biopsy and the other a probable mesothelioma based on radiographic findings. Cullen, Baloyi, "Chrysotile asbestos and health in Zimbabwe: I. Analysis of miners and millers compensated for asbestos-related diseases since independence (1980)," Am. J. Ind. Med., 19:161-169 (1991)(Ex. 21). The authors estimated that 7000 Zimbabweans were engaged in the mining and milling operation. Among the chosen cohort of 27 miners with sufficient documentation, the authors discovered one mesothelioma case proven by pathology. Given the rarity of the disease and the size of the exposed population, the incidence of mesothelioma among these Zimbabwean miners significantly exceeded double that of the general population. Like the chrysotile ore mined in Balangero, Italy, no tremolite was detected in any of the samples, although there might have been a small percentage of anthophyllite.
- In the German Federal State of Saxony-Anhalt, Strum and his colleagues reviewed 843 cases of "proven asbestos-accepted mesotheliomas" and determined that 67 of the cases were related to exposure to only chrysotile asbestos. Strum, Menze, Krause, Thriene, "Use of asbestos, health risks and induced occupational diseases in the former East Germany," Toxicol Lett, 72:317-24 (1994)(Ex. 22).
- A study of 5932 male employees of a plastics research and development facility that used chrysotile asbestos reported a SMR of 3.73 [more than three times the incidence in the general population] with a 95% confidence interval of 1.21 to 8.70 for other respiratory deaths, all of which were attributable to the five deaths from pleural mesothelioma. Dell, Teta, "Mortality among workers at a plastics manufacturing and research and development facility: 1946-1988," Am J Industr Med 28:373-384 (1995) (Ex. 23). The actual relative risk was probably higher because a review of death certificates for the entire cohort revealed an additional four deaths from pleural mesothelioma as contributory causes during the observation period and a fifth death after the study had closed.
- A study of 3276 male and female workers in an asbestos textile friction and packing plant that used 99% chrysotile asbestos revealed 17 deaths from mesothelioma, representing 4.3% of all of the deaths. Robinson, Lemen, Wagoner, "Mortality patterns, 1940-1975 amoung workers employed in an asbestos textile friction and packing products manufacturing facility," Dust and Disease, Lemen, Dement (eds.). Pathotox publishers, Park Forest, IL (1979)(Ex. 24). The authors concluded that there was an excess risk for mesothelioma among males and females.
- The highest rate of mesothelioma deaths per 100 deaths in any population ever reported is that which occurred to railroad machinists exposed to chrysotile. Mancuso "Relative risk of mesothelioma among railroad machinists exposed to chrysotile," Am J Industr Med 13:639-657 (1988)(Ex. 25). There were 14 mesothelioma deaths in 156 deaths among these workers. In comparison, as noted by Mancuso, in the American Cancer Society study of 31,665 deaths in the general population, there were 3 mesothelioma deaths. While no relative risk calculation was made, it is obvious that it would exceed twice that of the general population. In addition, confidence limits are unimportant since it is clear the findings are not due to chance, and even the lower confidence limit would be much above 2. While there may have been a minor amount of amphibole asbestos used by some workers in this cohort, the author concluded that, "[t]he findings of this study demonstrate a very high relative risk for those exposed to chrysotile asbestos in the development of mesothelioma . . ."
- In a study of 1,261 males employed in a chrysotile asbestos textile operation in South Carolina, 2 mesotheliomas were observed among the cohort and an additional mesothelioma was identified among plant workers after the study follow-up period. Dement, Brown, Okun, "Follow-up study of chrysotile asbestos textile workers: cohort mortality and case-control analyses," Am J Ind Med, 26:431-447 (1994)(Ex.26).

Finally, Dr. Allen Smith, professor of epidemiology in the School of Public Health at the University of California at Berkley reviewed dozens of epidemiological articles regarding chrysotile and mesothelioma. Dr. Smith summarized his conclusions as follows:

(1) *chrysotile asbestos is a potent cause of pleural mesothelioma*; (2) the large majority of mesothelioma is attributable to asbestos exposure; and (3) chrysotile asbestos has been the major type used. Based on this evidence, we

conclude that *chrysotile asbestos is by far the main contributor to pleural mesothelioma causation in the United States and other countries in which it has been the predominate fiber*. Crocidolite may be 2-4 times more potent, but there is no valid evidence that amosite is more potent that chrysotile. Even considering an extreme that crocidolite and amosite were two times more potent than chrysotile, the extent of use of chrysotile means that it would still be the main contributor of pleural mesothelioma causation.

Smith and Wright, "Chrysotile Asbestos is the Main Cause of Pleural Mesothelioma," American Journal of Industrial Medicine 30:252-66 (1996) (emphasis added)(Ex. 17). Although Garlock asserts Smith's review "reaches conclusions not expressed in the articles it reviews," without explaining why, the simple, unavoidable truth is that this article and the volumes of others cited above indicate there is a strong association between exposure to chrysotile and mesothelioma.

C. A Consistent Association Exists Between Exposure to Chrysotile and the Development of Mesothelioma.

The causative relationship between chrysotile and mesothelioma is further supported by the consistency with which the relationship has been documented. In addition to the studies set forth above, cases of mesothelioma have been observed in studies of (1) workers manufacturing chrysotile containing cements in Louisiana (2) workers manufacturing chrysotile containing friction products in Connecticut and Germany; (3) wives of workers who manufacture chrysotile friction products and textiles in New York; (4) mechanics who installed chrysotile brake linings in Canada, the United States, England, and Denmark; (5) an Italian worker in the wine filter industry; and (6) individuals who lived near chrysotile textile and friction products plants(**5**).

D. A Dose-Response Relationship Exists Between Exposure to Chrysotile and the Development of Mesothelioma.

Like any true causative relationship, there is also a biological gradient or dose response relationship between exposure to chrysotile asbestos and the development of mesothelioma. In other words, the more exposure, the more likely the disease will develop. Researchers have found a significant increase in the risk of mesothelioma with an increase in fiber concentration as shown by an odds ratio of 15.7. *See* Lemen Affidavit at pp. 7-8 (Ex. B); Rogers, Leigh, Berry, Ferguson, Mulder, Ackad, "Relationship between lung asbestos fiber type and concentration and relative risk of mesothelioma," Cancer, 67:1912-1920 (1991)(Ex. 40). The amount of exposure necessary to cause mesothelioma, however, is unknown because *any* exposure to chrysotile asbestos in excess of normal, ambient air levels is capable of causing mesothelioma. A recent study has shown a significant excess of mesothelioma at levels of cumulative exposure that were probably far *below* the limits adopted in most industrial countries during the 1980s. Iwatsubo, Pairon, Boutin, Menard, Massin, Caillaud, Orlowski, Galateau-Salle, Bignon, Brochard, "Pleural Mesothelioma: Dose-Response Relation at Low Levels of Asbestos Exposure in a French Population-based Case-Control Study," Am J Epidemiol, 148: 133-42 (1998) (Ex. 41).

E. The Association Between Exposure to Chrysotile and the Development of Mesothelioma is Scientifically Plausible.

In addition to the epidemiologic studies and case reports, an evaluation of other available data sets including general biologic principles, molecular studies, and animal studies confirm a causal connection between exposure to chrysotile asbestos and mesothelioma. With regard to biological plausibility, it is well known that the health effects of asbestos were related to the shape of the fiber and not its chemical composition. Therefore, any argument regarding the chemical constituents of the various asbestos fibers types, as a determinant of their capability for causing mesothelioma, is not biologically plausible. It is the fibers with similar morphology that react similarly and are probable causes of mesothelioma. For example, many researchers contend the extreme potency of crocidolite asbestos is related to its thin diameter. Chrysotile fits this pattern because chrysotile fibers have a tendency to cleave longitudinally creating extremely thin fibrils.

Moreover, it is undisputed that chrysotile is a cause of cancer in the lung. Since chrysotile is an independent cause of human lung cancer it is irrefutable that it can cause intracellular changes that result in cancer. It is ridiculous to argue that the mechanisms of lung cancer induction are somehow different from the mechanisms of mesothelioma induction.

Finally, researchers have documented the fact that chrysotile fibers leave the lung and migrate to and are concentrated in the pleura, the site of most mesotheliomas. *See* Suzuki and Kohyama, "Translocation of Inhaled Asbestos Fibers from the Lung to Other Tissues," Am. J. Ind. Med, 19:701-704 (1991)(Ex. 42); Kohyama and Suzuki; "Analysis of asbestos fibers in lung parenchyma, pleural plaques, and mesothelioma tissues of North American

insulation workers," Ann. NY Acad. Sci., 643:27-52(Ex. 43); Sebastien, Janson, Gaudichet, Hirsch and Bignon, "Asbestos retention in human respiratory tissues: comparative measurements in lung parenchyma and in parietal pleura," IARC Sci. Pub, 30:237-246 (1980)(Ex. 44). Since chrysotile is carcinogenic and is present in high concentrations in the pleura where mesothelioma is induced, it is biologically plausible that it causes or contributes to cause mesothelioma.

This plausibility is confirmed by molecular studies that have shown how chrysotile fibers can penetrate the cell, enter the nucleus and induce abnormal chromosome formations in dividing cells. *See* Levresse, Renier, Fleury-Feith, Levy, Moritz, Vivo, Pilatte, Jaurand, "Analysis of Cell Cycle Disruptions in Cultures of Rat Pleural Mesothelial Cells Exposed to Asbestos Fibers," Am. J. Respir. Cell Mol. Biol., 17:660-671 (1997)(Ex. 45). It is further supported by studies of several different animal species who have inhaled or been injected with pure chrysotile fibers(**6**) and have developed mesothelioma. Bolton, Davis, Donaldson, Wright, "Variations in the carcinogenicity of mineral fibres," Ann Occup Hyg, 26:569-582 (1982)(Ex. 48); Minardi, Maltoni, "Results of recent experimental research on the carcinogenicity of natural and modified asbestos," Ann. NY Acad. Sci, 534:754-761 (1991)(Ex. 49).

Once the general causation has been established between exposure to chrysotile asbestos dust and the development of mesothelioma, specific causation can be drawn from the fact of the diagnosis of mesothelioma and the individual's occupational history of exposure to asbestos. The scientific reliability of this method of specific attribution is demonstrated by consensus criteria adopted recently in Helsinki, Finland. *See* Consensus Report, "Asbestos, asbestosis, and cancer: the Helsinki criteria for diagnosis and attribution," Scand. J. Work Environ. Health, 23:311-6 (1997) (Ex. 60). This group, that had collectively published over 1000 articles on asbestos and associated disorders, recognized that the great majority of mesotheliomas are due to asbestos exposure, that mesothelioma can occur in cases with low asbestos exposure, and that an occupational history of brief or low-level exposure should be considered sufficient for mesothelima to be designated as occupationally related.

Accordingly, the consensus conclusion was that:

A lung fiber count exceeding the background range for the laboratory in question *or* the presence of radiographic or pathological evidence of asbestos-related tissue injury (eg., asbestosis or pleural plaques) *or* histopathologic evidence of abnormal asbestos content (eg, asbestos bodies in histologic sections of the lung) should be sufficient to relate a case of pleural mesothelioma to asbestos exposure on a probability basis. In the asbsence of such markers, a history of significant occupational, domestic, or environmental exposure to asbestos will suffice for attribution.

Id. at p. 316.

The McGill studies, so heavily relied upon by the asbestos company experts, reveal that the rate of mesothelioma in the Canadian chrysotile mines was 35.3 per 100,000 person years or 353 per 1,000,000 person years. *See* McDonald, Case, Churg, Dufresne, Gibbs, Sebastien and McDonald, "Mesothelioma in Quebec Chrysotile Miners and Millers: Epidemiology and Aetiology," Ann. Occup. Hyg., 41(6):707-719 (1997)(Ex. 53) at p. 713. The background incidence of mesothelioma in the United States is estimated at 1 case per million person years or less. Accordingly, the workers who were removing the chrysotile asbestos from the earth that was eventually incorporated into the products to which Plaintiff was exposed had a relative risk exceeding ***350*** times the general population(**7**).

As shown in Section V(B) above, other epidemologic studies confirm that workers exposed to chrysotile have a risk of contracting mesothelioma that exceeds twice that of non-exposed workers. For example, Yano and his colleagues, in a study that covered 11,625 person-years, discovered two cases mesothelioma in a population of workers exposed only to chrysotile asbestos. *See* Ex. 62. Based on the background incidence rate, this finding represents a relative risk exceeding **170** times the general population.

In addition, Camus, Siemiatycki, and Meek calculated a seven-fold increase of mesothelioma in women who lived in the area of two chrysotile mines. *See* Ex. 19 (Standard Mortality Ratio of 7.63 at a 95% confidence interval of 3.06 to 15.73). Moreover, Dell and Teta reported a three-fold increase in male employees of a plastics research and development facility that used chrysotile asbestos. *See* Ex. 23 (Standard Mortality Ratio of 3.73 with a 95% confidence interval of 1.21 to 8.70).

There is significant evidence that *all* chrysotile asbestos mined in Canada was contaminated to some degree with tremolite. Indeed, as set forth in numerous published, peer reviewed articles and studies, *including* the McGill studies upon which Garlock relies, there is a consensus that *all* commercial chrysotile products in the United States, including necessarily those manufactured by Garlock, contained the contaminate tremolite.

For example, in the article *Chrysotile, Tremolite and Carcinogenicity*, attached as an exhibit to Garlock's motion, the authors state that "[g]iven that chrysotile and tremolite tend to occur together it has not been easy to assess separately their effects on mortality . . . In the meantime it must be accepted that for practical purposes chrysotile asbestos, *as used commercially*, may contain low but varying concentrations of fibrous tremolite." Ex. 51 at p. 703(emphasis added).

In addition, asbestos company expert witness Dr. Bruce Case concedes that "[*p*]*ure chrysotile exposure rarely, if ever, occurs*." Case, "Biological Indicators of Chrysotile Exposure," Ann. Occup. Hyg., 38(4):503-518 (1994)(Ex. 61) at p. 505 (emphasis in the original). In that same article, Dr. Case commented that, "[i]t is possible that chrysotile is always associated with some degree of tremolite (an often other amphiboles, commercial and non-commercial) if exposure has been long enough and it is looked for (in the lung) hard enough." Id. At p. 514.

Similarly, an article published in the American Journal of Public Health in 1996 stated that:

The hypothesis that these observations may be attributable to trace amounts (<1%) of tremolite contamination may seem to be primarily of academic interest, because chrysotile exposures in workers and the public are also contaminated with tremolite. However, the percentage of tremolite has been reported to range from 0.5% to 6.9% in one analysis of eight commercial chrysotile asbestos samples....

Stayner, Dankovic, Lemen, "Occupational Exposure to Chrysotile Asbestos and Cancer Risks: A Review of the Amphibole Hypothesis," Amer J Public Health, 86:179, 184 (1996)(*citing* J. Addison & L. Davies, "Analysis of Amphibole Asbestos in Chrysotile and Other Minerals," Ann Occup Hyg, 34:159-175 (1990) (regarding tremolite in the 8 samples)(Ex. 57).

The contamination of finished chrysotile products is also supported by the lack of evidence that the processing of chrysotile ore into the raw asbestos fibers used in making commercial products does anything to remove the tremolite contamination. Indeed, studies of lung tissue samples from persons who never worked in the mines but only worked with finished or processed products containing chrysotile have demonstrated the presence of tremolite fibers. Thus, the basis for the conclusion that, "...the existence of 'pure' chrysotile is a theoretical concept that does not exist in the real industrial world." *Id.*

Footnotes

(**1**) *Garlock relies very heavily on the writings of Dr. J.C. McDonald and his wife, A.D. McDonald and their colleagues at McGill University. While certain earlier publications by the McDonalds acknowledge financial assistance from the QAMA, their 1997 papers contain no such disclosure. Compare McDonald and McDonald, "Epidemiologic Surveillance of Mesothelioma in Canada," CMA Journal, 109:359-362 (1973)(Ex. 1) and McDonald and McDonald, "Malignant Mesothelioma in North America," Cancer,*

44:1650-1656 (1980)(Ex. 2) with McDonald et al, "Mesothelioma in Quebec Chrysotile Miners and Millers: Epidemiology and Aetiology," Ann Occup Hyg., 41:606-719 (1997)(Ex. 3).

(**2**) *Liddell, McDonald, McDonald, "The 1891-1920 birth cohort of Quebec chrysotile miner and millers: development from 1904 and mortality to 1992," Ann. Occup. Hyg, 41:13-36 (1997)(Ex. 50); McDonald, McDonald, "Chrysotile, tremolite and carcinogenicity," Ann. Occup. Hyg, 41:699-705 (1997) (Ex. 51); and McDonald, Case, Churg, Dufrense, Gibbs, McDonald, "Mesothelioma in Quebec chrysotile miners and millers: epidemiology and aetiology," Ann. Occup Hyg, 41:707-719 (1997)(Ex. 53). Throughout the brief, these studies will be referred to as the McGill studies since all of the participants have ties to McGill University in Montreal, Quebec, Canada.*

(**3**) *See Excerpt of Deposition of Dr. Bruce Case taken on July 19, 2001(Ex.H) at pp. 106-107.*

(**4**) *23.3% for lungs and mesothelial tissues, 23.3% for lung only, and 25.7% for mesothelial tissues alone.*

(**5**) *Hughes, Weill and Hammad, "Mortality of workers employed in two asbestos cement manufacturing plants," Brit. J. Indus. Med., 44:161-174 (1986)(Ex. 27); Teta, Lewinsohn, Meigs, Vidone, Mowad and Flannery, "Mesothelioma in Connecticut, 1955-1977," Journal of Occupational Medicine, 25(10):749-756 (1983)(Ex. 28); Konetzke, Beck and Herold, "Asbestos-Induced Mesotheliomas - Results of a Retrospective Study," Proceedings of the International Symposium on the Prevention of Occupational Cancer, Helsinki, Finland (1981)(Ex. 29); Vianna and Polan, "Non-Occupational Exposure to Asbestos and Malignant Mesothelioma in Females," The Lancet, May 20, 1978, pp. 1061-1063 (Ex. 30); McDonald, Harper, Attar and McDonald, "Epidemiology of Primary Malignant Mesothelial Tumors in*

Canada," Cancer, 26(4):914-919 (1970)(Ex. 31); Langer and McCaughey, "Mesothelioma in a Brake Repair Worker," The Lancet, November 13, 1982, pages 1101-1103 (Ex. 32); Kagan and Jacobson, "Lymphoid and Plasma Cell Malignancies: Asbestos-related Disorders of Long Latency," American Journal of Clinical Pathology, 80(1):14-20(1983)(Ex. 33); Huncharek, Muscat and Capotorto, "Pleural mesothelioma in a brake mechanic," Brit. J. Indus. Med., 46:69-71 (1989)(Ex. 34); Greenberg and Davies, "Mesothelioma Register 1967-68," Brit. J. Indus. Med., 31:91-104 (1974)(Ex. 35); Hansen, "Mortality of auto mechanics, a ten year follow-up," Scand. J. Work Environ. Health, 15:41-46 (1989)(Ex. 36); Scansetti, Mollo, Tiberi, Andrion, and Piolatto, "Pleural Mesothelioma After a Short Interval From First Exposure in the Wine Filter Industry," Amer. J. of Indus. Med. 5:335-339 (1984)(Ex. 37); Lieben and Pistawka, "Mesothelioma and Asbestos Exposure," Arch. Environ. Health 14:559-566 (1967)(Ex. 38); Wolf, Piotrowski, Engel, Bekeris, Palacios and Fisher, "Malignant Mesothelioma With Occupational and Environmental Asbestos Exposure in an Illinois Community Hospital," Arch. Intern. Med. 147:2145-2149 (1987)(Ex. 39).

(**6**) *Standard "pure" asbestos samples to be used for biomedical research were first prepared by the International Union Against Cancer (UICC) in 1966 in the United States and South Africa. Analysis of these samples shows that the Canadian chrysotile UICC sample does not contain any fibrous impurities like tremolite. Kohyama, Shinohara and Suzuki, "Mineral Phases and Some Reexamined Characteristics of the International Union Against Cancer Standard Asbestos Samples," Am. J. Indus. Med., 30:515-528 (1996)(Ex. 46). This has led researchers to conclude that chrysotile has a greater potential to cause mesothelioma than previously accepted. Frank, Dodson, Willikams "Carcinogenic Implications of the Lack of Tremolite in UICC Reference Chrysotile," Am. J. Ind. Med, 34(4): 314-7 (1998)(Ex. 47).*

(**7**) *2 cases per 11,625 person-years = 17.2 cases per 100,000 person-years or 172 cases per 1,000,000 person-years.*

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