ORIGINAL

SUPERIOR COURT OF THE STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO

DEPARTMENT NUMBER NINE

In re ASBESTOS INSURANCE COVERAGE CASES, All Included Actions	JUDICIAL COUNCIL COORDINATION PROCEEDING NO. 1072 DATE: January 26, 1987 TIME: 9:30 a.m. DEPT: Nine (Nourse Auditorium)

POLICYHOLDERS' PROPOSED
MEDICAL FINDINGS OF FACT

PLAINTIFF'S EXHIBIT WV-01226

PLAINTIFF'S EXHIBIT 21603.0

I. THE MEDICAL WITNESSES

1. Medical evidence was presented during Phase III of this proceeding by eight expert witnesses. The policyholders called:

a. Dr. Elliott Kagan, who is board certified in both clinical and anatomic pathology. (Kagan, Tr. 8951.) The main thrust of Dr. Kagan's research for the past 7 1/2 years has been the pathogenesis of asbestosis. (Kagan, Tr. 8957, 9006.)

b. Dr. Edward A. Gaensler, who is board certified as both a general and thoracic surgeon. (Gaensler, Tr. 9407.) He considers himself a clinician, (Gaensler, Tr. 9406), and in recent years has focused on the study of interstitial lung disease. (Gaensler, Tr. 9403.) He is a certified B-reader of x-rays, i.e., a specialist in interpreting x-rays for evidence of lung disease caused by dust inhalation. (Gaensler, Tr. 9407.) He has previously devised a diffusing capacity test widely used today in the clinical diagnosis of asbestos-related diseases. (Gaensler, Tr. 9412, 9417.) In order to study the early clinical development of interstitial lung diseases, using asbestosis as a model, he began a longitudinal study of asbestos workers in 1965. (Gaensler, Tr. 9422-23.) As part of that study, he has seen about 1,600 employees an

average of ten times each. (Gaensler, Tr. 9425.) In addition, he has since 1955 diagnosed about 300 cases of asbestosis in a clinical setting. (Gaensler, Tr. 9757.)

c. Dr. Marvin Kuschner, who is board certified in pathology. (Kuschner, Tr. 9988.) His major areas of interest have been the study of environmentally induced pulmonary disease and lung cancer. (Kuschner, Tr. 9987.) He has done about 500 consultations with respect to asbestos-related diseases. (Kuschner, Tr. 9997.)

The manifestation carriers called:

a. Dr. Ronald Crystal, who is board certified in internal medicine with the subspecialty of pulmonary medicine. (Crystal, Tr. 10321.)

b. Dr. Jerome Kleinerman, who is board certified in the specialties of anatomic and clinical pathology. (Kleinerman, Tr. 10754.)

c. Dr. Paul Epstein, who is board certified in internal medicine with the subspeciality of pulmonary disease. (Epstein, Tr. 11071.) Dr. Epstein has never conducted any original research on the pathogenesis or any other aspect of asbestos-related diseases. (Epstein, Tr. 11197, 11208.)

Finally, the exposure carriers called:

a. Dr. John Craighead, who is board certified as an anatomic and clinical pathologist. (Craighead, Tr. 11523.)

b. Dr. Gerhand Brand, who has specialized in tropical medicine and infectious diseases. (Brand, Tr. 11956.) He also has been interested in the field of foreign body tumorigenesis, i.e., cancer induction by the implantation of a foreign body. (Brand, Tr. 11967, 11968.)

II. GENERAL DEFINITIONS

2. "Pathology" means literally the study of disease. (Kagan, Tr. 8952.) A pathologist is a physician concerned with the study of the natural history of disease, including its causation. (Kuschner, Tr. 9987.) The term "pathogenesis" refers to the reasons for and time course of the natural evolution of disease. (Kagan, Tr. 8953.)

3. "Bodily injury" is a term not generally used by doctors. (Kagan, Tr. 9180-81, 9318; Crystal, Tr. 10353; Kleinerman, Tr. 10764; Craighead, Tr. 11898.)

4. "Injury" is variously defined by the medical experts. The concept of cellular injury is a basic tenet of pathology. (Kagan, Tr. 9004.) The pathologist characterizes as injury any alteration in cellular form or function brought about by the influence of a noxious agent. (Kuschner, Tr. 10003; Craighead, Tr. 11571; Kleinerman, Tr. 10762.) Clinicians recognize this usage by pathologists to describe microscopic

changes from normal. (Crystal, Tr. 10349-50; Epstein, Tr. 11222.)

5. "Disease" is also variously defined by the medical experts. Two clinicians defined it as a process or condition that so interferes with the function of an organ as to produce noticeable symptoms or measurable signs. (Crystal, Tr. 10353-54; Epstein, Tr. 11143-44.) Pathological disease can, however, be identified and diagnosed without there being any clinically measurable loss of function. (Kuschner, Tr. 10055; Crystal, Tr. 10354; Kleinerman, Tr. 10765; Craighead, Tr. 11691, 11745.)

6. "Latency period", as most often used today with respect to asbestos-related diseases, refers to the time interval between initial exposure to asbestos and the subsequent development of clinical signs and symptoms. (Gaensler, Tr. 9471, 9751, 9779; Kleinerman, Tr. 10826; Epstein, Tr. 11152; Brand, Tr. 12032, 12048-49.) The latency period for asbestosis varies according to the intensity of exposure. (Gaensler, Tr. 9472-73; Kleinerman, Tr. 10897; Craighead, Tr. 11550, 11626.) This illustrates the recognized dose response relationship common to all interstitial lung diseases of known etiology. (Gaensler, Tr. 9513; Crystal, Tr. 10360; Kleinerman, Tr. 11022-23.) During the early decades of this century before any protective measures to reduce asbestos exposure were implemented, the exposure levels in certain industries would be so heavy that workers would die of asbestosis after only seven or eight years of exposure. (Gaensler, Tr. 9473.) Regulation by the government of

occupational exposure levels in this country is simply intended to increase the latency period to the point where a worker will not develop clinical signs and symptoms of disease during his lifetime. (Kagan, Tr. 9123; Gaensler, Tr. 9474.) The majority of workers exposed to asbestos since those regulations first went into effect about twenty years ago have in fact received negligible exposure between then and now. (Gaensler, Tr. 12507.) The latency period for persons clinically diagnosed with asbestosis after about 1965 has generally been measured in decades. (Kagan, Tr. 9251; Gaensler, Tr. 9474; Epstein, Tr. 11152.)

III. ASBESTOS

7. Asbestos is a general name for a group of naturally occurring fibrous silicates. (Kagan, Tr. 8978.) The mineral asbestos is broadly classified as either serpentine or amphibole based on the general shape of the fiber. (Kagan, Tr. 8978; Epstein, Tr. 11093.) Each of these broad categories is further broken down into specific kinds of asbestos fibers. In the United States, three main kinds of asbestos have been used commercially over the years -- chrysotile (serpentine), crocidolite (amphibole) and amosite (amphibole.) (Kagan, Tr. 8979-80.) Because these different kinds of asbestos have historically been used interchangeably and as mixtures, all have contributed to the occupational exposure of workers in this country. (Kagan, Tr. 8981; Craighead, Tr. 11757, 11795; Gaensler, Tr. 12386-87; Kuschner, Tr. 12607-08; Craighead, Tr.

13882-84.) Asbestos is virtually an indestructible mineral and the fibers of all kinds of asbestos are non-biodegradable. (Kagan, Tr. 8982; Gaensler, Tr. 9507; Epstein, Tr. 11100; Craighead, Tr. 11602; Brand, Tr. 12057; Kuschner, Tr. 12605.)

8. There is no distinction between the different kinds of asbestos fibers in their ability to cause asbestosis. (Kagan, Tr. 8981; Crystal, Tr. 10579; Kleinerman, Tr. 10775-76; Epstein, Tr. 11368; Craighead, Tr. 11547-48, 13881.) There is some medical uncertainty as to whether short asbestos fibers (less than 5 microns) contribute to the fibrotic disease process. (Epstein, Tr. 11367; Craighead, Tr. 11796-97.) It is believed that the most damaging fibers are the longer ones that cannot be completely engulfed or phagocytozed by macrophages, the scavenger cells found in the alveoli and interstitium of the lung. (Gaensler, Tr. 9437; Kuschner, Tr. 9995, 10016; Craighead, Tr. 11592, 11689, 11732; Brand, Tr. 12057; Kuschner, Tr. 12642.)

IV. ANATOMY AND FUNCTION OF THE RESPIRATORY SYSTEM

9. In order to understand the development of asbestos-related diseases, some familiarity with the gross and microscopic anatomy of the respiratory system is required. Air enters that system through the nose and mouth and is drawn through the trachea and into the various branchings of the bronchi. (Kagan, Tr. 8968.) The bronchi branch further into bronchioles which terminate in alveolar ducts surrounded by microscopic air sacs called alveoli. (Kagan, Tr. 8971.) The tissue that makes up the alveoli constitutes the bulk of the lung

and is called the parenchyma. (Kagan, Tr. 8985; Crystal, Tr. 10371.) The lungs of an adult contain approximately 300 million alveoli. (Kagan, Tr. 8977; Gaensler, Tr. 9440; Crystal, Tr. 10369-70; Epstein, Tr. 11092.) These alveoli are separated from one another by extremely thin partitions called alveolar septa which provide a delicate supporting structure and collectively constitute the interstitium of the lung. (Kagan, Tr. 8972; Crystal, Tr. 10333.)

10. The function of the respiratory system is to deliver oxygen to the blood and to carry away dissolved carbon dioxide. The basic gas exchange unit of the lung is the alveolus and its adjoining capillaries. (Kagan, Tr. 8976.) These capillaries carry red blood corpuscles and run throughout the interstitium, the thin and delicate membrane through which the gas exchange between the alveoli and blood occurs. (Kagan, Tr. 8974.) Any thickening of the interstitial wall or impediment to the flow of blood through that wall will adversely affect gas exchange. (Kagan, Tr. 8976, 8994; Craighead, Tr. 11593.)

11. Normal lungs have a considerable reserve capacity. (Kagan, Tr. 8976-77; Gaensler, Tr. 9422-23; Crystal, Tr. 10369-70; Craighead, Tr. 11550; Brand, Tr. 12086; Epstein, Tr. 12990.) An otherwise healthy individual can actually function normally with one entire lung removed. (Kagan, Tr. 8977; Craighead, Tr. 11629.) Similarly, an adult can lose the function of at least a third and probably half of the individual alveolar/capillary gas exchange units constituting the lung parenchyma without

experiencing any noticeable symptoms or presenting any clinically measurable signs. (Crystal, Tr. 10369-70; Kleinerman, Tr. 10889.)

V. ASBESTOSIS

12. Asbestosis, as the name implies, is a disease caused by the inhalation of asbestos fibers. (Kagan, Tr. 8978.) It is characterized by scarring of the alveoli and interstitium of the lung and thus is classified as an interstitial lung disease. (Kagan, Tr. 8977, 8993; Gaensler, Tr. 9406; Kuschner, Tr. 10000, 10002; Crystal, Tr. 10333, 10355; Brand, Tr. 12156.) It is a chronic disease that affects the lung diffusely. (Kagan, Tr. 9069; Gaensler, Tr. 9404.) Asbestosis is a type of pneumoconiosis, i.e., a dust disease in which interstitial fibrosis results from inflammation induced by inhaled particles or fibers. (Gaensler, Tr. 9429-30.)

13. The scarring in the lung caused by inhaled asbestos fibers is called fibrosis. (Kagan, Tr. 8994.) It consists of a pathological accumulation of collagen in the alveolar walls and interstitium which has the effect of impeding or destroying altogether the gas exchange capability of affected alveolar/capillary units. (Kagan, Tr. 8994-95, 9036, 9056; Gaensler, Tr. 9439; Craighead, Tr. 11593.)

14. Fibrosis in the lung is preceded by and is a response to injury caused by inhaled asbestos fibers. (Kagan, Tr. 9002-03, 9177; Kleinerman, Tr. 10872, 10916, 10949, 10971.) Since it results in distortion and destruction of the delicate

alveolar/capillary gas exchange units, fibrosis is itself more accurately characterized as a form of injury than of repair. (Kagan, Tr. 8995, 9094; Gaensler, Tr. 9570; Kuschner, Tr. 10119.) Fibrosis is an irreversible process. Once the gas exchange capacity of an individual alveolar/capillary unit is compromised, that loss is permanent. (Kagan, Tr. 8997; Gaensler, Tr. 9439, Kuschner, Tr. 10123; Crystal, Tr. 10562, 10613, 10620; Kleinerman, Tr. 10871, 11048; Epstein, Tr. 11324; Craighead, Tr. 11549; Brand, Tr. 12209; Kuschner, Tr. 12682.)

15. From a pathological standpoint, the disease asbestosis is defined as scarring in the alveolar region of the lung in association with asbestos fibers or asbestos bodies. (Kagan, Tr. 9002; Kleinerman, Tr. 10847; Craighead, Tr. 11810.) If tissue examined microscopically by the pathologist satisfies these criteria, a diagnosis of asbestosis is complete even though only a few pulmonary subunits may be affected. (Kagan, Tr. 9068; Kleinerman, Tr. 10849, 10892.)

16. From a clinical standpoint, the disease asbestosis is defined as the accumulation of enough fibrosis in the lung to affect its function as measured by noticeable symptoms or clinically measurable signs. (Epstein, Tr. 11141.) This can only occur after fibrosis has affected enough individual alveolar/capillary units to produce measurable lung dysfunction. (Crystal, Tr. 10371.)

17. Absent an established history of exposure to asbestos, examination of tissue by the pathologist is essential

to making a definitive clinical diagnosis of the disease asbestosis. (Gaensler, Tr. 9419; Crystal, Tr. 10533-54.)

VI. METHODS FOR STUDYING THE PATHOGENESIS OF ASBESTOS-RELATED DISEASES

18. Because the only way one can examine human lung tissue is to remove it from the body, it is rare to have the opportunity to examine such histologic material during the early course of asbestos-related diseases. Medical researchers, therefore, must and do rely on animal experiments to elucidate the pathogenesis of these diseases in man. (Kagan, Tr. 9008; Gaensler, Tr. 9477, 9576-77; Kleinerman, Tr. 10830, 11013; Epstein, Tr. 11112.)

19. At the microscopic level, the rat and other mammalian lungs are virtually identical to those of man. (Kagan, Tr. 9008-10, 9247; Gaensler, Tr. 9764; Brand, Tr. 12000.) The nature and timing of the cellular-level reaction by such animals to inhaled asbestos fibers also closely approximate the human response. (Kagan, Tr. 9011, 9249; Gaensler, Tr. 9577, 9763; Kuschner, Tr. 10088; Kleinerman, Tr. 10940; Epstein, Tr. 11215; Craighead, Tr. 11750, 11754.) This is evidenced by, among other things, wound healing experiments which demonstrate that it takes about the same time for an incision to heal in a rat as in a man. (Craighead, Tr. 11574-75; Kuschner, Tr. 12670.)

20. The amount of asbestos to which an experimental animal is exposed affects only the overall extent of the

resultant reaction, not its time course. (Kagan, Tr. 9399; Gaensler, Tr. 9765-66; Kuschner, Tr. 10129-30, 12630, 12669.)

21. Because of the large reserve capacity of the lung, a large number of alveolar/capillary gas exchange units must be compromised by fibrosis before the disease asbestosis can be clinically detected. (Kagan, Tr. 8978, 9250-51; Gaensler, Tr. 9416, 9422-23, 9440, 9974, Kleinerman, Tr. 10836, 10949-50; Epstein, Tr. 11255; Craighead, Tr. 11550, 11859; Brand, Tr. 12086.) It is estimated that in order for the disease asbestosis to be clinically diagnosed, the gas exchange function of at least 100 million alveolar/capillary units must be affected. (Crystal, Tr. 10369-70, 10514, 10539, 10702.) It is thus apparent that the disease asbestosis can exist on a pathological or sub-clinical level, even though it is not clinically detectable. (Kagan, Tr. 9057-58; Crystal, Tr. 10715; Kleinerman, Tr. 10836, 10848, 10897; Craighead, Tr. 11554.) This fact is evidenced by lung tissue samples showing pathological evidence of fibrosis taken from asbestos workers who have not been clinically diagnosed as having the disease. (Kagan, Tr. 9057-58; Gaensler, Tr. 9477, 9485, 9973-74; Crystal, Tr. 10716.) By the time that asbestosis is clinically diagnosed, injury and irreversible fibrotic changes have already occurred in the lung. (Crystal, Tr. 10568; Epstein, Tr. 11213.)

22. The current clinical tools for diagnosing asbestosis are relatively crude and provide an insensitive indicator of the degree of injury to, and the fibrotic changes

within, the lung. (Kagan, Tr. 9250-51; Gaensler, Tr. 12329; Craighead, Tr. 13861.) Fibrosis can be detected pathologically without appearing on an x-ray. (Crystal, Tr. 10529; Kleinerman, Tr. 10915, 10934, 11034; Epstein, Tr. 11285, 11412, 11418; Gaensler, Tr. 12568; Epstein, Tr. 12897, 12979, 12993-94.) There may also be histologic evidence of fibrosis not revealed by pulmonary function tests as administered by a clinician. (Crystal, Tr. 10528, 10699; Epstein, Tr. 11412, 11418, 11489, 12990, 12992-4.) There is, moreover, a poor correlation between x-rays and measured functional impairment as indicators of clinical asbestosis. (Crystal, Tr. 10692-93, 10696-97.)

23. The ability of a clinician to diagnose the disease asbestosis is dependent on the sensitivity and sophistication of the available diagnostic tools as limited by the current state of medical technology. (Gaensler, Tr. 9487-88; Kuschner, Tr. 10033, 10056; Crystal, Tr. 10534-36; Epstein, Tr. 11434-35; Kuschner, Tr. 12694.)

VII. THE PATHOGENESIS OF ASBESTOSIS

24. The upper respiratory system filters incoming air and prevents most inhaled foreign matter, including asbestos fibers, from ever reaching the alveolar region of the lungs. (Kagan, Tr. 8969; Gaensler, Tr. 9432.) This defense is not, however, completely effective and, in those occupationally exposed to asbestos, some fibers are deposited on the very first day of such exposure. (Kagan, Tr. 9014-15, 9279-80; Brand, Tr. 12048.) In accordance with the aerodynamic principle of laminar

flow, it is the diameter of a fiber rather than its length that determines whether the fiber can transit the bronchi and bronchioles to reach the gas exchange region of the lung. (Kagan, Tr. 8981; Kuschner, Tr. 10097; Epstein, Tr. 11344-46; Craighead, Tr. 11589, 11591-92; Kuschner, Tr. 12641.) This is the reason why many long asbestos fibers of up to 100 microns are deposited in the alveoli. (Gaensler, Tr. 9434; Epstein, Tr. 11201; Kuschner, Tr. 12642.) Inhaled fibers of all lengths are dispersed throughout the lung by the random flow of air through the multiple branches of the bronchi and bronchioles. (Kagan, Tr. 8970, 9069; Kuschner, Tr. 10072, Crystal, Tr. 10404.)

25. Once deposited in the alveolar region of the lung, asbestos fibers tend to remain there. This is because the normal clearance mechanisms of the lung are ineffective as applied to non-biodegradable fibers which cannot be destroyed by metabolic processes. (Kagan, Tr. 8982, 9016-17, 9086; Gaensler, Tr. 9437-38, 9442, 9506-07, 9514; Kuschner, Tr. 10003; Kleinerman, Tr. 10983; Epstein, Tr. 11164-65, 11519-20; Brand, Tr. 12057; Kuschner, Tr. 12605.) The permanent retention of asbestos fibers accounts for the high concentration of fibers found at autopsy in the lungs of occupationally exposed workers. (Kagan, Tr. 9018; Gaensler, Tr. 9438, 9507; Epstein, Tr. 11348, 11358; Craighead, Tr. 11722-23, 13885-86.)

26. Because asbestos fibers deposited in the lung are long, thin and pointed, they cause mechanical injury to cells and adjoining tissue. (Kagan, Tr. 9019, 9086; Gaensler, Tr. 9434,

9437, 9579, 9440; Brand, Tr. 12061-62; Epstein, Tr. 12953.) Fibers must, for example, penetrate the alveolar wall in order to reach the interstitium where they are frequently observed. (Kagan, Tr. 9020-23; Kuschner, Tr. 10092.) This mechanical injury occurs within minutes or hours of the deposition of asbestos fibers in the alveolar region of the lung. (Kagan, Tr. 9023; Gaensler, Tr. 9441.) It continues for as long as asbestos fibers remain in the lung. (Kagan, Tr. 9023.)

27. Inhaled and deposited asbestos fibers can and do move from one part of the lung to another. (Kagan, Tr. 9070; Gaensler, Tr. 9578-79, 9740.) This is evidenced by the well established translocation of fibers from the parenchyma to the periphery of the lung and the thin membrane covering its outer surface called the visceral pleura. (Kuschner, Tr. 10007.) This movement has been attributed to physical penetration by asbestos fibers induced by the constant respiratory motion of the lung. (Epstein, Tr. 11233; Brand, Tr. 12042.) Based on animal studies, it is assumed that some asbestos fibers reach the pleura within a comparatively short period of time measured in days, weeks or at most months following their inhalation. (Kagan, Tr. 9081; Gaensler, Tr. 9468; Kuschner, Tr. 10013, 10126; Craighead, Tr. 11682, 11747; Brand, Tr. 12042.)

28. The macrophage is a specialized form of white blood cell found freely in the alveolar spaces and within the interstitium. (Kagan, Tr. 8975, 9025; Kuschner, Tr. 12633.) The natural function of the macrophage is to act as a scavenger cell

by completely engulfing ("phagocytozing") foreign particles and releasing digestive enzymes to dissolve such particles within itself. (Kagan, Tr. 9025.) The macrophage is, however, poorly equipped to deal in this manner with inhaled asbestos fibers because all such fibers are non-biodegradable and many are longer than the diameter of the macrophage and thus cannot be completely engulfed. (Kagan, Tr. 9297; Gaensler, Tr. 9437; Epstein, Tr. 11250; Craighead, Tr. 11600-02; Brand, Tr. 12057; Kuschner, Tr. 12605, 12632.) The inability of a macrophage to completely engulf a long fiber leads to what is called "frustrated phagocytosis." (Craighead, Tr. 11600-02.)

29. When a macrophage comes in contact with and attempts to engulf an asbestos fiber, the macrophage becomes "activated." (Gaensler, Tr. 9434.) An activated macrophage is hyperactive and produces and secretes a wide variety of chemical substances. (Gaensler, Tr. 9435; Epstein, Tr. 11107-08, 11386-87.) Asbestos activation of an individual macrophage persists for a long interval since asbestos is capable of macrophage activation without resulting in macrophage death. (Epstein, Tr. 11386.)

30. Among the chemicals released by a macrophage when it comes in contact with and attempts to engulf an asbestos fiber are various chemotactic factors, i.e., substances which have the ability to attract additional cells to the scene or otherwise produce a response in them. (Gaensler, Tr. 9435; Craighead, Tr. 11614; Kuschner, Tr. 12605.) One such factor attracts additional

macrophages. (Kagan, Tr. 9041-42; Gaensler, Tr. 9435; Crystal, 10363; Epstein, Tr. 11115; Craighead, Tr. 11614; Kuschner, Tr. 12605.) Another summons smaller white blood cells, not normally found in the lung, called neutrophils. (Gaensler, Tr. 9435-36; Crystal, Tr. 10364; Epstein, Tr. 11108, 11114, 11234; Craighead, Tr. 11614.)

31. The mobilization of white blood cells and their accumulation at the sites of deposited asbestos fibers constitutes an inflammatory reaction. (Kagan, Tr. 9040, 9298; Crystal, Tr. 10363; Epstein, Tr. 11114; Craighead, Tr. 11614; Kuschner, Tr. 12635.) This inflammation of the alveoli is sometimes termed "alveolitis" and is an essential feature in the pathogenesis of all interstitial lung diseases, including asbestosis. (Gaensler, Tr. 9429-30; Crystal, Tr. 10570; Epstein, Tr. 11395.) The alveolitis constitutes the earliest microscopic manifestation of such a disease, (Crystal, Tr. 10571), but cannot be clinically detected. (Gaensler, Tr. 9586.) As newly arrived macrophages attempt to engulf the asbestos fiber, they likewise release chemotactic factors causing the inflammatory process to build on itself and become chronic. (Gaensler, Tr. 9438; Kuschner, Tr. 10003.) Asbestosis is thus characterized as a chronic inflammatory disease of the lower respiratory tract. (Gaensler, Tr. 9566; Crystal, Tr. 10359; Kleinerman, Tr. 10782.)

32. The inflammation produced by inhaled asbestos fibers is an injurious pathological process, not a normal one. (Kagan, Tr. 9298; Kuschner, Tr. 12636.) It results from the

fibrous and non-biodegradable nature of asbestos fibers and does not arise during the normal removal from the lung of inert dust particulates by the macrophages. (Gaensler, Tr. 9523; Kuschner, Tr. 12632.)

33. Macrophages attempt to engulf asbestos fibers within minutes or hours of their inhalation and deposition. (Gaensler, Tr. 9434-35; Epstein, Tr. 11112-13, 11215, 11234, 11333-34; Kuschner, Tr. 12604.) The inflammatory response elicited by the macrophages occurs within the same time frame or at most several days. (Kagan, Tr. 9046; Gaensler, Tr. 9434-35; 10603; Crystal, Tr. 10605; Kleinerman, Tr. 10949-50, 11009; Epstein, Tr. 11113-14, 11229; Craighead, Tr. 11614-15; Brand, Tr. 12052; Kuschner, Tr. 12628-29, 12630, 12633.)

34. With respect to someone clinically diagnosed as having asbestosis, there is agreement among the medical experts that the inflammatory response caused cellular and tissue injury which preceded the compromise of lung function by the accumulation of fibrosis. (Kagan, Tr. 9002; Gaensler, Tr. 9438, 9440; Crystal, Tr. 10359, 10639, 10643; Epstein, Tr. 11399; Craighead, Tr. 11616.) It is the alveolitis that causes the injury and the fibrosis which deranges the alveolar/capillary units resulting in their destruction and loss. (Crystal, Tr. 10570.)

35. There is also general agreement among the medical experts concerning the process by which the inflammatory response produces injury. Most of the injury is caused by the effect of

substances released by the inflammatory cells on the alveolar walls and the connective tissue matrix of the lung. (Crystal, Tr. 10365.) The frustrated phagocytosis that occurs when a macrophage attempts to engulf a fiber longer than itself results in the release from the macrophage into surrounding tissue of damaging digestive (lysosomal) enzymes. (Kagan, Tr. 9029, 9046; Kuschner, Tr. 10002-03, 10017, 10090; Craighead, Tr. 11733, 11736; Brand, Tr. 12081.) Macrophages summoned to the site of a deposited asbestos fiber also produce and release upon their arrival toxic substances which "eat away" at the surrounding tissue. (Craighead, Tr. 11616.) Included among these are oxidants and proteases. Oxidants damage the tissue comprising the alveolar wall. (Kagan, Tr. 9046; Crystal, Tr. 10371, 10436; Kleinerman, Tr. 10791-92; Epstein, Tr. 11108, 11110, 11234.) Connective-tissue-specific proteases are enzymes which attack and derange the interstitial framework of the lung. (Crystal, Tr. 10371, 10436; Epstein, Tr. 11108, 11110, 11234.)

36. To the extent that neutrophils participate along with macrophages in the inflammatory reaction to deposited asbestos fibers, the injurious effects of that reaction are compounded. The neutrophil is a much more potent producer of oxidants and proteases than the macrophage. (Gaensler, Tr. 9436; Epstein, Tr. 11234.) The same chemotactic factor released by macrophages that recruits neutrophils to the site of a deposited asbestos fiber also induces them to release into the surrounding tissue their toxic oxidants and proteases. (Epstein, Tr. 11234.)

37. Fibrosis consists of a pathological accumulation of collagen in the interstitium of the lung. (Kagan, Tr. 9036.) The cells that make this collagen are called fibroblasts. (Kagan, Tr. 9036.) There is general agreement among the medical experts as to the process by which fibrosis develops. Fibrosis of the lung is a response to injury and is equivalent to the formation of a scar over a cut in the skin. (Kagan, Tr. 9037; Kuschner, Tr. 10002, 11619; Crystal, Tr. 10371, 10629-30; Craighead, Tr. 11619.) Macrophages activated by the presence of asbestos fibers secrete a chemotactic protein called fibronectin which both attracts fibroblasts and causes them to proliferate. (Kagan, Tr. 9037-38, 9046; Gaensler, Tr. 9439; Kuschner, Tr. 10002; Crystal, Tr. 10365, 10371, 10436; Kleinerman, Tr. 11062-63; Epstein, Tr. 11108, 11110, 11234-35; Craighead, Tr. 11620; Brand, Tr. 12022.) The poliferating fibroblasts produce the excess collagen that constitutes fibrosis. (Kagan, Tr. 9038; Kuschner, Tr. 10003; Crystal, Tr. 10365, 10371, 10437; Craighead, Tr. 11620; Kuschner, Tr. 12605.) In someone clinically diagnosed as having asbestosis, this fibrosis has compromised enough alveolar/capillary gas exchange units to cause measurable lung dysfunction. (Crystal, Tr. 10371; Epstein, Tr. 11252.)

A. The Timing of Injury and Fibrosis

38. Most of the medical experts who testified agreed that in an individual clinically diagnosed as having asbestosis, the initial injury occurred almost immediately after the first deposition of asbestos fibers in the lung on the first day of

occupational exposure. (Kagan, Tr. 9045-46; Gaensler, Tr. 9755; Kuschner, Tr. 10003; Craighead, Tr. 11617; Brand, Tr. 12026-29, 12055, 12213.) Most of the experts also concurred that in such a person, the first asbestos-induced fibrosis developed in response to the initial injury within a short period measured in days or weeks. (Gaensler, Tr. 9737; Kuschner, Tr. 10079, 10127; Kleinerman, Tr. 11048; Craighead, Tr. 11621; Brand, Tr. 12075.)

39. The view of the majority of the medical experts who testified that injury and the onset of fibrosis occur soon after the initial deposition of asbestos fibers in the lung of an occupationally exposed worker is supported by the overwhelming weight of the medical evidence. Animal experiments uniformly show a prompt reaction and fibrotic response to asbestos fibers. (Kagan, Tr. 9060-67; Brand, Tr. 12026-27.) The extensive research showing the rapidity of wound healing is also supportive, since the biologic processes that lead to a scar over a cut in the skin are essentially the same as those involved in the formation of fibrosis in an internal organ like the lung. (Kuschner, Tr. 10081; Crystal, Tr. 10629-30; Craighead, Tr. 11573-76; Kuschner, Tr. 12628-29, 12631, 12675.) In both man and animal, a scar will form over an incision in about a week. (Kuschner, Tr. 12670.) There is no reason to believe that the time frame for the development of fibrosis in response to asbestos-induced injury in the human lung is any different. (Craighead, Tr. 11575-76; Kuschner, Tr. 12628-29, 12675, 12692-93.) Although the opportunities to observe human lung tissue for

..rly signs of asbestosis are necessarily limited, fibrosis satisfying the pathological definition of the disease has been seen within six months after the beginning of occupational exposure. (Kagan, Tr. 9057, 9250-51.) The prompt development of fibrosis in response to deposited asbestos fibers is further evidenced by the observed time course for fibrosis in human tissue exposed to other foreign substances such as talc. (Kuschner, Tr. 12671; Epstein, Tr. 12954-55.)

40. The three medical experts proffered by the manifestation carriers dispute the view that the clinical diagnosis of asbestosis is preceded by many years of continuous injury and the gradual accumulation of fibrosis commencing at or near the time of initial occupational exposure to asbestos. .hese doctors appear to concede that the inflammatory reaction and the release of all the toxic chemicals and chemotactic factors necessary to produce injury and lead to the onset of fibrosis do, or at least can, occur shortly after the initial deposition of asbestos fibers in the lung. (Crystal, Tr. 10603, 10605; Kleinerman, Tr. 10949-50; Epstein, Tr. 11235, 11374, 12898-99.) According to the manifestation doctors, however, the substances released as a result of the inflammatory reaction are only potentially damaging to the surrounding tissue and are normally neutralized or balanced by other chemicals present in the lung. (Epstein, Tr. 11115, 11119.) These doctors also assert that such a balance can usually be maintained for many years and only if and when it is lost does the injury and the

fibrosis leading to the clinical onset of asbestosis result. (Kleinerman, Tr. 10785; Epstein, Tr. 11154.) The proponents of this "loss of balance theory" further contend that in someone diagnosed clinically with asbestosis, the injurious chemical imbalance and virtually all of the fibrosis occurred within months or at most a year of the time the disease first became capable of clinical diagnosis. (Crystal, Tr. 10725; Epstein, Tr. 11149-50, 12923.)

41. The "loss of balances" theory espoused by the manifestation doctors is convincingly refuted by the previously cited affirmative evidence presented by all the other medical experts concerning the time course of injury and fibrosis leading to clinical asbestosis. See Finding of Facts Nos. 38, 39. Each of these doctors who was asked about the loss of balance theory categorically rejected it as contrary to all medical evidence. (Kuschner, Tr. 10035, 10130; Craighead, Tr. 11621, 11853; Brand, Tr. 12226; Gaensler, Tr. 12347; Kuschner, Tr. 12604, 12628-30, 12633, 12642, 12683.)

42. The opinion that virtually all of the injury and fibrosis necessary to produce clinically detectable asbestosis does not occur until just months prior to the time a clinical diagnosis becomes possible is also refuted by other testimony from the very proponents of the loss of balance theory. Each of the manifestation doctors repeatedly professed ignorance as to when injury, fibrosis or disease first occurred in someone clinically diagnosed with asbestosis. See Finding of Facts Nos.

38, 39. (Crystal, Tr. 10463, 10621, 10702, 10708, 10729-30; Kleinerman, Tr. 10815, 10820, 10883, 10884, 10885, 10886, 10888, 10917, 10949, 11046; Epstein, Tr. 11258, 11279.) Each of these doctors, moreover, either admitted or as least conceded the possibility that asbestos-induced injury or localized fibrosis could occur many years prior to the clinical diagnosis of the disease. (Crystal, Tr. 10708, 10710; Kleinerman, Tr. 10836; Epstein, Tr. 11487, 11488, 11504, 12295-96.) Finally, each of the manifestation doctors either expressly discounted the notion that all fibrosis could suddenly form within a few months of when asbestosis first became clinically detectable or acknowledged at least the possibility that fibrosis could accumulate gradually over a prolonged period of time. (Crystal, Tr. 10703; 10731; Kleinerman, Tr. 10949-50; Epstein, Tr. 11253, 11259, 11408, 11414.)

43. Other evidence in the record also refutes the loss of balance theory. Long-term survey studies of workers occupationally exposed to asbestos show that the clinical signs and symptoms of asbestosis do not appear suddenly as would be true under the loss of balance theory, but rather develop imperceptibly and tentatively over a period of years with little demonstrable change evident from one year to the next. (Gaensler, Tr. 12327-29, 12343, 12504-05.) At least two of the manifestation doctors agree that the onset of clinical symptoms for asbestosis is insidious. (Crystal, Tr. 10548, 10549-50; Kleinerman, Tr. 10897.) The slow and gradual onset of clinical

asbestosis is consistent with the other evidence showing that asbestos-induced fibrosis starts very early during the course of occupational exposure and accumulates gradually over a period of many years until enough alveolar/capillary units have been compromised to produce clinically measurable lung dysfunction. The loss of balance theory is also impugned by the admission of Dr. Epstein that he did not know why his postulated loss of balance suddenly occurred, together with the corresponding failure of the other manifestation doctors to offer any explanation. (Epstein, Tr. 12851.)

44. All of the proponents of the loss of balance theory have published at least a few articles specifically discussing the pathogenesis of asbestosis. None of those writings articulate the loss of balance theory or otherwise expresses the view that fibrosis occurs at the time or in the manner asserted under that theory. (Crystal, Tr. 10727; Epstein, Tr. 11413, 11450, 11473, 11507-08, 12956-57.) Moreover, none of the manifestation doctors could identify even a single medical publication that set forth such matters. (Crystal, Tr. 10725, 10728; Epstein, Tr. 11207-08, 11292, 11413, 11450, 12956-57.) Other medical experts who testified confirm this total lack of support in the medical literature for the loss of balance theory. (Gaensler, Tr. 12347; Kuschner, Tr. 12642.)

B. Progression After Cessation Of Exposure

45. The evidence overwhelmingly supports the proposition that in a case where asbestosis first becomes capable

of clinical diagnosis in someone not occupationally exposed to asbestos for a period of many years, the injury and disease process that began with the first occupational exposure continuously progressed on a pathological level throughout the period of non-exposure preceding the development of clinical signs and symptoms. This is so because the countless asbestos fibers permanently retained in the lung during the occupational exposure continue to cause injury and elicit a fibrogenic response. (Kagan, Tr. 9023-24, 9047, 9083, 9154, 9371; Gaensler, Tr. 9438, 9463; Kuschner, Tr. 10003, 10004, 10036, 10037, 10108; Gaensler, Tr. 12278-79, 12321-22.) It is the total number of asbestos fibers in the lung rather than the time that the fibers arrived there that determines the ultimate extent of any resulting clinical disease. (Kuschner, Tr. 10037.) Even under the loss of balance theory, it is acknowledged that the reaction to retained asbestos fibers never stops, and asbestos-induced injury and clinical disease can and do occur many years following the cessation of exposure. (Crystal, Tr. 10573; Epstein, Tr. 11113, 11164-65, 11235, 11319, 12851, 12924-25.)

46. Animal studies that address the subject uniformly demonstrate the pathological progression of asbestosis following the cessation of exposure. (Kagan, Tr. 9083; Kuschner, Tr. 10037; Craighead, Tr. 11945.)

47. It is quite common for clinicians first to detect the signs and symptoms of asbestosis in a patient who has not been occupationally exposed to asbestos for a period of many

years. (Gaensler, Tr. 9441; Crystal, Tr. 10573; Craighead, Tr. 11826.) This is indeed the usual clinical experience. (Gaensler, Tr. 9441, 9443, 9457, 9712, 12331.) Many of those persons clinically diagnosed with asbestosis in recent years were occupationally exposed only for three to four years while working in defense industries during and shortly after World War II, after which they went on to other trades not involving exposure. (Gaensler, Tr. 9443, 12331, 12574-75.) Dr. Craighead himself agrees that this wartime exposure is probably responsible for a "substantial portion" of the disease occurring today. (Craighead, Tr. 13882.) And even with respect to those persons who have continued to work in an environment contaminated by asbestos, the levels of exposure over the past 20 years have been negligible compared to those prevalent in some industries prior to government regulation. See Finding of Fact No. 6. The medical literature is replete with case studies of individuals exposed to high levels of asbestos for very short periods of time -- often less than a year -- who subsequently developed clinical asbestosis after a latency period of several decades. (Gaensler, Tr. 12281, 12332-33, 12334-35.) Dr. Gaensler presented histologic slides and other evidence of just such a case. (Gaensler, Tr. 9444-63.)

48. The prolonged duration of the latency period after the cessation of exposure in many, if not most, persons clinically diagnosed with asbestosis provides compelling evidence that the injury and development of fibrosis which commenced with

and continued during occupational exposure must also have progressed throughout the period of non-exposure preceding the development of the signs and symptoms of clinical disease. (Gaensler, Tr. 9442-43, 9472, 12336.) While admitting that asbestosis often develops clinically years after the cessation of exposure, Dr. Craighead expressed the view that this fact is attributable to aging and other factors that reduce pulmonary reserve rather than to the continuation and progression of the asbestos-induced injury and disease process during the period of non-exposure. (Craighead, Tr. 11629-31.) This opinion is refuted by the overwhelming weight of evidence. Aging does not produce fibrotic changes in the lung and is not a factor in the development of clinical asbestosis. (Kagan, Tr. 9083; Gaensler, Tr. 9463, 9496-97, 9629; Kuschner, Tr. 10037; Epstein, Tr. 11332; Craighead, Tr. 11747; Gaensler, Tr. 12576; Epstein, Tr. 12832.) Moreover, even Dr. Craighead agrees with the other medical experts that the pulomonary function tests used to diagnose asbestosis and measure its clinical progression are adjusted for age, thus negating that variable as a factor in the determination of disease. (Kagan, Tr. 9165-66; Gaensler, Tr. 9492, 9494; Craighead, Tr. 11748-49; Gaensler, Tr. 12319, 12561.) Nor can other factors such as smoking or diseases such as emphysema produce the kind of fibrotic changes and restrictive lung dysfunction characteristic of asbestosis. (Kagan, Tr. 9165; Gaensler, Tr. 9519-20, 9523; Kuschner, Tr. 10031-32; Crystal, Tr.

10355; Craighead, Tr. 11548; Brand, Tr. 12098; Gaensler, Tr. 12452, 12560, 12576; Kuschner, Tr. 12627.)

49. Years after the cessation of exposure, asbestosis also can progress clinically as measured by lung function tests and x-rays. (Kagan, Tr. 9083, 9085, 9164; Gaensler, Tr. 9457, 9462, 9617, 9724; Kuschner, Tr. 10010; Epstein, Tr. 11320; Gaensler, Tr. 12277, 12322-26; Epstein, Tr. 12817. The relative frequency of such progression among persons clinically diagnosed with asbestosis is evidenced by the extensive survey and clinical experience of Dr. Gaensler. (Gaensler, Tr. 9457, 9617, 9724, 12322-26.) Numerous medical studies published over the last 40 years involving serial x-ray and lung function tests uniformly show that clinical asbestosis may and often does progress in the absence of continued exposure. (Gaensler, Tr. 9498, 9613, 9713, 12277, 12280, 12285, 12316.) Even the exposure doctors were forced to concede that there are no published studies that support their view. (Craighead, Tr. 11764, 11776-77; Brand, Tr. 12206; Craighead, Tr. 13856.)

50. The fact that the numerous published studies of populations previously exposed occupationally to asbestos uniformly show clinical progression of asbestosis in some but not all such workers is readily explained. First, these studies generally include in the survey group workers who, during the course of the evalutation, never develop the initial signs and symptoms of disease from which clinical progression can be measured. (Gaensler, Tr. 12566.) Second, even in those persons

clinically diagnosed, the disease process may advance so slowly on the pathological level as to render such progression incapable of measurement by the relatively crude diagnostic tools available. (Crystal, Tr. 10737; Craighead, Tr. 11767; Gaensler, Tr. 12474, 12567; Kuschner, Tr. 12686.) Just as there must be pathological progression of asbestosis during any period of non-exposure preceding the development of signs and symptoms of disease, histologic injury and the development of fibrosis will also invariably continue following clinical diagnosis. (Gaensler, Tr. 12399, 12474, 12496; Kuschner, Tr. 12625-26.)

51. There is no real dispute within the medical community over the fact that the injury and fibrosis resulting from occupational exposure to asbestos continue to progress indefinitely following the cessation of exposure. (Kagan, Tr. 9090; Gaensler, Tr. 12429; Kuschner, Tr. 12696.) Although three of the doctors proffered as experts by various insurance carriers expressed a different view at the trial, they offered nothing in support of their opinion that even approaches the overwhelming weight of evidence to the contrary. One of those doctors agreed that the process leading to clinical asbestosis takes place continually from the date of first exposure to the date of diagnosis, (Kleinerman, Tr. 10949-50), but asserted categorically that clinical disease must develop within a year following the end of exposure or never at all. (Kleinerman, Tr. 10961.) Dr. Kleinerman also testified that he was personally unfamiliar with any case where an individual first developed the clinical signs

and symptoms of asbestosis many years following the cessation of exposure. (Kleinerman, Tr. 10959.) Similarly, another of the exposure doctors testified that any clinical diagnosis of asbestosis made many years after the cessation of exposure must have been possible within a year of that time. (Brand, Tr. 12083-84.) Neither of these doctors is a clinician experienced in diagnosing and treating asbestosis patients. (Kleinerman, Tr. 10754; Brand, Tr. 11956.) Their testimony concerning when clinical disease occurs is contradicted by the irrefutable evidence of record showing that the signs and symptoms of asbestosis more often than not develop many years following the end of exposure. See Finding of Fact No. 47. This fundamental error substantially undermines the opinions of these doctors concerning progression.

52. None of the three doctors who testified that there is no progression of asbestosis following the cessation of exposure has ever advanced that opinion in his own published writings and, moreover, could not identify a single medical article from any source so stating. (Kleinerman, Tr. 10853-54; Craighead, Tr. 11741, 11764, 11776-77; Brand, Tr. 12099) The testimony of the other medical experts confirms the general agreement within the medical community that such progression can and does occur and the total lack of any conflicting authority. (Kagan, Tr. 9090; Gaensler, Tr. 12429; Kuschner, Tr. 12642, 12696.) Indeed, two of the three doctors who advanced a contrary position at this trial have in recent years co-authored -- or

been members of scientific committees that have jointly drafted -- widely disseminated and rigorously reviewed publications which expressly state that asbestosis does, or at least can, progress in the absence of continued exposure. (Kleinerman, Tr. 10839, 10976; Craighead, Tr. 11539, 11555-56, 11760, 11772-74, 11779-80, 11788-89, 11793, 13898-99, 13900-03); Ex. 824 at 584; Ex. 848 at 1449; Ex. 849 at 2594, 2595.) It bears note that Dr. Craighead served as chairman for the committees that produced two of these reports, the most recent of which (Ex. 849) was published barely a year prior to his testimony before this Court. (Craighead, Tr. 11539, 13900-01.)

53. Both medical experts proffered by the exposure carriers agreed that asbestosis is progressive throughout the period of occupational exposure, as fibers taken into the lung cause continued injury and the accumulation of fibrosis. (Craighead, Tr. 11550, 11623-24, 11672, 11743; Brand, Tr. 12063.) Both doctors also agreed with the other medical experts that once asbestos fibers are deposited in the lung they tend to remain there. (Craighead, Tr. 11722-23; Brand, Tr. 12057; Craighead, Tr. 13885-86.) In support of their testimony that there is no progression after cessation of exposure, each doctor attempted to address the obvious question of why retained asbestos fibers do not elicit the same response as newly deposited ones. Dr. Craighead relied principally on a "neutralization" theory while Dr. Brand espoused "fibrous encapsulation." Apart from being largely inconsistent with each other, these two theories cannot

withstand even minimal scrutiny under the evidence of record, including the testimony of their respective proponents.

54. Dr. Craighead testified that soon after the cessation of exposure, retained asbestos fibers are "neutralized" by a thin coating of various proteins produced within the lung. This coating reduces the cytotoxicity of the fibers and prevents them from immediately killing the macrophages with which they come in contact. (Craighead, Tr. 13807, 13872-74.) Thus, as freely admitted by Dr. Craighead, the coating of asbestos fibers by body fluids is what allows the macrophages to undertake the slow process of attempted phagocytosis. (Craighead, Tr. 13875-76.) As more fully explained by other medical experts who testified, the key to the injury and disease process caused by asbestos is the ability of the fibers to interact over a prolonged period with macrophages which, because they are not killed, continue to produce and release a host of harmful substances into the surrounding tissue. (Kuschner, Tr. 10082-84; Epstein, Tr. 11385-86; Kuschner, Tr. 12614.) So understood, the neutralization theory advanced by Dr. Craighead strongly supports rather than refutes the proposition that asbestosis progresses after the cessation of exposure. (Kuschner, Tr. 12615.)

55. There is no credible evidence of record to support the notion that the body fluids which bathe and naturally coat all asbestos fibers deposited in the lung somehow neutralize those fibers in the sense of preventing them from eliciting an immediate response by macrophages. Other medical experts,

including Dr. Brand, categorically rejected the idea of such neutralization by affirming that asbestos fibers in the lung invariably precipitate an inflammatory response by any macrophages to which they are accessible. (Kagan, Tr. 9087, 9345-46; Brand, Tr. 12055, 12066, 12079, 12103, 12164-65; Kuschner, Tr. 12611-12.) Dr. Craighead has never published the opinion that asbestos fibers deposited in the lung become biologically inert and stop interacting with macrophages after the cessation of exposure. (Craighead, Tr. 11741, 13900.) The other medical experts confirmed the complete lack of support in the medical literature for any such contention. (Kleinerman, Tr. 10853-54; Brand, Tr. 12224; Kuschner, Tr. 12642.)

56. Dr. Brand testified that within a year following the cessation of exposure, all asbestos fibers deposited in the lung become "encapsulated" in scar tissue which isolates them from attack by macrophages and thus prevents any further progression of disease. (Brand, Tr. 12083.) No other medical expert who testified supported this theory, and Dr. Brand himself conceded that it is not set forth anywhere in the medical literature. (Brand, Tr. 12099.) The theory is also contradicted by Dr. Brand's own testimony. He both admitted having no opinion on how long the foreign body reaction to inhaled asbestos fibers persists in the human lung and conceded repeatedly that fibrosis can occur for "many years" or at least "years" following the cessation of exposure. (Brand, Tr. 12064-65, 12080, 12099, 12214.) Dr. Brand also indicated he could not even estimate the

percentage of retained asbestos fibers that ultimately end up being encapsulated in scar tissue, (Brand, Tr. 12102-03), and -- along with some of the other experts who testified -- expressed uncertainty over whether surrounding scar tissue could in fact prevent fibers from eliciting a further response by macrophages. (Gaensler, Tr. 9582; Kuschner, Tr. 10096; Brand, Tr. 12073, 12210; Kuschner, Tr. 12625.) Finally, Dr. Brand's theory of fibrous encapsulation is repudiated by histologic evidence. Tissue samples taken at autopsy from persons once exposed to asbestos who die many years later from unrelated causes demonstrate that most retained asbestos fibers are in fact not walled off by fibrous tissue. (Kuschner, Tr. 12624.)

57. Some asbestos fibers in the lung become covered with a relatively thick coating of iron-containing proteins to form readily identifiable structures called asbestos bodies. (Kagan, Tr. 8995; Gaensler, Tr. 9443, 9483; Crystal, Tr. 10429; Gaensler, Tr. 12379.) Undisputed evidence shows that the formation of asbestos bodies cannot impede the progression of injury and disease after the cessation of exposure. Only about one percent of the asbestos fibers present in the lung at any given time have been converted into asbestos bodies. (Kagan, Tr. 8996-97, 9082; Crystal, Tr. 10575, 10672; Kleinerman, Tr. 10777; Epstein, Tr. 10368-69; Craighead, Tr. 11688, 11723; Brand, Tr. 12058.) From the testimony of the medical experts, it is unclear whether, once formed, asbestos bodies are capable of producing continued injury. (Kagan, Tr. 8996, 9106, 9217, 9242; Gaensler,

Tr. 9443; 9484; Kuschner, Tr. 10010; Crystal, Tr. 10429, 10577; Epstein, Tr. 11369; Craighead, Tr. 11691, 11730; Kuschner, Tr. 12610, 12678.) Among those doctors expressing an opinion on the subject, the consensus view, as also supported by graphic evidence produced at trial, is that the formation of asbestos bodies is a dynamic process soon followed by degeneration of the iron coating and the reemergence intact of the bare fiber. Gaensler, Tr. 9443, 9456, 9485, 9611, 9732-33; Crystal, Tr. 10577, 10672; Epstein, Tr. 11370; Gaensler, Tr. 12251-52, 12380-81, 12383.) Thus, even if the formation of asbestos bodies can be accurately characterized as a defense mechanism, it is not a very effective one given both the extremely small percentage of fibers involved and the limited durability of the iron coating.

58. There is some evidence that chrysotile, but not other forms of asbestos, may fragment in the lung although the process by which this occurs and how long it takes is unknown. (Gaensler, Tr. 9612; Epstein, Tr. 11366-67; Craighead, Tr. 11797; Kuschner, Tr. 12609; Craighead, Tr. 13876.) There is, moreover, no way of telling whether short chrysotile fibers found in the lung were of that length when initially inhaled or resulted from the subsequent break up of longer fibers. (Kuschner, Tr. 12609; Craighead, Tr. 13872.) Moreover, the longitudinal splitting of chrysotile fibers along their major axis does not result in a shortening of the fiber but rather in a proliferation of so-called "fibrils," each of which then becomes subject to attack by macrophages. (Kuschner, Tr. 12606-07; Craighead, Tr. 13877.) A

macrophage unable successfully to engulf a chrysotile fiber because it is too long is no better equipped to handle a fibril of equal length but reduced diameter, (Craighead, Tr. 13878), and such long thin fibrils may indeed be more damaging to the lung then their thicker parent fibers. (Kuschner, Tr. 12607.) The undisputed evidence showing that chrysotile is as potent as other forms of asbestos in causing asbestosis and that all forms of the mineral have contributed to the occupational exposure of workers in this country further confirms that the fragmentation of chrysotile, to whatever extent it occurs, does not impede the progression of the disease process following the cessation of exposure. See Findings of Fact Nos. 7, 8.

VIII. PLEURAL PLAQUES

59. The inhalation of asbestos fibers can also lead to the development of pleural plaques. (Kagan, Tr. 9079; Gaensler, Tr. 9466; Kleinerman, Tr. 10829; Craighead, Tr. 11691-92.) These are scattered area of fibrosis located on the parietal pleura. (Kagan, Tr. 9079; Gaensler, Tr. 9464; Crystal, Tr. 10457; Craighead, Tr. 11691-92.) The parietal pleura is a thin membrane lining the chest cavity which is distinct from and rubs against the visceral pleura covering the outer aspect of the lungs. (Kagan, Tr. 9078; Craighead, Tr. 11586.) The process leading to the development of pleural plaques begins with the arrival of asbestos fibers to the periphery of the lung and the pleura. (Kagan, Tr. 9080.) Asbestos fibers deposited in the lung can translocate to these areas within a comparatively short

period of time measured in days, weeks, or at most months. (Kagan, Tr. 9081; Gaensler, Tr. 9468; Kuschner, Tr. 10013, 10126; Craighead, Tr. 11682, 11747; Brand, Tr. 12042.) Although the pathogenesis of pleural plaques is uncertain, it is thought that the fibers penetrate the visceral pleura and rub against the parietal pleura, thereby causing continuous injury to that surface and leading to the development of fibrosis. (Gaensler, Tr. 9467, 12563.) Pleural plaques are generally detected by x-ray, (Kagan, Tr. 9079), and almost never appear until 20 years after the initial exposure to asbestos. (Gaensler, Tr. 12564-65.) As evidenced by longitudinal x-ray studies, they continue to progress both in size and number following the cessation of exposure. (Kagan, Tr. 9080, 9243; Gaensler, Tr. 9468; Epstein, Tr. 11320; Gaensler, Tr. 12564-65.) Although pleural plaques do not usually produce clinical symptoms, they do involve injury in a microscopic sense, (Crystal, Tr. 10591), and are considered a disease from a pathological standpoint, although not from a clinical standpoint. (Kagan, Tr. 9079; Kleinerman, Tr. 10844; Craighead, Tr. 11823); Ex. 824 at 551.

Ex. CANCER

60. Also at issue in this case is insurance coverage for underlying tort actions where it is alleged, or found by the trier of fact, that asbestos is a cause of cancer. The two forms of cancer most frequently involved are bronchogenic carcinoma and mesothelioma. (Gaensler, Tr. 9429; Epstein, Tr. 11141.) Bronchogenic carcinoma is cancer of the lung. (Epstein, Tr. 11141.) Mesothelioma includes both cancer of the pleura covering

the lung and cancer of the peritoneum which lines the abdominal cavity. (Kuschner, Tr. 10000.) The time between first exposure to asbestos and the clinical diagnosis of bronchogenic carcinoma generally ranges from 25 to 30 years. (Kleinerman, Tr. 10826.) For mesothelioma, the latency period is usually even longer, the disease not being clinically diagnosed until 35 to 45 years after first exposure. (Kleinerman, Tr. 10826.)

61. In order to be present in the body, both bronchogenic carcinoma and mesothelioma must be preceded by a malignant transformation at the cellular level. (Gaensler, Tr. 9591; Kleinerman, Tr. 10824; Craighead, Tr. 11890, 11895.) For those cancers found to be caused by asbestos exposure, it is unknown when during the latency period the malignant transformation occurs. (Gaensler, Tr. 9592; Kuschner, Tr. 10064; Crystal, Tr. 10471; Kleinerman, Tr. 10823-24, 10828; Craighead, Tr. 11665, 11890, 11895.) For such cancers, the exact nature and cause of the malignant transformation are also unknown. (Kuschner, Tr. 10064, 10011.)

62. The three medical experts who testified on the pathogenesis of cancers attributed to asbestos exposure agreed that the fibers themselves do not initiate the malignant transformation at the cellular level but rather enhance the potential of other agents to cause such a change. (Kuschner, Tr. 10006, 10008, 10012, 10029; Craighead, Tr. 11641, 11649, 11672; Brand, Tr. 12037, 12088, 12120.)

63. In those cases of bronchogenic carcinoma found to be caused by asbestos exposure, it is the asbestos-induced injury and scarring in the lung that sets the stage for the development of the malignancy. (Kuschner, Tr. 10006, 12691; Brand, Tr. 12017, 12037, 12088.) Such fibrosis must exist before bronchogenic carcinoma related to asbestos exposure will develop, (Kleinerman, Tr. 10987), and the cancer arises at the site of the scarring. (Kuschner, Tr. 10001; Brand, Tr. 12087); Ex. 824 at 589 (Fig. 37). The diffuse fibrosis characteristic of asbestosis causes proliferation of the epithelial cells lining the air passages and air spaces. (Kuschner, Tr. 10009, 10009, 10012; Brand, Tr. 12013, 12088.) The resulting rapid turnover of the epithelial cells makes them more susceptible to malignant transformation caused by other agents which, unlike asbestos, can alter the genetic makeup of a cell to produce cancer. (Kuschner, Tr. 10006, 10012, 12691; Brand, Tr. 12088.)

64. The two medical experts in addition to Dr. Brand who testified concerning the pathogenesis of asbestos-related mesothelioma both relied on Dr. Brand's research into solid-state carcinogenesis. (Kuschner, Tr. 10008, 10029; Craighead, Tr. 11666.) Such cancers arise at the site of asbestos-induced fibrotic thickening of the visceral pleura or peritoneum. (Kuschner, Tr. 10007-08; Brand, Tr. 12015, 12017, 12037, 12087.) The subpleural connective tissue at those sites is subject to early scarring, (Kuschner, Tr. 10007), by the same process that produces fibrosis in the lung. (Kuschner, Tr. 10008, 10100.) As

the subpleural connective tissue grows, it entraps the mesothelial cells lining the surface of the pleura or peritoneum in which the cancer arises. (Kuschner, Tr. 10026-27.)

65. The first injury leading to the development of bronchogenic carcinoma or mesothelioma found to be asbestos-related is the inflammatory reaction and onset of fibrosis which occur at the time of initial exposure. (Kuschner, Tr. 10009-10, 10073; Brand, Tr. 11994, 12033, 12037, 12043-44, 12047-48, 12052.) The complex and lengthy disease process associated with these cancers commences with that first injury, as marked by the progressive accumulation of fibrosis, and continues through the ultimate development of clinical signs and symptoms. (Kuschner, Tr. 10009; 10016-30, 10030; Brand, Tr. 12047, 12049, 12216.) As conceded by Dr. Brand, this disease process operates continuously thoroughout the latency period, regardless of whether or not there is a period of non-exposure preceding clinical diagnosis. (Brand, Tr. 12049.)