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Before the
Committee on Environment and Public Works
United States Senate

On
Examination of the Health Effects of Asbestos and Methods of Mitigating Such Impacts

June 12, 2007

Senator Boxer, Senator Inhofe, and Members of the Committee:

Thank you for the opportunity to testify before you about the health effects of asbestos. I will comment today specifically on the differences in toxicity associated with a variety of inhaled fibrous and non-fibrous minerals. These minerals are often grouped under the broad category of "asbestos," but there are fundamental differences among these minerals in terms of their potential of each mineral to cause human disease. My testimony is from a clinician's point of view, using appropriate support from the scientific literature.

I'll begin by telling you a bit about my background. I am board certified in Pulmonary and Critical Care Medicine. Currently, I hold several positions at the Stanford University Medical Center, including Associate Professor of Medicine in the Division of Pulmonary and Critical Care

Medicine, and I am the Director of the Lung and Heart – Lung Transplant Program.

I am also a "B Reader," which means I have been certified by the National Institute of Occupational Safety and Health ("NIOSH") as competent to classify chest x-rays for lung conditions such as those caused by exposure to asbestos dust. At Stanford, we are referred and treat patients with both common and rare respiratory conditions. Such referrals include patients with both occupational and non – occupational diseases.

I have also had the opportunity to testify before the United States Senate Judiciary Committee when it was considering the FAIR Act in 2005 and the Texas State Legislature regarding legislation addressing the handling of asbestos and silica claims. It is of course a privilege to testify before you here today.

Heath Effects of Asbestos

Asbestos exposure can lead to nonmalignant conditions such as asbestosis (a parenchymal fibrotic lung disease) and pleural changes (pleural effusion, pleural thickening, pleural plaques, and rounded atelectasis), as well as malignant conditions such as lung cancer and mesothelioma. The asbestos – related diseases and, for that matter, all pneumoconiosis, are dose-dependent, meaning that increased level and total amount of exposure

results in increased risk and/or severity of the diseases. Conversely, as workplace exposures have been substantially reduced in the last several decades, asbestos-related health effects have become less prevalent.

Health Effects of Different Asbestos Fibers

Asbestos is the commercial designation for 6 fibrous minerals of two broad types: serpentine and amphibole. Chrysotile is the only type of serpentine asbestos, while there are five different amphibole asbestos fibers: crocidolite, amosite, tremolite, actinolite, and anthophyllite. While our focus here today is to discuss the differences between asbestiform and non – asbestiform substances, it is important to note that there are important differences even among various asbestos fiber types and considerable evidence that different types of asbestos have different potentials to cause disease. While many epidemiologic studies have demonstrated an association between asbestos exposure and mesothelioma, the asbestos-mesothelioma association is particularly strong in occupations that involved heavy amphibole asbestos exposure, such as shipyard workers and insulators.

The message of these studies is simple: different asbestos fiber types have different potential to cause disease.

Health Effects of Cleavage Fragments

Now, let's examine the health effects of amphibole minerals more closely. There has been a considerable body of literature about the health effects of cleavage fragments derived from non-fibrous amphibole minerals, specifically whether they can cause human disease. Although I am by no means a mineralogist, I have some understanding about the physical and chemical properties of asbestos fibers and cleavage fragments, particularly as they are important to the development of human lung disease.

Most amphibole minerals are "non-asbestiform", designated as such because they have different characteristics that make them behave differently. Cleavage fragments result through the physical manipulation of these non – asbestiform particles and are sometimes difficult to distinguish from amphibole asbestos fibers using standard counting procedures.

Based on the scientific literature and my experience is a clinician, I have three general opinions regarding the health effects of cleavage fragments:

1) The different properties of asbestiform amphibole fibers and non - asbestiform cleavage fragments impact human health differently and should not be considered as the same;
2) Animal data reveal a lack of pathogenicity;
3) Human epidemiological studies have established no association between cleavage fragments and human disease

Physical Properties of Amphibole Asbestos Fibers and Cleavage Fragments

First, a bit about the different properties of asbestos fibers and cleavage fragments. Although the non – asbestiform and asbestos amphiboles are chemically similar, they differ with regards to morphology. Asbestiform amphiboles are made up of fiber bundles that run parallel to each other, which when they split, form single fibrils. Each individual fibril is long, thin, and very flexible. Non – asbestiform amphiboles are not unidirectional fibers but run in two or more different planes, forming a prism. These non – asbestiform structures do not break down into fibers or fibrils but instead into cleavage fragments that are thick and short and therefore not likely to be inhaled into the more distant (or deep) parts of the lung.

If one then compares more closely asbestiform and non – asbestiform amphiboles, they differ with respect to three important characteristics: surface properties, tensile strength, and dissolution.

1. Surface properties. The outside surface of amphibole asbestiform fibers is smooth, free of defects, and very strong, largely because there are no crevices or cracks in the fiber surface that can be subject to degradation strategies present after inhalation into the lung. This is not the case in non – asbestiform structures that have mechanical planes that can be exploited and lead to degradation.
2. Tensile strength. Amphibole asbestos fibers have inherent flexibility, giving them great tensile strength. Cleavage fragments,

however, are inflexible and brittle, making them vulnerable to physical stress.

3. Dissolution properties. The human body's natural defenses, particularly macrophages, generate an acidic environment to break down inhaled particles in the lungs. Amphibole asbestos fibers are resistant to acidic dissolution and are said to be biopersistent, meaning they remain in the lungs indefinitely. Cleavage fragments have surface defects or cracks that make these fragments amenable to acidic dissolution, which enables the body's natural defenses to expel them.

These fundamental physical differences between amphibole asbestos fibers and cleavage fragments result in each category of minerals having different health effects. Cleavage fragments are generally too wide to penetrate into the deep parts of the lung, particularly when longer than 5 microns. If shorter than 5 microns, as is commonly the case, there is a body of literature that suggests that, even if they shared the same properties as those of asbestos fibers, that these smaller particles have no pathologic effect, either in terms of fibrosis or mesothelioma development. In fact, the epidemiology and basic science literature (beginning in 1968) demonstrates that fiber length correlates strongly with development of asbestos-related diseases. This proposition is described as the Stanton hypothesis and assumes that fibers greater than about 8 microns in length and less than a quarter of a micron in diameter are the most potent in producing mesothelioma.

Highlighting this point, the EPA in 2003 reviewed the available literature to devise a protocol to assess asbestos-related risk. The expert panel agreed with the development of a protocol that considered, for purposes of evaluating asbestos-related risk, that fibers less than 0.5 microns in diameter and greater than 5 microns in length were more important in disease development. Fibers with greater diameters were believed to be unlikely to be inhaled to the more distal parts of the lung.

Animal Studies Involving Exposure to Cleavage Fragments

Let's move on to my second opinion, specifically that animals studies involving exposure to cleavage fragments have not found any adverse health effects from such exposures. It should be noted that there are limitations of the findings of any animal studies of this nature. First, animal studies generally use direct intrapleural or intraperitoneal injection of the substance being studied, bypassing the lung's natural defense mechanisms. And secondly, the amount of a substance administered to the animals (i.e. the dose) is usually massive and well beyond what could be observed in any occupational setting. However, notwithstanding these limitations, there are several animals studies that have been conducted that show no carcinogenic potential for cleavage fragments. This is very different from similarly conducted studies when true amphibole asbestos fibers were instead injected.

Human Studies Involving Exposure to Cleavage Fragments

Finally, my third opinion is that the body of human epidemiological studies involving exposure to cleavage fragments has not found adverse health effects from exposure to cleavage fragments. The occupational settings for these epidemiological studies included gold, nickel, and taconite miners, as well as talc and pottery workers and tunnel diggers. In each of these cohorts, no excess mesothelioma, lung cancer, or pneumoconiosis risk could be shown from exposure to cleavage fragments.

The largest study of workers exposed to cleavage fragments has been the Homestake gold mining cohort. In this study, there was no excess lung cancer risk identified. In fact, as exposure levels increased, the lung cancer risk tended to decrease, indicating no association of exposure with lung cancer development. Importantly, there were no mesothelioma deaths in this group. A study was also conducted of the Minnesota taconite miners who were exposed to grunerite cleavage fragments and this cohort showed no evidence of an excess of asbestos – attributable diseases. Other studies of cohorts exposed to cleavage fragments have reached similar conclusions. Therefore, the health risks demonstrated to be associated with amphibole asbestos exposure should not be assumed to apply to cleavage fragments.

Fortunately, with the institution of policies which limit occupational exposure to asbestos, the incidence of asbestos related lung conditions is decreasing. Further, it is my opinion that not all types of asbestos have the same potential to cause human disease. Even further, cleavage fragments are

naturally occurring and rarely meet the regulatory definition of an asbestos fiber. Therefore they are designated as “non – asbestiform” and have fundamentally different properties than amphibole asbestos. Currently, there is no existing evidence that cleavage fragments of nonasbestiform fibers are pathogenic for the reasons that I reviewed in my testimony, and there is no animal or human data that implicates these fragments as a cause of disease.

The impetus to perform epidemiologic studies on substances that may have a human health risk generally results from hypothesis-generating information to suggest that there might be a health risk. I do not believe such data exists. Further, with the asbestos exposure levels so low currently and the inability to study in isolation the health effects of cleavage fragments, I do not feel that human studies could be conducted which would result in meaningful conclusions. The medical literature is already informative on non – asbestiform fragments, and while it is always important to gain new scientific knowledge, I feel my opinions expressed today are based on the sound scientific evidence already available.

I hope that my perspective is helpful to the Committee’s efforts. Thank you.