Bringing Data to the Fog of War—or at Least Litigation

Retrospective-Exposure Assessment

By Michael J. Crist

Science can temper the siren song of plaintiffs' counsel that all asbestos causes injury and by doing so, help to calm the emotionally charged playing field of the courtroom.

Litigation has devolved. In toxic tort cases, where many courts are lenient in the admissibility of expert opinions, the fundamental issue of product identification often rests upon nothing more than unsubstantiated allegations without documentary support. Malleable recollections of the distant past faded by time, dulled by illness, and then redirected by litigation are often the bulwarks of a plaintiff's product identification. Litigation then molds and crystallizes amorphous, distant memories until they become marketable and monetized commodities. *See generally* Paul Barrett, *The Business of Litigation Finance is Booming*, Bloomberg Businessweek (May 30, 2017), https://www.bloomberg.com. In the realm of toxic tort litigation, these commodities are product identification and exposure.

In thousands of depositions taken by this author, an all-too-common scenario features a plaintiff with hyperacute testimony about specific, viable defendants, but a glaring amnesia regarding bankrupt manufacturers that had far greater market share and penetration. *See also Expert Report of Lester Brickman in In Re Garlock Sealing Technologies, et al.*, Case No. 10-BK-31607 (Bankr. W.D.N.C. Apr. 23, 2013). At times, they have provided detailed descriptions of products that they never purchased or used, while simultaneously denying recollection of those that they did. Similarly, they may have poignant recollections of the dusty environment caused by the products of viable defendants, while claiming only a fog of memory relating to the atmosphere created by non-viable entities to which apportionment would otherwise point.

Such scenarios breed tension. It is the tension between the emotional claim of injury and its logical defenses, between the vagaries of memory and the clarion call of science, and between litigation fantasies and harsh realities. All too often, the parties, lawyers, and courts create a self-sustaining feedback loop of alternative realities based upon the exigencies of the particular case, which may have only tenuous grasp on reality.

We will never have a videotape of a lifetime of activities. We will never have actual measurements of each activity, product, and exposure experienced by a plaintiff during the totality of his or her life. We do, however, have a body of science that has studied exposures from products, product use, individual workers, craftsmen, factories, and residences for over 100 years. We

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have industrial hygienists who measure and calculate exposures both prospectively and retrospectively to ensure work place safety and can outline the practical limits of both a plaintiff's claimed exposure and its effects, even where data is limited.

Such analysis is the lynchpin from which other defenses evolve. It is provided to experts on causation, regulation, and corporate knowledge, who may opine that such exposures were below background, regulatory, or causation levels. Thus, the industrial hygienist is the first key to unlocking causation, state of the art, and regulatory compliance defenses.

The Magic Hands of the Magic Mineral

While the mass-market advertising of plaintiffs' attorneys seeks to persuade the populace that there is not, and never will be, a safe level of exposure to asbestos, the reality is that all persons are exposed to significant amounts of asbestos that occur naturally in the environment, as well as those that were generated by over a century of asbestos use in residential, commercial, and industrial facilities. Asbestos has been used for over 4,500 years. John Craighead, *Asbestos and Its Diseases* 23 (2008). Lauded by science and industry as the "magic mineral," it was present in over 3,000 products. Victor Roggli, *Pathology of Asbestos-Related Diseases* 1 (2d. ed. 1992). For many years, use of asbestos was the rule, rather than the exception.

While few consumers would ask for more asbestos in their cornflakes, the presence of asbestos was once perceived as a positive point for both consumers and industry. It was chemically inert, providing a cheap and natural resistance to heat, fire, and strong chemicals. It provided protection from mankind's primordial fear of fire—a very real and constant danger when buildings were made of wood, heated by coal, and lit by lamps. It was a rock that could be woven into cloth, while its fibers provided a light-weight strength and flexibility that was not easily replicated. It was the stuff of faith and magic—the basis of King Charlemagne's unburning cloth and Marco Polo's skin of the salamander. The military protected and even hoarded it in stockpiles during times of war. It was specified, required, and demanded by government and industrial buildings codes and mechanical specifications. *See generally* Rachel Maines, *Asbestos and Fire: Technological Tradeoffs and the Body at Risk* (2013).

A 1958 Johns-Manville advertisement exclaimed that asbestos was the "Magic Mineral… [a] miracle of heat, pressure, and time." Johns-Manville, The Magic Mineral Advertisement, Jan. 1958. Other advertisements were less subtle. Whereas Michelangelo's Sistine Chapel featured the delicate hands of the deity and Adam reaching toward one another, Johns-Manville showed a human hand springing from the fibers of asbestos as it reached toward the heavens, offering its product as prayer. Johns-Manville, Transite Pressure Pipe Advertisement, July 1955.

Such advertisements extolled the ubiquity of asbestos. The 1958 advertisement proclaimed that "from basement to attic, from roof and exterior sidewalls to finished floors, walls and ceilings, asbestos building products make many important contributions to better living in today's homes." Johns-Manville, The Magic Mineral Advertisement, Jan. 1958. At the time of that statement, Johns-Manville alone manufactured more than 400 different product lines of asbestos products at 26 plants. *Id.*

As might be expected in such a world, some historical industrial exposures were truly staggering. In 1938, Dr. Dreessen reported that high-speed carding operations in textile mills generated readings that were over 800 to 8,000 times those currently permitted. Dreessen *et al.*, *A Study of Asbestosis in the Asbestos Textile Industry,* Public Health Bulletin No. 241 (1938) (carding operations produced up to 139 MPCCF, which, using a 1 to 6 conversion factor, represents an exposure of roughly 834 f/cc—over 800 times the current 30-minute excursion limit of 1.0 f/cc and over 8,000 times the current Occupational Safety and Health Administration PEL of 0.1 f/cc).

As such, all persons have asbestos exposure derived from both the general environment and a multiplicity of products, regardless of whether they ever used any themselves. Thus, it is not the existence of exposure that is important, but rather, the quantum of exposure to any particular product and whether that exposure exceeded scientific, historic, and regulatory limits. In short, the relevant issue for litigation is whether exposure, if any, to your defendant's product rises above the background noise to a level that would be substantial factor in causing disease. Since the manufacturers of many of the dusty products previously used are now bankrupt, such issues are of particular importance to the remaining low-dose defendants.

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This article will briefly discuss the science of industrial hygiene, the methodology of retrospective-exposure assessment (or "REA"), significant scientific, historic, and regulatory frameworks, and how the results of a retrospective-exposure assessment direct, define, and outline the retention of experts and the defenses in toxic tort cases.

Industrial Hygiene

Industrial hygiene is "the science of protecting and enhancing the health and safety of people at work and in their communities." *See* Am. Board of Indust. Hyg., About ABIH, http://www.abih.org. Certified industrial hygienists anticipate, recognize, evaluate, and control the exposures of workers to potential and known health hazards. S.R. DiNardi, Am. Indust. Hyg. Ass'n, *The Occupational Environment: Its Evaluation and Control*, White Book (1997). Industrial hygienists routinely measure and calculate past, present, and future exposures to a variety of substances and compare those to regulatory levels. J. Mulhausen & J. Damiano, *A Strategy for Assessing and Managing Occupational Exposure* 62, 68 (2d ed. 1988); J. Mulhausen & J. Damiano, *The Occupational Environment: Its Evaluation, Control Management* 104, Fig. 6.1 (DiNardi ed., 2d ed.). In the workplace, these experts are responsible for hazard identification via exposure characterization, evaluation, and estimation. U.S. Dep't of Health & Human Servs., *Exposure Assessment Methods: Research Needs and Priorities* 2–3 (July 2002).

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Measuring Exposures

Exposure is the presence of a hazard that contacts the body or is experienced by a worker, while dose refers to the amount of a substance absorbed or retained by the body. U.S. Dep't of Health & Human Servs., *Exposure Assessment, supra,* at 2. Exposure measurements may be direct or indirect, qualitative or quantitative. For instance, an individual's exposure in the workplace may be directly measured by air monitors on his or her person or in various locations where he or she may work throughout the day. Such exposures may be measured in terms of peak exposures for various tasks associated with a product or process. For instance, the process of cutting a product could be divided into various subprocesses such as moving, measuring, cutting, and cleaning that product. An industrial hygienist would measure the peak exposure of each subprocess. A similar analysis would be performed for the various types of products and processes to which a worker could claim exposure, both directly and indirectly.

However, peak exposures are exactly that: peak exposures. They are the highest exposures encountered during a day, which are often irregular, intermittent, and of short duration and significance. They do not represent an individual's total exposures for that day. While the Occupational Safety and Health Administration (OSHA) has provided limits based upon 15- or 30-minute peak exposures, an individual's total daily exposure is expressed as a time-weighted average (TWA) of exposures for an 8-hour work day. These measurements define the permissible exposure limits (PELs). The time-weighted averages provide uniformity of measurement and predictability that can be viewed in terms of historical measurements, regulatory guidelines, industry protocols, and causation guidelines.

While an industrial hygienist can directly convert peak exposures into time-weighted averages, such extrapolations would tend to amplify the actual results and provide a worst-case scenario. Williams *et al.*, *Retrospective Exposure Assessment of Airborne Asbestos Related to Skilled Craftsmen at a Petroleum Refinery in Beaumont, Texas (1940–2006),* 70 J. Tox. Envtl. Health, 1076–107 (2007). It would be similar to describing the average speed of your daily commute by only recalling your highest speed on the highway, and not the time stuck in traffic. The proper method for determining a time-weighted average considers the duration and frequency of each exposure from a typical day, including those periods of low or no exposure, to determine an overall average. The combination of an individual's lifetime of time-weighted averages would represent his or her cumulative occupational exposure, which is expressed in fiber-per-cubic-centimeter years (f/cc/yrs). However, a cumulative occupational exposure is the not the same as an individual's cumulative lifetime exposure, which includes a worker's nonoccupational exposures. Such readings may include calculations for both outdoor and indoor exposures.

Each data point provides an important link in determining the medical, scientific, and legal import of a plaintiff's exposure. As similar measurements for craftsmen and factory workers have been made for over 100 years, there is a wealth of historic, commercial, scientific, and regulatory literature outlining both the parameters of similar exposures and their effects. However, application of these historical measurements requires knowledge of the limitations of historical processes. Historical devices with esoteric names such as Konimeters and Midget Impingers, simply did not have the sensitivity of modern devices and further referenced different standards of counting dust. Both devices measured total dust in millions of particles per cubic foot (MPPCF), as opposed to modern measurements of fibers, expressed in fiber per cubic centimeters (f/cc). As the conversion of MPCCF to f/cc may vary (1 MPPCF = 6 or 10 f/cc), depending upon the asbestos percentage, product use, and environmental conditions, the relative significance of such measurements must be weighed in examining such information. Williams *et al.*, *Retrospective*, *supra*, at 1102, 1090. Konimeters also tended to measure shorter periods, thus yielding higher results than the Midget Impingers when considered over time. *Id.* at 1090.

Even the more modern phase contract microscope (PCM) techniques that produce f/cc readings directly cannot distinguish asbestos fibers from non-asbestos fragments of similar size and shape. Williams *et al.*, *A Review of Historical Exposures to Asbestos Among Skilled Craftsmen (1940–2006)*, 10 J. Tox. Envtl. Health 319–77 (2007). Therefore, non-asbestos components of a product may produce high false readings, depending in part upon the proportion of asbestos to non-asbestos components in both the raw materials as well as those modified by encapsulation or binding. *Id.* at 371–73. Moreover, early phase contract microscope measuring methods featured a degree of variability due to discrepancies in fiber-counting protocols. Williams *et al.*, *Retrospective, supra*, at 1087 (citing G. Gibbs *et al.*, *A Summary of Asbestos Fibre Counting Experience in Seven Countries,* 20 Ann. Occup. Hyg. 321–32 (1977); Beckett *et al.*, *A Comparison of Airborne Asbestos Fibre Counting with and Without An Eyepiece Graticule,* 19 Ann. Occup. Hyg. 69–76 (1976)).

If measurements have not been conducted in the workplace, industrial hygienists are trained to create simulation studies that measure exposures for specific products and work practices in a controlled environment. The American Industrial Hygiene Association (AIHA) guidelines note that "simulations conducted with the goal of measuring the resulting exposures should pay attention to accurately recreating (or accounting for differences) in materials, methods, and environmental conditions compared to the historic period being simulated." Am. Indust. Hyg. Ass'n, *Guideline for Occupational Exposure Reconstruction* 44 (2008). Simulations, properly done, provide an effective surrogate for actual measurements of historical exposures. Experienced industrial hygienists "would be expected to reasonably rank potential exposure events similarly and would be expected to produce results that could be correlated with the results of other experienced industrial hygienists." Am. Indust. Hyg. Ass'n, *Mathematical Models for Estimating Occupational Exposure to Chemicals* 171, 173 (2009).

Mathematical modeling that compares historical measurements with the proximity, duration, frequency, and intensity of exposure experienced in a particular case provides a range of exposures to variety of tasks and products for a class of workers or individual workers themselves.

Measurements of exposures in a variety of settings have been made and recorded for over 100 years in scientific, peer-review literature, company records, and regulatory reviews. Since it is both impractical and impossible to measure every individual's exposure for commercial, industrial, or medico-legal reasons, such measurements are used by industrial hygienists to calculate a similarly situated individual's exposures, which may consist of other occupational groups of craftsmen who used, or were around, similar products.

Retrospective-Exposure Assessment—Use and Methodology

A retrospective-exposure assessment calculates past exposures. In 1983, the National Research Council (NRC) described risk assessment as "the process of measuring or estimating the intensity, frequency, and duration of human exposures to an agent currently present in the environment or of estimating hypothetical exposures that might arise from the release of new chemicals into the environment." Nat'l Research Council, *Risk Assessment in the Federal Government: Managing the Process* 20 (1983).

A retrospective-exposure assessment is a "qualitative or quantitative estimate of magnitude, frequency, duration and route of exposure." Dennis J. Paustenbach, *The Practice of Exposure Assessment: A State-of-the-Art Review*, 3 J. Tox. Envtl. Health, 179, 181 (2000). Quantitative results are expressed in a range of values, which may provide best- and worst-case scenarios. Where data is lacking and only qualitative values can be determined, the values may be compared with similarly situated crafts so that the relative importance, if any, of the exposure may be determined.

Mathematical modeling that compares historical measurements with the proximity, duration, frequency, and intensity of exposure experienced in a particular case provides a range of exposures to variety of tasks and products for a class of workers or individual workers themselves. Keil *et al.*, *Mathematical Models for Estimating Occupational Exposures to Chemicals* (2009). Advanced statistical modeling employing computerized data analysis such as Monte Carlo and Bayesian statistics, which can estimate the frequency of events and integrate probabilities for observational data and expert judgment, can provide a revised probability of event occurrence. Mark Nieuwenhuijsen *et al.*, *New Developments in Exposure Assessment: The Impact on the Practice of Health Risk Assessment and Epidemiological Studies*, 32 Env't Int'l 996, 1004 (2006). Such studies have demonstrated that factors such as ventilation, outdoor usage, respiratory protection, fiber encapsulation, safe-work practices, and increased distance from exposure source all dramatically reduce exposures. Similarly, fiber encapsulation and safe-work practices may also reduce exposures to negligible levels.

An entire alphabet soup of scientific, regulatory, and government agencies regularly rely upon retrospective-exposure assessments to determine the amount and significance of exposures to a variety of chemicals and minerals (including the ACGIH, AIHA, ATSDR, EPA, FDA, IARC, NIOSH, NAS, NIC, and OSHA, to name a few—respectively the American Conference of Government Industrial Hygienists, American Industrial Hygiene Association, Agency for Toxic Substances and Disease Registry, Environmental Protection Agency, Food and Drug Administration, International Agency for Research on Cancer, National Institute for Occupational Safety and Health, National Academy of Sciences, National Research Council, and Occupational Safety and Health Administration). *See generally* Agency for Tox. Subst. & Disease Registry, *Health Consultation-Asbestos Exposures at Oak Ridge High School*, 12 (El Dorado Hills, Cal.), EPA Facility ID: CAN000906055 (Jan. 31, 2006); 42 C.F.R. Ch. 1 §§82.30–83.15 (Oct. 1, 2007); Guidelines for Exposure Assessment, 57 Fed. Reg. 22,888 (May 29, 1992); 61 Fed. Reg. 56,746 (1996); U.S. Dep't of Health & Human Servs., *Exposure Assessment, supra*.

While the process has been outlined generally above, the specific applications of its methodologies provide a roadmap of its utility. For instance, in 2007, scientists examined historical exposure data for

13 trades. Williams *et al.*, *Review, supra*. They used database search engines such TOXNET and Medline–Ovid to identify conference proceedings and papers in the peer-reviewed literature. They then examined governmental and regulatory records that included federal reports, U.S. Environmental Protection Agency (EPA) exposure and risk assessments, and National Institute for Occupational Safety and Health (NIOSH) site investigations. They further examined the information considered by rule-making agencies such as OSHA, which included private surveys and analyses, NIOSH reports, and OSHA compliance records. Postings by the U.S. Department of Labor and local and national union and tradesman apprenticeship programs were similarly considered.

For each craft, scientists considered the tasks performed during a typical workday and then outlined the tasks that may have led to asbestos exposure, the time for each task, and the product used. They further considered the crafts of persons who typically worked around such trades and the exposure that they would produce. *Id.* at 354. In viewing such activities, the scientists specifically considered typical processes associated with each product. They considered the variations caused by product type, asbestos content, asbestos type, encapsulation of asbestos, friability of product, and location. *Id.* at 365. For instance, applications of wet products such as slurries in an exterior location generated less exposure than the use of powdered products in an interior setting. Such measurements were then compared with present and past occupational standards. As knowledge advanced, regulations changed, work and safety practices evolved, exposures dropped significantly. *Id.* at 370.

This and similar studies acknowledge that there are limitations. *See generally* U.S. Dep't of Health & Human Servs., *Exposure Assessment, supra,* at 4–12. Ambiguities may exist in prior measurements, which may not have provided a significant amount of detail regarding study designs, durations of exposure measured for activities, or whether personal or area samples were used. In some historical studies, there may be limited information reported regarding the background conditions or the specifics of the occupational groups or job classifications used. Such issues challenge, but do not defeat, the industrial hygienist.

That same year, those same authors also calculated the exposure of 12 different crafts during seven-time periods at a large refinery, examining the following:

> (1) the historical use of asbestos-containing materials at the refinery, (2) the typical workday of the different crafts and specific opportunities for exposure to asbestos, (3) industrial hygiene asbestos air monitoring data collected at this refinery and similar facilities since the early 1970s, (4) published and unpublished data sets on task-specific dust or fiber concentrations encountered in various industrial settings since the late 1930s, and (5) the evolution of respirator use and other workplace practices that occurred as the hazards of asbestos became better understood over time.… [Mathematical modeling] such as a probabilistic (Monte Carlo) model accounted for potential variations in data sets.

Williams, *et al.*, *Retrospective, supra*, at 1076 (2007).

Here, too, the authors reviewed company records, corporate policies and safety manuals, and historical industrial hygiene information. They interviewed witnesses and analyzed depositions of employees, health and safety personnel, and contract workers. The use of such depositions highlights their importance for both scientific and legal reasons. Then the authors analyzed published and unpublished data about fiber concentrations associated with the work performed by discrete crafts. The significance of fiber type, friability, and encapsulation on exposures were noted. Non-friable, encapsulated chrysotile products were associated with significantly less disease potential. *Id.* at 1078. As had been long reported, encapsulation of fibers in various binding materials was also noted to reduce or eliminate the production of free fibers. *See also* Selikoff, *Partnership for Prevention—The Insulation Industry Hygiene Research Program,* 39 Ind. Med. I. J. 21–25 (1970).

Drawing from the authors' collective experience working in the fields of industrial hygiene, exposure assessment, and process engineering, this information was analyzed "to address various data gaps and provide greater context for the available data." *Id.* at 1081. While the results were described in terms of crafts, the authors noted that this "data can be combined with an individual's work history information to estimate that person's cumulative exposure to asbestos over a lifetime." *Id.* at 1080.

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The Data Defends

The resulting data may show that a plaintiff's claimed use of a product did not meet the regulatory definitions of exposure, was below ambient levels of cumulative exposure, was below the advised or regulatory levels of the era, or was below the levels associated with the development of disease from that type of product. Each provides a critical element to fashioning a defense.

Advisory Thresholds and Regulatory Limits

A plaintiff's peak, time-weighted average and cumulative exposures to a specific product or product type can be compared with those permitted historically. In fact, appreciation of the risk of injury based upon various levels of exposure has changed dramatically over time, with acceptable limits dropping a hundred-fold in the last 50 years. As such, historical exposures that would violate current regulations may have been common, accepted, and perceived as safe when actually encountered. The actions of a manufacturer in designing, manufacturing, and selling products would have thus complied with the state of the art of that era.

Roughly defined, no observed adverse effect levels (NOAELs) are the highest-cumulative exposure levels at and below which there are no statistically significant increased risk for disease. Low observed adverse effect levels (LOAELs) are the lowest-cumulative exposure levels at which there are statistically significant increased risks of disease.

In 1946, the American Conference of Government Industrial Hygienists (ACGIH) set maximum allowable concentrations (MACs) for asbestos at 5 million particles per cubic foot (MPPCF), which were not reduced until 1968 and 1970. *See generally* TLV Comm. Report, Proceedings of the 8th Ann. Meeting of the ACGIH (Apr. 7–13, 1946); Transactions of the 30th Ann. Meeting of the ACGIH (May 12–14, 1968); Transactions of the 32th Ann. Meeting of the ACGIH (May 10–12, 1970). By 1956, maximum allowable concentrations were renamed as threshold-limit values (TLV). The ACGIH currently defines threshold-limit values as "airborne concentrations of chemical substances and represent conditions under which it is believed that *nearly all* workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects." *See* ACGIH Statement of Position Regarding the TLV and BELs (adopted Mar. 1, 2001).

In 1951, the Walsh Healey Act adopted these levels for government contractors. Wage & Hour & Contracts Divisions, U.S. Dep't Labor, Safety and Health Standards for Contractors performing Federal Supply Contracts under the Walsh-Healey Public Contracts Act, Document No. 921345 (GPOApr.24, 1951). In April of 1971, OSHA adopted the outdated ACGIH level of 12 f/cc as an 8-hour permissible exposure limits (PELs). The initial commentary noted that "so long as the ceiling limit is complied with, no harm is reasonably expected to result from exposures during the transitional period." Occupational Safety & Health Standard for Exposure to Asbestos Dust, 37 Fed. Reg. 11318, 11319 (1972). By December of that year, OSHA had issued an emergency temporary standard of 5 f/cc PEL, with a ceiling limit of 10 f/cc, which was made permanent by June 7, 1972. The permissible exposure limit was reduced to 2 f/cc in 1976, to 0.2 f/cc in 1986, and to 0.1 f/cc in 1994. 29 C.F.R. parts 1910, 1915, and 1926. Occup. Safety & Health Admin., U.S. Dep't of Labor, Occupational Exposure to Asbestos Final Rule (Aug. 10, 1994). Thus, the permissible exposure limits reduced over a hundred-fold in only 23 years. Meanwhile the excursion or ceiling limits had reduced from 10 f/cc for 15 minutes in 1972, to 1 f/cc for 30 minutes in 1988. *See generally* Pub. L. 91-596, Dec. 29, 1970, 84 Stat. 1590; 29 C.F.R. parts 1910, 1915, and 1926 (1994).

Low and No Observed Adverse Effect Levels

A plaintiff's cumulative exposures to a specific product or product type can be compared with levels associated with evidence of disease. Scientists have studied the occurrence of disease in populations to various intensities and durations of exposures. With the advent of advanced computer modeling and statistical analysis, reams of data can be sorted, selected, analyzed, weighed, and used to demonstrate the levels at which disease does and does not occur for various substances. Jennifer Pierce, *An Updated Evaluation of Reported No-Observed Adverse Effect Levels for Chrysotile Asbestos for Lung Cancer and Mesothelioma*, Critical Reviews in Toxicology (2016). For asbestos, such levels vary, depending upon fiber length and type, with chrysotile having a lower pathogenicity than other types. For instance, Hodgson and Darnton reported that the risk of mesothelioma for chrysotile, amosite, and crocidolite exposure is broadly in the ratio of 1 to 100 to 500, for each respectively. J.T. Hodgson, & A. Darnton, *The Quantitative Risks of Mesothelioma and Lung Cancer in Relation to Asbestos Exposure,* 44 Ann. Occup. Hyg., 565–601 (2000); *See generally* IARC Working Group on the Evaluation of Carcinogenic Risk to Humans, *A Review of Human Carcinogens: Arsenic, Metals, Fibers, and Dust*, Vol. 100 C (IARC Monographs, 2012).

Roughly defined, no observed adverse effect levels (NOAELs) are the highest-cumulative exposure levels at and below which there are no statistically significant increased risk for disease. Low observed adverse effect levels (LOAELs) are the lowest-cumulative exposure levels at which there are statistically significant increased risks of disease. In calculating these levels for chrysotile asbestos, the Pierce article examined more than 600 studies describing exposures to various types of products and processes to determine chrysotile exposures, selected a set of articles with sufficient information, and analyzed the details of product, product type, exposure, and disease levels for various groups of workers. The authors analyzed potential confounding factors in each study. The best estimates of the upper and lower bounds for mesotheliomas possibly related to chrysotile were from 208 to 415 f/cc-yrs. *Id.* at 13. These numbers are far in excess of the possible exposures of most modern plaintiffs. The authors noted that in the majority of studies, there was no increased risk of mesothelioma, despite "chrysotile exposures in the hundreds to thousands of f/cc years." *Id.* at 22. The authors also reported that the lack of peritoneal mesothelioma in studies of cement or friction workers in the absence of amphibole exposures supports the proposition that "processed short fiber chrysotile may not cause peritoneal mesothelioma." *Id.* at 21.

Final Note

Plaintiffs' attorneys often preach a siren's song of simplicity that all asbestos use is bad and causes injury—an argument that has an immediate emotional appeal to those viewing an injured plaintiff. Such arguments also appeal to persons not interested in critical analyses. Even good people trying to do good things may produce bad results when they are not inculcated in terms of general education, patience, and interest to listen patiently to both sides. Consider that there is a large segment of the population for whom it is easier to describe the mating habits of the Kardashians than to define the basic mechanisms of science, and for whom written communications are more commonly expressed in emojis, rather than in words. Much of our population defaults to feeling, rather than thinking; to reacting, rather than planning; and to blaming, rather than understanding. We live in an era when information is filtered through Facebook feeds and television channel selections and when allegations of fake news are used to describe any contrary or unfavorable views. One need only watch MSNBC and Fox News during the daily political crisis to see such filtration mechanisms in effect. At the same time, the very governmental institutions in which we as a people have invested the duty of oversight and regulation are being dismantled from the inside. All of this tends to undermine the faith in institutions, science, and law—and too often result in the reflexive rejection of information contrary to preconceived notions.

A multiweek, science-laden trial thus challenges the interest, patience, and capacities of many jurors (and judges and lawyers). The minutia of the topics discussed here are not simple, but a juror need not understand the specifics of every methodology and process. One need not be able to build a car, just to drive it. One need not grow the wheat, just to buy the bread. At the most fundamental level, a juror need only understand that asbestos does not cause every disease, that not every exposure is significant, and that the science has established that the exposures to your product were not significant and not harmful. If you can demonstrate that exposures to a defendant's product were below background levels, below adverse effect levels, below causation levels, below regulatory levels, or a combination of these, you have laid a foundation "For The Defense."