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Asbestos and Disease: An Industrial Hygienist's Perspective

MORTON CORN, Ph.D., CSP
Professor and Director, Division of Environmental Health Engineering, School of Hygiene and Public Health, Johns Hopkins University, 615 North Wolfe Street, Baltimore, MD 21205

oduction

is not personally acquainted with Donald Cummings, I know of him. At the Harvard School of Public Health he mid-1950's he was occasionally referred to as part of famous Saranac Laboratory team consisting of Leroy dner, Homer Sampson and Don Cummings. Cummings the hygienist, a man exhibiting professional compe-ce, curiosity and energy relative to investigation of the t silicosis tuberculosis interaction. He was said to have an abiding belief in our capacity to unravel this complex logical interaction, as well as other pneumocomotic dis-es of our industrial society. His tragic and untimely death in an airplane crash in 1942 curtailed the life of a man who, by all accounts, had his major scientific and professional contributions ahead of him. It is a privilege and an honor to be selected to deliver this address honoring Donald Cummings.

The subject of this lecture is an industrial hygienist's perspective on asbestos, and United States approaches to reducing the risk of disease to those inhaling this extraordinary material. Asbestos has probably received more attention in the United States and worldwide than any other potentially toxic agent addressed by practitioners and investigators in the fields of industrial hygiene, occupational medicine,

Dr. Morton Corn, Ph.D., CIH, currently is Professor and Director of the Division of Environmental Health Engineering, School of Hygiene and Public Health at The Johns Hopkins University, where he has been a faculty member since 1980.

Prior to his appointment at Johns Hopkins, Dr. Corn advanced through the ranks from assistant to full professor while on the faculties of the Graduate School of Public Health and the Department of Chemical Engineering at the University of Pittsburgh (1962-1979). A leave of absence from 1975 to 1977 presented him the opportunity to serve under President Ford as Assistant Secretary of Labor for Occupational Safety and Health in the United States Department of Labor.

While obtaining his undergraduate degree in Chemical Engineering from Cooper School of Chemical Engineering Dr. Corn worked summers as a Research Assistant for the U.S. Atomic Energy Commission, thus beginning a career that has earned him numerous awards, fellowships and other honors.

Beginning with the New York State Regents Scholarship, which he was awarded from 1951-1955, Dr. Corn has amassed a lifetime of achievements, including the National Science Foundation Postdoctoral, the John Simon Guggenheim Fellowship, the USAEC Fellowship, awards for published works, and invitations as guest speaker and lecturer at conferences throughout the world.

Dr. Corn also has served on various panels and committees, such as the Environmental Protection Agency Science Advisory Board (1977-1984) and the Office of Technology Assessment Committees on Control Technology in the Workplace and Hazardous Wastes.

In 1981 Dr. Corn was elected Vice Chairman of the American Conference of Governmental Industrial Hygienists, succeeding to Chairman in 1983. In 1984 he was elected President of the Association of Universities in Occupational Safety and Health. Dr. Corn currently chairs the Industrial Hygiene Commitee of the International Resource Center in Occupational Safety and Health; and is a member of NIOSH's Mine Health Research Advisory Committee.

Among his other memberships, Dr. Corn also belongs to the American Association of University Professors; the awards committee of the ACGIH; the American Industrial Hygiene Association, as a member of the Management Committee; the American Institute of Chemical Engineers, full grade; American Public Health Association; Air Pollution Control Association; British Occupational Hygiene Society; Society of Occupational and Environmental Health, founding member; and numerous others.

Dr. Corn's published works include papers, book chapters, and conference and symposia proceedings dealing with the subjects of aerosol physics, air pollution, industrial hygiene, safety in the workplace and public policy.

occupational epidemiology and toxicology. One could argue that more is known about the toxicity of asbestos and the dose-response curve for its inhalation by those exposed than is known about any other industrial material. Asbestos has created economic crises in selected corporations responsible primarily for its production and product distribution, causing two major U.S. corporations to enter into Chapter 11 bankruptcy.[1] The concern for asbestos has spread from those exposed occupationally to those experiencing nonoccupational exposure. Asbestos has precipitated regulation of the nonoccupational environment by the Environmental Protection Agency and the Consumer Product Safety Commission in the United States.

One could review our experience with the health effects of asbestos from the perspective of the lawyer; asbestos has set precedents in personal injury and property damage litigation. One could also view the asbestos experience as a case study in the evolving occupational and environmental medical literature, where scientific and technical precedents have been established. There are numerous facets to the asbestos story and one could select different vantage points to observe and evaluate those facets. I focus here on the industrial hygienist perspective. What can we learn, as individuals and as a profession from this experience, this extraordinary case of societal utilization of a valuable material and the associated growing recognition of its disease potential?

Background to the Occupational Standard

My introduction to asbestos occurred in 1955 as a graduate student in Industrial Hygiene at the Harvard School of Public Health. Our class studied the properties of dusts and fine particles in general, under the tutelage of Professors Leslie Silverman, Philip Drinker, and Charles Williams. In retrospect, I was instructed extremely well on the technical assessment of airborne concentrations of asbestos. At that time we evaluated asbestos dustiness according to the American Conference of Governmental Industrial Hygienist's Threshold Limit Value (TLV) guideline of five million particles per cubic foot of air determined by light microscopy. Students were instructed by Dr. Williams in the appropriate sample collection by midget impinger, slide preparation, and microscopic counting procedures. Perhaps the first lesson to be derived from this experience was that we were not urged to critically evaluate the documentation of the TLV. The Dreesen study[2] of textile workers was the basis for the TLV guideline. It was an extremely limited cross sectional epidemiological investigation, characterized as follows in the first edition of the *Documentation of Threshold Limit Values*, published by the ACGIH in 1962:

> "The present threshold limit relates to the prevention of asbestosis. It was recommended by Dreesen, *et al.*, after study of 541 employees in three asbestos textile plants using Chrysotile. Only three doubtful cases of pneumoconiosis were found in those exposed to dust concentrations under 5 mppcf, whereas numerous well marked cases were found above 5 mppcf. Counts were from impinger-collected samples in ethyl alcohol and distilled water. Both fibrous and non-fibrous particles were counted, but the latter greatly predominated. While chemical analyses of collected samples of airborne dust corresponded to those of settled dust samples it is believed that dust counts of particulates by conventional methods can be expected to give only an indirect measure of the risk of asbestosis because of the great relative importance of long fibers."[3]

The above was the total documentation for the guideline in 1962. In 1955 the brief discussion of asbestos disease found in the book *Industrial Dust* by Drinker and Hatch[4] was the major reading for graduate industrial hygiene students on the rationale for the guideline. The TLV was for pure chrysotile fiber. In practice, U.S. industrial hygienists utilized the TLV for all situations where airborne asbestos was encountered.

It was not until 1968 when the British Occupational Hygiene Society (BOHS) published their occupational hygiene standard for asbestos that a specific level of risk for basal rales and x-ray changes was offered for asbestosis.[5] I

TABLE I
U.S. Asbestos Standards[12]

				Million particles/ per cubic ft.	Fibers/ cc	STEL,* fibers/ cc
1938		Recommended	TLV	5	30^A	
1946	ACGIH	Adopted		5	30^A	
1970		Adopted		2	12^A	
1971		Proposed		-	5	
1971	OSHA	Emergency	TWA	-	2	10
1975		Proposed		-	0.5	5
1976		Adopted		-	2	10
1976	NIOSH	Recommended		-	0.1	0.5
1983	OSHA	ETS			0.5	
1984	OSHA	Proposed		-	0.4 or 0.2	

*Short Term Exposure Limit.
^A Approximate fiber equivalent.

TABLE II
Factors Included in EPA Exposure Assessment Algorithm[4]

Condition of material
Water damage
Exposed surface area
Accessibility
Activity and movement
Air plenum or direct air stream
Friability
Asbestos content

: others instructed in industrial hygiene in the 1950's and ·)'s were aware of the limitations of measurement tech- :ues for asbestos-in-air, but were not seriously concerned ·ı the adequacy of the TLV and were not addressing the d for change. Had our instruction focused more heavily ·ınderstanding the basis for the numbers in the TLV's, the :ertainties would probably have caused us great discom- : and concern. The BOHS publication profoundly affected . manner in which I assessed asbestos-in-air in the field ·ing the late 1960's. I obtained midget impinger samples :he traditional U.S. method, but also obtained simul- :ously collected membrane filter samples, expressing ·ults as both mppcf (U.S. method) and fibers/cc of ·ropriate size (BOHS method). Of course, part of the growing concern of hygienists was the increasing realization of the carcinogenic properties of inhaled asbestos, a subject soberly addressed in the 1968 BOHS standard.

Why is familiarity with the basis for a guideline and its weaknesses essential to the hygienist? While the standard is a single number, the interpretation of air sampling results and the accompanying recommendations will inevitably be shaded by the hygienist's insight into the basis for the standard. Standards, as we often repeat, are not fine lines between acceptable and unacceptable conditions (or risks). However, how we place the results in perspective for concerned clients will be a reflection of our own awareness of the "softness" or "hardness" of documentation supporting the guideline or standard.

In the 1971 third edition of the Documentation of Threshold Limit Values by the ACGIH there is a more critical paragraph on the Dreesen study, as well as a lengthier description of results relevant to a standard. The Dreesen study is further treated as follows:[6]

> "A conference on the biological effects of asbestos in 1965 called attention to the very real probability that the 5 mppcf limit recommended by Dreesen is inadequate to give complete working-lifetime protection against all forms of asbestos. Medical data on which the limits had been based were inadequate; more than

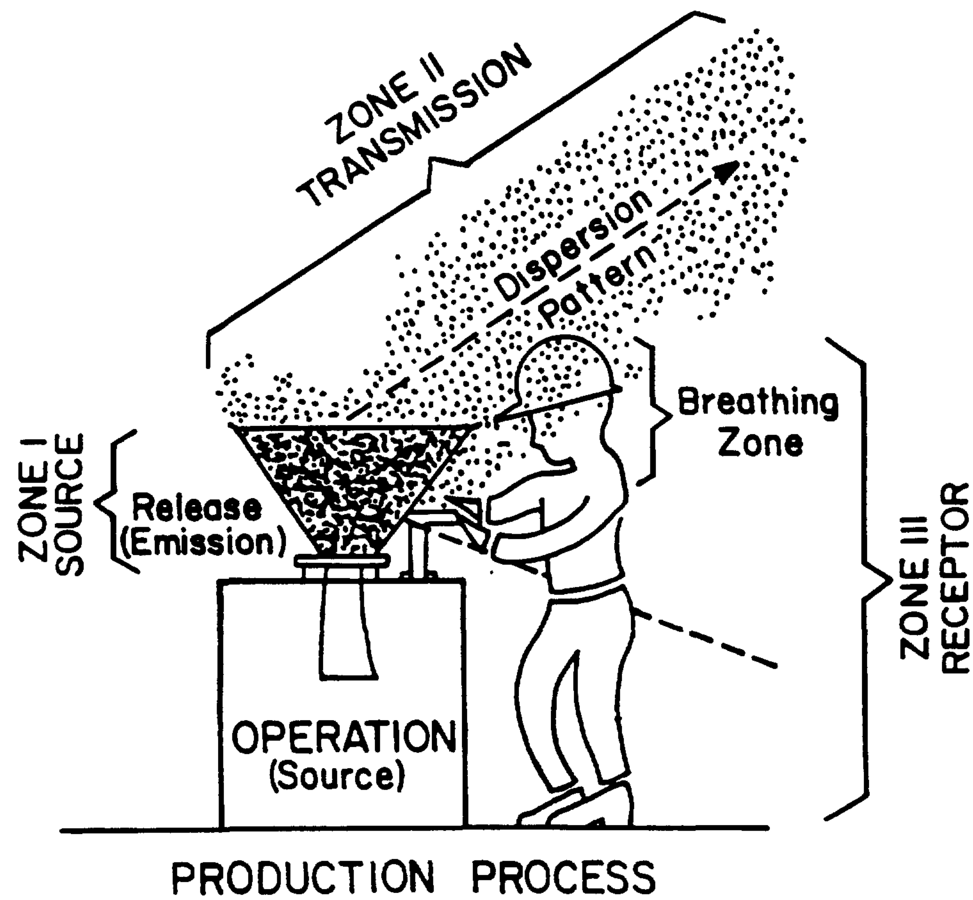

Figure 1 — Conceptual model of the three zones of influence to control workplace hazards.[20]

half of the asbestos workers studied were under 30 years of age and thus provided an insufficient exposure time for asbestosis to develop. Of the 105 workers exposed to less than 5 mppcf, 82 had worked less than 5 years; 101 less than 10 years; only 4 had more than 10 years exposure. Seven of 36 workers exposed to 5-9.9 mppcf had asbestosis; 3 of 50 workers exposed to 10-19.9 mppcf for less than 5 years had asbestosis. Moreover, it was a "point-in-time" study; many of the ill were missing and the dead uncounted, hence not considered in the over-all evaluation of the limit."

The recommended guideline based on the Dreesen study had stood for 33 years without critical reappraisal in the U.S. until the 1965 New York Conference[7] and the 1968 BOHS recommended standard prompted reappraisal. Let me be clear: I am not criticizing the TLV committee. The responsibility for reexamination of the standard was and is that of practicing industrial hygienists; it is too important a matter to leave entirely to the toxicologists.

Clearly, the first lesson of the asbestos story for industrial hygienists, particularly at a time when the field and this association is expanding to include industrial hygiene technicians, is that one must critically examine the supporting documentation for a standard when utilizing it in field situations. Fortunately, the Occupational Safety and Health Act, with its requirements for adherence to the Administrative Procedures Act for standards promulgation, necessitates agency publication of a Proposal for a standard, followed by comments and in every case to date, a public hearing. These procedures should force currently practicing industrial hygienists to familiarize themselves with the uncertainties of permanent OSHA standards. The limitation of this procedure for enforced learning is that OSHA has only passed 28 permanent health standards during its sixteen year history. The majority of standards in OSHA are still Permissible Exposure limits, as listed in Table Z-1 of the OSHA General Industry Standards.[8] They lack extensive documentation and associated engineering, medical, environmental, work practice and administrative controls. Thus, the burden remains on the hygienist to familiarize his/herself with the epidemiological and toxicological literature on which standards or guidelines are based. The passage of a new standard by OSHA will, of course, involve public review of the health related data base.

How is the hygienist to integrate this type of knowledge into work and the discharge of his or her duties? The approach must be to indicate to a client and to those potentially affected in the work environment the airborne standard involved, but to moderate this with full clarification of the uncertainties associated with the numerical values of permissible exposure time weighted average or peak values. The degree of concern of the industrial hygienist must be related to the relative uncertainties of the standard. It is only in this way that the practice of industrial hygiene will be a science and an art, and not a mindless application of numbers and techniques. The Hazard Communication Standard of OSHA and state "right-to-know" laws should also serve to develop this approach.

Surrogate Measures of Exposure

In addition to the basis for the asbestos standard, we should briefly address the sampling methodology for airborne fiber concentrations. The early midget impinger mppcf methodology involved counting all particles present, although there was good indication at the time of adoption that this surrogate for the active agent may not apply in environments where all materials processed or used were not asbestos. The heritage of adoption of this weak surrogate measure for fibers was felt throughout the 1960's. For example, I was involved as consultant to the Pittsburgh Corning Corporation and designed dust control systems for their Port Allegany, Pennsylvania and Tyler, Texas Unibestos plants. These facilities later became the subjects of major personal injury litigation; unfortunately, large numbers of people contracted asbestos disease at these sites. In both the Tyler and Port Allegany cases I reviewed reports of practicing hygienists prior to undertaking my own surveys and dust control systems design. [A dust control system was installed in Port Allegany, Pennsylvania but not in the Tyler, Texas plant. These cases can now be discussed because the litigation has been completed.[9]] The hygienists had misinterpreted the 5 mppcf guideline* and had counted fibers, instead of particles and fibers, while determining adherence to the mppcf standard. Because it was a mixed material environment, the fiber counts were low when compared to the standard, as one would expect. Therefore, startling conditions of dustiness were encountered in Tyler, conditions addressed in previous hygienist reports and concluded to be in compliance with the 5 mppcf TLV for asbestos-in-air.

The lesson suggested is that adoption of a surrogate measure for extent of exposure to a toxic agent, although appropriate in an isolated or particular situation, may not be appropriate to many other situations. There must be an extraordinarily high level of care and foresight when a surrogate in assessment is adopted. Indeed, we must as a profession take every precaution to make sure our members understand the compromise inherent in the surrogate measure. Such a measure was adopted in the OSHA Coke Oven Standard. The benzene soluble organic portion of the respirable dust was invoked as the surrogate measure for the risk of exposure to coke oven fumes, a very complex mixture of potentially toxic materials. In this case, OSHA procedures, including public hearing and wide discussion of the strengths and weaknesses of the surrogate measure resulted in the compromise being widely understood. The current phase contrast microscopic method for examination of filter samples containing asbestos fibers does not measure asbestos fibers exclusively, a result of technical imitations of the microscope illumination. In mixed material environments a very prudent measure of exposure is obtained. Unfortunately, this is not well understood by many hygienists and the 2 f/cc OSHA standard is often thoughtlessly invoked in all environments. I will later return to the problems of a

*Because the plant was producing pipe insulation for the U S Navy, it was covered by the Walsh-Healey Public Contracts Act: the mppcf TLV was an enforceable Federal Standard under this Act

...rrogate measure for asbestos in regard to nonoccupational ...xposure to asbestos. I will not further dwell on the safety ...ctor or lack of safety factor the use of surrogate measures ...ay include; my point is that those who use such surrogates ...ust very clearly understand what they are doing.

...nks to the Past

...nder present regulatory procedures in this country, OSHA ...rmanent health standards for airborne contaminants ...quire that an initial determination be made of the concen-...ation of the agent in air. If the concentration is above a ...ggering permissible exposure limit, periodic surveillance ...undertaken. When the measurement technique and approach ...asbestos evaluation in the environment was altered and ...e membrane filter method introduced in the late 1960's, ...orts were not made to link this assessment methodology to ...st measurement techniques using the midget impinger and ...e mppcf method. Today we are struggling with so called ...trospective industrial hygiene."[10] In order to project the ...duced impact of lowering standards for potentially toxic ...aterials, it is necessary to have fairly reliable dose-response ...rves based on past exposures and health effects unfortu-...ately already experienced. There must be a period of simul-...neous environmental evaluation using new and old method-...ogies for assessment, with subsequent correlation of ...sults. When we changed from the midget impinger mppcf ...chnique to the membrane filter phase contrast microscopy ...chnique, there should have been a required period of dual ...easurement to permit conversion of old measurements to ...e new framework. Such a required period could be part of ...e regulatory requirements or could be voluntarily under-...ken by the industrial hygiene profession. We are now ...uessing at the conversion factors. I have personally simu-...ated phased-out past production processes to perform simul-...aneous exposure measurements by these two measurements. *Surely the lesson of this experience, so vividly illustrated ...ith asbestos where the projection of future disease is so ...mportant,[11] is that as a profession we must take steps to ...nsure simultaneous measurement by new and old techniques ...hen an assessment methodology is changed.*

Non-Occupational Exposure to Asbestos

Asbestos concerns spanned the years from the 1930's until the present time. They overlapped the creation of the Occupational Safety and Health Administration in 1970. One of the first issues addressed by OSHA was asbestos; in 1972 a permanent federal standard for asbestos was promulgated. Table I indicates the consistent lowering of the federal permissible exposure limits.[12] We are currently awaiting a further reduction in the federal standard. OSHA made it very clear to me and to other hygienists that the procedure up to that time of reporting our results to employers or clients exclusively, would not fulfill duties and responsibilities assigned to us by law. We are in an entirely different phase of discharging our responsibilities by sharing information. The implications of the Act for industrial hygienists was a subject that I addressed in 1976.[13] It remains a difficult subject area to sort out. Current hazard communication standards at the federal level and right to know standards at the state levels are articulating the types of concerns that we attempted to resolve as individuals or as groups of professionals during the 1970's and early 1980's. Needless to say, the awareness of these responsibilities suggested there was justifiable concern and that there should be scrutiny of other areas of asbestos exposure, areas not covered by the Occupational Safety and Health Administration because they do not occur in places of employment involving exposures to employees. This category of concerns has been called non-occupational exposure. The asbestos story provided evidence that exposed workers could carry asbestos from the workplace to the home, thus causing exposure of those not employed. Awareness of this potential for contamination and the use of asbestos in other environments has focused on asbestos in schools and buildings, an area addressed by the Environmental Protection Agency (EPA) under the Toxic Substances Control Act. It is an area engaged in complex property damage and third party personal injury litigation. The non-occupational asbestos exposure area also suggests certain lessons for the industrial hygienist; I'll now address several of these.

Air Sampling for Asbestos in Nonoccupational Environments

The EPA in a series of guidance documents often referred to as the Orange Book,[14] the Blue Book,[15] and the Purple Book[16] indicated early on that the agency had a very crystallized view of the role of air sampling in evaluating the risk of exposure of building occupants to airborne asbestos. In the 1979 orange document the following statement is made in Chapter 7 on Exposure Assessment:

> "Air sampling is inappropriate to estimate asbestos contamination and exposure. In the school environment, it is virtually impossible to establish exposure potential using standard air sampling techniques."[14]

Instead of relying on the well-established science and art of air sampling, EPA adopted an algorithm, a device that could be viewed as a tool for qualitative risk assessment. The EPA offered a series of relevant environmental factors, listed in Table II. Numerical weighting factors were then assigned to each environmental factor and a formula was used to derive a numerical score for the given situation. Based on the algorithm score, the responsibile party was directed to take immediate action (removal) or to postpone action. The environmental factors weighting was biased towards a resulting score which dictated immediate action, in most cases. What was not known by the professional community and the public in 1979 when EPA issued the first guidance document was that the algorithm had never been tested for its correlation with airborne asbestos concentrations in different environments. Subsequently, two contractors to EPA indicated the poor correlation of the algorithm scores with airborne fiber measurements.[17,18] The only highly consistent environmental factor was water damage to the material. Other investigations of algorithm validity reached similar conclusions about the EPA algorithm usefulness.[19]

The need to correlate an algorithm with airborne fiber concentrations is essential if risk is to be estimated by a method other than measuring airborne concentrations. Figure 1 is a bedrock conceptual framework for exposure to environmental agents.[20] The mere presence of a source or agent is a potential hazard; the transmission of the agent to the receptor is necessary for a potential hazard to become a real hazard. Asbestos in a building is a *potential* hazard; asbestos-in-air concentration is the measure of that hazard being realized. The issuance of the 1979 guidance document by EPA in the absence of algorithm validation and in the presence of initial air sampling results discrediting the algorithm, can only be viewed as agency arrogance bordering on "chutzpah."[21]

In 1983 the "blue book" by EPA again discussed air sampling and the algorithm. It indicated that two of the eight factors assumed to correlate with measured levels of asbestos-in-air did, indeed, do so. These were water damage and the proximity of the material to an airstream created by a ventilation system. A report to the EPA by Battelle Memorial Institute was the basis for the conclusions.[22] In spite of these findings regarding the lack of validation of the algorithm in terms of fiber-in-air concentrations, EPA in the blue book recommended use of six of the factors to predict "fiber release potential." Once again, the agency recommended use of factors not validated by correlation with the property to be predicted, *i.e.*, fiber release potential, a term not well defined by the EPA to this day.

What about measuring airborne asbestos in nonoccupational environments? In the blue book of 1983,[15] EPA states the following in Section 3.2.3.:

> "Another proposed approach to assessing the need for corrective action is to measure asbestos fibers in the air. At best, this approach provides information only on current asbestos contamination and no information about the potential for fiber release and future air levels. Moreover, the use of air monitoring as an assessment tool involves substantial technical and economic problems which limit its use even for determining current levels of contamination."

After devoting two additional paragraphs to the limitations of air sampling, the following sentence concludes the air sampling discussion:

> "Given the limitations, EPA does not recommend the use of air monitoring for assessment purposes at this time."

In the latest "purple book,"[16] EPA states that it does not recommend air monitoring "as a primary assessment tool at this time." Algorithm factors are still endorsed, but with qualitative scores only. Air sampling *is* recommended for post abatement evaluation.

Why have I dwelled on this EPA asbestos story?

The lesson to the industrial hygiene profession is that we must always be alert and respond to obviously incorrect evaluations of some of the principal scientific tools of our profession. Our associations did not challenge the EPA in its denigration of air sampling. Much to my dismay, some hygienists have appeared in court on behalf of plaintiffs to reiterate EPA's downgrading of air sampling as a scientific tool. It eludes me as to how these individuals can, on the one hand, repeat the EPA position and then on the other hand, proceed in their daily utilization of air sampling methods for assessment of airborne hazards in a large variety of other environments. What is unique about asbestos in indoor environments?

Risk Assessment in Nonoccupational Environments

Another lesson stemming from shift of concern for asbestos in the workplace to asbestos in the nonoccupational setting is that this transition will occur with other potentially toxic agents. We must be prepared to place nonoccupational risks to potentially toxic agents in perspective with regard to other risks to life and health in the nonoccupational setting, utilizing the best techniques available. Risk assessment is certainly not an exact science, but in its present state of development it is a valuable input to the assessment of health hazards, as stated by the National Academy of Sciences.[23] Risk assessment highlights relevant factors related to the risk under scrutiny and it often permits scientific assumptions, or "inference guidelines"[23] to be made in order to estimate the risk quantitatively. If hygienists abandon these matters of risk assessment, others may lose sight of the health component of the dialogue. The current situation with regard to asbestos risk in non-occupational settings is a mess because EPA has never addressed the magnitude of the risks involved. Table III displays the ranges of airborne concentrations of asbestos in non-occupational settings in buildings and schools. The lifetime risks associated with non-occupational exposure to occupants of buildings and schools have been estimated by the National Academy of Sciences,[24] by a Royal Commission of the Province of Ontario, Canada,[25] and most recently by Hughes and Weill.[26] Table IV indicates lifetime deaths per million exposed attributable to six years of asbestos exposure in schools. The exposure concentrations assumed are reasonable based on Table III data. In my opinion, the model used for Table IV is a defensible one, but you must refer to the original article to follow its development. Hughes and Weill compared these risks to other commonplace risks in life. The upper estimate of approximately fifteen lifetime excess deaths (mixed fibers at 0.003 f/cc) would constitute an average annual rate of approximately 0.25 deaths per million exposed. The latter rate compares with approximately 1200 deaths for long-term smoking, 15 for bicycling, 15 for ingestion/inhalation of foreign objects and 10 from playing high school football. The upper estimate of an average annual rate of 0.25 deaths per million exposed would be equivalent to 0.75 annual U.S. deaths, based on EPA's estimate of 3 million students currently exposed.[26]

Postclearance Standard After Removal

The least defensible and perhaps strangest aspect of the current U.S. approach to non-occupational asbestos, is the standard for a clearance concentration for asbestos-in-air following a major abatement activity. Three states, *i.e.* Massachusetts, New Jersey and Rhode Island, have adopted standards of 0.01 f/cc after "aggressive sampling." Air samples are evaluated by the PCM, or NIOSH method. A brief review of Table III will reveal that *before* removal of asbestos the building air concentrations were, on the average, at least an order of magnitude less than the clearance concentration in the majority of buildings. The justification for the standard is apparently that, because samples are collected after "agressive" sampling and because evaluation by the PCM method results in *all* fibers of a certain size being counted, the 0.01 f/cc standard actually represents an asbestos-in-air concentration far below 0.01 f/cc. This could or could not be a valid rationale; data have not been collected to accept or reject it.

Of course, the clearance standard could well be a license to permit building contamination to increase, resulting in more airborne asbestos fibers after removal than before. I am already aware of such cases, but data have not been systematically collected.

The clearance standard is a so-called concession to "practicality." Post removal air evaluation by electron microscopy has not been deemed feasible. PCM is rapid and would permit efficient conclusion of the removal contract and release of contractors. However, the risk to building occupants from inhalation of asbestos could well be greater after removal than before removal, when the original risk was presumably judged sufficiently compelling to trigger removal!

The illogic of this aspect of non-occupational exposure to asbestos is sobering if one considers the large expenditures of effort and money which may increase, rather than decrease occupant risk to asbestos disease. I question the conclusion that electron microscopy is not feasible for postclearance evaluation of air samples. Indeed, in my opinion it is the only way to certify an abatement effort as satisfactory. The standard should be that post clearance air concentrations are, on a statistically valid basis, lower than preabatement concentrations. If they are not, contractors should clean the premises until they are.

What can we conclude from the juxtaposition of the above estimates of risk from nonoccupational exposure to asbestos, the manner in which EPA has proceeded to regulate this risk and the current level of public concern for this potential hazard? Obviously, those responsible for national regulatory policy have lost sight not only of some well established principles of environmental assessment, but of comparative or relative risks and the setting of priorities. Today, members of the public need only learn of the presence of asbestos in a building and they want it removed. This attitude can be traced to the manner in which EPA presented the subject: it failed to relate the asbestos risk to other environmental risks. It is still not too late for our professional associations to issue a scientific document, albeit abbreviated, which states our position on these matters. Such a document would not be responsive to immediately pending specific regulation; therefore, the urgency with which this must be done is not great. We can utilize a democratic form of assessing membership input to reach a position on the value of industrial hygiene tools in assessing the risk and the value of risk assessment in comparative risk delineation *re*: asbestos in non-occupational environments.

TABLE III
Summary of Asbestos Exposure Samples in Different Environments[24]*

Sample Set	No. of Samples	Measured Concentration ng/m^3		Equivalent Concentration (fibers/cc)**	
		Median	90th Percentile	Median	90th Percentile
Air of 48 U.S. cities	187	1.6	6.8	0.00005	0.00023
Air in U.S. Schoolrooms without asbestos	31	16.3	72.7	0.00054	0.00242
Air in Paris Buildings with asbestos surfaces	135	1.8	32.2	0.00006	0.00107
Air in U.S. Buildings with cementitous asbestos	28	7.9	19.1	0.00026	0.00064
Air in U.S. buildings with friable asbestos	54	19.2	96.2	0.00064	0.00321

*Table III does not include all references and associated results, as contained in the more extensive NAS table.[24]

**Based on conversion factor of 30 μg/m^3 = 1 fiber/cc.

TABLE IV
Estimated Number of Lifetime Deaths Attributable to 6 Yr of Asbestos Exposure in Schools (Per 10⁶ Exposed) By Fiber Type and Average Concentration[b]

	Lung Cancer*	Mesotheliomat	Total
0.001 f/cc			
Mixed fibers	0.6 (0.3 to 1.2)	4.4 (2.2 to 8.8)	5.0 (2.5 to 10.0)
Chrysotile only	0.6 (0.3 to 1.2)	0.9 (0.4 to 1.8)	1.5 (0.7 to 3.0)
0.003 f/cc			
Mixed fibers	1.9 (0.9 to 3.7)	13.2 (6.6 to 26.4)	15.1 (7.5 to 30.1)
Chrysotile only	1.9 (0.9 to 3.7)	2.6 (1.3 to 5.3)	4.5 (2.2 to 9.0)

*Refer to original article for model assumptions re: calculation of table entries.

The tripartite descriptor of industrial hygiene has been recognition, evaluation and control. The movement of asbestos concerns from the workplace into the non-occupational environment suggests that we should add "anticipation" to these valuable descriptors of our activities. Anticipation, recognition, evaluation and control should be the future guiding lights of the field.

Recently, EPA issued a proposal to sequentially ban asbestos usage in the United States.[27] Asbestos is a unique and valuable material. Can it be used in certain unique applications at an acceptable level of risk? That is an issue on which we as a profession should sort out our views and make them known. Safety is a relative term; it is acceptable risk.[28] The tools of engineering controls, combined with work practices and personal protective equipment usage can reduce the risk of using potentially toxic materials to a level comparable to other commonplace risks in life. Should we ban a material from usage if it is not a trivial material with numerous substitutes? Asbestos is not in the latter category. The setting of a sequential asbestos ban leading to a total ban will establish a precedent that we, as industrial hygienists, should address publicly as a profession after crystallizing our viewpoint.

Summary

I have traced a personal thirty year journey of involvement with asbestos in the workplace and the nonoccupational environment, one still in progress, in an attempt to extract selected lessons for the industrial hygienist. Lessons for other professions, namely medicine, law and management have been studiously avoided in the interests of the scope of this presentation and permissible time. There are certainly numerous other lessons to contemplate. The movement of asbestos from the occupational to the nonoccupational environment is a case study that will undoubtedly be followed in the future by other potentially toxic materials. We must determine our position as a profession with regard to the tools we utilize, the procedures we follow, and our understanding of our moral and legal obligations to prepare for the often scientifically and technically unsupportable positions assumed by others, including governmental agencies, in their zeal to bring about change. We must discourage the opportunistic distortion of professional practices in these matters, and must issue well considered statements as a profession, statements relevant to the way these matters are addressed by society. We have a responsibility to lend perspective to these issues, to not permit understandably emotional responses to documented past severe health effects in other areas, such as the case of asbestos in the workplace, to carry over into conditions of very low exposures in the public domain. We must remind people of the relevance of dose-response and toxicological principles to assessment of risk. These principles are very much in the professional tradition of Donald Cummings. Perhaps that is what this address is really about, namely a reiteration of principles and an appeal, that as a profession we reassert these principles in order to discourage and thwart their distortion in the marketplace.

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Unfortunately, not a great deal of information exists about the asbestos problem in industrial plants, or on abatement and control methods. Use of the material in industry was similar to that in other facilities. It was applied as insulation on hot or cold water pipes, ducts, boilers, and tanks. It can be found almost anywhere: in kilns in a glass plant, between the corrugated siding and the outer covering on an old building, in gaskets, and in fireproofing and soundproofing materials, to name a few.

Localized occurrences can be handled with a minimum of disturbance to work areas using the established "glove/bag" method. This method involves isolating small portions of asbestos-laden objects — sections of piping, valves, fittings, etc. — with specially designed bags made of polyvinyl chloride, polyethylene, or similar materials.

However, more often the problem is widespread, involving large surfaces such as ceilings, walls, and beams on which asbestos materials have been sprayed or troweled. Asbestos also may be found in materials such as ceiling and floor tiles and wallboard. In general, asbestos-containing materials that have been sprayed or troweled are of the greatest concern, especially if the material is friable. Asbestos in this form is most likely to release fibers into the air and create a hazard.

Abatement Considerations — Ideally, asbestos abatement is performed when no employees are in the plant. At these times, heating, ventilating, and air conditioning systems, which can circulate harmful particles, can be shut down without causing discomfort or interfering with the operation of sensitive electronic equipment. However, in most industries it is impractical to cease operating for asbestos removal. Instead, good planning must be adopted and work areas must be totally isolated. The objective is to assure that as few people as possible are exposed for the shortest possible time to any possible hazards.

This goal may be accomplished in various ways. The work can be done when plant staff levels are lowest, for example, on weekends or holidays, or during vacations, although an asbestos removal contractor might charge premium rates for these times. Even so, it might be more economical to have a contractor work around-the-clock at favorable times than to have the task completed at the expense of production and employee convenience.

When it is not feasible to stop the operation or remove people from the plant, and there is no slack time available for asbestos removal, the most practical solution is to isolate the work from the people. Contaminated areas can be sealed off effectively, but spe-

Glove/bags allow small portions of asbestos-laden objects to be isolated and the fibers removed and handled without any contaminant escaping into the atmosphere. (Courtesy Asbeguard Equipment, Inc., Toronto, Ontario)

cial attention must be paid to the duct system, air shafts, and elevators connected to the asbestos removal zone. In multifloor structures, it is difficult, but not impossible, to seal all particle escape routes. All floor penetrations, including those for pipes and electrical conduits, and any hollow outer walls must be considered.

Once the need to take action on asbestos abatement has been identified, the first step is to select someone to do the job. Many larger plants have inhouse maintenance staffs that, with adequa: :raining and the right equipment, ca : perform the work. Use of an

Two workers wearing dual cartridge, high-efficiency, air-purifying respirators roll up and discard plastic sheeting ·at has covered surr.. es during a removal project. One of the most common errors made by workers in donning protective clothing is wearing respirator headbands over the top of the hoods. They should be worn under the hoods so the contaminated clothing can be discarded before the respirators are removed.

outside contractor also should be considered. In either case, the major issue is whether the group can carry out the project efficiently and safely.

The experience and capabilities of inplant personnel are known, but an outside firm usually is an unknown quantity. The right questions must be asked to make sure the firm selected is at e to handle the job. One guideline is contractor certification, but only some states require it. (Fourteen states have active programs, nine additional states are expected to have them within a year.) It more likely will be necessary to probe the track record of the candidate, including checking references.

Several other points should be investigated. Does the contractor have adequate safety equipment? Are his employees trained to use it? Is he adequately insured? Have any complaints been filed against him by either customers or government agencies? Has he experienced prematurely terminated jobs or incurred cost overruns? Surprises can be unpleasant, and it is best to make sure that quality, not potential trouble, is being purchased.

Regulations and Exposure Limits — Both the contractor and plant safety personnel must be aware of multiple hazards that may exist during an asbestos cleanup. When a plant keeps operating during abatement work, harmful mists or vapors, or dangerous nonasbestos particles, may be generated by normal production processes. Such factors will influence the choice of abatement methods, controls, and protective equipment. Conferences should be held with the contractor and any other personnel involved in the abatement work to discuss the environment and recognize and thwart any hidden hazards in advance.

Determining a safe exposure level for airborne asbestos fibers is extremely difficult. According to one representative of the National Institute for Occupational Safety and Health, there is no safe exposure level because asbestos is a known carcinogen. Government agencies have struggled with, and for the most part disagreed on, a permissible exposure limit (PEL). Therefore, it is generally recommended that those involved in abatement work apply maximum protection, using proper personal protective equipment, especially respirators, and thoroughly training all workers in proper procedures.

Controlling legislation consists of two standards issued by the Occupational Safety and Health Administration, effective July 21, 1986, governing exposures to asbestos, tremolite, anthophyllite, and actinolite. The standards, one for general industry (29 CFR 1910.1001) and one for construction (29 CFR 1926.58), reduce the permissible exposure limit for asbestos to 0.2 fiber (longer than 5 μm) per cubic centimeter of air (f/cc) over an 8 hr workday and based on a 40 hr week. This level is the one many abatement contractors already have established for their employee respiratory programs. The previous limit, set in 1976, was 2 f/cc with a 15 min exposure level of 10 f/cc.

The standards, which have drawn court challenges, set no short-term exposure limit and prohibit the practice of rotating employees in and out of asbestos containing areas. They also have set an action level of 0.1 f/cc. At that exposure level, specific programs for monitoring, worker training, and medical surveillance must be initiated. Employees must be equipped with adequate protective clothing, including coveralls with hoods, gloves, and foot coverings, and be provided with changing rooms and showers. They must receive information and training initially and be retrained and given a medical examination annually.

Areas in which exposure levels might be met or exceeded must be regulated and marked with caution signs. When feasible, negative-pressure enclosures must be established before removal, demolition, or renovation operations begin. If the exposure level cannot be reduced to or below the limit with engineering and work practice controls, the level must be reduced as much as possible and employees equipped with respiratory protection. The exposure of each employee in a regulated area must be monitored daily, except when all employees are equipped with positive pressure, supplied-air respirators. Monitoring also may be discontinued if reliable measurements reveal that employee exposure levels are below the action level.

A worker protected by a full-facepiece supplied-air respirator removes asbestos-containing material from a ceiling. The respirator is equipped with a high-efficiency filter that can, should the air supply be interrupted, provide a backup system that allows the worker to disconnect from the air line and leave the area safely.

The primary source of protection for workers involved in asbestos abatement activities is respirators. The type of unit selected is based on the airborne concentration of asbestos fibers. For exposures up to 10 times the PEL, negative-pressure, half-mask air-purifying respirators with high-efficiency filters may be used. A high-efficiency filter is at least 99.97 percent efficient against monodispersed particles of 0.3 μm or larger. Full-facepiece air purifying respirators equipped with high-efficiency filters may be used for exposures up to 50 times the PEL because they generally provide a better fit than half-mask units and incorporate eye protection. Negative-pressure respirators must be fit tested on the user initially and checked at least every 6 mo thereafter.

A powered air-purifying or constant-flow supplied-air respirator is required for exposures between 50 and 100 times the PEL. A powered air-purifying unit is equipped with high-efficiency filters and a battery-powered air blower pack worn by the user. For exposures between 100 and 1000 times the PEL, full-facepiece supplied-air respirators operated in the pressure-demand mode are necessary.

For exposures to concentrations greater than 1000 times the PEL, or if the concentration is unknown, the user must be protected with a full-facepiece supplied-air respirator operated in the pressure-demand mode and equipped with an auxiliary positive-pressure self-contained breathing apparatus. These combination units consist of a pressure-demand supplied-air respirator and a small compressed-air cylinder. If the airflow to the supplied-air hose is reduced or cut off, the user can switch from the supplied-air respirator to the cylinder instantly.

Continuous-flow supplied-air respirators, including hoods, supply a constant flow of air to the facepiece. Pressure-demand supplied-air respirators have a mask or belt-mounted regulator that supplies air on demand while maintaining a positive pressure inside the facepiece. Pressure-demand respirators may be operated from an air cylinder or cascade system or from an air compressor system that provides Grade D air, but not with powered air pumps.

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Workers with facial hair or conditions that interfere with the seal of a tight-fitting facepiece should use air-supplied hoods. Hoods equipped with a powered air pump or compressed-air system provide respiratory protection and allow communication.

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The lack of specific information about asbestos abatement makes advance planning imperative. Employee understanding is a must to avert any possible hysteria. As long as controversy about asbestos exists, contractors and employers must be extremely careful to safeguard employee health.

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Quite a mess of oil, isn't it?

Now you've got to stop whatever you're doing and start cleaning up the whole mess.

But wait. Before you start pouring clay all over the place, let us explain why you shouldn't. And don't need to.

Clay doesn't really absorb much of anything.

That's why you need so much of it. And why oil slips right past it. And why it's such a pain to clean up messes with it.

Clay also happens to be a particularly nasty substance around anything except cats. It's hard and gritty. So it can go right through your machine's oil seals and couplings, creating more leaks, drips and spills and the need for more clay.

Clay leaks.

Pigs don't.

Discouraging, isn't it?

Now for the good news.

You can stop using clay. And start feeding your messes to our pigs.

Actually, what you do is wrap a PIG® around the machine making the mess. Or around a spill. And that pig will suck up to a half gallon of oil in just minutes.

Why, that's faster than any human could drink it.

And, unlike clay which has to be trucked to a landfill, when our pig has picked up the whole mess, you just pick up the pig and throw it in an incinerator.* Just like that.

But wait, there's more.

Besides pigs for spills and leaks, we also have Pig Pans for drips. And Haz Mat Pigs for acids, caustics and other hazardous materials. All of which do the same incredible job, the same incredible way.

We know our pigs are the best way to clean up all your messes. But you don't. That's why we're backing our pigs

Pigs literally suck up oil.

Clay just sits there.

*Pigs must be disposed of in compliance with local state and federal regulations
PIG® is a registered trademark of New Pig Corporation
Patent Pending

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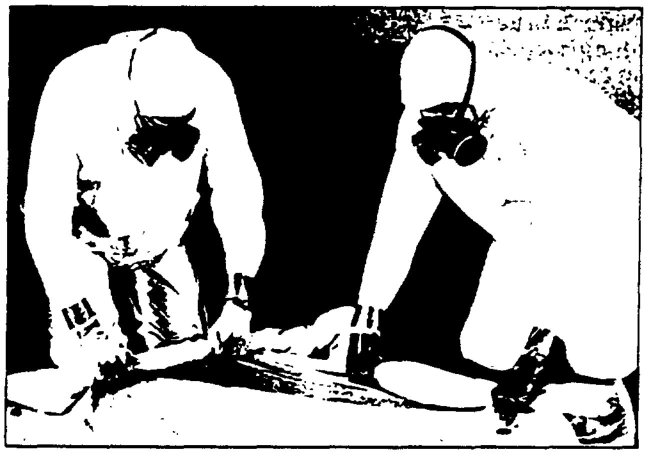

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Another Good
Article on Asbestos
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Asbestos: menace in the boiler room

) avoid the tragedies from asbestos related :seases, HVAC workers should have a full ıderstanding of asbestos and how to deal with it

DANIEL CULBERG,
resident,
rand Asbestos Control Co.,
ark Ridge, Ill.

Since the mid 1970s, concern for asbestos related health problems has focused on those who worked directly with asbestos. More recently, however, the focus has shifted to people who work in any environment where asbestos may be present. HVAC workers fall into both categories.

The Environmental Protection Agency has reported that while cancer risk from asbestos for people in an urban environment is one in 10,000, the risk for highly exposed construction workers is one in 10.

The accuracy of such risk projections and what constitutes "high exposure" can of course be questioned, particularly since experts are far from agreement on what constitutes a dangerous level of exposure. There are documented cases of death resulting from only incidental exposure to asbestos. At the other end of the spectrum, research in an asbestos mining town where the air is laden with asbestos particles showed that this posed no significant health problem.

However, what is indisputable is the fact that workers continue to die from asbestos related diseases. Currently, more than 8000 die each year, and by the year 2000, scientists believe that figure will reach 10,000 a year.

Unfortunately, HVAC workers find themselves full-square in the middle of this controversy. It has been over a decade since workers installed asbestos insulation on and around HVAC systems. But most of what they did install remains in place, endangering the health of those who now must repair and maintain those systems.

To avoid a repeat of the tragedy that befell those who installed asbestos containing materials, today's HVAC worker should have a full understanding of the issues surrounding asbestos, what it is, where it's found, when it is dangerous, and how it should be dealt with.

What is asbestos?

Asbestos is a generic term for a group of naturally occurring fibrous minerals. Asbestos is virtually indestructible. When separated or broken down, even to its molecular level, asbestos remains an extremely tough fiber. This characteristic is asbestos' greatest attribute—and its tragic flaw.

Asbestos is mined all over the world and is found primarily in Canada, the Soviet Union, Australia, and South Africa. There are five major types of asbestos:

- Chrysotile (white asbestos).
- Crocidolite (blue asbestos).
- Amosite (brown asbestos).
- Anthrophyllite.
- Tremolite.

Historians trace the first use of asbestos back to the 5th century BC when it was used as lamp wick. Touted as the miracle fiber of the 20th century, its mechanical strength, fire resistance, flexibility, and good wear characteristics made asbestos the mineral of choice in a wide variety of products from construction materials to clothing.

Asbestos was used commercially as fireproofing as early as the 1890s. The use of asbestos in insulation materials began in England early in the 1900s and continued through the mid 1970s in the United States.

At the height of its popularity, more than 3000 commercial applications of asbestos were in use. Its low cost and the ease with which it can be mixed with binders and spray applied created applications for millions and millions of tons of the mineral.

Asbestos' ability to be woven into thread or cloth made asbestos popular in fire resistant clothing, curtains, and draperies. Its fire and heat resistant properties provided innumerable uses for asbestos as an extremely versatile building material. It is believed that at least one asbestos containing product can be found in virtually every building constructed from 1900 to the mid 1970s.

Promise turns to disaster

The promise of this "miracle fiber" turned to disaster after nearly 100 years of modern use when in the mid 1970s asbestos was proved to be a cancer causing agent.

While the useful properties of asbestos were known for centuries, it was not until the early 1900s that asbestos became suspect as a potential health hazard. Early warnings of asbestos related health hazards in the workplace focused on the British textile industry where heavy concentrations of asbestos-laden airborne dust were common.

The first connection between asbestos dust and disease was published in a British medical journal in 1906, and in 1924 the first known case of asbestosis (a lung disease) was documented. In 1930, Dr. E. R. A. Merewether, a British government factory inspector, published a study that solidified the relationship between disease and heavy concentrations of asbestos dust in textile plants.

Heavy concentrations of dust, as opposed to asbestos itself, seemed to be the culprit. As a result, in 1931 regulations were put in place to increase ventilation and thereby decrease visually obvious dust in the environment. As yet, no direct connection between asbestos and cancer was made.

By the late 1930s, a correlation between asbestos and disease was also established by medical researchers in the United States. But again, the problem was considered an occupational hazard that could be controlled by controlling the levels of dust in the manufacturing environment.

This assessment of the problem was supported in a 1945 study of pipe insulation/covering operations that concluded that this operation was relatively safe. However, subjects of the study had been at their jobs less than 10 years whereas asbestosis symptoms take 10 to 20 years to become apparent.

Table 1—Types of asbestos most commonly used.

Chrysotile	Amosite	Crocidolite
White asbestos	Brown asbestos	Blue asbestos
90% of usage	Coarse, good	High tensile strength
High tensile strength	Good acid resistance	Acid resistant
Good overall workability	Less flexible and workable than chrysotile	Low resistance to heat
Used in fireproofing and insulating materials	Used principally in high temperature products	Good flexibility and fair workability

It was not until 1965 that a true link between asbestos and cancer was established. In that year, Dr. Irving Selikoff studied over 1500 insulation workers who had been at the trade for a significant length of time. Selikoff found that of workers with more than 40 years in the industry, more than 90 percent had asbestosis related medical problems. The real scope and magnitude of the problem were beginning to be recognized.

Since that time, asbestos has been identified as one of only eight known naturally occurring cancer causing agents. All five types of asbestos can cause cancer. There is no "safe" type of asbestos.

Table 2—Categories of asbestos containing materials.

Friable materials are those that can be crumbled, pulverized, or reduced to powder in the hand, readily releasing fibers with minimal mechanical disturbance.

Friable	Nonfriable
Sprayed-on fireproofing	Cementitious products
Thermal insulation	Paper products
Textiles	Roofing felts

The regulatory environment

By 1973, the government moved to ban asbestos containing materials from new construction. In that year, the EPA Clean Air Act prohibited spraying of asbestos containing materials. In 1975, all asbestos was banned from use in pipe, boiler, and other types of thermal insulation.

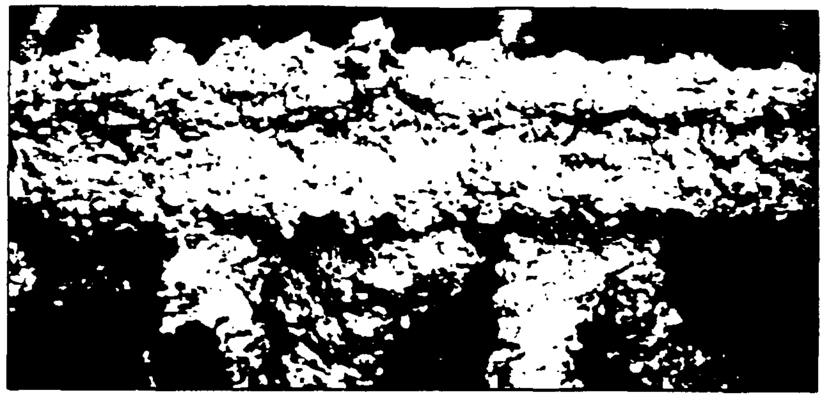
In 1976, Occupational Safety and Health Administration (OSHA) standards mandated removal for applications where asbestos fibers 5μ or longer were present in the atmosphere with a density of two fibers per cu cm or greater. Recently, allowable limits were reduced to 0.2 fibers per cu cm.

These two agencies, OSHA and the EPA, are in the forefront of regulation regarding asbestos control. OSHA regulates exposure to asbestos in the workplace, and the EPA regulates the use, removal, and disposal of materials containing asbestos under authority of the Clean Air Act and Toxic Substances Control Act.

EPA regulations focus primarily on applying and removing asbestos-containing materials in new or remodeled buildings and on identifying friable asbestos in schools.

There are no federal requirements mandating tests to determine asbestos levels in commercial buildings unless building renovation or asbestos removal is planned.

When renovation or removal is planned, EPA regulations call for filing notice with the agency's regional office and sometimes the state if more than 260 ft of asbestos pipe insulation or 160 sq ft of asbestos surfacing material will be removed. The notice must name the building's owners, location, and description; how the removal will be done; and where the asbestos will be disposed.



Asbestos insulation on piping and ductwork is hazardous in a friable condition when it can be crumbled or reduced to powder by hand pressure alone.

When problematic asbestos is identified in a building or renovation is planned, the federal standards governing asbestos control are lengthy, detailed, and quite specific. Also, many states are establishing or strengthening existing training and enforcement programs for asbestos removal. Fourteen states have certification programs, and 15 others have bills pending in their legislatures. A dozen states already have licensing and training requirements for asbestos removal contractors, although only four of these have been in force for over a year.

When it is dangerous

Asbestos is virtually everywhere: in auto brake linings, in electric hair dryers, and in nearly every building constructed from 1900 to the mid 1970s.

Asbestos-containing materials are found on ceilings, walls, and structural beams where they were sprayed or trowled on. Asbestos is also common as insulation around hot or cold pipes, ducts, boilers, and tanks. It is also found in many building materials such as tile and wallboard.

Sprayed-on asbestos and asbestos in pipe insulation are of greatest concern to the owners of commercial/industrial buildings and the people who service their HVAC systems. It is in these applications that asbestos is most often in a dangerous state.

Asbestos is dangerous only when it is "friable," that is, old and crumbling. In its friable state, asbestos can be crumbled, pulverized, and reduced to powder in the hand. Friable asbestos does not have to be visible as airborne dust to be dangerous. Minimal disturbance releases microscopic asbestos particles into the air that are so light they may take days to settle.

Asbestos-containing materials that are usually considered nonfriable include cementitious products, paper products, and roofing felts. Categories of materials that are likely to become friable with time include sprayed-on fireproofing, textiles, and all types of asbestos-containing insulation.

Experts agree conservatively that 1 million tons of friable asbestos materials are in schools, shops, offices, and industrial buildings as thermal and acoustic insulation. It has been estimated that 21 million living Americans have been exposed to asbestos in the workplace.

Routine activity, including the installation of phone lines, HVAC system work, and general maintenance, can free asbestos into the air, endangering workers and building occupants. Dangerous amounts of asbestos can also be freed into the atmosphere in and around a building during renovation and related construction.

Asbestos fibers have the tensile strength of steel and are sharper than fine needles. Asbestos particles are microscopic in size; it would take as many as 1 million fibers laid side-by-side to measure just 1 in.

When these fibrils escape into the air, they are easily inhaled or swallowed. Asbestos fibers that are inhaled and enter the lungs stay there for life. They may also enter the blood stream or the lymphatic system where they are transported throughout the body.

Asbestos has been linked to asbestosis; cancers of the lung, esophagus, stomach, colon, and other organs; and mesothelioma, a cancer of the chest and abdominal lining that is extremely rare except when asbestos is involved.

Respiratory protection is standard equipment for workers to prevent the inhalation or ingestion of hazardous asbestos fibers.

Asbestos ranks second as the leading cause of cancer. Only cigarettes rank higher. Asbestos related cancer is usually inoperable as cancer cells cluster around microscopic asbestos fibers that lodge throughout the system. As a result, it is almost always incurable. More than 100,000 workers have died as a result of installing asbestos years ago. Leading experts on the subject project at least an additional 300,000 deaths from asbestos related cancer in the next 25 years.

The dilemma

The asbestos abatement industry is headed for increasing attention because of strict state and federal legislation on the books and in the wings. In addition, record court awarded settlements of asbestos related lawsuits and the documented health hazards of asbestos are creating greater public awareness of the problem.

Commercial buildings built before 1973 suffer an added penalty. Mortgage lenders, investors, insurers, and potential tenants are growing hesitant to become involved in buildings that contain asbestos. The result is potential economic liabilities for owners and managers of these buildings.

For commercial building owners and managers, the asbestos dilemma assumes two dimensions, safety and economics, both compounded by the lack of qualified people who can help. Up to 75 percent of all asbestos related projects are done improperly, according to estimates of industry experts and federal agencies. Federal and state agencies cited more than 1300 violations last year.

Most industry observers agree that the high incidence of poor workmanship in asbestos abatement stems from several factors. Among them are the lack of training, the "quick buck" artists who entered the business, and the tendency of building owners to accept the lowest bid for removal. This obviously has serious implications for the health and safety of the work crews but also for those surrounding the work area.

With large asbestos control contracts at stake for renovation of commercial and industrial buildings, many contracting firms are vying for success in asbestos abatement. While there are many reputable, experienced, and qualified firms in the business, the concern over asbestos related issues has spawned numerous "opportunistic" newcomers.

Many of these firms are undercapitalized, staffed with untrained people, uninsured or underinsured, and generally ill-equipped to do a safe, competent job of asbestos control or abatement.

For some of them, the path to contracts is the low bid. But for their clients, that path could lead to health dangers, lawsuits, and economic disaster. It's easy to take shortcuts on an asbestos removal project. Since health effects of shoddy practices may not show up for decades, it is sometimes difficult to know exactly when or how the poor work was done when it is less than obvious.

The work of unqualified contractors has given rise to many horror stories about inept and dangerous practices. For example, workers have been seen gathering up asbestos debris with brooms "the way you clean up your garage," an EPA official told the *Wall Street Journal.*

In another example, asbestos-coated workers tramped into a building cafeteria for lunch, exposing the diners, cafeteria personnel, and the food to significant hazard, not to mention the danger the asbestos workers themselves were courting.

How to identify asbestos

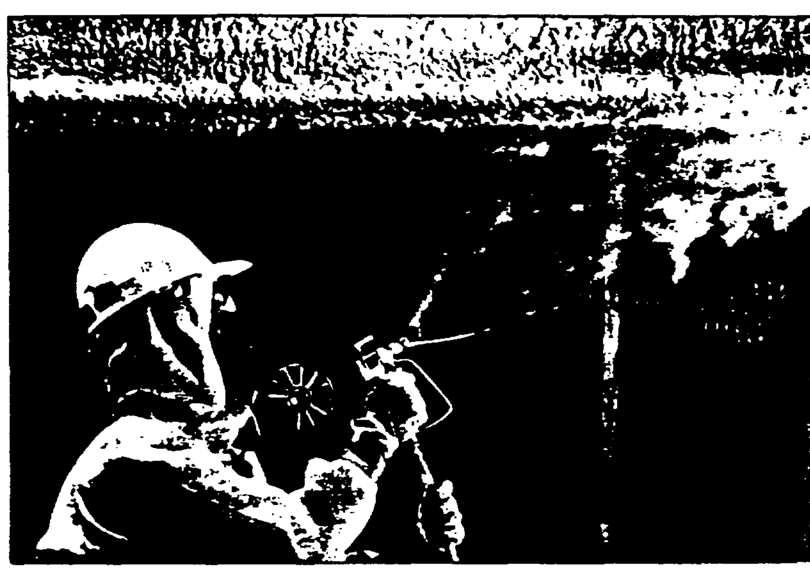
All sprayed-on fireproofing and insulation materials used prior to the early 1970s have a good chance of containing some type of asbestos. Sprayed-on fireproofing is usually found on ceilings and/or above suspended ceilings in all types of buildings. Thermal insulation products such as steam and cold water piping and boiler insulation are found in many commercial and industrial buildings.

The insurance environment

The hesitancy shown by many owners of older buildings to renovate, by lending institutions to finance, and by insurers to cover the work is due in no small part to the ever present possibility that some day liability claims for asbestos related illnesses may be filed.

Adding to that concern is the way all insurers are now writing liability policies. Major changes in the industry in recent years have been triggered by the hundreds of millions of dollars paid to settle asbestos related claims on policies 30 or 40 years old. By one estimate, asbestos related settlements could cost insurance companies up to $87 billion in payouts over the next several decades.

This has led to a big difference in the types of policies insurers are now writing. The insurance industry is shifting from the long-term liability coverages of "occurrence" type policies to short-term "claims



Well protected, well trained technician applying wetting agent to asbestos prior to removal.

Scraping sprayed-on asbestos from walls and ceiling beams.

made" type policies.

The claims made policy has become the policy of choice for insurance companies because the insurers are responsible only for defense and payment of claims filed during the short-term period while the policy is in force. A claims made policy will not cover claims for injuries or damages filed after the policy has expired—even if the injury or damage took place during the policy period.

Under the terms of an occurrence policy, the insurer pays claims for all injuries and property damage occurring during the policy period. The big advantage to policy holders is that once the policy is written, claims can be made at any time afterward. These policies cover acts, errors, and omissions that occur during the policy period. The insurer is responsible for paying claims at any time in the future following an "occurrence"—even after the policy is no longer in force.

The difference between the two types of insurance coverage is of particular significance considering that asbestos related illnesses typically take up to 40 years or more to manifest themselves.

Simply put, insurance experts agree that occurrence type insurance affords adequate protection while claims made insurance does not.

As this whole issue becomes more volatile, additional changes will occur in the types and amounts of insurance available. The insurance industry will continue to minimize its long-term liability by decreasing coverages in policies. This will increase the asbestos removal contractors' (and their customers') future business related risks.

It is, therefore, of paramount importance for the customer to deal with large, well managed, financially stable asbestos abatement contractors. When there are only a few companies left who can obtain occurrence type insurance coverage, it will be this kind of firm that will have it.

Abatement, the first step

The first step in an asbestos abatement program is risk analysis. Whether the asbestos in a given building is contaminating the environment and posing a real danger can be determined only by an on-site audit.

While most HVAC workers can probably recognize and identify asbestos, this work is best performed by an experienced and qualified registered industrial hygienist or abatement professional. These people will collect samples of suspected asbestos in a manner that will not disturb surrounding materials and send them to an independent laboratory for analysis.

While any HVAC worker can collect samples, the danger of the worker being exposed or unnecessarily releasing asbestos fibers into the air while collecting samples is great. Also, a hygienist or other competent professional will know of the best independent laboratories for testing.

Once it has been determined that asbestos is present, four factors should be considered prior to deciding what, if anything, should be done about it. These four factors are damage, friability, location, and air movement.

Asbestos causes little concern if it is in perfect condition. If asbestos is found in good condition, leave it alone! However, if the asbestos has been frayed or damaged, it should be either removed or contained.

Asbestos also poses a problem when it is located where it may be disturbed by building occupants, maintenance personnel, or the vibration of machinery or building activity. Air movement around friable asbestos is extremely problematic. Microscopic particles of asbestos are easily transported by the slightest draft or air movement.

Considering that significant amounts of asbestos were originally installed as insulation for HVAC components, the danger of friable asbestos entering the HVAC system and circulating throughout an entire building is great.

When asbestos is determined to be problematic by virtue of damage, friability, location, or air movement, an abatement program is in order. Asbestos abatement can constitute one or more of three basic abatement methods: removal, enclosure, or encapsulation.

The choice among all three techniques depends on the condition of the asbestos-containing material; *i.e.*, whether is is rated as good, showing minor damage, or poor. Removal is generally perceived to be the most desirable choice since the other alternatives are considered temporary.

Removal can cost anywhere from $10 to $25 per sq ft, a high price in a multi-million sq ft building. Two somewhat lower priced alternatives for asbestos abatement are enclosure and encapsulation.

Enclosure involves construction of airtight drywalls around the material. Encapsulation is achieved by spraying the material with a sealant. Neither is recommended when dealing with highly friable asbestos. In this case, proper and safe removal is the preferred method for eliminating this imminent health hazard.

Selecting an abatement firm

Once a decision is reached that asbestos abatement—removal, enclosure, or encapsulation—is needed, the next step is to select a qualified firm to do the work. That is not as simple as it may seem.

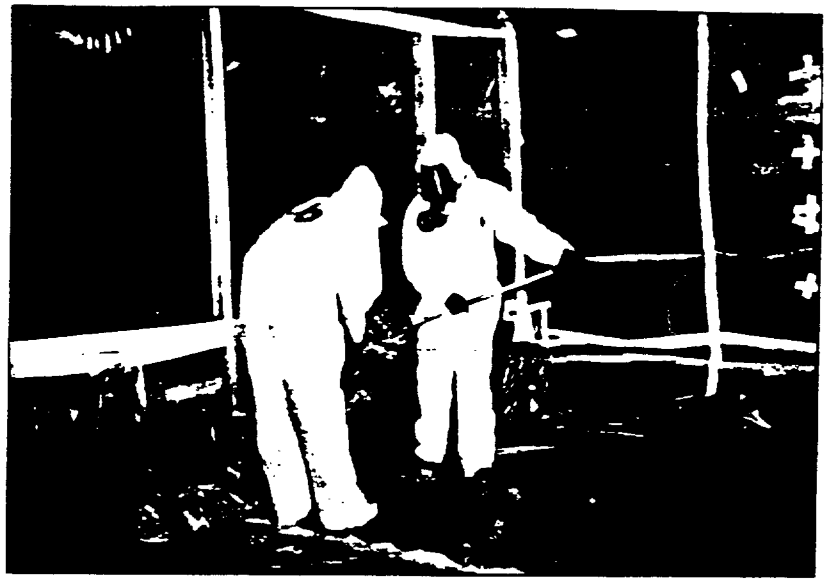
It's not just a matter of looking in the *Yellow Pages*, asking a few firms for bids, and then choosing the lowest. In fact, that may be the worst way.

There are, unfortunately, some firms that will low ball a job, bidding their work at break even or below, merely to gain experience and to train people. Too often, however, they find the project quickly becomes unprofitable. So they seek additional contracts, again low balling their bids. Then, to make up for unsatisfactory profit margins, the shortcuts and slipshod and unsafe work begin.

To avoid this scenario, an approach in pricing asbestos abatement projects that is growing in popularity is price negotiation as opposed to contract bidding.

Larger, more reputable firms are willing to work at a negotiated price. The privacy of negotiations also preserves the confidentiality of a project if necessary. Letting out bids, on the other hand, is a good way to tell the world that a building may have an asbestos related problem.

The key is to identify a competent organization with a successful track record in asbestos abatement—one that has mastered practices approved by regulatory agencies to ensure the safety of tenants, the workers on the job site, and the surrounding environment.



Cleanup of asbestos debris. All work is carried out within containment to prevent the release of asbestos fibers to the surrounding environment.

Preliminary packaging of asbestos debris prior to final packaging and shipment to EPA approved waste sites.

The movement toward increasingly sophisticated and expensive asbestos abatement equipment is expected to knock smaller, less reputable firms out of the business. OSHA and industry leaders, for example, are backing more routine use of Type C equipment, which through a remote air system continually creates a negative air pressure in the containment area, thereby preventing breaches and providing maximum protection to workers inside.

Compared to half-masks and personal battery powered air packs, this type of equipment is the cream of the crop and an expensive investment. Asbestos control firms must be well capitalized and intend to stay in the business to purchase this equipment. And operators must be extremely well trained to use it.

Weeding out the less than competent contractors can still be tricky business. There are several screening criteria that can be applied to find the good ones.

• *Insurance*—With the changes taking place in the insurance industry concerning liability coverage (*i.e.*, the trend toward writing short-term claims made vs. long-term occurrence policies), a copy of the contractor's certificate of insurance should be part of the bid package. Sharp building owners and managers have also begun asking for a notarized letter from the contractor's insurance broker stating that the contents of the insurance certificate are in fact authentic and current.

The client should ask how much and what kind of insurance the contractor carries. Since occurrence type policies offer the best protection and since they are hard to get, only the large, well managed, and financially stable companies can qualify.

- *Performance bonding*—Because of the enormous risk that asbestos lawsuits pose, asbestos abatement firms should be bondable for large projects, and the bond should be backed by the U.S. Treasury. Large, well capitalized, stable firms with a minimum net worth of at least $5 million are the safest partners when undertaking an asbestos abatement program. These are the companies that will remain solvent and continue in business should liabilities arise.
- *Training*—The contractor's asbestos removal personnel must be thoroughly trained, with dangers clearly outlined to them, protective and safety measures presented and explained, and workers tested as to how well they learned. Moreover, on-the-job training and retraining should take place as well as classroom instruction.
- *Safety of contractor employees*—In addition, the responsible firm does not employ smokers or permit bearded workers on asbestos jobs. Studies have proved that a smoker's chances of developing lung cancer are many times greater than a nonsmoker's. Beards prevent proper respirator fit. Respirators should be approved by the National Institute of Occupational Safety and Health, and full body protective clothing, eye protection, headgear, and footwear should also be used.
- *Referrals*—References should be checked for all prospective contractors. Some things to ask: How big a job was it? Was it done professionally, on time, and within budget? What kind of air and bulk sampling were done? Were proper authorities involved as required? Were project management and worker safety and training satisfactory?

Other criteria include the use of insured waste haulers and EPA approved dump sites, the ability to render 24 hr emergency services, third party verification of compliance with federal and other guidelines, and the contractor's ability to perform confidentially.

The hitch

Where problematic asbestos is identified, it must be dealt with; that's the law. However, there is as yet no federal directive requiring asbestos audits, monitoring, or testing in commercial or industrial buildings unless renovation is planned. For that matter, it is not even required that owners determine whether a building has asbestos-containing materials.

How then can HVAC workers, or any employee, protect themselves from this menace? The answer is found in OSHA's Occupational Safety and Health Act.

OSHA's Occupational Safety and Health Act includes a general clause that mandates that employers must provide a safe workplace for all employees. In addition to this general clause, OSHA has a number of specific standards for particular toxic substances, including asbestos.

An employee may not be exposed to over 0.2 fibers of asbestos per cu cm of air averaged over an 8 hr day. In addition, OSHA has specified an "action level" of 0.1 fibers per cu cm of air averaged over 8 hr. If this level is exceeded, employers must begin air monitoring, employee training, and medical surveillance.

Wetdown procedures and ventilation methods can be attempted to comply with the limit. If these fail to reduce the exposure level to within the standard, respirators must be worn. Employees must also be provided with protective clothing and a changing room.

OSHA also stipulates that warning signs and labels must be used in asbestos work areas and on waste disposal containers. In addition, employers must monitor the exposure level and maintain records.

Protecting yourself

Asbestos abatement is serious and dangerous work—too serious and too dangerous to ever be considered as part of HVAC work. Once asbestos enters the lungs, it stays there forever. While no minimum dangerous exposure to asbestos has been established, once may be enough.

HVAC workers who smoke should never work around asbestos. Smoking and asbestos have a synergistic effect on increasing the risk of cancer. Experienced asbestos abatement contractors have a policy of not hiring smokers because it has been shown that smokers are 50 to 90 times more susceptible to asbestos related lung cancer than nonsmokers. The message to others who work in areas where asbestos may be present is clear.

In addition, HVAC workers with beards should not attempt to work near asbestos even while wearing respirators. Beards prevent proper fitting of respirators.

As a final caution, it is an unfortunate fact that many years ago HVAC workers installed asbestos, worked near the installation of asbestos, or handled asbestos in the course of routine work and thus were exposed to its dangerous effects. Do not repeat this exposure by working on or around asbestos removal.

First line of defense

The first line of defense in preventing asbestos related health problems is awareness—awareness of the issues, of what asbestos is, where it's found, when it is dangerous, and how it should be dealt with.

Other than building owners and managers themselves, HVAC engineers, supervisors, and workers are in the forefront of asbestos detection. While building owners and managers have a moral, ethical, and legal obligation to protect employees, it is HVAC engineers, supervisors, and workers who are coming into contact with asbestos in the course of day-to-day operations. It therefore rests to a great extent upon these people to develop awareness and bring potentially problematic asbestos situations to the attention of management.

HVAC engineers and supervisors in particular should seek the knowledge and information necessary to become well educated on all issues related to asbestos. Building owners and managers must take the initiative to protect employees, but they depend on their HVAC engineers and supervisors to recognize that a problem may exist that must be dealt with.

Where obviously problematic asbestos exists, HVAC engineers and supervisors must work with management to find competent people to bring the situation under control. Where asbestos is identified but apparently in a good nonfriable state, HVAC engineers should work with management to develop a systematic program of monitoring the situation.

In either case, any and all physical contact with asbestos should be performed only by competent professionals in the asbestos control industry.

The asbestos problem did not develop overnight, and it is likely to be with us for generations to come. Whether the future of the asbestos problem is to be defined in terms of sensible, clear headed action or by more needless human tragedy depends on how willing we are to educate ourselves and act responsibly based on that knowledge. Ω