[redacted] W. Wolter

Am Ind Hyg Assoc J 47(8):497-504 (1986)

Non-Occupational Exposure to Asbestos in Buildings: A Practical Risk Management Program

JEFFREY MARK PAULL, MORTON CORN, PETER S.J. LEES and PATRICK N. BREYSSE
Department of Environmental Health Sciences, School of Hygiene and Public Health, The Johns Hopkins University, 615 N. Wolfe Street, Baltimore, MD 21205

Current federal regulations do not address non-occupational exposure to asbestos. In the absence of such regulations, if asbestos-containing materials are present in a building, it is advisable to develop a management program to ensure that the inhalation risk to building occupants does not increase with time and that appropriate steps are taken during activities which have the potential to release asbestos fibers to air. When numerous areas of a building contain asbestos, priorities must be established for selecting and implementing appropriate surveillance or interventions for control. We present a framework for implementing an Asbestos Risk Management Program, the primary objective of which is to minimize the risk of employee and public exposure to asbestos in air. The program includes a decision framework for evaluating and ranking building areas according to the asbestos fiber release potential, and assigns priorities for control interventions. Another decision framework is presented for selecting an air monitoring strategy and for making appropriate decisions based upon measured airborne fiber concentrations. Procedures are included for minimizing employee exposure, operating a maintenance permit system and maintaining an episode response plan. Procedures for employee education and training, medical surveillance programs, asbestos monitoring and record-keeping also are presented.

Introduction

The Environmental Protection Agency (EPA) has estimated that approximately 733,000 (20%) of all government, residential, and private nonresidential buildings in the U.S. contain some type of friable asbestos-containing material — sprayed-on or troweled-on material or pipe or boiler insulation.[1]

Although EPA regulations restrict the use of asbestos in new buildings, specify work practices during removal of asbestos from existing buildings and require the identification of asbestos in schools,[2,3] regulations have not been promulgated by the federal government regarding asbestos exposure in non-occupational environments. Several states, including Rhode Island, Maryland, New Jersey and Massachusetts, have adopted a "clearance" standard of either 0.01 fiber/cc or 0.1 fiber/cc for airborne fiber concentrations in buildings following asbestos removal.*

For the occupational environment, the Occupational Safety and Health Administration (OSHA) specifies standards for worker exposure to asbestos.[4] The application of these standards to non-occupational environments is inappropriate for several reasons, including the following:

1) The current OSHA asbestos standard was designed to protect workers, not the general public;
2) The permissible exposure limit adopted as part of the standard was established to protect workers by reducing the risk of incurring asbestosis; it does not address or consider the risks of bronchogenic cancer or mesothelioma, although reduction of exposure reduces these risks; and
3) The measurement technique for analysis of airborne asbestos fibers specified by the OSHA standard cannot distinguish between asbestos and non-asbestos fibers.

This situation has engendered uncertainty on the part of building managers regarding those circumstances when asbestos-containing materials should be of concern to building occupants, and how to manage any risk they may pose.

The purpose of this paper is to present a set of operational guidelines for the management of health risk in buildings and other indoor environments where non-occupational exposure to asbestos may occur.

The concentration of asbestos in the air of buildings varies with the nature of the application of the asbestos-containing material, its condition and a host of other factors such as building activity and airflow patterns; however, within this context it is known that asbestos concentrations in non-occupational settings are far below those of occupational environments.

Non-occupational settings such as residential buildings, offices and schools containing asbestiform materials have been associated with airborne asbestos fiber concentrations in the range of 0.00006 to 0.004 fiber/cc (>5 μm in length). Outdoor concentrations are generally lower than indoor, with these airborne fiber concentrations in the range of 0.00002 to 0.00075 fiber/cc. Airborne asbestos concentration ranges and median values for outdoor, indoor, and occupational environments are summarized in Table I.[5]

At present, it is not possible to relate effects from exposure to low airborne concentrations of asbestos in office buildings, public buildings or schools directly to the manifestations

*For example, see Rhode Island Act #6260 relating to Asbestos Abatement, adopted 1985.

TABLE I
Summary of Environmental Asbestos Exposure Levels[A]

Type of Environmental Exposure	Measured Concentration (ng/m^3)		Equivalent Concentration (fibers/cc)[B]	
	Range	Median	Range	Median
Outdoor, Urban	0.7 - 22.5	2.1	0.00002 - 0.00075	0.00007
Indoor, Asbestos-Containing Materials Present	1.8 - 121.5	18.0	0.00006 - 0.004	0.0006
Occupational	3 000 - 30 000[C]	15 000[D]	0.1 - 1.0	0.5[D]

[A]Adapted from National Research Council, National Academy of Sciences (Ref. 6).
[B]Based on conversion factor of 30 $\mu g/m^3$ = 1 fiber/cc (> 5 μm length).
[C]Highly variable and dependent on fiber size resulting from particular industrial process.
[D]Median concentration levels for occupational exposures estimated from the average concentration range in fibers/cc.

of asbestos disease associated with earlier exposures to much higher concentrations of asbestos in air in the workplace. Therefore, all estimates of the possible impact of asbestos exposure in non-occupational environments, such as those of the National Research Council,[5] the Occupational Safety and Health Administration[6] and the Canadian Province of Ontario Royal Commission[7] are predicated on the assumption that the same effects, with proportionately lower incidence, will occur to those exposed to asbestos at lower concentrations in air as occurred to those exposed at higher workplace concentrations. The estimates of risk for non-occupational exposures are derived by linearly extrapolating downward the dose/response curve derived from earlier, high exposures of asbestos workers.

Asbestos Risk Management Program

Administration of the Program

It is advisable to establish an effective asbestos risk management program in facilities where asbestos is present to assure that asbestos exposures of employees and the general public are minimized or avoided.

The complexities in the development and implementation of such a program require that a qualified safety and health professional be designated to serve as the Asbestos Control Program Manager (ACPM). The responsibilities of the ACPM include the following:

1) Developing scope and funding requirements for the program;
2) Selecting appropriate technical experts and health professionals to administer the program;
3) Training and supervising control program staff and providing for education of employees;
4) Identifying, labeling and evaluating potential asbestos hazards;
5) Determining abatement priorities, if deemed necessary, and implementing ingredients of a short- or long-term control program;
6) Evaluating the alternative options of abatement or leaving in place, and selecting qualified contractors to perform abatement, if it is necessary;
7) Identifying employees to be included in a medical surveillance program; and
8) Implementing a comprehensive recordkeeping and reporting system.

Effective planning and coordination of each of these activities by the ACPM are essential if the asbestos risk management program is to be successful.

Assessing the Degree of Potential Hazard

Figure 1 is a decision matrix for evaluating and prioritizing asbestos in buildings, if it is present. Determining its presence or absence is the first step in the decision-making process. Several sequential survey activities are performed, including the determination of the following:

1) The location(s) of the asbestos;
2) The condition of the asbestos;
3) The number of persons potentially exposed to the asbestos; and
4) The concentrations of asbestos fibers in the air.

A comprehensive survey of the presence of suspected asbestos-containing materials is performed first. The presence of asbestos, its type, and percentage content are determined by laboratory analysis of bulk samples of the materials. Then a complete inventory of all asbestos-containing materials in an area or building is prepared.

Qualitative Evaluation Procedure

Once the location(s) and amount(s) of asbestiform materials have been determined (Step 1), each area containing these materials then is evaluated qualitatively with regard to the condition of the asbestos (Step 2). The number of persons potentially exposed and their duration of exposure are then determined (Step 3). These three steps provide information for estimating the fiber release potential of the asbestos and the potential exposure of building occupants to asbestos.

10003252

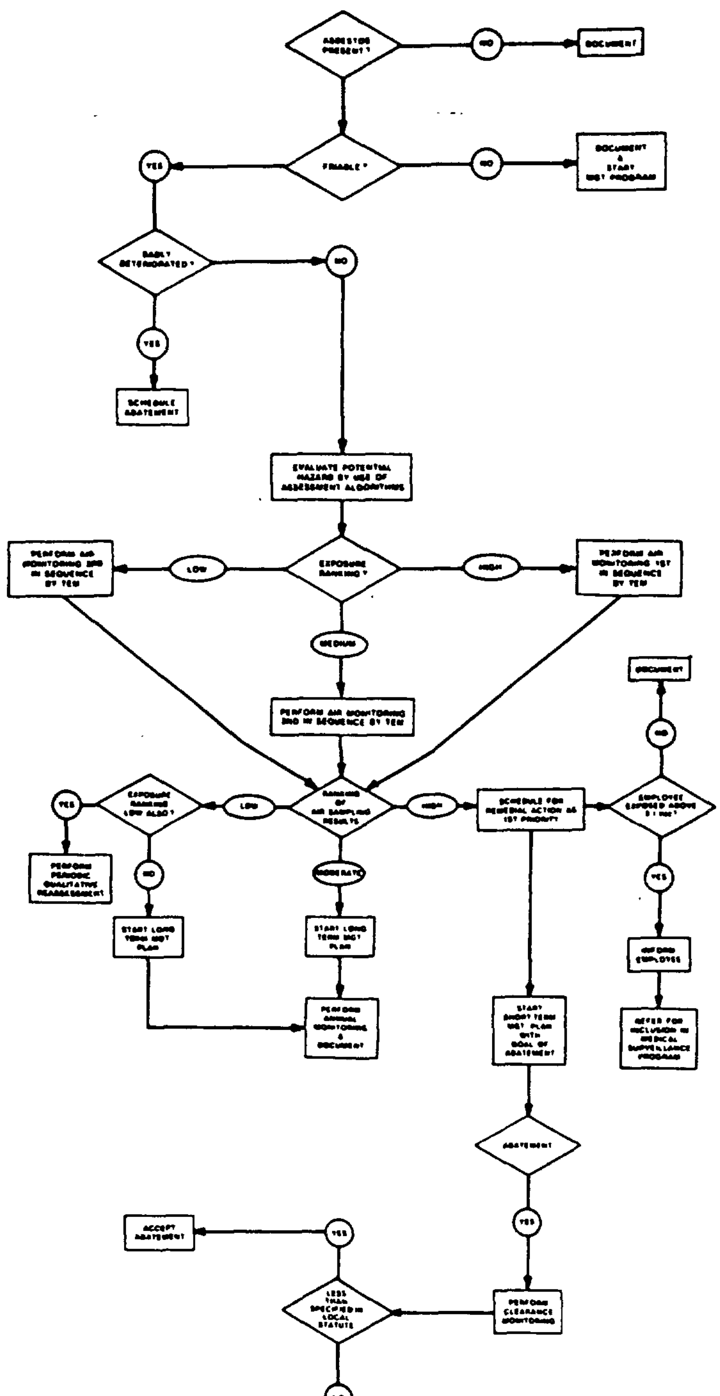

Figure 1 — Decision matrix for evaluation and ranking of building areas according to health hazard potential.

Hazard Assessment Algorithms

In order to set priorities where one must deal with multiple buildings or multiple areas in a building containing asbestos, algorithms have been utilized which combine relevant factors to generate a numerical index for the potential hazard of the particular building or building area. Several types of hazard assessment algorithms have been utilized, including the Ferris Index and modified Ferris Index used by the Massachusetts Asbestos Commission and the Colorado Department of Education, respectively,[8,9] the EPA's Asbestos Hazard Evaluation Algorithm[10] and the U.S. Navy Asbestos Hazard Index.[11]

These algorithms contain factors relating to the amount of asbestos present, its current condition, the vulnerability of the material to physical damage and air movement, and the degree of potential exposure. The factors are scored and combined into an overall index, thereby providing a mechanism for evaluating and comparing the potential hazard of asbestos-containing materials in various locations within a single building, or in different buildings.

Because several subjective factors such as material friability, accessibility, and condition enter into algorithm usage, the resultant indices provide relative rather than absolute rankings of hazard potential. Judgment also should be exercised in selecting or modifying an existing hazard algorithm or in devising a new one, in order to insure that the algorithm is capable of yielding reliable results that are related to the degree of potential hazard. A wide range of highly variable results, for both untrained and trained observers, coupled with poor correlation with experts' scores, led the EPA to withdraw its Asbestos Hazard Evaluation Algorithm as an assessment tool,[12] and thus far, attempts have not been made to validate the other algorithms.

The numerical scores derived from the use of an appropriate asbestos assessment algorithm may be grouped into categories (low, medium, high) according to the degree of potential hazard represented by their numerical ranking (Figure 1).

Despite the current unsatisfactory state-of-the-art of these algorithms, we find them useful for orientation purposes and recommend that the Ferris or modified Ferris and Navy algorithms be used. Only when the rating of a particular building or location is ranked consistently by all three algorithms do we gain some confidence in the qualitative appraisal.

Quantitative Hazard Assessment

We recommend that airborne fiber concentrations be measured in addition to performing a qualitative asbestos hazard assessment. The results of air monitoring serve two primary purposes.

First, they establish the degree of *actual* hazard present in building areas by determining the airborne concentrations of asbestos fibers that are present in the breathing zones of employees and/or the general public occupying those areas.

Second, air samples obtained at this stage establish *background* concentrations of asbestos in air prior to any

10003253

planned or unplanned modification of asbestos materials, thereby providing a yardstick by which to measure such factors as contractor performance following asbestos removal. Following asbestos removal, airborne asbestos concentrations should not exceed those measured before removal work began, *i.e.*, removal efforts should not contribute to increasing airborne asbestos fiber concentrations above background. Airborne concentrations such as 0.01 fiber/cc (>5 μm in length), or 100 ng/m^3 presently are being applied or are being considered as post-removal acceptance concentrations or "control levels" by several state regulatory agencies, however. These concentrations are often higher than pre-removal concentrations in most facilities (Table I).

The classification scheme depicted in Table II permits ranking of building areas to establish management program priorities, based on the ratio of background building airborne asbestos concentrations to concurrently measured ambient asbestos concentrations.

The background building concentration of airborne asbestos is evaluated using transmission electron microscopy (TEM) to analyze air samples. TEM is used because, in areas of buildings not undergoing some form of penetration of asbestiform materials, accurate determination of asbestos fibers in air requires a more sensitive analytical method for air samples than the phase contrast light microscopy (PCM) method used by OSHA to analyze air samples obtained in occupational environments. Also, PCM is a non-specific method in which all fibers are counted as asbestos. This may produce misleading results in non-occupational environments.

At this time TEM analysis is preferred over other electron microscopy techniques, such as scanning electron microscopy (SEM), because recommended standard procedures for TEM analysis have been developed by the EPA[13] and others.[11] An Asbestos International Association Recommended Technical Method exists for asbestos fiber analyses by SEM, but it has not been recognized by the EPA.[15]

Prioritizing Building Areas for Asbestos Risk Management Strategies

When numerous areas of single or multiple buildings are involved, priorities must be set for monitoring building areas and, if necessary, for initiating specific management program ingredients.

The decision tree depicted in Figure 1 summarizes previously discussed assessment procedures and utilization of results for setting priorities. Those areas showing evidence of badly deteriorated friable asbestos are scheduled for immediate asbestos removal. All other areas are subject to the evaluation of hazard potential by the use of qualitative assessment algorithms. The performance of air monitoring may be prioritized on the basis of hazard assessment algorithm results, with those areas showing the highest ranking scheduled first in the sequence for air monitoring, and the lowest ranked areas scheduled last.

Air monitoring results then may be used in conjunction with asbestos hazard assessment rankings to determine a priority ranking scheme for initiating program ingredients and scheduling removal, if removal is the favored option. Building areas with the highest concentrations of asbestos in air are scheduled for earlier interventions to reduce the airborne concentrations. If average airborne concentrations in two or more areas cannot be differentiated statistically within predetermined confidence limits, they then are assigned priorities on the basis of their qualitative hazard assessment rankings.

Building areas ranked either medium or low from the qualitative asbestos hazard assessment, but having an unexpectedly high classification based upon the results of air sampling, should be investigated for possible sources of fiber release. Once the source of airborne contamination has been located and corrected, the area should be re-monitored to ensure that airborne concentrations are consistent with the low degree of potential hazard predicted by the assessment algorithms.

Short-Term Management Approach

For those building areas classified as having high airborne fiber concentrations (>0.01 fiber/cc, >5 μm, by TEM), it is necessary to institute a short-term management plan in order to achieve a significant reduction in airborne concentration, *before* a long-term management or removal plan is implemented. This short-term plan includes such procedures as

TABLE II
Ranking Building Areas for Management Programs According to Airborne Asbestos Fiber Concentrations

Priority Ranking	Ratio of Indoor Airborne Asbestos Fiber Concentration to Outdoor Fiber Concentration[A]	Asbestos Concentration Approximate Equivalents[B]	
		fiber/cc	ng/m³
Low	Less than 10 times	0 - 0.002 f/cc	0 - 60 ng/m³
Moderate	Between 10 and 50 times	0.002 - 0.05 f/cc	60 - 300 ng/m³
High	Greater than 50 times	>0.05 f/cc	>300 ng/m³

[A]A high outdoor urban asbestos concentration of 0.0002 fiber/cc is used here as a guide. Actual outdoor concentrations at the site should be used.

[B]Based on a conversion factor of 30 μg/m³ = 1 fiber/cc (>5 μm in length). The concentration levels in the table represent values based upon 8-hr TWA concentrations with samples analyzed by TEM.

10003254

covering and sealing damaged or exposed surfaces of asbestiform materials, substituting appropriate cleaning methods such as the use of HEPA-vacuums, and controlling of episodic sources of contamination, such as removing asbestos-containing debris from above suspended ceilings and air plenums.

Long-Term Management Approach

One of the primary purposes of the Asbestos Risk Management Program is to implement a satisfactory long-term management approach for controlling exposure to the asbestos which is retained in a building. The management program must encompass all asbestos-containing material, including that which is in good condition, not damaged and not likely to be disturbed.

Where large areas of asbestiform materials are relatively intact but contain small areas of deteriorated friable material, removal or repair of these affected sections is usually advisable. Removal of entire installations are not triggered, pro forma, by small subsections of unacceptable asbestos fire-proofing, insulation, coated ceiling or other applications.

If the material is in otherwise good condition and unlikely to be disturbed and if airborne fiber concentrations are in the low category (see Table II), a special operations, maintenance, and periodic reinspection program can be selected as the long-term management strategy.

Deferment of removal for these "low priority" installations is an attractive option. This option has the advantage of avoiding the expense, disruption and possible building contamination associated with removal. As the asbestos removal industry matures, removal projects probably will improve in general quality. If the deferral option is selected, a sound and thorough ongoing management program must be instituted, including:

- Taking measures to minimize access to material;
- Operating a permit system to prevent the accidental penetration of asbestos-containing materials during building maintenance and renovation and ensuring that those permitted utilize appropriate work practices;
- Maintaining an episode response plan;
- Providing for instruction and training of employees who must have access to the material;
- Providing a medical surveillance program for those employees exposed to "significant" concentrations of airborne asbestos (at or above 0.1 fiber/cc $> 5\ \mu m$, TWA, by PCM);
- Implementing a continuing environmental monitoring and surveillance program;
- Implementing procedures to prevent overexposure of personnel during small asbestos removal activities; and
- Maintaining a comprehensive recordkeeping and reporting system.

These specific program elements will now be briefly discussed. Detailed implementation plans are presented elsewhere.[16]

Minimizing Access and Exposure

All building maintenance, custodial, and service personnel should be informed of the known locations of asbestos-containing materials and instructed to report areas containing damaged insulation or suspected asbestos-containing friable materials to the ACPM. These personnel should be included in a training and education program which, among other topics, addresses safe work practices which minimize exposure to asbestos. In addition, precautionary signs should be posted at entrances to areas which have damaged exposed friable materials until such time as these materials can be covered or repaired. Warning labels should be affixed to asbestos-containing materials until removal takes place in order to prevent accidental disruption. Labels should be of the type specified by OSHA.

Permit System

A permitting system should be instituted as part of the risk management program. Permits contain such information as building location, presence of asbestiform materials, description of the work to be performed, and nature of the control methods to be employed to control access and limit accidental disruption of asbestos-containing materials. For purposes of the permitting procedure, all maintenance, renovation and repair work is classified as either *major* or *minor*

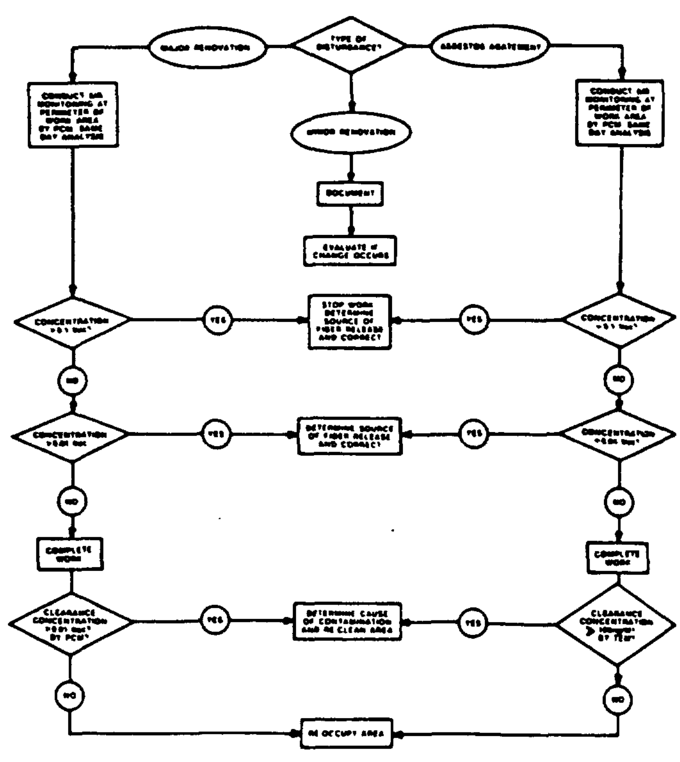

Figure 2 — Decision matrix for selecting an appropriate air monitoring and intervention strategy according to hazard potential resulting from material disturbance.

10003255

by the ACPM. Minor work includes such activities as routine maintenance performed above a suspended ceiling, while major work includes such activities as asbestos removal or major renovation.

Minor renovations are distinguished from major renovations in that they do not involve penetration or disruption of intact asbestos-containing materials, they present only a minimal potential for causing significant fiber release, and air monitoring generally is not performed.

Minor work procedures involve work practices which are least likely to cause fiber release or to disturb settled dust containing asbestos, and may include the wetting of surfaces, the use of containment bags, and vacuuming, using HEPA-equipped filtration.

Major renovations require more elaborate control techniques, similar to those used for an asbestos removal project, and air monitoring is required.

Episode Response Plan

If episodic asbestos contamination occurs in a building (*e.g.*, friable material distributed above a suspended ceiling is released into an occupied area), monitoring should be conducted immediately to evaluate the airborne concentration of asbestos fibers. Wherever air sampling results exceed a *control level* of 0.01 fiber/cc by PCM analysis or there is visible asbestos contamination of work surfaces, the ACPM should arrange to relocate personnel from the affected areas.

The ACPM also should control access to all contaminated areas, post warning signs at all entrances, and inform employees in writing of any exposure to asbestos above 0.1 fiber/cc (see Medical Surveillance Program).

Prior to decontamination of the area, airlocks should be constructed at all entrances and exits, and the ventilation system to the area should be shut down and sealed off to prevent contamination of other building areas.

All contaminated surfaces (including desks, chairs, shelves, books and equipment) should be cleaned thoroughly by HEPA vacuuming of all visible material, followed by wet wiping. If a carpet can be seen to be contaminated, sequential vacuuming followed by "aggressive" air sampling should be performed until significant airborne concentrations of asbestos fiber (0.01 fiber/cc, >5 μm, by TEM) are not detected at breathing height. Air sampling of contaminated areas should be conducted under conditions which simulate periods of high activity in the affected areas.

Employee Education and Training Program

Employee education and training are essential components of an asbestos control management program. Several levels of training should be incorporated into the overall program.

Level 1 of the training program should be offered to all employees who are assigned to work in buildings undergoing long-term asbestos management. It provides awareness training to those needing general orientation to the nature of the potential asbestos problem. Training focuses on the uses and applications of asbestos materials in the particular facility, the steps employees can take to minimize their exposure to asbestos and the ways they can reduce asbestos-exposure inside and outside the building.

Level 2 training is for those who perform maintenance and repair work in buildings in which there is potential for asbestos exposure. This group would include personnel, such as maintenance employees, custodial staff, carpenters, electricians, plumbers, and other service personnel, such as outside contractors and utility service personnel. In addition to Level 1 training, they would be instructed on the practicalities of performing maintenance on asbestos-containing materials.

These employees should be given training and instruction in the use of wet-cleaning methods and special equipment such as HEPA filtered vacuums. They should be cautioned about removing suspended ceiling panels, installing lighting or plumbing fixtures, repairing air handling systems or, in general, engaging in any activity that might damage asbestos-containing materials and release fibers. Instruction and training also should address proper use of protective equipment and respirators, personal hygiene techniques, the use of maintenance permits, reporting procedures, and compliance with relevant regulations. Annual retraining is recommended.

Level 3 training is designed for management personnel who have responsibility for overseeing the health and safety of employees under their supervision or asbestos work taking place in their facilities. It includes the equivalent of both Levels 1 and 2 training, in addition to instruction on the policies and procedures adopted by management for controlling asbestos-related hazards.

Medical Surveillance Program

The current OSHA asbestos standard requires medical surveillance for employees exposed to "airborne concentrations of asbestos," which has been interpreted by OSHA as representing concentrations in excess of 0.1 fiber/cc. Here OSHA assumes that exposure measured on a single day is representative of exposures at other times, although this is seldom the case for non-occupational exposures.

In instances where significant exposure to airborne asbestos fibers has taken place, affected individuals should be informed of their exposure and advised of their option to obtain the services of a licensed physician specializing in occupational medicine. We recommend that the option for inclusion in a medical surveillance program should be offered to all employees exposed to asbestos concentrations at or above 0.1 fiber/cc, 8-hr TWA on at least two or more days during any one year period.

The major objective of medical surveillance is to insure proper management of individuals who may show evidence of reaction to past exposure to asbestos. Medical management may range from recommendations for job placement, improved work practices and personal hygiene habits (such as cessation of smoking) to specific therapy for asbestos-related disease or its complications. A board-certified occupational health physician should establish the medical surveillance protocol and the frequency of any recommended clinical tests.

10003256

Periodic Monitoring and Surveillance

In those buildings where asbestos removal is not undertaken, management has a responsibility to determine, on an ongoing basis, that asbestos exposure in the building does not change. Therefore, one year after background monitoring is performed, certain facilities will be triggered into a surveillance mode.

Building vibration, damage to materials from accidental or mechanical contact, and aging of materials may alter the fiber-release potential of asbestiform materials. It is therefore necessary to repeat air sampling annually in all building areas having either a high or medium ranking from qualitative hazard assessment to determine if airborne concentrations of asbestos have changed. Low-ranked building areas should be re-evaluated qualitatively on an annual basis. They do not require annual air sampling unless their hazard ranking is raised to a higher category. Of course, ongoing visual surveillance will occur in all facilities. If repeated results of annual sampling indicate that airborne asbestos concentrations are not changing, the sampling frequency may be reduced to a bi- or tri-annual basis.

Asbestos Abatement Monitoring Procedures

Intervention options to reduce building average asbestos concentrations are encapsulation, enclosure or removal. Encapsulation, while involving a somewhat lower initial cost, necessitates an ongoing control program because damage to the asbestos matrix still can occur if the encapsulant is penetrated or water damaged. Prior to the start of an intervention, the ACPM should establish criteria for determining successful project completion.

During asbestos removal, a strict set of operating procedures must be followed to restrict any fiber release to the immediate sealed-off work area. These operating procedures, cited in detail elsewhere,[17-19] include the construction and maintenance of containment barriers and decontamination enclosures, the posting of warning signs, the appropriate use of protective equipment, the use of HEPA-filtration equipment and ventilation units, wet-removal methods and the proper disposal of asbestos-contaminated wastes.

The purpose of air monitoring during abatement projects is to detect asbestos contamination outside the perimeter of the enclosed work area in order to implement immediate, effective interventions to control the source(s) of contamination. Perimeter sampling during major renovations is most useful when same-day analysis of samples is performed. In this way, corrective actions may be taken to prevent the spread of fiber release from the work area as soon as possible. For this reason and because airborne fiber concentrations during a contamination "event" will exceed ambient levels, PCM is the analytical method of choice for analysis of perimeter air samples.

Figure 2 displays the decision matrix for selecting an appropriate air monitoring strategy and taking appropriate action based upon measured airborne fiber concentration from disturbance of asbestos-containing material.

In the absence of state or federal regulations, we utilize the following fiber concentrations as guidelines to evaluate the effectiveness of asbestos containment procedures. When airborne asbestos fiber concentrations outside of a containment work area are found to exceed an *alert* level of 0.04 fiber/cc by PCM analysis during a major renovation or asbestos-removal project, the sources(s) of asbestos contamination should be investigated, located and controlled. When fiber concentrations outside of the containment area exceed an *action* or ceiling level of 0.1 fiber/cc by PCM, work should be halted immediately until the source of contamination can be diagnosed and corrected. This concentration is also the action level for the triggering of medical surveillance.

Air monitoring for asbestos removal projects differs from monitoring for other major renovations in one important respect. Following removal, airborne fiber concentrations determined by TEM should meet a specified clearance level. Ideally, the pre-removal background concentration may serve as the clearance level for each area, although for reasons concerning administrative and technical practicality, it may be necessary to set the clearance concentration at a predetermined level (*e.g.*, 0.003 f/cc or 100 ng/m^3), which is independent of pre-abatement concentrations for each area. During major renovations, which generally occur more frequently and involve a smaller work area than an abatement project, sample analysis by PCM may be sufficient. In these cases, the area may be re-occupied by meeting a specified *control* level (*e.g.*, 0.01 fiber/cc).

Recordkeeping and Reporting Procedures

It is the responsibility of the ACPM to develop and maintain accurate and complete recordkeeping and reporting procedures, which encompass the following types of information:

Environmental Recordkeeping

1) Building survey information including the locations of all asbestos-containing materials (asbestos inventory);
2) Background environmental monitoring and hazard assessment data and results;
3) Episodic monitoring data and results;
4) Periodic monitoring and surveillance data and results; and
5) Clearance (post-abatement) monitoring data and results.

All environmental reports should describe air monitoring in detail, showing sketches of floor areas or photographs, results of all sample analyses, and analytical methods used.

Administrative Recordkeeping

1) Employee education and training records;
2) Employee medical surveillance program referrals and medical records;
3) Maintenance permit applications, notifications and approvals;
4) Reports of exposed or damaged friable materials, and actions taken;
5) Prioritization scheme for scheduling of areas for abatement; and

10003257

6) Abatement contractor reports and evaluations.

Administrative reports should include complete descriptions of all incidents, and any instances of non-compliance with Asbestos Risk Management Program procedures, or applicable EPA and OSHA regulations.

Both environmental and administrative records should be stored in a format that will permit them to be readily accessed. Environmental data should be maintained for the duration of the long-term management program. Medical, training and education records should be maintained for at least 40 years.

Summary

The basic framework of an Asbestos Risk Management Program for buildings has been presented, the primary objective of which is to minimize employee and public exposure to asbestos in air. The program utilizes a decision framework for assessing the degree of hazard, determining appropriate action, assigning priorities for asbestos abatement and incorporating specific guidelines for the control of potential asbestos-related hazards in non-occupational environments.

Acknowledgments

The Asbestos Risk Management Program described is derived from programs developed by the authors, either singly or in combination for the U.S. General Accounting Office, the Library of Congress, the General Services Administration and the IBM Corporation. We gratefully acknowledge the support of asbestos control program development by these sponsors.

References

1. **U.S. Environmental Protection Agency:** *Asbestos in Buildings: A National Survey of Asbestos-Containing Friable Materials* (EPA 560/5-84-006). Washington, D.C.: Environmental Protection Agency, 1984.
2. **U.S. Environmental Protection Agency:** *National Emission Standards for Hazardous Air Pollutants: Asbestos* (38 CFR 8826). Washington, D.C.: Government Printing Office, 1973.
3. **U.S. Environmental Protection Agency:** *Friable Asbestos-Containing Materials in Schools, Identification and Notification Rule* (47 FR 23360). Washington, D.C.: Government Printing Office.
4. **Occupational Safety and Health Administration:** *Standard for Occupational Exposure to Asbestos* (29 CFR 1910.1001). Washington, D.C.: Government Printing Office, 1972.
5. **National Research Council:** *Asbestiform Fibers. Nonoccupational Health Risks.* Washington, D.C.: National Academy Press, 1984.
6. **Office of Carcinogen Identification and Classification:** *Preliminary Risk Assessment for Asbestos. Occupational Safety and Health Administration* by H.K. Kang and K. Chu. Washington, D.C.: Government Printing Office, 1981.
7. **Ontario Ministry of Government Services:** *Report of the Royal Commission on Matters of Health and Safety Arising From the Use of Asbestos in Ontario by J.S. Dupré et al.* Toronto, Canada: 1984.
8. **Irving, K.F., R.G. Alexander and H. Bavley:** Asbestos Exposures in Massachusetts Public Schools. *Am. Ind. Hyg. Assoc. J. 41*:270-276 (1980).
9. **Baldwin, C.A., H.J. Beaulieu, R.M. Buchan and H.H. Johnson:** Asbestos in Colorado Schools. *Prevention 97*:325-330 (1982).
10. **U.S. Department of Health Education and Welfare:** *Asbestos Detection and Control, Local Educational Agencies, Asbestos Detection and State Plan* (FR 61950 - 61954). 1980.
11. **U.S. Navy:** Procedure for Risk Evaluation: Asbestos Hazard Index. In *Management Procedure for Assessment of Friable Insulating Materials* (Report R883). Port Hueneme, Calif.: Civil Engineering Laboratory, Naval Construction Battalion Center, 1979.
12. **Findley, M.E., V.E. Rose, G.R. Cutter and R.A. Windsor:** An Assessment of the Environmental Protection Agency's Asbestos Hazard Evaluation Algorithm. *Am. J. Pub. Health 73*:1179-1181 (1983).
13. **U.S. Environmental Protection Agency:** *Provisional Methodology for Transmission Electron Microscopic Analyses of Asbestos Fibers* (EPA-600/2-77-178). Washington, D.C.: 1978.
14. **Middleton, A.P. and E.A. Jackson:** A Procedure for the Estimation of Asbestos Collected on Membrane Filters Using Transmission Electron Microscopy (TEM). *Ann. Occup. Hyg. 25*:381-391 (1982).
15. **Asbestos International Association:** *Method for the Determination of Airborne Asbestos Fibers and Other Inorganic Fibers by Scanning Electron Microscopy.* London, England: 29 February 1984.
16. **Corn, M.:** "Asbestos Control Management Document for U.S. Library of Congress." Johns Hopkins University School of Hygiene and Public Health Div. Environmental Health Engineering. Typescript 9 August 1985.
17. **Maryland Department of Health and Mental Hygiene:** *Recommended Guidelines for Asbestos Abatement Contractor Licensing Programs.* Baltimore, Md.: Office of Environmental Programs/Science and Health Advisory Group, April 1985.
18. **Maryland Department of Health and Mental Hygiene:** *Recommended Contract Specifications for Asbestos Abatement Projects.* Baltimore, Md.: Office of Environmental Programs/Science and Health Advisory Group, April 1985.
19. **Ewing, W.M. and W.H. Spain:** Getting to the Very Fiber of Industrial Asbestos Removal. *Occupational Safety & Health 53(6)*:29-33, 60, 68 (1984).

2 December 1985, Revised 14 May 1986

10003258