REMOVAL

Are asbestos-containing floor tile and mastics friable or non-friable? What governmental regulations apply to their removal? Which removal methods are most effective? Here's why there aren't any uniform answers.

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Multiple EPA reports have indicated that there are 35,000 schools and 733,000 private and commercial buildings in the United States that contain asbestos. Additionally, many private residences contain certain asbestos products such as floor tile. There are millions of square feet of floor tile in these buildings, and a portion of that tile contains asbestos.

Polyvinyl chloride/asbestos tile has been manufactured since 1950. Containing 18 to 25 percent asbestos, the tile combines strength, flexibility, fire resistance, impermeability to water and excellent wear characteristics. Asphalt asbestos floor tile, which contains 26 to 33 percent asbestos, has been manufactured since 1920. Chrysotile asbestos is used in tiles because of its high tensile strength and inherent flexibility. These tiles are often adhered with a mastic that also contains asbestos.

When left in place, well-maintained and undisturbed, these asbestos floor tile and mastic combinations perform their function well without posing a significant asbestos exposure hazard. However, if they are broken, cut, drilled or otherwise disturbed, as occurs during renovation or demolition, they can release asbestos fibers into the air and pose a potential health hazard. Because of this potential, asbestos floor tile and mastic should be kept under an asbestos operations and maintenance (O&M) program while in place. When it is intentionally or unintentionally disturbed, more drastic precautions should be followed.

The issue of what precautions to take and why has been an evolving debate over the past several years. There are now several options to choose from and issues to consider.

REGULATIONS

There has been much confusion about whether asbestos-containing floor tile and mastic should be considered friable and subject to the same techniques and regulations as other friable asbestos-containing materials (ACM). Environmental Protection Agency (EPA) regulations define "friable asbestos" as any material containing more than 1 percent asbestos by weight that hand pressure can crumble, pulverize or reduce to powder when dry.

On July 9, 1985, the EPA Region IV adopted the following position on non-friable ACM, which presumably includes floor tile and mastic:

Without any type of disturbance (breaking, cutting) to this material, the material would not be considered friable and therefore the provisions of 40 CFR 61, Subpart M (NESHAP) would not apply.... However, if this material is disturbed or broken up in the demolition process (including disposal) such that asbestos fibers are released, then the material is considered friable and then subject to the NESHAP asbestos regulations.

In December 1985, the EPA National Office issued a four-page memorandum addressing the subject of NESHAP applicability to the removal of non-friable ACM. The following guidance was included in that memorandum:

Even though the (NESHAP) regulations address only material that is presently friable, it does not limit itself to material that is friable at the time of notification. Rather, if at any point during the renovation or demolition, additional friable asbestos material is either discovered or created from non-friable forms, then this additional friable material becomes subject to the regulations from the time of creation or discovery. This additional friable material will become subject to all of the regulations, including the notification requirements.

The memorandum also states:

The owner or operator is not exempt from the other requirements of the standard, such as wetting, during the (notification) waiting period. When non-friable material is frac-

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tured or otherwise becomes friable during the removal, the operator must wet after the fracture occurs and follow all of the additional requirements in 40 CFR 61.147 and 61.152 (NESHAP). In some instances, these requirements may be burdensome. For example, when ragged edges result from the removal of the material, such edges may be friable.

In that same 1985 time frame, the Environmental Protection Division of Georgia's Department of Natural Resources suggested several steps to be taken during the removal and disposal of non-friable asbestos boards or other types of non-friable ACM. It suggested a variety of steps, including:

- isolating the removal area;
- posting EPA/OSHA warning signs;
- wetting the materials prior to removal;
- wrapping the materials in plastic or placing them in lined containers;
- having the workers wear respirators and protective clothing;
- disposing of the material in an approved sanitary landfill;
- checking on legal liabilities;
- preventing visible emissions;
- controlling airborne fiber exposures; and
- collecting and analyzing air samples.

In spite of this and other governmental guidance concerning the issues, the way in which floor tile and mastic removal projects are regulated and performed remains a matter of considerable local interpretation. In some geographic areas, it is still considered to be a project involving basically non-friable material. In other areas it is treated and regulated as involving fully friable material.

There is also reported to be variability in OSHA's enforcement of worker protection requirements for these projects. According to one account, a federal OSHA inspector required the use of type C respirators for floor tile removal projects in Colorado.

These differences in regulatory interpretation have left building owners, consultants, contractors, inspectors and others somewhat confused about what is required and appropriate for floor tile and mastic removal projects. The trend definitely seems to be moving toward treating the projects as involving friable materials. However, those who take the opposite view argue strongly that the projects do not cause visible emissions (one NESHAP criteria) and do not generate personal exposures above 0.1 fibers per cubic centimeter of air (the OSHA action level).

BULK SAMPLING & ANALYSIS

Trying to figure out how the regulations apply is not the only problem with asbestos floor tile and mastic. It can also be difficult to determine if the tile and mastic *contain* asbestos.

The EPA Asbestos in Schools Rule of 1982 (and many early building inspections) failed to address the issue of asbestos in floor tile and mastic. As a result, building owners, architects, contractors and consultants often have been surprised when they had to stop a demolition or renovation project involving asbestos floor tile or mastic. In fact, floor tile and mastic are frequently the trigger issue for "change orders" on renovation and demolition projects.

"There are still many questions regarding asbestos-containing floor tile and mastic for which there are no generally accepted or uniform answers."

As of 1987, EPA/AHERA requires schools to include floor tile and mastic in their building inspections and asbestos management plans. All building owners are well-advised to do likewise. There is an alternative to the expensive and difficult process of collecting and analyzing large numbers of bulk samples to determine if asbestos is present. All tile and mastic can be assumed to contain asbestos (until proven otherwise) and placed under a minimal asbestos operations and maintenance program (O&M). This assumption can be tested by collecting and analyzing a few samples from locations such as closets and corners. Erring on the side of safety, any positive results should cause the assumed area to be treated as asbestos-containing material; however, a few negative results should be considered inadequate to conclude that the area is asbestos-free.

Before removal and replacement is scheduled for the assumed asbestos materials, representative samples from both the tile and mastic should be collected and analyzed. Inexperienced inspectors often fail to sample the mastic. This sampling and analysis could help avoid an expensive removal and replacement project based upon a faulty assumption.

Unfortunately, it is often difficult to analyze the tile and mastic samples. There are no generally accepted or standard techniques for these multistep analyses. The problem becomes separating the collected sample so it can be analyzed by polarized light microscopy (PLM). The EPA recommends a process using solvents, but other highly qualified laboratories prefer other methods.

Julian Gray, laboratory microscopist for Environmental Analytical Laboratories of Atlanta, comments that it is easy for analysts to miss the asbestos in some floor tile. The aswbestos fibers are usually very finely milled and of fiber sizes near the resolution limit of PLM. Gray also says analysts have difficulty determining the quantity (percentage) once they find asbestos in the tile. Most laboratory results fall in the range of 1 to 3 percent asbestos. About 25 percent of tested tile contain more than 1 percent asbestos. Manufacturing information indicates that tiles usually contain 26-33 percent asbestos. The asbestos is essentially always of the chrysotile variety. Shreds of mica may be present that interfere with the analysis. These analytical difficulties often lead to false negative results.

According to Gray, analyzing the mastic is even more difficult. The mastic is smeared on a slide and then immersed in a refractive index liquid. Unfortunately, the mastic binder material is usually opaque and obscures the fibers. Thus the analyst must look for exposed ends of the fibers. Over half the mastic samples contain more than 1 percent asbestos. Most positive results

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fall in the range of 10 to 30 percent asbestos and are essentially always chrysotile. Only highly qualified analysts should be depended upon for accurate mastic analysis.

TILE REMOVAL METHODS

Methods employed in the removal of vinyl asbestos tile (VAT) and mastic tile adhesive (MTA) vary greatly, depending primarily on the existing conditions surrounding the subject facility and future or continued use of the involved space. Methods of choice also vary between contractors performing this work. However, the contractor's decision is usually based upon the factors mentioned above and previous experiences using the various available methods. One factor agreed upon by experienced contractors in asbestos abatement today is that no VAT removal job should be performed without utilizing proper personal protective equipment (PPE), decontamination facilities and effective work area isolation and enclosure, including negative-pressure differentials within the work area.

Work area preparation may not be left up to the contractor's discretion if he is working a project that has specified methods and procedures. Still, contractors are often called on to fulfill a design/build-type contract. Essentially, this will allow the contractor—with the owner's consent—to use the methods he feels will adequately protect the work areas from a physical standpoint, and all parties to the contract from a legal and liability standpoint. In these design/build situations, especially where work areas are within occupied buildings or adjacent to occupied spaces, experienced contractors are not currently opting for full work-area enclosure and isolation before approaching VAT removal.

Studies are available showing elevated fiber levels during VAT removal, and contractors now consider this data when making decisions concerning methods and procedures. Of course, limited or partial work-area isolation and enclosure is still very much in use today, especially in pre-demolition projects in which all surfaces can be effectively washed and any residual fibers positively "locked down" prior to the demolition. Partial isolation and enclosure is also still used in some occupied building projects, but only by operators who are willing to "throw the dice" from a legal/liability standpoint, or by those who have not had data such as the study noted above made available to them.

Once the degree of work-area isolation and protection is decided upon, the appropriate removal method must be addressed. When VAT removal takes place on the ground floor of a facility that is "on slab" with no danger of water damage to floors below, or when working on multistory buildings scheduled for demolition, in which water damage to lower floors is not a consideration, the method of choice for VAT removal is still controlled "flooding" of the work area with amended water

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containing a surfactant. This method has been very effective in causing the VAT to release from the mastic material and virtually float to the top for ease in removal. Many abatement contractors have discovered this method inadvertently, through past experiences working in areas in which existing floor tile has *not* been scheduled for removal. They found that once the floor enclosures were removed, undetected water leaks, or even collected moisture, left them facing a tile removal and replacement job not anticipated in their original work estimate.

This process sometimes can be accelerated by using a hot amended water mixture if an abundant supply of hot water is available on the site. The amended water method has other advantages as well. Asbestos contractor Raymond McQueen, vice president of Safehouse, Inc., in Atlanta, states, "The amended water method not only provides the most effective method of removal, but we have also had outstanding success in keeping airborne fiber levels within the work very low during removal, even when chipping and other mechanical methods must be utilized. The newer removal encapsulants/surfactants have done a much better job in this respect."

In some cases, no matter how much amended water is used, or how hot the water is, or what type or brand of surfactant is utilized, the VAT will not just "float to the top" and mechanical methods must be utilized to facilitate complete removal of the tile materials.

Several indicators are available to help the contractor determine the amount of labor that will be needed for completion of a VAT removal project. Sunlight exposure and the amount of pedestrian traffic in an area are significant factors contributing to an increase in the difficulty of VAT removal. The light/heat and constant downward pressure in heavy traffic areas such as corridors and other public-use areas help the tiles "set" in their base materials, adding to the difficulty of removal.

Ron Amonds, vice president of Applied Asbestos Technology, Inc., based in Atlanta, says, "We know that areas which are heavily used and exposed to constant sunlight can cut production during removal by as much as 75 percent. These areas are estimated at 40-50 square feet per man hour as compared to 165-180 square feet per man hour in areas where these conditions are not present." The age of the installation, if determinable, should also be considered in conjunction with these sunlight and traffic conditions.

Another factor complicating VAT removal is the existence of multiple layers of flooring materials. Many older buildings are found to contain several floor coverings applied on top of one another. In one current project, Amonds has encountered this problem.

"We are in a situation at the present time where, after removing the top layer of tile and mastic, we found three additional layers of flooring materials and two layers of VAT with a layer of linoleum sheet goods in between them. The owner's consultant failed to identify these additional materials and the cost of the project has increased by approximately 50 percent."

Amonds goes on to say that, in

this case, his additional work will be compensated by way of a change order, a common occurrence in dealing with the removal of flooring materials. However, the contractor should always make every effort to discover items such as this prior to bidding a project. He may find himself caught in a contractual language trap by wording such as *The contractor shall remove all flooring materials.* Or if working in a design/build capacity, the contractor may be held responsible for any additional work involving materials not considered to be part of the original scope of work.

In any of these cases, unanticipated costs and schedule extensions are the result, and they only serve to erode the relationship of the involved parties. Amonds suggests, "In a situation where we suspect multiple layers of floor coverings, we will always try to ascertain the actual existing conditions, even if this means additional bulk samples to be analyzed at our expense. These bulk samples could provide information which will save us significant sums. This is also the time to find out what type of MTA you are dealing with. A closet or other isolated area is an excellent location to test the mastic for its reaction to different dissolving agents."

The point to remember in every situation is that all parties to the contract are better served by knowing as much detail as possible about the work facing them. This fosters an interdisciplinary approach to the project and helps the "team" to properly address the project from the start, limiting surprises during the progress of the work. Contractors who perform a significant amount of work in schools should note that all of the complicating factors discussed here are prevalent in school buildings, and should always be considered when evaluating VAT projects performed there.

When a VAT removal job moves up from the ground floor, a contractor faces a formidable challenge in effectively removing the materials while simultaneously using limited amounts of water to prevent potential damage to the spaces below. Two alternative methods are presently in use by contractors trying to find an acceptable solution to this dilemma: the application of heat and the application of extreme cold. Both have received mixed reviews with regard to effectiveness and cost efficiency.

Heat, supplied from electric heat guns or electric heat machines, will eventually cause VAT to release from its adhesive base materials. But this is a very time-consuming method. It has been utilized on small-scale projects with success; but as the projects increase in size, this method becomes less cost-efficient. Additionally, the same heat that causes the tile to release turns the mastic materials into a gummy mess that potentially can be tracked out of the work area and into other areas of the facility. The heat removal method will allow VAT to be removed in whole pieces. This helps to control the emission of airborne fibers, thus limiting the need for large amounts of water during the process. However, the VAT materials should always, at a minimum, be misted with amended water during handling and packaging for disposal.

New technology has been introduced recently to the abatement industry in the form of an infrared heat machine. It is claimed that this machine is able to automate VAT removal on large-scale projects. Unfortunately, data relating to the effectiveness of this method is very limited at this time.

The removal of VAT utilizing extreme cold is presently being used on a limited basis in several areas of the country. The cold is supplied by either dry ice or liquid nitrogen applied to the top surface of the VAT. Extreme care must be used in the application of these materials to prevent damage to any adjacent finishing materials. This method also will eventually cause the tiles to release from their adhesive base. But like the heat method, it is a long, time-consuming process. The cold method can be used on small-scale projects; however, the cost of the materials relative to the amount of VAT removal they provide is prohibitive for projects of any significant size.

The cold method also has two notable side effects. First, the cold-source materials dissipate oxygen content in the ambient air as they evaporate. This oxygen depletion can reach a critical stage within an enclosed work area. It has been reported that on some projects utilizing the cold removal process, workers have lost consciousness. Additionally, the application of these low temperatures to VAT makes the materials very brittle for handling. The breakage increases the potential for elevated fiber levels within the work area and magnifies the need to use more amended water during the handling and packaging operations.

An innovative floor tile removal method has been introduced by James Walton of Walton Systems in Massachusetts. This method involves laying a layer of foam (suds) approximately 12 inches deep. A power chipper is moved through the foam, breaking the floor tile loose from the substrate. The foam, similar to shaving cream in consistency, keeps the tiles wet and inhibits the release of airborne fibers. Walton reports that the foam dissolves in about 30 minutes, leaving a damp surface with little build-up of water that could cause damage.

John Mayer, a contractor from Lake Oswego, Ore., suggests that contractors try a 316. sledgehammer for removing old floor tile. He reminds contractors that many old floor tiles will simply break loose with a quick blow of the hammer at the center of each tile. His remarks remind us that sometimes we can forget the obvious when immersed in evaluating innovative or complex removal options. As new technology catches up with the abatement industry, more productive methods for VAT removal will come to the forefront. Until that time, the manual scrape or mechanically assisted scrape will continue to be the most utilized methods on these projects.

MASTIC REMOVAL

Once the VAT materials are removed, the abatement contractor is faced with yet another task, often more challenging than the tile removal. He must now remove all traces of the asbestos-containing mastic tile adhesive. The MTA is found in two general categories: organic/petroleum-based or synthetic-based.

The synthetic-based MTAs will show a reddish tint and will seem almost brittle in consistency. Many solutions and compounds have been

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experimented with to aid in removal of synthetic MTA. Success has been limited, and experienced contractors rely heavily on the manual scraping of these materials. The scraping process can be helped significantly by using a powered chipping machine. Amonds utilizes the powered chipper almost exclusively on synthetic MTA. He says, "An experienced chipper operator can start at one side of an area and roll the synthetic material up like a newspaper. The friction generated by the mechanical motion produces just enough heat to allow the materials to be worked in this fashion."

But Amonds reinforces the point that "The time to ascertain whether you are dealing with a petroleum-based MTA or synthetic is *before* you bid or negotiate the project. The synthetic MTAs will not be affected by the various dissolving agents available. A simple test in some isolated, unexposed area can give you the indication one way or another in less than five minutes."

After the mechanical process removes the greater portion of the synthetic MTA, manual scraping is still required for removing residual material remaining in corners and other irregularly shaped areas not accessible with the powered machines.

A new generation of dissolving agents are rapidly gaining wide popularity for the removal of the petroleum-based MTAs. These solutions, based on natural citric acid, are being marketed under many trade names, including Limi-sol, Target, Citriclean and Mastic-Be-Gone, just to name a few. These products cause a natural reaction within the petroleum base to produce effective results. However, the process happens very fast and must be performed in a well-organized manner to achieve the desired level of cleanliness.

> *"All tile and mastic can be assumed to contain asbestos and therefore should be placed under a minimal asbestos operations and maintenance program (O&M)."*

"Our men utilize the citrus cleaners on a predetermined area applying it in several stages at approximately three-minute intervals," says McQueen. "The thickness of the mastic and the degree of cleanliness desired determine the number of applications." McQueen's workers provide agitation between stages with a broom to help facilitate the reaction. When the desired penetration is achieved, McQueen adds an oil-sweep absorption material to gather any liquid run-off. Then the dissolved MTA can be easily scooped into disposal bags.

Amonds and his crew use a similar technique, although they prefer a commercial floor machine with a stripping pad to the broom method. Amonds comments, "The floor machine can cover a somewhat larger area than the broom method. We can scrub the area with the floor machine after a heavy application of the citrus cleaner and have the resulting slurry ready for collection by a HEPA vacuum in approximately five minutes. This process has performed well for us thus far."

Both McQueen and Amonds agree that the citrus cleaners leave little residual material with the exception of corners and other inaccessible locations. These hard-to-reach areas can be cleaned with minimal amounts of labor and spot applications of the citrus cleaner.

This method may sound too good to be true, and in a way it is: the citrus cleaners require some significant precautions. They are based on natural citric acid extracted from citrus fruit rind and pulp; one "load" of the rind/pulp material can be reprocessed to yield up to three runs of the citric acid base. Obviously, the first run of the base contains the strongest concentrations and is the purest product. As the reprocessing continues, subsequent runs become progressively weaker. Consequently, these weaker base materials must be rejuvenated by the addition of solvent agents. Some of these solvents have been found to contain components such as methylene chloride, and in some cases polychlorinated biphenyls (PCBs). The contractor can avoid these hazardous compounds and the necessary extra precautions when they are present by specifying first-run materials when purchasing citrus cleaner products.

But even the first-run cleaners can present problems, specifically

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those related to the high concentration of citric acid vapors within an enclosed work area. Negative air machines must remain in operation for ventilation, and special protective measures regarding worker health must be taken. McQueen cautions, "We have found the citric acid vapors to be very irritating to the mucous membranes (eyes, nose and throat). We require our workers to wear full-face respirators for eye protection, and we utilize piggyback filter cartridges with asbestos/charcoal elements for protection to the respiratory tract." Speaking from past experience, McQueen adds, "When workers have attempted to work with these materials without the charcoal filter element, we have found them suffering from various symptoms including severe headaches, mild intoxication and even loss of equilibrium. We will not allow anyone in the work areas during this process without the added respiratory protection."

From a performance standpoint, citrus cleaners do an outstanding job in removal of the petroleum-based MTAs. The abatement contractor, when observing the precautions noted here, will have a safe, efficient system by which to accomplish the MTA removal.

There are other ways to remove mastic. Jim Walton suggests that a high-pressure water system is more advisable than the chemical approach to mastic removal. This method uses a high-pressure (he

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reports 4,000 PSI) water jet to mechanically dislodge the mastic. Both water and mastic are then vacuumed from the surface by the same machine, leaving little opportunity for significant water damage or fiber release.

One contractor reports using a shot-blast machine coupled with a HEPA vacuum to remove both synthetic and petroleum-based mastics. Extremely hard beads are directed by the machine at the floor's surface. Upon impact, the beads mechanically dislodge the mastic from the substrate and both the expelled beads and the mastic are drawn back into the machine. The beads are recycled and the mastic is drawn into a HEPA vacuum for subsequent disposal.

PACKAGING AND DISPOSAL

Because requirements for packaging and disposal will vary from state to state and from locale to locale, each appropriate agency should be consulted before planning which methods to utilize for any particular project. Federal interpretation of the NESHAP regulations has remained fairly consistent. Once non-friable VAT and MTA are removed and subsequently broken, or dislodged from their place of installation, they should be packaged, handled and disposed of as friable asbestos-containing materials.

At a minimum, if more stringent requirements are not applicable, VAT and MTA should be wetted with amended water and sealed in double 6 mil disposable bags with the statutory warning labels properly affixed. The VAT materials will, in most cases, require added protection in transport and disposal because of their relative weight and the rough, sharp edges that can potentially puncture even double layers of 6 mil bags. Boxes and fiber or metal drums provide excellent containers for transport. Additionally, some landfills may require this rigid packaging for deposition into their facilities.

AIR SAMPLING

Typical asbestos removal projects often involve air samples being collected and analyzed before, during and after the asbestos removal. Since airborne fiber counts tend to remain relatively low during tile and mastic removal, less air sampling is justifiable, although some sampling is required. Sample results are needed to assure appropriate respirator use and to "clear" the project.

During most tile and mastic removal projects, contractors seem to be very efficient in keeping the phase contrast microscopy (PCM) fiber count for personal and area samples at or below 0.1 fibers per cubic centimeters of air (f/cc). However, experience and reported data show that there is often difficulty getting transmission electron microscopy (TEM) results below the typical clearance level of 0.01 f/cc, especially when the samples were collected under aggressive clearance techniques. Such TEM clearance sample results are often found as high as 0.1 f/cc. In one case, 3.0 f/cc was reported. Analysis of the fiber sizes detected by TEM has shown that most of the fibers are less than 5 microns in length.

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John M. Jenkins, an architect with Comprehensive Technical Consultants, Inc., in Atlanta, presented the following conclusions after conducting research on air counts associated with tile removal:

1. A significant amount of asbestos fiber is released during removal of vinyl asbestos tile using conventional tile removal methods.
2. Fiber control methods such as damp removal or isolation of areas by plasticizing, and use of appropriate respirators, should be utilized for tile removal.
3. Areas subjected to contamination by tile removal using uncontrolled methods should be thoroughly cleaned and tested prior to being returned to use.

WORKER PROTECTION

Floor tile and mastic removal projects pose many of the same worker hazards as do any other asbestos removal projects. W[illegible]ile there should be major concern for protecting workers against the hazard of airborne asbestos fibers that might cause disease in five to 30 years, there are hazards uniqu[illegible] to this type of removal that can cause injuries or illness in a matter of seconds or days.

As previously described, airbo[illegible]e fiber counts in the tile and mastic removal area are usually below the OSHA excursion level (1.0 f/cc fo[illegible] [illegible]0 minutes), permissible exposure limit (0.2 f/cc for 8 hours) and action level (0.1 f/cc for 8 hours). However, [illegible]e levels do become elevated ab[illegible] [illegible]e background and clearance concentrations during routine removal and may even exceed one or more of t[illegible] OSHA limits while using sev[illegible] removal techniques.

It is prudent to require employe[illegible] to wear respirators and protecti[illegible] clothing. In most cases, the respirator choice will range from a half-face air purifier with appropriate ca[illegible]tridges to a full-face, tight-fitti[illegible] powered air-purifying respirator (PAPR) with appropriate cartridges. The most desirable minimum resp[illegible]ratory protection is a respirator th[illegible] reduces the exposure to 0.01 f/cc inside the respirator. And some loc[illegible] jurisdictions may enforce even mo[illegible] stringent requirements or interpretations.

The protective clothing of choic[illegible] is most frequently disposable cove[illegible]alls. When a full decontamination setup is used, the employees should remove all "street clothing and items in the clean area before donning th[illegible] disposable coveralls, plus foot, hand, eye and head protection. Since th[illegible] purpose of this protective clothing i[illegible] to prevent asbestos contamination from being carried outside the work areas and causing subsequent exposure, the clothing requirement should be based upon several factors: airborne fiber concentration, potential for contamination during tile and mastic removal, and potential for contamination during handling, packaging and disposal.

Special foot protection may be necessary. If heavy, long-handled scrapers are used for tile or mastic removal, or if there are other potential foot hazards such as handling drums or barrels of materials, employees should have safety-toe protection. Foot protection against many hazards often can be provided by safety-toed rubber or synthetic boots. These can provide protection from wetness and slipping, asbestos contamination and chemicals. Of course, they become contaminated with the first trip into the project and must be stored in the dirty equipment area. Safety shoes or deck shoes will sometimes provide the level of needed protection and may be acceptable choices. Some foot protection over the booties is always necessary because they tear and rip quickly in these types of projects. Boot and shoe selection can be even more critical if they will be worn on surfaces covered with solvents or citric acid solutions that may attack and dissolve the materials or the glues used to construct the footwear.

Hand protection is also a concern. Gloves should be worn to keep asbestos contamination off the hands and protect against skin damage from cuts, abrasions and the amended water and chemicals used in the project. The contents of the solvents and citric acids used to remove mastic may pose unexpected hazards. Actual glove selection should be made keeping these hazards in mind. Styles range from short cotton gloves to long neoprene gloves with moisture-absorbent linings.

Many of the removal techniques make eye protection necessary. The basic options for eye protection are full-face respirators or safety glasses and goggles with half-face respirators. The full-face respirator gives increased respiratory protection in addition to eye protection.

A formal hazard communications program should be offered to inform employees about the potential hazards of the chemicals used on the project. Such chemicals include wetting agents, solvents and citric acid mastic removal agents. The hazard communication program should include, at a minimum, a list of chemicals that will be used on the project, proper container labeling, material safety data sheets (MSDS) and appropriate employee training. If the chemicals are kept in their original containers, they are usually adequately labeled; but if the chemicals are transferred to other containers, those containers should have appropriate labels placed on them identifying the contents and precautions. A copy of the MSDS for all chemicals used on the project should be kept at the jobsite and readily available to supervisors, employees and inspectors for review before the chemicals are used. However, proper labeling procedures and making MSDSs available are not adequate sources of information by themselves. Employees also should receive on-site training covering the chemicals on the list, the labels, the MSDSs, the hazards and the required precautions.

From identification to government regulations to the many removal techniques, there are still many questions regarding asbestos-containing floor tile and mastic for which there are no generally accepted or uniform answers. But considering the potential health and legal problems associated with these asbestos-containing materials, it is necessary to consider the current data and take appropriate actions based on that knowledge. As more research better clarifies these issues, the removal techniques for asbestos floor tile and mastic will accordingly become more or less stringent. ■

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