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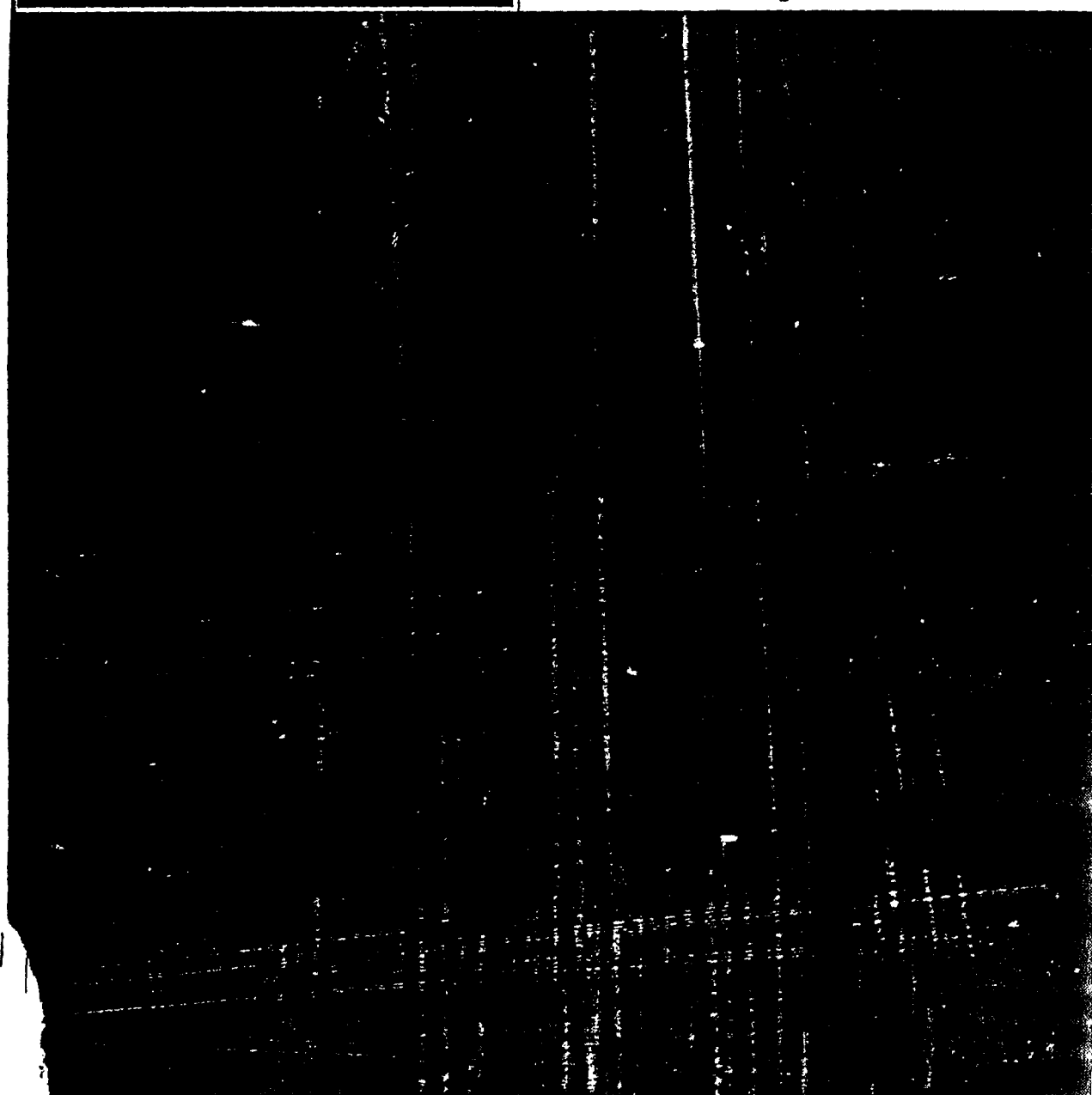
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SPECIAL SECTION

JANUARY 1986

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In June 1985, the editorial staff of *OH&S* provided its readers with the first special Asbestos section, a magazine which has received more requests for reprints than any other in our magazine's history.

For this second edition, again, we turned to the experts, and again, we were inundated from writers throughout the country who wanted to be a part of this month's magazine. Articles in this Asbestos section cover a variety of topics: vacuum removal, proper encapsulation, worker liability, the controversy between the United States and Canadian asbestos experts, and keeping workers safe in asbestos projects, in time for the National Asbestos Council meeting Feb. 18-20 in Baltimore, Md.

As the debate on asbestos continues, *OH&S* hopes this second special section will be a useful tool in Asbestos abatement projects in the months to come.


Carolyn L. Aydelotte
Editorial Director

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Electrical Hazards Should Not Be Overlooked During Abatement

Basic safety hazards may be forgotten in the push to confine asbestos fibers and protect workers

Editor's Note: This is the first in a series dealing with the basic and often overlooked safety problems faced during an asbestos abatement project. While specifically focused on the abatement project, the hazards noted are equally applicable to non-asbestos work.

Asbestos abatement projects have become increasingly technically sophisticated as the body of knowledge grows regarding effective control methods. A great deal of attention has been given to protecting workers and confining fibers. Basic and more immediate safety hazards, however, are often overlooked.

The methods used in a typical abatement project (sealing the work area, using wet methods, working at heights on ladders and scaffolding, and shutting down normal building systems) add new dimensions to the task of providing a safe working environment.

ELECTRICAL SAFETY. Electrical safety is one of the most potentially serious problems faced during an abatement project. Three factors determine the severity of electrical shock. They are:

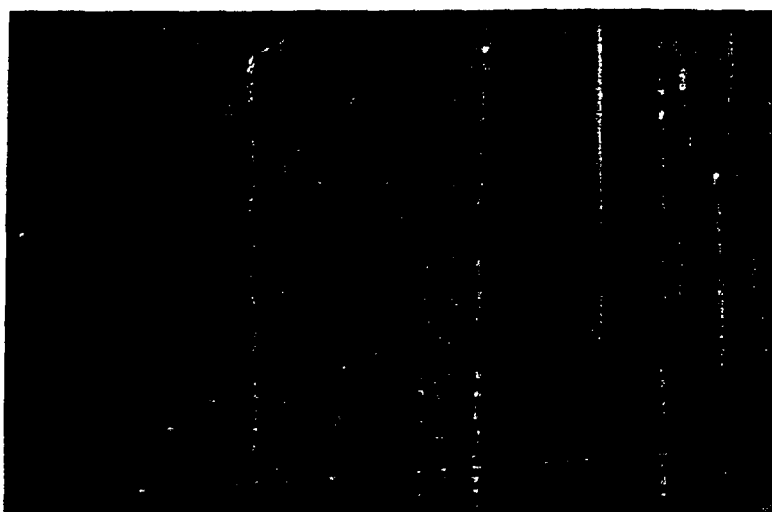
- The amount of current flowing through the body
- The path of the current flowing through the body
- The time the current is allowed to follow this path

The path of the current depends on the points of contact. Most often the path is from the hands, through the body, and out the feet. The amount of electrical resistance determines in part the amount of current flow. Moist skin or damp conditions greatly reduce electrical resistance and significantly increase a person's risk of serious injury if he comes in contact with a current source. In addition to the obvious shock potential, many deaths result from falls after a non-fatal electrical shock.

IDENTIFYING HAZARDS. During the pre-bid inspection, during preparation of the worksite and during asbestos removal, potential electrical hazards can be identified and eliminated. Examples include:

continued on page 50

By Michael D. Lowish, Safety and Health Specialist, Environmental Health and Safety Division, Georgia Tech Research Institute, Atlanta, Ga.



Basic safety should not be lost amid the sophistication of abatement.

Electrical Safety Checklist

- ☐ The use of wet methods increases the potential for electrical shock when working around electrical panels, conduit, light fixtures, alarm systems, junction boxes, computers, transformers, etc.
- ☐ De-energize as much equipment as possible. Use portable floodlight systems for lighting and regularly check the system and wiring for damage.
- ☐ Consider using dry removal in areas immediately adjacent to energized electrical equipment if de-energizing is not feasible.
- ☐ Use non-conductive scrapers and vacuum attachments (wood, plastic, rubber).
- ☐ Supply workers with heavy insulated rubber boots and/or gloves when working around energized wiring or equipment.
- ☐ Use "hot-line" covers over energized cables and powerlines when possible.
- ☐ Make sure all electrical equipment in use is properly grounded before the job starts. This means checking outlets, wiring, extension cords and power pickups. Check for the ground-pin on plugs. These checks should also be made while setting up and during the job.
- ☐ Take care not to violate insulated coverings with scrapers or scaffolding wheels. Rolling a heavy cart or scaffold over a flexcord can cause internal damage.
- ☐ Avoid stringing electrical wiring across floors. Elevate wiring if possible to keep it away from water on the floor and from damage caused by foot traffic and rolling scaffolds.
- ☐ Do not allow water puddles on work area floors. Some removal contract specifications require *damp* floors—not deep water.
- ☐ Make sure electrical outlets are tightly sealed and taped to avoid water spray.

- ☐ Always perform a walk-through check before beginning work to identify potential sources of electrical hazards to abatement workers, or equipment that may be damaged by wet removal methods.
- ☐ Use stable wooden or fiberglass—not metal—ladders.
- ☐ Determine operating voltages of equipment and lines before working on or near energized parts.
- ☐ Electrical equipment and lines should be considered energized unless tested and determined otherwise.
- ☐ Insulate or guard energized parts from employee contact and any other conductive object.
- ☐ Extension cords used with portable electrical tools and appliances should be three-wire cords connected to a GFI circuit. Extension cords:
 - should be protected from accidental damage.
 - should not be fastened with staples, hung from nails or suspended by wire (tape is an acceptable alternative).
- ☐ Portable electrical handtools should be equipped with a three-wired cord having

a ground wire permanently fixed to the tool frame, or a double-insulated type and labeled as such.

- ☐ For circuits greater than 600 volts, if electrical disconnects are not visible and open or locked out, these requirements should be met:
 - Circuits to be de-energized should be clearly identified and isolated from all energy sources.
 - A designated employee could see that all switches and disconnectors that could supply energy have been de-energized, locked out, and plainly tagged to show men at work.
 - Visual inspections and tests should be made to assure de-energizing of lines and equipment.
 - Apply protective grounds to disconnected lines or equipment.
 - A separate tag and lockout should be attached for each crew requiring de-energizing of the same line or equipment.
 - Tags and lockouts should not be removed from completed work until designated employees report that all crew members are clear and the protective grounds they installed have been removed.

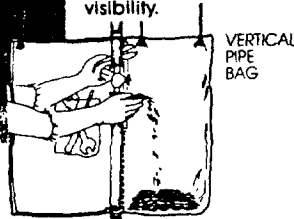
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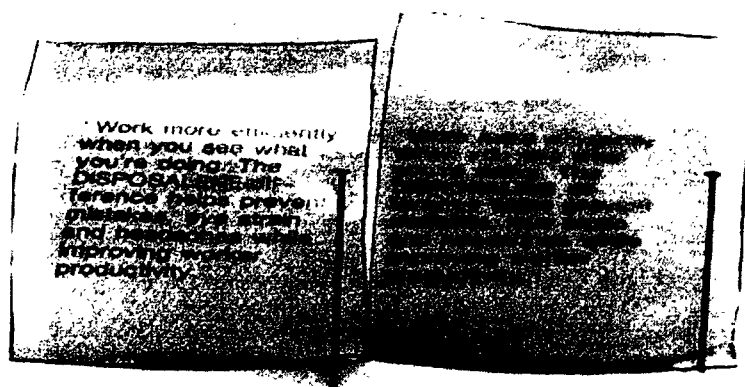
- *Wiring faults in the building.* Open ground paths, reversed wiring polarity and reversed hot-neutral or hot-ground wires can be identified with a volt/ohm meter or with plug-in circuit testers. These common faults should be corrected prior to beginning a project. This is particularly important if these circuits will be used to provide power inside the removal area.

- *Uninsulated or exposed and energized wiring or equipment.* Asbestos removal jobs are often part of renovating or remodeling projects. Overhead lighting is often removed for cleaning.

Equipment or machinery may have been moved out of the area during the removal job and wiring left in place. Damaged equipment or electrical fixtures may not have not been repaired by the building owner. All of these oversights may create sources of contact with energized electrical circuits. When possible, circuits that will not be used during removal efforts should be turned off and locked out. Wiring and electrical connections should be considered energized unless tested. Unenclosed wiring junctions in overhead areas are likely points of contact for removal workers.

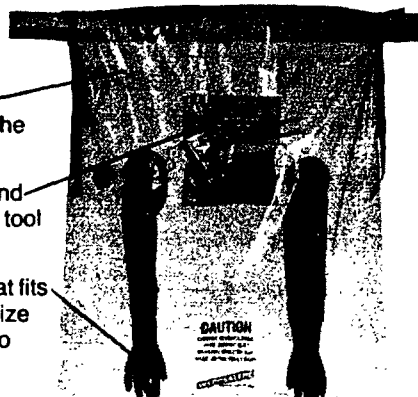
- *Asbestos abatement projects where the building remains occupied.* This is becoming more common as industrial and commercial projects are increasing. Problems occur where electrical circuits or control panels inside the removal area must remain energized because they control electricity in other parts of the building. Sealing transformers or control boxes may not be possible due to heat buildup. If this situation is encountered, polyethylene will have to be kept away to allow for air circulation and dry removal around control boxes may be necessary to avoid a serious shock exposure. In this situation, all breakers and switches should be clearly labeled in case power must be secured to other areas of the building

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These hazards are equally applicable to non-asbestos work.

during the removal project.

- *Providing power inside the removal area.* This can create hazards not associated with the building systems. Since OSHA considers abatement projects under the "29 CFR 1926 Construction Industry Safety and Health Standards," there are special requirements for supplying temporary power. This may be done by supplying power through ground fault circuit interruptors (GFCI) or by using an assured equipment grounding program. Use of GFCIs to protect all circuits prove the safest power source since any significant current leakage will trip the circuit. These devices prove most effective when kept outside the work area away from high humidity. An assured equipment grounding program requires regular inspection of all tools, cords and electrical devices with written documentation maintained.

- *Commonly found electrical devices on abatement projects.* They include lights, vacuum cleaners, negative air systems, drills, saws, heaters, sump pumps and often radios. All of these should be inspected regularly for damage, proper grounding, and integrity of insulation.

There are still several basic items that should not be overlooked. Non-metallic tools should be used for scraping to prevent a possible shock if wiring is cut or contact is made with energized equipment. Hard rubber or plastic scrapers, while more difficult to obtain, perform well for removal. Wooden or fiberglass ladders reduce or eliminate a ground path if a worker contacts an energized circuit.

OCCUPATIONAL HEALTH & SAFETY

Filtration, Pressure, Air Flow Important in Vacuum Systems

Vacuum cleaners can pick up settled dust, debris and fibers that negative air machines will miss

Selecting an asbestos abatement contractor with plenty of experience and a good track record should not be the only criteria an industrial engineer or safety hygienist should consider. Equally crucial to the success of the project is the type of equipment and vacuum cleaners the contractor is using.

In asbestos abatement operations, vacuum cleaners should complement—rather than replace—negative air units. Negative air machines are designed to trap airborne asbestos fibers, filter them out of the airflow no matter how fine they are, and maintain a negative air pressure within the abatement enclosure. Negative air machines do not pick up settled dust and debris.

Vacuum cleaners, on the other hand, recover asbestos fibers which have settled on surfaces within the abatement enclosure, filter them regardless of size, and package them in a form which is convenient and safe for "dust-free" disposal. In certain unusual situations, where the enclosure itself measures only a few hundred cubic feet, asbestos vacuums can be used effectively as negative air units.

PERFORMANCE. A vacuum cleaner's most significant performance parameters are static pressure and air flow. Both vacuums and negative pressure units are measured by these yardsticks. Static pressure is generally stated in "inches of water" or "inches of mercury." Air flow is measured in cubic feet per minute. Negative air units are large air volume/low velocity machines, while vacuums are low air volume/high velocity systems. Typical negative air units move 1,750 cubic feet of air per minute (CFM) and are capable of developing a maximum static pressure of 2.5 inches of waterlift.

Vacuums, on the other hand, vary in performance from 75 CFM to 225 CFM and create a maximum static pressure of between 55 and 110 inches of waterlift.

Whereas static pressure breaks the electromagnetic or chemical bond between the fiber and the surface to which it clings, air flow whisks that fiber away in a hurry. One feels static pressure on the palm when one seals the inlet of the



Experts recommend that sturdy plastic bags be used instead of paper bags.

vacuum cleaner with the hand. To feel air flow, on the other hand, one must insert one or two fingers into the vacuum inlet or nozzle. The combination of static pressure and air flow is what is called suction.

A delicate balance must be struck between static pressure and air flow, since it is the combination of both which translates into performance. The higher the static pressure, the lower the air flow, and vice versa. Maximum static pressure comes from closing off the inlet or hose end so it is airtight. There is no air flow at all. If you take a vacuum-producing motor out of its vacuum cleaner shell (where the air flow is channeled), you will have maximum potential air flow, but no appreciable static pressure. Somewhere between the two absolutes is where it is best to be, and nozzles are designed with this balance in mind.

FILTRATION. While a vacuum's motor is important in asbestos abatement use, the most important component of a vacuum cleaner intended for this use is its filtration system. An asbestos vacuum has to trap fibers one one-hundredth

of the thickness of a human hair. This requires a filter system which is carefully designed and properly assembled.

A word of caution: ordinary household vacuum cleaners, even those which make claims to being "heavy duty," have filters only intended to trap carpet lint, dust and at best workshop sawdust. *Household vacuum cleaners should never be used in asbestos abatement operations.* Their filters are inadequate. While you experience a false sense of security, superfine asbestos fibers blow right on through the filter, and back into the air, where they become breathable.

Filter performance involves several variables: coarseness of filter material, angle of fiber impact, air velocity and length of time in service.

Permeability (coarseness) of the filter material is one major variable because superfine dust will easily penetrate coarsely made filters. As a general rule, asbestos vacuums incorporate several stages of filtration, the coarsest being upwind or closest to the inlet. Coarse fibers are designed primarily to trap the largest agglomerations and

By Robert S. Magdelain, President,
Nilfisk of America, Malvern, Pa.

ASBESTOS—VACUUMS

"boulders" and are therefore inexpensive. As fine particles work their way through several stages of increasingly finer filters, eventually they will be trapped. Staged infiltration also ensures that all particles and fibers regardless of size are not trapped by the tightest (and most expensive) filter.

STAGED SYSTEM. A typical staged filter system consists of a primary filter (100 percent efficient at 4 microns), and a second pre-filter (99.5 percent at 2 microns). Generally, the final stage in a multi-stage filter system is the HEPA (high efficiency particulate air) filter. To be considered HEPA, each individual filter must be tested and certified to have performed with a minimum of 99.97 percent retention efficiency when challenged by a test aerosol of DOP (dioctylphthalate) averaging 0.3 microns in diameter. Such test data and certification should appear on the HEPA filter element. Those reviewing abatement equipment should realize that no vacuum cleaner of any kind should be used for asbestos abatement work if it is not equipped with a tested and certified HEPA filter.

Because HEPA filters are constructed of high technology materials

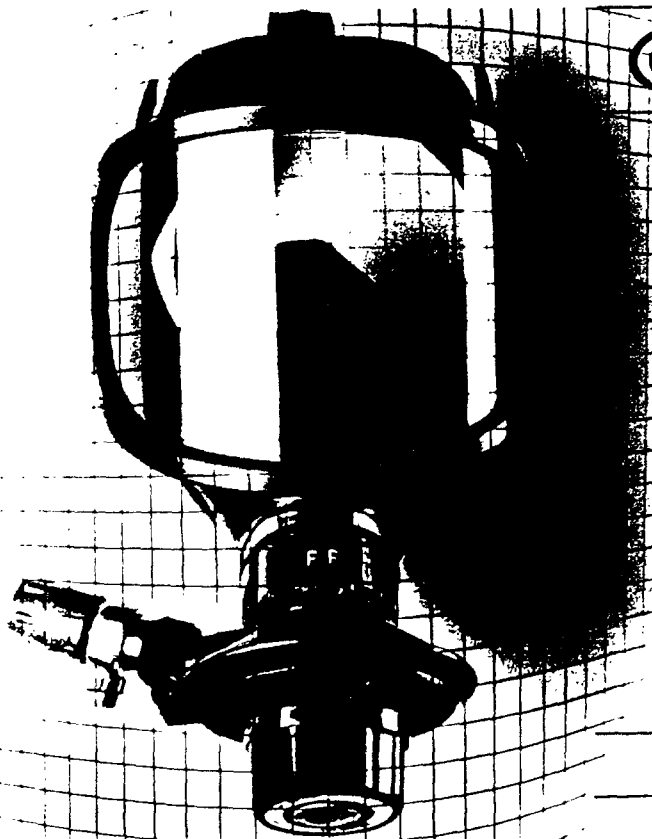
Evaluating Asbestos Vacuums Need Not be Complicated

Due to the glut of equipment and supplies now available for use in asbestos abatement procedures, it is often difficult to evaluate a product until it is used.

While most products currently available are beyond reproach, new and untested ones, as well as those that make vague declarations, should bear close scrutiny. The good news is that the quest for a suitable vacuum cleaner for asbestos can be simplified. Using only vacuum cleaners equipped with DOC (dioctylphthalate) test certified HEPA (high efficiency particulate air) filters is a reliable guarantee that the exhausted air is essentially free of asbestos fiber emissions.

The standard for HEPA filtration, in which an aerosol of very uniform DOP smoke particles is the test criterion, was forged about 40 years ago. A filter must be capable of retaining 99.97 percent of these spherical particles, down to 0.3 microns in diameter, before it can be labeled as a DOP test certified HEPA filter.

Currently, HEPA filters are widely used in a variety of manufacturing and procedural applications, most of which involve filtration of fairly large volumes of air (1,000 to 5,000 cubic feet per minute) at low velocities (5 to 25 feet per minute). Vacuum cleaners, however, move small volumes of air (75 to 250 cfm) at comparatively high velocities of 5,000 to 10,000 cubic feet per minute, or greater. At these high velocities, airborne fibers take on the characteristics of projectiles, and behave accordingly when they encounter a filter barrier. When it comes to asbestos, this presents a difficult and dangerous problem.



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OSHA's current permissible exposure limit (PEL) addresses the control of asbestos fibers of five microns in length and longer. As a result, a number of vacuum cleaner products have surfaced with optional "asbestos filters," described as 99.99 percent efficient at five microns in particle size. Due to the characteristically modest cost of these products, they may, at first glance, appear to be the most attractive choice.

Unfortunately, fibrous particles, whether asbestos or ordinary fiberglass, don't behave like spherical or irregularly shaped particles when they collide with a filter at high velocities. Fibrous particles, especially rigid and inflexible asbestos fibers, tend to align themselves with the air flow, so that it is easy to imagine one aerodynamically akin to a javelin or arrow. Just as an arrow fired at a fishing net would be more likely to penetrate than be snared, an asbestos fiber's ability to penetrate a filter is predominantly a function of its diameter, rather than its length.

A five-micron size efficiency rating can only guarantee a limit to the diameter of the asbestos fibers that will not pass through, rather than their length. Vacuum cleaners equipped with DOP test certified HEPA filters will not only capture fibers five microns in length, but also those having lengths of less than one micron.

The selection of a vacuum cleaner for asbestos should begin by eliminating products that are not so equipped. Ask for a thorough "hands-on" examination of the product before putting it to use. Look for a label certifying that the HEPA filter has successfully passed a DOP test. A retention efficiency of 99.97 percent, or greater, for 0.3 micron size particles must be inscribed on the label. With that certification in hand, the only things left to determine the quality of the product's construction warranty are correct operation and flexibility in application. ■

—By William E. LeBlanc, Nilfisk of America, Malvern, Pa.

necessary for this retention efficiency, and because all filters must be tested (no random sampling permitted), these cartridges are expensive to replace. Every effort should be made to extend the service life of such filter elements by maintaining and replacing the less expensive and less sophisticated earlier stages of filtration or pre-filters.

The angle at which a fiber or particle approaches the surface of the filter is also important. A fiber which meets the filter's surface perpendicularly (straight on) has a better chance of penetrating the filter than one which approaches tangentially. Those perpendicular fibers which don't penetrate the filter's surface have a better chance of sticking into or onto the surface, and that is how filter clogging begins.

MATERIALS. Many different materials can be used in a staged filtering system. Typically, a woven cotton or polyester cloth is used as the first stage filter, followed by either a fiberglass wool pad or a microfilter of synthetic felt, followed ultimately by an ultrafine filter or corrugated fiberglass felt. This felt, in sheet form before being corrugated, resembles the ink blotting material used before the advent of the ball point pen.

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Different surface treatments may be applied to the various filter components. Polyester filters are woven into "mole-skin" to improve their retention. Cotton

**Staged filtration
helps conserve
expensive filters.**

fibers are "napped" or brushed up to give them a surface resembling a tennis ball cover. Such a fuzzy texture reduces fiber penetration and cake buildup on the fiber exterior. Felts of all kinds are effective filtering materials because of their own random fiber alignment. Fiberglass and polyester are also favorite materials for such filtering applications because of their relative resistance to the moisture which is frequently found in an asbestos removal area.

VELOCITY. Velocity is arguably one of the most important design variables. The faster the approach velocity of a speeding fiber, the greater the likelihood the fiber will pass through the filter without being stopped. The slower the fiber's speed, the more likely its entrapment becomes. Because gross air velocity is a "constant" result of vacuum motor performance, the variable means of control over air speed is the size of the filter. The larger the surface area of the filter, the slower the speed of fiber impact on the filter surface. Similarly, undersized filters will clog faster, and as the pores in the small filters fill up, the air velocity through the clean portion of the filter will increase, improving a fiber's chances of passing through.

This relationship of volume to air to overall filter size is known as "air-to-cloth ratio" (ATC). The smaller the ATC (that is, the smaller the air volume passing through a given square foot of filter surface), the better the chances of fiber retention. To illustrate: 5:1 ATC is far better than 50:1. Vacuum designers therefore strive to pack as much filter surface as possible into a vacuum cleaner to reduce the ATC.

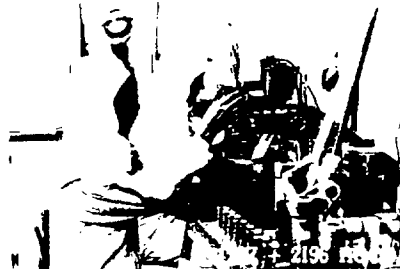
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The length of time a filter has been in service has a great deal to do with how well the filter will perform. In the beginning, a fresh filter is more porous than it is after some use. This is due to the inevitable buildup of fibers on the outside of the filter. These fibers, then, become an effective part of the filter, and make it a finer retainer of the fibers. This is true up to a point. Eventually this increasingly fine filter gets so fine that air can no longer pass through it. This clogging situation is known in the industry as "filter blinding."

DUST. Most asbestos abatement projects also generate large quantities of dust. Whether the dust is plaster, gypsum, or asbestos, it must be treated as if it were asbestos. It is therefore essential that the vacuum cleaners used in such applications be resistant to premature clogging. If a filter is undersized, it will clog quickly. Clogged filters take time and effort to unclog or replace, costing the contractor precious time. Vacuums used in asbestos abatement must have oversized filters to resist early clogging, and some means of cleaning a clogged filter without having to disassemble the cleaner. Disassembly takes time, and can result in secondary exposure of the operator to the

contents of the machine. Proper asbestos vacuum design requires the incorporation of a filter-shaking mechanism, or a reverse air purge, which can be activated from outside the vacuum cleaner, to cause caked material to fall off into the sealed container.

With the noise, bustle and heat characteristic of most asbestos abatement jobs, it is frequently difficult for the vacuum operator to know if and when his filter system should be purged. Negative air machine manufacturers, and vacuum cleaner makers may offer manometers, either as standard or as optional accessories.

Over a prolonged period of time, the fiber buildup on the contaminated side of the filter causes the pores in the filter medium to become fiber-clogged. Air transfer through the filter is restricted, causing an increase in static pressure after the filter. (As air flow is reduced, static pressure is increased.) This differential is sensed by the manometer, which alerts the vacuum operator by audible or visual means to the need for filter purging. The operator then need only activate the external purging device and resume normal vacuum cleaning operations with a renewed filter.

SAFE DISPOSAL. Containment and safe, dust-free disposal of the debris collected in the vacuum cleaner is the final consideration. Most vacuum cleaner manufacturers offer disposable paper filter bags for their machines. In an asbestos abatement environment, however, these paper bags prove to be under-engineered. Either the paper is too porous to provide fine filtration and retention of the fibers, or the liquids used to loosen friable asbestos will wet the paper and cause it to become excessively soggy. Soggy paper bags lose their ability to filter fine dust, and eventually disintegrate altogether.

Some vacuum manufacturers offer paper bags which fit inside plastic liners. When the bag is full, it is disconnected from the container inlet, and the plastic bag's sides are drawn up around the paper bag to seal it. Other suppliers have designed their equipment so asbestos is collected directly in the plastic bag, eliminating the false sense of security a potentially soggy bag can provide. Since Environmental Protection Agency guidelines provide for ultimate disposal in 6-millimeter polybags, it makes sense to capture the fibrous material in plastic bags in the first place.

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Non-Asbestos Fabrics Perform Against Heat and Metal Splashes

Workers who must be protected from heat exposure can satisfactorily wear asbestos substitutes

Asbestos has been referred to as a miracle fiber because it has a unique combination of properties in one material: high strength, durability, heat and flame resistance and excellent chemical resistance.

Conventionally, heat protective garments made from asbestos fabrics have been used in a variety of forms: proximity suits, fire smothering blankets, curtains and splash aprons. The miracle asbestos fiber provided the best heat resistance, thermal insulation and protection for molten metal splash needed to protect workers in the metals industries. However, the health hazards of working with it have challenged the resourcefulness of the safety clothing industry. In recent years, numerous substitute fibers have been developed using various high-heat resistant non-asbestos fibers; little, however, has been documented on their protective performance value, usefulness and cost-effectiveness.

Traditionally, workers in the steel industry who work near blast furnaces, pouring platforms, continuous casters and melt shop pits have used aluminized asbestos garments to get the needed protection from burn injuries caused by radiant heat exposure and splashing of molten metals.

SIMPLE CRITERIA. The fabric acceptance criteria was very simple. Often the area foreman made the final decision. Evaluation techniques consisted of in-plant trials and actual use. Variables affecting the life of the garments and safety were not always documented or quantified. In general, the aluminized asbestos fabrics offered satisfactory protection; any deviation or change from them always caused a certain degree of uncertainty and confusion.

With the advent of non-asbestos materials, consumer confusion increased. Although the consumer has a large selection, he does not have answers to his questions:

- Will the new fabric provide the same protection as "good old asbestos?"
- Will it last long enough?
- Is it cost-effective?
- Does it or will it have any health hazards?

By H.N. Lilani, BText, DIM, MBA, Manager, Research and Product Development, Amatex Corp., Norristown, Pa.

Figure 1

Types of fabric used in the study

FABRIC TYPE	FABRIC WEIGHT
1. Asbestos UG Grade	24.0 oz/yd ²
2. Core Spun Glass/Aramid fiber sheath	20.0 oz/yd ²
3. Core Spun Semi Carbon Pan/ Aramid fiber sheath	18.5oz/yd ²
4. Permanently Flame Retardant Rayon	19.0oz/yd ²

Figure 2

Maximum temperature rise, Maximum rate of heat flow values

Fabric Type	Maximum Temp. Rise In 30 Secs. (Degrees F)	Maximum Rate Of Heat Flow (CAL./CM ² SEC)
1. Asbestos—UG	34.6	1.11
2. Core Spun Glass/ Aramid	42.9	1.02
3. Core Spun SC PAN/ Aramid	16.0	0.51
4. PFR Rayon	92.6	2.88

The fabrics were visually evaluated for charring, shrinkage, perforation and metal adherence. The rating system uses number one through five in each category, with "1" representing good behavior and "5" representing poor behavior.

CATEGORIES:

CHARRING
SHRINKAGE
PERFORATION
METAL ADHERENCE

RATINGS:

1—VERY SLIGHT
2—SLIGHT
3—MODERATE
4—SIGNIFICANT
5—HEAVY

Asbestos fabric rated:

CHARRING	2
SHRINKAGE	1
PERFORATION	2
METAL ADHERENCE	2

PFR Rayon fabric rated:

CHARRING	4
SHRINKAGE	1
PERFORATION	4
METAL ADHERENCE	1

Core Spun SC PAN/Aramid fabric rated:

CHARRING	2
SHRINKAGE	1
PERFORATION	1
METAL ADHERENCE	1

Core Spun Glass/Aramid fabric rated:

CHARRING	2-3
SHRINKAGE	1
PERFORATION	4
METAL ADHERENCE	2

HEAT TRANSFER. Previous researchers have used a variety of aluminized and non-aluminized fabrics to study the fabrics' heat transfer values in molten metal splash situations and have attempted to correlate these values with important fabric properties such as weight, weave, air-permeability, fiber content and finish. Now, an attempt has been made to expand fabric evaluation techniques to incorporate other available test methods to measure fabric performance with respect to radiate heat exposure and simulated fabric wear patterns.

In the first part of this study, under controlled conditions, a certain amount of molten iron was poured onto the aluminized side of the fabrics and the heat flow through these fabrics was measured. In the second part, the aluminized surface of these fabrics was exposed to a radiant heat source for a certain length of time and then the base fabric surface was exposed to abrasion to study the wear patterns.

Although a variety of fabrics are used in outerwear safety garments, this study was limited to certain aluminized fabrics, with asbestos fabric used mainly for comparison. (See Figure 1.)

MOLTEN METAL SPLASH. These fabrics were subjected to a molten iron test to study heat flow through the fabrics. Conditions for the test consisted of pouring two pounds of molten iron from a height of 18 inches at a temperature of approximately 2,760 F to 2,850 F onto the aluminized side of the fabric samples attached to a transite board at an angle of 70 degrees. A calorimeter was used to measure the temperature rise during and shortly after the splashing, and was used to calculate heat flow through the fabric. The tested fabrics were rated into four categories. Results of the molten metal splash test are recorded in Figure 2.

The SC PAN/aramid sheath fabric showed the minimum temperature rise, whereas the PFR rayon fabric showed the maximum temperature rise. Except for the PFR rayon fabric, charring ranged from slight to moderate. PFR rayon fabric became brittle and cracked when bent.

No shrinkage was found in any of the fabrics. Significant perforation was seen in the core spun glass/aramid and the PFR rayon fabrics. Asbestos fabric was slightly perforated, whereas the core spun PAN/aramid showed only a very slight perforation.

No metal adherence was seen on the surface of the PFR rayon and the core spun PAN/aramid fabrics; whereas a small amount of metal adhered to the asbestos and the core spun glass/aramid fabrics.

REFLECTIVITY AND WEAR. A steel industry worker is often not only exposed to the risk of molten steel splash but also to the radiant heat emitted from furnaces, open ladles or red-hot metals. Generally, aluminized garments provide better protection from radiant heat. Aluminized fabric reflects 90 percent to 95 percent of radiant heat, depending on the garment

Variables affecting garment life have not always been recorded.

condition. But the remaining 5 percent to 10 percent of the heat does penetrate the base fabric. Depending on the type of fabric, exposure time, wear and tear on the garment and intensity of heat, the base fabric starts to degrade and reaches a point where it does not provide the necessary protection. It is usually discarded at that point.

In order to simulate this effect, researchers modified principles of the military heat reflectivity test. In brief, this method involved exposing the abraded aluminized surface of the fabric to a radiant heat source consisting of five infrared

quartz lamps. The average temperature of the lamps is kept at about 2,730 F. The standard specimen is placed at a distance of 1 inch from the radiant heat source. Standard exposure time is 30 seconds. The degradation through the fabric is assessed by examining the darkening of blotting paper which is normally kept behind the test specimen. These methods were modified somewhat for this study. For example, researchers eliminated the use of blotting paper and further tested the samples by studying their wear resistance after exposure. In addition, the researchers used three different exposure time modes: 60, 120 and 180 seconds, respectively.

Exposed samples were cut to 1 and seven-eighths by 9 inches to study their wear resistance. They were subjected to a simulated wear test using the Wyzenbeek Abrader. Under this method, specimens are subjected to a unidirectional rubbing action under known conditions of pressure, tension and abrasive action. The abrasion resistance is measured by the number of cycles until the fabric breaks or until the aluminum layer becomes visible through the base fabric surface. The results were charted to compare the wear resistance of the fabrics. (See Figure 3.)



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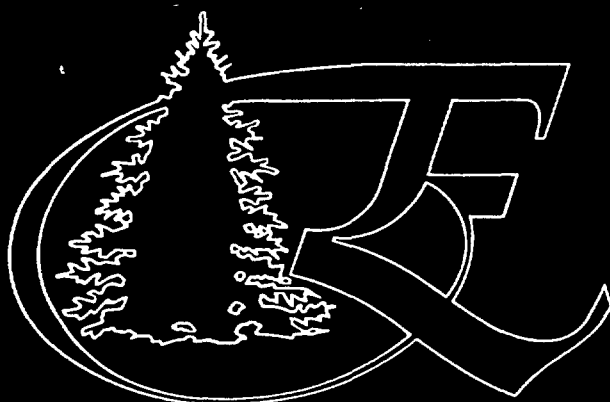
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Figure 3
Physical Properties of Fabrics

Fabric Type & Weave	Fiber Content (base fabric only), Percent	Aluminized Fabric Weight in oz/ yd ²	Thickness in Inches	Breaking Strength Lbs/Inch (min.) Warp x Fill	Tear Strength in Lbs. (min.) Warp x Fill	Char Length in Inch (max.)
1. Asbestos UG Grade (Herringbone)	Asbestos ... 85 Rayon 15	24.0	0.034"	110x85	15x13	0.5
2. Core Spun Glass/Aramid (Plain)	Glass 25 Aramid 75	20.0	0.055"	220x80	25x20	0.5



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The aluminized asbestos fabric had the greatest weight, but its breaking strength and tear strength were the lowest. The highest breaking and tear strength were observed in the PFR fabric. For all the fabrics, the char length almost remained the same 0.5 inch except for the PFR rayon fabric, which showed a maximum char length of two inches.

WEAR PERFORMANCE. The resistance of textile materials to abrasion as measured on a laboratory testing machine is generally only one of

Certain fabrics are the most cost-effective.

several factors contributing to wear performance or durability as experienced in the actual use of the material. In a comparative study only, as the heat reflectivity exposure time increases, the wear resistance of fabric decreases. This was evident in all the fabrics. Considering the three-minute exposure time mode, apparently core spun SC/aramid fabric retained the maximum wear resistance.

Based on these findings, the researchers said they believe a correlation exists between the fabric wear resistance and its exposure to radiant heat. Since this study was limited to four fabrics only, more work needs to be done to establish the validity and repeatability of this technique to evaluate fabrics.

COST EFFECTIVENESS. Based on the available unit cost information of the fabrics that were used in this study, a cost-constant was reached. The wear cost-constant is a ratio of the number of abrasion cycles it takes to break a fabric to the unit fabric cost.

Considering a 60-second time mode, the asbestos, core spun glass

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Figure 3 continued

Fabric Type & Weave	Fiber Content (base fabric only), Percent	Aluminized Fabric Weight in oz/ yd ²	Thickness in Inches	Breaking Strength Lbs/ Inch (min.) Warp x Fill	Tear Strength in Lbs. (min.) Warp x Fill	Char Length in Inch (max.)
3. Core Spun S.C. PAN/ Aramid (Herringbone)	S.C. PAN ... 75	18.5	0.040"	190x130	20x18	0.5
4. PFR Rayon (Herringbone)	PFR 85 Rayon 15	19.0	0.036"	340x170	30x30	2.0
Federal Standard Test Method	#191	5041	5030	5100.1	5134	5903

aramid and core spun SC PAN/aramid fabrics ranged between 460 and 560 cycles per dollar, whereas the PFR rayon fabric showed a cost-constant of 212 cycles per dollar. In the 120-second time mode, the PFR rayon, asbestos and the core spun glass/aramid fabrics ranged between 150 and 170 cycles per dollar. However, the core spun SC PAN/aramid performed remarkably higher, showing a cost-constant of 270 cycles per dollar.

At the 180-second time mode, PFR rayon fabric showed the lowest cost-

Steelworkers need protection from radiant heat exposure.

constant of 10 cycles per dollar. The core spun SC PAN/aramid fabric showed 210 cycles per dollar. The core spun glass/aramid and the asbestos fabrics ranged from 95 to 145 cycles per dollar.

CONCLUSION. This research indicates that the present technique to evaluate fabrics against molten metal splash can be extended to incorporate other available test methods such as the heat reflectivity test and the wear test. The wear performance of thermally degraded fabrics could be related to its cost.

Using this technique, comparative cost effectiveness data can be generated to answer a few of the questions that the consumers in the metals industry have raised. ■

For further information about non-asbestos, high-heat resistant industrial textiles, the author can be reached at 1032 Stanbridge St., P.O. Box 228, Norristown, Pa. 19404, (215) 277-6100.

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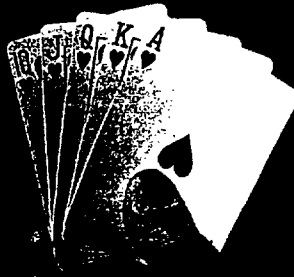
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Extent of Asbestos Danger Is International Disagreement

Canadian and American experts agree on need for more study, but disagree on dangers of chrysotile fibers

There is something of a war going on between Canada and the United States. The issue is asbestos and the disagreement centers on the question of health hazards resulting from asbestos in non-occupational settings.

Last year, two reports were issued, one by a Royal Commission for the Minister for Labour of Canada, the other by the National Research Council (NRC) for the Environmental Protection Agency. The Royal Commission report titled *Report of the Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario*, concluded in part: "We have found no evidence that disease afflicts individuals who breathe asbestos in outdoor air or inhale it as occupants of asbestos-containing buildings." But the NRC report titled *Asbestiform Fibers/Non-Occupational Health Risks*, concluded: "Non-occupational exposure to asbestiform fibers in air presents a risk to human health."

SEMANTICS QUESTION. On the surface, the two conclusions seem diametrically opposed, yet the crux of the disagreement as expressed in the conclusions seems almost a matter of semantics rather than science. It is almost a question of just how much risk is enough risk to warrant being labeled as such.

The Royal Commission Report employs an analogy to express its assessment of the risk: "The risk that an individual who had been exposed to asbestos in a building for, say, 10 years would die of an asbestos-related disease is less than one-fiftieth the risk that death would come from commuting by auto to and from that building daily for the same period."

The NRC approaches the subject with statistics: "If a person inhaled air containing asbestos at . . . 0.0004 fibers/cubic centimeter (approximate average level in indoor and outdoor air) . . . throughout a 73-year lifetime, the committee's best judgment is that the lifetime risk of mesothelioma would be approximately nine in a million. . . lung cancer would be 64 in a million for male smokers; 23 in a million for female smokers; and 6 and 3 in

By M. David Logan, Environmental Writer, Chicago, Ill. Reprinted with permission of The Asbestos Monitor, 1985.



Canadian and American authorities disagree on the threat of undisturbed asbestos.

a million, respectively, for male and female non-smokers."

SMALL RISK. Both studies admit that the risk is small, but it is important to note that these conclusions are drawn from environments where the asbestos present is undisturbed. Both groups concede that significantly greater exposure and concurrently greater risk occur when the asbestos present is disturbed. The Canadian report suggests that unwarranted removal may increase risk by disrupting a basically abeyant material.

If the two reports reach basically the same conclusion about the amount of risk in non-occupational settings, their interpretations of existing criteria in reaching those conclusions differ substantially. Of significant interest are the Canadian and American approaches to the subject of chrysotile asbestos. Chrysotile asbestos is the type of asbestos most commonly found in schools and other public buildings in

this country. In treating the question of health risks, the Canadian committee chose to examine the three asbestos types—crocidolite, amosite and chrysotile—separately. Their research found: "Crocidolite and amosite fibers tend to be more hazardous than chrysotile fibers." On the other hand, the NRC committee chose not to differentiate among the different asbestos types, citing the great uncertainty about the nature of asbestos in non-occupational settings. They subsequently put together a risk assessment that lumped together all types of asbestos fibers with no regard for the differences in toxicity detailed in the Canadian report.

LUNG PENETRATION. Those differences in toxicity were determined by gathering information from a variety of studies on the subject and examining the disease-making potential of different types of asbestos in the body. Asbestos fibers are the most danger-

ous when they penetrate deeply into the lung and embed themselves in lung tissue. There, they can cause fibrosis (scarring of the lung) and other diseases. Consequently, any influence that prevents entrance into the lung or promotes clearance before penetration reduces the chances for disease. Amazingly, estimates indicate that the body's clearance mechanisms are 95 to 98 percent effective. But a long, thin needle-like fiber can thwart the body's clearance mechanisms and embed itself deeply into tissue. If a fiber's long, thin shape is further enhanced by a resistance to acid, it is doubly dangerous because it cannot be broken up or dissolved in the weakly acidic environment it encounters inside the human body.

Crocidolite and amosite fibers tend to be long and thin. They are more likely to make their way through the narrow airway branches and nasal passages en route to the lung. The shape of the chrysotile fiber is curly, giving it a wider cross-sectional area which helps it to be trapped in the narrow airway branches, stopping its progress to the lung. In many cases, it never reaches the lung, but is coughed

up. If a fiber does manage to make its way to the lung, it may be dealt with in different ways, depending on the fiber type. Crocidolite and amosite fibers are acid resistant and tend not to be affected by the lung's weakly acidic environment. Some authorities suggest that chrysotile, on the other hand, seems vulnerable to acid and displays a tendency to split into tiny fibers or dissolve in the lung, according to the Canadian report.

Chrysotile is the type most commonly found in schools.

The experts who contributed to the Canadian report provided enough concurring evidence to conclude that: "Whatever the factor or factors of importance, there does appear to be evidence to indicate a preferential clearance of chrysotile as opposed to amphibole for example crocidolite and amosite fibers from body tissue."

CURLIER FIBERS. The NRC report grants that: "Because the curlier chrysotile fiber has a relatively large

cross-sectional area, its chances for interception in the airways is greater." It even concedes that chrysotile "seems to degrade or be removed *in vivo* more readily than amphiboles." But it remains steadfast in applying its risk assessments for generalized asbestos exposure to situations where chrysotile is the primary agent of exposure.

One reason for the NRC's firm position may be found in a study conducted in September 1980 of asbestos textile workers at Charleston, S.C. by Dr. John Dement. This study of occupational exposure found an excess of disease higher than in any other similar study, yet the workers had been exposed almost solely to chrysotile asbestos. The Royal Commission report acknowledges Dement's study and registers its misgivings, but lends credibility to the NRC's decision to play it safe and not treat chrysotile as a separate or necessarily less dangerous type of asbestos.

CRITICISM. Some authorities in the United States have criticized the NRC report, however, for its failure to make a distinction between chrysotile and other types of asbestos, claiming

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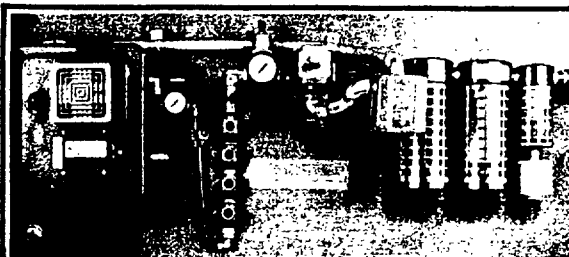
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Pleural Tumors Related to Industrial Environment

Pleural mesothelioma—tumors caused primarily from asbestos exposure—long have been a major concern to occupational physicians and industrial hygienists. Because of extensive asbestos installation in ships during World War II, and resultant tumors associated with the work 30 years later, the prevalence of the cancer is even more important today because of efforts to remove the fiber from thousands of buildings across the country.

CASES INCREASING. Since 1960, the number of recorded cases of pleural and peritoneal tumors associated with past occupational or paraoccupational exposure to asbestos has been increasing. In the United Kingdom, annual incidence is now at least 120 cases. In 1975, 260 cases were recorded in death certificates in South Africa, Australia, the United States, Holland, West Germany and other countries. The U.S. figure alone currently is estimated at more than 600 incidents per year.

The "attack rate" among occupationally exposed individuals, in general is less than 7 percent, and the excess risk of malignant mesothelioma varies according to the type of industrial exposure. It has been predicted that by the year 2000 the mortality from these tumors among men and women will increase even more.

In the United States, crude incidence rates of the tumors range from 3.0 to 7.1 per million per year. Sex-specific incidence rates adjusted by age to the 1970 population ranged from 4.4 to 11.1 per million per year in males and 1.2 to 3.8 per million per year for females—many of them also spouses of asbestos workers.

CHEST PAIN. The clinical picture of mesothelioma is characterized by chest pain in approximately 65 percent of those diagnosed. Shortness of breath is the frequent accompanying symptom present in more than half of the patients and is usually the predominant symptoms in approximately 33 percent of the patients. Joint pains also may occur.

Mesothelioma is a tumor found in persons after with an average latency period of 22 years. Prognosis is usually grave, and nearly all patients die of complications within 12 to 18 months of diagnosis. Benign forms include adenomatoid tumors of the genital tract, multicystic peritoneal mesothelioma, and benign localized fibrous mesothelioma.

Pleural mesotheliomas commonly are found covering the lower lobe and diaphragm. It can cause compression of the lung, obliteration of the pleural cavity and invasion of the superficial lung parenchyma.

The treatment of this condition is generally unsatisfactory except in the case of benign lesions. True mesotheliomas are uniformly fatal at the present time.

SURVIVAL RATE. After prognosis, patients with mesotheliomas of the epithelial type live longer than patients with a sarcomatous or mixed tumor type. The extent of the disease at the time of diagnosis seems to be the single, most important prognostic factor. Mean survival of those patients is approximately 16 months. If the chest wall or the lungs are affected, the median survival rate is only 9-10 months. With extra-thoracic involvement, the median survival is five months or less in the majority of patients. Less than 10 percent of the patients survive more than three years.

Intensive research toward new chemotherapeutic, radiotherapeutic and other treatment is being conducted at the present time. Improved industrial hygiene standards, in addition to comprehensive occupational health surveillance, should potentially reduce the prevalence of disease, although the latency of the disease and the enormous number of people exposed will result in a large number of cases before the end of this century. A NIOSH recommendation that 1 fiber per cubic foot per hour with fiber size 8mm. long by 0.5 micrometers in diameter, be standardized as the threshold limit value (TLV), may possibly result in the reduction of asbestos related diseases, including pleural tumors.

An asbestos standard currently is being developed by the Occupational Safety and Health Administration.

By Edward M. Cordasco, MD, FACP, FCCP, Dept. of Pulmonary Medicine, Cleveland Clinic Foundation; John Simelaro, DO, FCCP, FACP, Div. of Pulmonary Medicine, Philadelphia College of Osteopathic Medicine; James McMahon, PhD, Dept. of Pathology, Cleveland Clinic Foundation; and Steve Becker, MD, FCCP, (deceased) Former Staff Physician, Dept. of Pathology, Cleveland Clinic Foundation.

Editor's Note: For the authors' complete medical evaluation and references, please contact OH&S.

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it gives a false picture of asbestos health risks. Whatever the outcome, the dispute over the dangers of asbestos in general and chrysotile in particular are sure to rage on. In the meantime, both the Royal Commission and the NRC have acknowledged the need for further study.

The asbestos issue remains a fledgling one, often informed by emotion rather than scientific reasoning and careful logic. The call for more in-

Crocidolite, amosite may be more hazardous than chrysotile fibers.

depth studies is warranted. But in the meantime, those who are watching the issue must look closely at the conclusions reached by those who are best informed. The evidence indicates that undisturbed, non-friable asbestos in non-occupational settings is probably far less dangerous than what may have been assumed—perhaps responsible for no more than three deaths in a million. But what is the value of three lives?

Asbestos Contractors Feeling Crunch of Insurance Dilemma

In February 1985, a small group of abatement contractors met in Memphis, Tenn. This group, led by Larry G. Ledford, became known as the Asbestos Research Group, Inc. ARG's purpose has been to explore possible methods of providing insurance and to research what is currently available, providing the contracting industry with a network of information. AGRI reports that the U.S. government is interested in gathering more information on the problems plaguing the industry; however, government intervention seems years away.

Meanwhile, the industry continues to look for a way to perform the demanded removal of asbestos. Two companies are currently offering a "claims made" policy for a reported 17.5 percent to 25 percent of gross receipts. Great America Surplus Lines is one of the two companies writing this type of policy. The second company is AMINS formed by ACMAT Corporation. Craig Craemer of AMINS in New Hartford, Conn., reports that the company is now writing insurance for asbestos abatement contractors in the states of Connecticut, Arizona, Illinois, Georgia and North Carolina, with the licensing process in the remaining 45 states well under way.

The EPIC Insurance Group expects to begin offering a claims made policy to the industry in March. The group is currently investigating "tail coverage." If the EPIC group of New York offers the tail coverage, it will be the first policy to come close to reaching the level of protection that the extinct "per occurrence" policy would afford the contractor. EPIC's Nelson Hanover said

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the group's goals include providing abatement contractors with a source for abatement and general liability insurance and bonding services, resulting in the creation of a full service mechanism for abatement contractors. The EPIC group plans to utilize a comprehensive form of risk management, incorporating engineering criteria and an active inspection program.

There are a few other groups working toward forming insurance entities to provide abatement insurance. Their plans include setting up off-shore captives. While off-shore captives are relatively simple to set up, in order for the captives to write and issue insurance policies in the United States they should either be licensed admitted carriers in the states where they plan to write insurance or have a U.S. insurance company act as a fronting company writing policies for the captive. Licensing in all 50 states is a long, expensive and time-consuming process, and insurance companies willing to accept the risk of acting as a fronting company writing insurance for asbestos abatement are hard to find.

The abatement industry will find little comfort in the fact that it is only one of the first layer of industries being deserted by the insurance industry. The search for larger profit margins and desire to minimize exposure to the current judicial system are two of the primary reasons that insurance carriers shy away from industries where exposure is high or profit low. Obviously, the move to "claims made" policies will change the way America does business in the future. A trend should develop resulting in refusal to accept financial responsibility for unfounded or unreasonable claims of injury.

—By Anita K. Nobles, Marketing Director,
Asbestos Research Group, Inc.,
Memphis, Tenn.

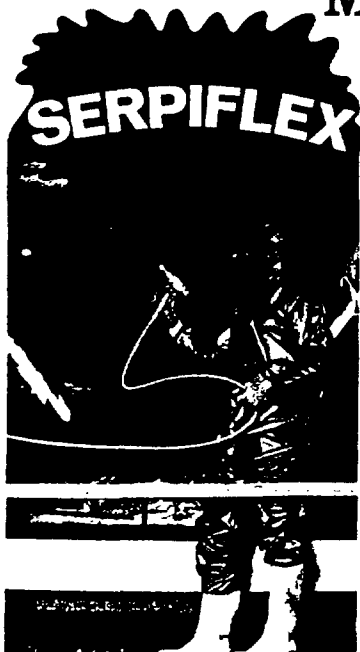
The question is not whether asbestos in non-occupational settings is dangerous. If even as few as three lives per million are lost, the answer to such a question would be yes. But how dangerous is dangerous enough

The call for more in-depth studies is warranted.

to warrant sinking time and money into programs and regulations that require asbestos removal? This is precisely the question the EPA is wrestling with in trying to construct a viable approach to the problem in schools and public buildings. ■

Editor's note: For more information on the Asbestos Monitor, contact Environmental Workshops, Inc. at P.O. Box 9318, Albuquerque, N.M. 87119.

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Asbestos Encapsulation: Penetrant Approach to Control

Encapsulation is a control approach where penetrants bind the asbestos matrix with a polymer coating

With more than 30,000 schools and 700,000 private and commercial buildings estimated to have asbestos-containing materials in them, and because ACM may pose health or legal hazards, building owners are taking control measures against these asbestos-containing materials and many are turning to encapsulation.

Encapsulation involves leaving the asbestos material in place and treating it with chemical mixtures to reduce the release of asbestos fibers.

Enclosure and encapsulation should be performed using special techniques involving strict safety and health considerations. In addition, since the ACM remains in the building, a special operations and maintenance program must be implemented and maintained to minimize exposures to airborne asbestos fibers.

BRIDGING, PENETRATING. Encapsulants are available in two designed formulations: bridging and penetrating. They are intended to work in different ways. Bridging encapsulants are formulated to stay on the surface of the ACM and form a barrier film which reduces the release of fibers. As the name implies, penetrating encapsulants (or penetrants) are characterized by penetration into the asbestos material being treated. Penetrants generally leave no thick discreet film on the surface of the asbestos like that which occurs with intentionally bridging encapsulants.

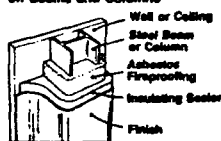
Penetrants have several basic characteristics:

- Solids content by weight is generally low (less than 35 percent), although some manufacturers recommend the reduction of higher solids materials with water prior to application.
- Viscosity of penetrants at time of application is generally less than 1,000 CPS. Lower viscosity materials generally will penetrate more rapidly and to a greater depth than more viscous material which tends to lay on the surface of the asbestos-containing material.
- Many penetrants are dye-colored, meaning they have a water-soluble dye added to impart color as opposed to a pigment. The dye-color penetrants are those having low viscosities and solids, sold ready to use without any reduction

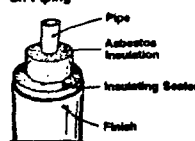
By Eugene Secor, H.B. Fuller's Porter Division, Houston, Texas.

TYPICAL ENGINEERED SOLUTIONS

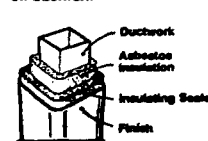
Asbestos Fireproofing on Beams and Columns



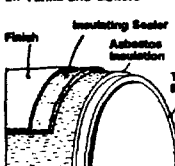
Asbestos Insulation on Piping



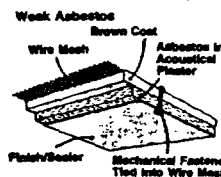
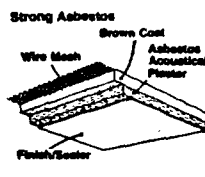
Asbestos Insulation on Ductwork



Asbestos Insulation on Tanks and Boilers

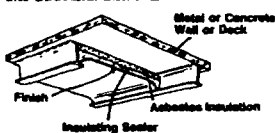


Asbestos in Cementitious Acoustical Plaster on Ceilings

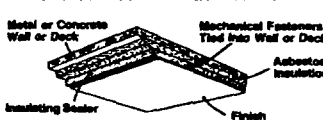


Asbestos Insulation or Fireproofing on Walls and Ceilings

Encasement System Tied into Structural Elements



Encasement System Tied into Substrate when Structural Elements are not Present



Some companies maintain that encasement is an effective alternative to encapsulation.

Some Consider Encasement Alternative to Encapsulation

Asbestos encasement is gaining increasing attention as an alternative to other abatement methods, according to researchers and industry contractors. Encasement is a method whereby a durable, structural shell is sprayed over the asbestos and, according to contractors, the sealant has high impact strengths and can withstand severe abuse.

Advantages of the encasement system, according to proponents, include:

- Preparation of areas to be encased is uncomplicated
- OSHA requirements for reduction of airborne fibers can be met
- Complete sections of buildings can be encased with minimum disruption of normal work schedules
- Materials used do not contain free water or solvents and therefore solidify immediately
- The system is less costly than complete asbestos removal
- When a building must be demolished, piping and other structures can be removed and buried with the encasing intact, making building demolition easier than under encapsulation systems, where asbestos becomes difficult to remove before demolition.

—By Sheri Hagen Poore, Managing Editor

with water. The higher-solids, water-reducible penetrants may have pigments to impart color. Color is important to help show coverage during and after application.

- The binder systems of penetrants generally are water-based organic polymers such as acrylic, vinyl acrylics, polyesters, polyvinyl acetate copolymers, acrylic vinyl acetate copolymers and modified polyester acrylics.

- Fire properties of penetrants should be rated "Class A" when evaluated by ASTM E-84 or UL723 methods. When penetrants are used on asbestos fireproofing systems, the additional organic material imparted by the penetrant should not affect the fire rating of the system. This is generally accomplished by running a small-scale ASTM E-119 test.

- In order for penetrants to be effective, they must soak or penetrate into the asbestos matrix. At least one-half inch penetration on thick asbestos systems is necessary for an effective penetrating encapsulant.

ABSORPTION PROCESS. Basically, penetrants work by soaking en masse into the asbestos material. The individual fibrous structures within the matrix

are covered on the surface with a polymeric film (binder) from the applied encapsulant through a process called absorption. It is accomplished through use of wetting agents that enhance the wetting characteristics of the polymeric material. Actual penetration is a function of capillarity and surface tension and will vary among the actual asbestos systems being treated. Upon curing—after water

Penetrants must soak into the asbestos matrix.

has evaporated—the polymeric binders harden and help bind the system together in a somewhat homogeneous mass.

Because penetrants are applied to the surface of the insulation and allowed to "soak in," the volume space near the surface will hold more binder than further in the interior. For example, in a cross section of a one-inch thick insulation, one-half inch will consist of a binder-rich, highly encapsulated layer; the next one-half inch will contain progressively less binder until the boundary is reached

where no penetration occurs.

PENETRATION TEST. One method used to determine depth of penetration is through use of a plug or bore removed from the treated insulation after curing. This plug is then placed in water to soak for several hours. After removal from the water, the length of the plug that is still intact (held together by the penetrant) is measured to be the depth of penetration.

Generally, the assumption is made that a given job has been evaluated and found suitable for encapsulation by the specifying architect, engineer or building owner. The method of encapsulation can only be successfully accomplished if the asbestos insulation is still well-bonded to its substrate, shows little evidence of water damage and is not deteriorated or delaminated.

A test can be used to determine if an asbestos-containing material has adequate adhesion and cohesion strength to handle the use of encapsulation as an abatement technique. This test method measures the adhesion force required to either separate the asbestos material from the base substrate or overcome the cohesive force within the asbestos material. It gives an indication of the ability of sprayed

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Effective Encapsulation Requires Certain Properties

Discussion of asbestos encapsulation and the products used mandates mention of the sealant testing program conducted for the Environmental Protection Agency by Battelle Columbus Laboratories in 1978 and 1979. This program developed the following list of properties to define an effective encapsulant.

- The sealant should eliminate fiber dispersal by adhering to the fibrous substrate with sufficient penetration to prevent separation of the sealant from the sprayed asbestos material.
- It should withstand most impact and penetration and still protect the enclosed sprayed asbestos material.
- It should possess enough flexibility to accommodate atmospheric changes and settling of the structure over time.
- It should have high flame retardant characteristics and a low toxic fume and smoke emissions rating. This is, of course, essential if the enclosed sprayed asbestos material was used initially for fire retardation and protection of structural members.

• It must be easily applied by nonspecialized personnel, with relative insensitivity to errors in preparation or application. Ease of repair by routine maintenance personnel is desirable.

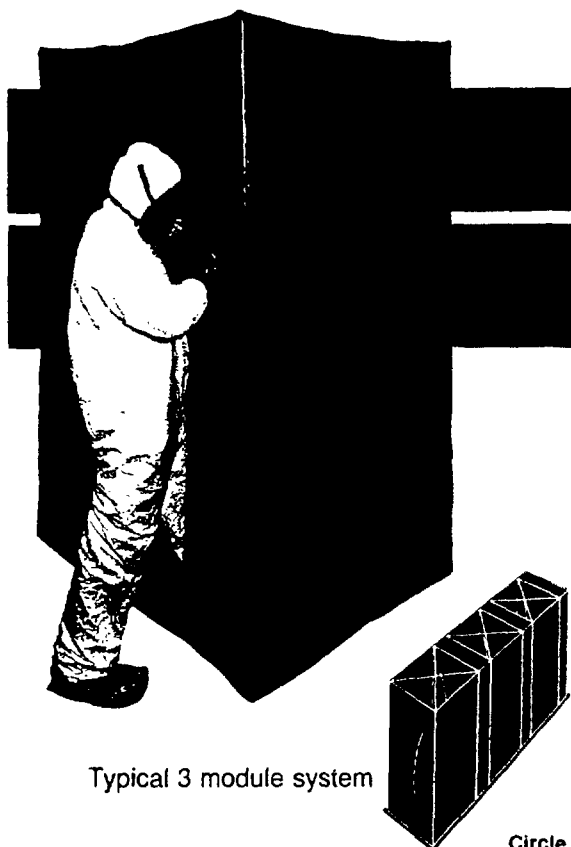
• The sealant must be neither noxious nor toxic to application workers and structure users. Since spraying creates fiber dissemination and exposure, fiber containment by barriers is desirable during application even though this may be incompatible with ventilation necessary for toxic vapor removal.

• It should have some permeability to water vapor to prevent condensation accumulation, and resistance to solution by common cleaning agents.

• It should have suitable stability to weathering and aging.

• It should be acceptable by architectural and aesthetic standards.

Of the 158 various type products evaluated under the Battelle Test Program, 33 were found to be satisfactory for encapsulation of asbestos insulation in accordance to the restricted conditions of use espoused by the EPA. The list of properties applies to both penetrating and bridging type encapsulants.



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ing by noting no further color change in a particular coat or by noting simply that the surface appears flooded. They are fooled into thinking that coverage has been achieved. A second coat may be applied in a similar fashion, but that will be the extent of it. If the job calls for the use of eight or 10 gallons per 100 square feet, for example, the contractor who has "painter's syndrome" may use only four or five gallons per 100 square feet. His conclusion is that material was overspecified or coverage rate was incorrectly determined. Neither conclusion would be valid if a proper spray test was conducted beforehand.

Proper education in the mini-coat technique with an understanding of the time-dependent nature of saturation is necessary to understand the penetration approach to encapsulation. In addition, the best—although not failsafe—method is to segregate the quantity of encapsulant necessary to do a given area and make sure the applicator spray applies all of this material prior to considering that area finished. To illustrate, consider a typical 800-square-foot classroom ceiling perhaps needing five gallons of encapsulant per 100 square feet, or a total of 40 gallons to do this room. Segregate 40 gallons specifically for this area, and do not consider the job

The contractor holds the key to the success or failure of any given project.

done until all 40 gallons have been applied. This is the recommended practice to assure proper and total application.

As an aid in helping show coverage to the applicator, many penetrants are available in various colors, generally meant to be used together on a given job. Often the quantity specified will be split evenly between the two colors. However, it may be better for estimating purposes to make the split between colors similar to 60/40 or 65/35 with the larger percent being the first color sprayed. Thus, a typical job may need four mini-coats of the first color and two mini-coats of the second to finish.

FINISHED CHARACTERISTICS. Properly encapsulated asbestos systems will have a harder, crusty surface and be much better bound than before encapsulation. Both impact strength and adhesion/cohesion strength should be enhanced. Fallout of asbestos fibers is reduced. Penetrants, however, do not turn the asbestos insulation into stone; it can still be damaged by vandalism and severe service, such as impact by basketballs or soccer balls. Keep in mind that end use is considered when evaluating asbestos insulation for encapsulation. Penetrants generally affect the acoustical and vibration properties of asbestos insulation systems less than bridging types. Asbestos-containing materials encapsulated with penetrants generally can be painted to enhance appearance.

Other uses of penetrants include:

- *Residual surface fibers.* Use of penetrants is relatively universal throughout the abatement industry for handling the so-called residual asbestos fiber problem that exists after removal. Cleaning and vacuuming techniques are not totally efficient in collecting residues from rough surfaces such as concrete or masonry decks, thus penetrants are sprayed in a flooding coat to seal this debris to the surface so it cannot be entrained into the environment. Removal of asbestos is often incomplete due to location, lack of access to the asbestos, or simply because it cannot be removed unless sandblasted. In these cases, penetrants are used to encapsulate the residue and the asbestos which cannot be removed.

- *Residual air fibers.* A more exotic use for penetrants in

removal operations and sometimes in encapsulation is to "fog" the area with penetrant, creating an aerosol atmosphere. The fog is created by spraying penetrant through a small spray tip using high pressure. The tiny droplets of penetrant contact and wet the surface of airborne asbestos fibers. Because the mass of the aerosol penetrant droplet is relatively large, it settles out rapidly, cleaning the volume space of airborne fibers.

- *Hybrid approach.* In some instances, it may be preferable to use a combination of the penetrating and bridging approaches to encapsulation. Often, this is done when the asbestos surfaces in question are extremely dusty and require a penetrating or priming first treatment to bind the surface insulation tightly together before applying a bridging encapsulant. This technique is sometimes used in stairwells or low ceiling corridors and rooms where heavy duty service is anticipated.

- *Wetting.* Penetrants can be useful for wetting down asbestos debris after insertion into proper containers. This procedure holds down release of fibers if the container is inadvertently opened.

- *Ground sizing.* Penetrants have been specified to "size" the ground or earth in the crawlspace under buildings where many asbestos pipe insulations are found. The purpose of the "ground sizing" after ACM removal and cleanup is to reduce asbestos dust.

An asbestos encapsulation project depends on the expertise of the applicator/contractor. Encapsulants are not fool-proof; in the case of penetrants, they must be applied until full saturation is achieved. The contractor holds the key to the success or failure of any given project. ■

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167- Is City of Brownsville following drilling procedure?

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in their supplies, which are drawn from the Guadalupe River. The Guadalupe is being monitored for chromium.

Steve Ellison, SHD chief of Data Reports & Water Quality Monitoring Branch, Divn of Water Hygiene, says "to the best of my knowledge, all residents whose wells were affected have been connected to Spring Hill. No one is drinking water with elevated levels of chromium in it." Chromium, particularly hexavalent types, is toxic to humans, producing lung tumors when inhaled; it also is a skin irritant. Very little is known of its effects in drinking water since it is not naturally found in groundwater.

Two persons from the area have been admitted to Brooke Army Hospital in San Antonio, but there was no confirmation that their illness is linked to chromium. However, chromium was found in their well.

Officials from the Atty General's Office were in the process of beginning legal action as TPR went to press.

MEXICAN OIL SPILL: Atty Gen Mark White held a Capitol press conference to announce Texas will sue Mexico "as a last resort" to recover damages caused by the Mexican oil spill, now contaminating Texas beaches.

Gov Bill Clements, who has met with two Mexican governors in the past week, has called it "ridiculous" to consider such a suit; new US Atty Gen Benjamin Civiletti also has downplayed such action. White notes, however, that such a decision would be up to his office.

The slick continues to increase in intensity; damage to a number of areas is being reported, and fears are increasing for sensitive estuarine areas and marine breeding grounds.

The House Environmental Affairs Cmte meets in Corpus Christi Friday and Saturday to consider the effects of the oil on the coast. Divn of Shellfish Sanitation Control, Dept of Health, continues monitoring oyster, fish, shrimp, and crab samples from the South Bay and lower Laguna Madre areas and is preparing to carry out similar samplings as the slick moves up the coast.

ACB PERMITS: The Air Control Board has received applications for these permits:

Mobil Oil Corp, R K Deford, Andrews, tank batter; Brazos Electric Power Cooperative Inc, lignite-fired steam electric power plants at Personville, Branchville, Caddo & Malakoff; Magna Corp, 2434 Holmes, Houston, 4,500-gal kettle facility; Shell Oil

Co, SB 225 & Center, Deer Park, Austin Paving Co, Carrollton, concrete batching plant; Builders Supply Co of Houston, Wright Ave, Jersey Village, & 12401 Old Westheimer, Houston, concrete batching plant; East Texas Asphalt Co, 307 Webber, Lufkin, hot mix asphalt plant.

Also, Paisano Concrete Co, El Paso, ready mix concrete facility; Border Steel Mills Inc, Vinton Rd, El Paso, spike machine reheat furnace; Exxon Corp, Neches, addition of 1,000-hp compressor to gas processing plant; Thorstenberg Materials Co Inc, Altair, sand & gravel plant; Texas Deepwater Port Auth, Freeport, marine support facility for offshore tanker unloading; Union Carbide Corp, Chemicals & Plastics, No. 19 Cock Tank Area, Texas City, marine terminal; Collins Concrete Inc, 12630 Ravenview, Dallas, ready mix concrete facility; Goodyear Tire & Rubber Co, Beaumont, crude isoprene storage tank.

ASBESTOS: State officials have no plans, at present, to take action against El Paso in connection with dumping of asbestos at the Zaragoza Landfill, where some 66 cu yds was dumped by Texaco at the site leased by the State to the city.

Weldon Baker, senior project engineer for Dept of Health's Solid Waste Management Divn, says the asbestos currently poses no health hazards "as long as (it) . . . is not disturbed." City officials had approved the dumping, which continued up to 1978; national emission standards set in 1973 require sites where asbestos is buried to be fenced and marked with signs, which wasn't done at the landfill. Baker says much of the material was dumped before the standards were set and indicates the disposal was handled much as would have been required, except for the marking.

Doug Caroom, head of the Atty General's Environmental Protection Divn, says an illegal disposal suit, or a suit for damage to state property, could be filed; it would be up to SDH or the General Land Office to request action. GLO says the matter is under study.

SOLID WASTE: The Texas Dept of Health has approved the following:

City of Crane, Type II, 60 acres, 3.25 miles NW of Crane, 1.75 miles W of US 385, S side of Oilfield Rd, Crane County.

— A new hearing is expected on an application by Cherokee County for a disposal site near Gallatin; the site is being opposed on grounds there is danger of pollution of underground water. Initial hearing was held in Rusk June 7 (See TPR 5-23-79).