HEALTH EFFECTS OF ASBESTOS EXPOSURE

Asbestos is a term that refers to a group of naturally occurring fibrous minerals. Because of their resistance to decay, and their remarkable insulating properties, asbestos fibers have been incorporated into thousands of products and materials. Unfortunately, it is now clear that exposure to airborne asbestos fibers can cause disease. The risk of developing asbestos-related disease varies according to the intensity, duration, and nature of the exposure.

THE RESPIRATORY SYSTEM

To be a significant health concern, asbestos fibers must be inhaled. An understanding of the mechanics of the respiratory system will aid in appreciating the potential for exposure, and the resulting health effects.

Every cell in the body needs a constant supply of oxygen. The respiratory system meets this need by bringing oxygen to the bloodstream, which delivers it to each cell and carries away carbon dioxide. The lungs are the focal point of the respiratory system, which also includes the respiratory tract, the channel by which air flows into and out of the lungs. Attached is an illustration of the respiratory system. Inhaled air passes through the nose, where moisture and tiny hairs filter dust. It then passes down the throat where air is also humidified. Air continues into the trachea, a tube supported by rings of cartilage. Just above the heart, the trachea divides into two bronchi. Each bronchus leads into a lung where it subdivides into bronchioles and smaller air tubes - giving the appearance of an upside-down tree. The tiniest tubes end in globular air sacs, or alveoli.

The actual exchange of gasses -- respiration -- takes place in the alveoli. There, blood vessels only one cell thick allow oxygen and carbon dioxide to trade places. The carbon dioxide is exhaled back up the respiratory tract. The blood picks up fresh oxygen and transports it throughout the body.

The lungs, cone-shaped, balloon-like, elasticized tissue, are located on either side of the chest. Each lung is encased by a double layer of membrane, or pleura. One layer is attached to the lung, the other to the rib cage. Space and fluid between the two layers enable the lungs to expand and contract in the chest cavity without friction. To visualize this association, think of two panes of glass with a drop of water between them. The pieces of glass, like the linings, slide easily across each other, but are difficult to pull apart. When we breathe in, the diaphragm stretches out flat and muscles between the ribs contract with it, pulling the ribs up and out. This expands the chest cavity, creating a vacuum between the linings that expands the lungs and sucks in air. When breathing out, the diaphragm and rib cage muscles relax, the ribs fall in and down, and the lungs contract and push out the carbon dioxide and unused oxygen.

The respiratory system is sensitive to bacteria, viruses, and many airborne particles that can be inhaled. Reactions to these irritants can disrupt the functioning of the system, resulting in many ailments including the following: the common cold, hay fever, sinusitis, sore throat, acute or chronic bronchitis, emphysema, and lung cancer.

The body has several mechanisms by which it filters the air it breathes. The tiny hairs in the nose filter out dust and airborne particles. Like the nose, the trachea and the bronchi are lined with small fine "hairs" called cilia. Together with mucous secreted by cells lining the airways, cilia trap particles and helps prevent respiratory infections. The cilia beat in an upward direction sweeping foreign particles up to the back of the mouth where they are expelled or swallowed. Viruses and bacteria are also attacked by enzymes called lysozymes in the mucous cells. Microbes that slip through are usually handled by white blood cells called phagocytes that envelop and eat these invaders in the lung.

Cigarette smoking temporarily paralyzed the cilia. If smoking continues long enough, the cilia wither and die. They are never replaced. The efficiency of the cilia is replaced by the smoker's inefficient cough which attempts to rid the respiratory tract of foreign particles and excess mucus.

Dirty, contaminated air presents the greatest challenge to the respiratory system. Some of the particles entering the airways reach the alveoli. When this occurs, white blood cells called macrophages attempt to engulf and digest the particles. In the case of asbestos, we are dealing with a mineral fiber, a substance which macrophages can often not successfully attack. As a means of secondary defense, the macrophages deposit a coating on the fibers which are then deposited in the smaller passages. Here they clog and actually scar the tissues. The walls of the alveoli lose their elasticity and useful function in respiration. Coated asbestos fibers ("asbestos bodies") are often seen at autopsy.

ASBESTOS-RELATED DISEASES

Asbestos exposure can cause a number of disabling and fatal diseases. The principal route of exposure is by inhalation through the nose and mouth. Asbestos, traditionally valued for its indestructibility, is especially resistant to the internal defenses of the human body. Once lodged inside the lungs, most fibers will not break up or dissolve, and they cannot be neutralized or removed.

ASBESTOSIS

Asbestosis is a disease which is characterized by pulmonary fibrosis, a progressive scarring of the lungs caused by the accumulation of asbestos fibers. Asbestosis is associated exclusively with chronic, occupational exposure. The build up of scar tissue interferes with oxygen uptake through the lungs and can lead to respiratory and heart failure. Often, asbestosis is a progressive disease, even in the absence of continued exposure. Symptoms include shortness of breath, cough, fatigue, and vague feelings of sickness. When the fibrosis worsens, shortness of breath occurs even at rest.

PLEURAL PLAQUES

Pleural plaques and pleural calcification are markers of exposure and may develop 10 to 20 years after initial exposure. Plaques are opaque patches visible on chest x-rays that consist of dense strands of connective tissue surrounded by cells. All commercial types of asbestos induce plaques. Plaques can occur even when fibrosis is absent and do not seem to reflect the severity of pulmonary disease.

LUNG CANCER

Of all the diseases related to asbestos exposure, lung cancer has been responsible for over half of the excess deaths resulting from occupational exposure. Although tissues and cells react to the presence of asbestos immediately, detectable symptoms take years, or more often decades, to manifest themselves. Asbestos-induced lung cancer may not show up on x-rays for twenty years or more after the exposure began (this delay is referred to as the latency period). Even in cases of prolonged, heavy exposure abnormalities commonly appear on x-rays only after ten or more years have elapsed since the onset of exposure.

ASBESTOS AS A CO-FACTOR

Other substances appear to cooperate with asbestos to multiply the risk of lung cancer. Asbestos exposure in combination with cigarette smoking can multiply the risk of developing lung cancer as much as ninety times over the risk to a non-smoker with no history of exposure to asbestos.

MESOTHELIOMA

Mesothelioma, a malignant cancer of the membranes which line the lung cavity, is another disease related to asbestos exposure. Malignant mesotheliomas of these membranes (the pleura and the peritoneum) are extremely rare in persons with no history of asbestos exposure, but may account for 10%-18% of excess deaths in workers exposed to asbestos. Generally, a latency period of at least 25 to 30 years is required in order to observe mesotheliomas, and some victims have had a latency period of forty years since their initial exposure to asbestos. This form of cancer is incurable and is usually fatal within a year after diagnosis. Mesothelioma had been associated with short term, incidental exposure, but there is no evidence of a relationship between cigarette smoking and mesothelioma risk.

OTHER CANCERS

Some health studies have observed increases in esophageal, stomach, colo-rectal, kidney, and possibly ovarian cancers, as well as, cancers in the nose and throat from exposure to asbestos. While the magnitude of increased cancer risk for these sites is not as great as for lung cancer and mesothelioma, the increased risk may be of considerable importance because of the high background rates of some of these tumors in the general population.

A 50% increase in a common cancer such as colo-rectal cancer results in many more deaths than a 50% increase in a rare cancer.

ASSESSING INDIVIDUAL RISK

We can define three kinds of exposure to airborne asbestos: occupational exposure occurs on the job as a result of job-related activities; non-occupational exposure occurs in buildings where asbestos-containing materials are present (and may have been disturbed); environmental exposure occurs when the ambient air outside contains asbestos fibers. The risk of developing disease will vary according to the nature of the exposure involved.

OCCUPATIONAL EXPOSURE

The Occupational Safety and Health Administration has declared that they are "aware of no instances in which exposure to a toxic substance has more clearly demonstrated detrimental health effects on humans than has asbestos exposure". By one count, over 21 million men and women were occupationally exposed to asbestos between 1940 and 1980 alone. 9,000 are expected to die every year from asbestos-related cancer. Thousands more will succumb to the debilitating effects of asbestosis.

The accumulation of data available on the risk of disease associated with occupational exposure to asbestos is of unusual quality and size. No extrapolation from animal data is required to predict human mortality, for example, because the dimensions of the human tragedy created by occupational exposure to asbestos are so great. The risks involved in non-occupational and ambient exposure are less well understood. Although many questions remain unanswered, several conclusions can be drawn (and many lessons learned) from the knowledge gained in this way.

The clearest discernible trend in the data is the linear relationship between the cumulative dose of asbestos inhaled and the incidence of disease. Simply put, large doses of asbestos fibers are clearly linked to a higher incidence of disease. Duration of exposure is also a factor. Brief exposure to enormous quantities of asbestos and long term exposure to low levels of asbestos has been associated with a higher risk of developing disease. Short term exposure to low levels of asbestos will not cause asbestosis, but it is not known what the risk of developing cancer is at low levels of exposure.

Although the initial focus of inquiry was on the exposures associated with the manufacture of asbestos products (it has been estimated that there are over 3,000 industrial and commercial applications for asbestos), after World War II the focus shifted to include exposure associated with product use. Research on short term occupational exposure and on workers with low cumulative exposures has confirmed that excess mortality can be expected at low occupational exposure levels.

OSHA published the following estimates of cancer risk from asbestos exposure in 1983:

Airborne Fiber Level (>5 microns long)	Duration of Exposure	Excess Deaths
.5 f/cc	45 years	17/1000
.5 f/cc	20 years	11/1000
2 f/cc	1 year (8 hrs. x 250 days)	3/1000

Prompted by this kind of information, in 1986 OSHA lowered the Occupational, eight hour time-weighted average, the Permissible Exposure Limit, from 2 fibers (longer than 5 microns) per cubic centimeter to .2 fibers (longer than 5 microns) per cubic centimeter.

NON-OCCUPATIONAL EXPOSURE

In 1980, a National Institute of Occupational Safety and Health (NIOSH)/OSHA work group concluded that there was no level of exposure to asbestos below which clinical effects did not occur and recommended a Permissible Exposure Limit based on the lowest measurable airborne fiber level (0.01 fibers per cubic centimeter). EPA has accepted this conclusion and recommends that 0.01 fibers per cubic centimeter be used to define the successful completion of asbestos abatement work. The risks associated with low levels of cumulative exposure are not well-established, however, and considerable debate surrounds the issue.

The principal evidence for the risk of developing asbestos disease from non-occupational exposure is derived from studies that found excess mortality resulting from incidental contact with asbestos. Some studies found excess mortality from mesothelioma among the wives and children of asbestos workers. Other studies found excess mortality among community members living near mines and factories that produce asbestos materials. Quantifying exactly how much exposure occurred in these instances, however, is not a straight forward process. The level of non-occupational exposure responsible for the excess disease encountered in these groups may have been significant. It is not inconceivable, for example, that the wives of asbestos workers were exposed to fiber levels above the current OSHA Permissible Exposure Limit (0.2 f/cc) whenever they laundered asbestos-laden clothes.

The limitations of epidemiology (research on epidemic diseases) are widely acknowledged, and become pronounced when the risk of disease from non-occupational exposure to asbestos is the object of study. Calculations are made and projections offered, but it will be very difficult to verify or contradict them. Epidemiologically, very large, carefully defined populations would be required before a conclusive study can be performed. Confounding variables such as migration into and from communities, and multiple exposures to other toxic chemicals and carcinogens consistently frustrate attempts to generalize about the risk of low level exposure.

At low levels of exposure, for example, asbestos may serve only as a "cancer promoter", acting as a co-factor along with other substances and carcinogens to elevate the risk of developing cancer above normal. This is clearly the case with asbestos and cigarette smoke, but other chemicals and agents may react in a similar way to the presence of asbestos fibers.

Defining how asbestos causes cancer may eventually allow us to discriminate between different kinds of exposure. The evidence that some kinds of asbestos are more toxic than others is, so far, contradictory and inconclusive. Other research has suggested that asbestos fibers of all kinds are toxic because of their size and shape, not because of the way they interact chemically with tissue. Fibers that are less than .25 microns in diameter (invisible, except to the electron microscope) and longer than 8 microns long may have especially toxic properties.

Because asbestos fibers do accumulate in the lungs, and because the risk of developing disease does increase as the <u>cumulative</u> dose increases, exposure to asbestos should be controlled or eliminated whenever possible. Even a relatively minor source of airborne asbestos fibers should be abated or avoided, in order to maintain the cumulative dose at a minimum.

AMBIENT EXPOSURE

Detectable levels of asbestos fibers in the ambient air are a fact of life in many metropolitan areas. The evidence for excess risk of disease from exposure to ambient levels of asbestos is very inconclusive. Similarly, attempts to quantify the medical effects of elevated levels of asbestos in drinking water have also failed.

The principal sources of ambient asbestos are quarrying, mining and milling, and manufacturing of asbestos products (both primary and secondary). Many automobile brake shoes contain asbestos, and the friction applied during braking releases fibers. The California Air Resources Board and the California Department of Health Services recently reviewed the existing medical evidence and decided to define asbestos as a Toxic Air Contaminant (TAC). A toxic air contaminant is an air pollutant that "may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health". They nevertheless concluded that "ambient asbestos levels in California are not expected to cause any acute health effects nor to result in asbestosis". It has also been suggested that the majority of ambient asbestos fibers do not fall within presumed toxic dimensions.

CONCLUSION

Dr. Irving Selikoff, the principal researcher on the health effects of asbestos, has observed that "concern about very low levels [of asbestos exposure] seems somewhat out of touch with reality [given that] maintenance and repair work on asbestos materials is often undertaken without precautions and supervision".

In fact, many researchers believe that an additional pulse of worker mortality will be the inevitable result of negligent management of asbestos materials in buildings. Although the focus of concern is once again an occupational exposure of this kind, anxiety about building occupants who enter areas after asbestos materials have been negligently handled and disturbed may not be entirely misplaced.

In order to prevent outbreaks of asbestos disease in the future, asbestos exposure must be controlled today. When asbestos materials are managed calmly and deliberately and handled properly when removal is necessary, the potential for non-occupational exposure can be significantly reduced.

REFERENCES

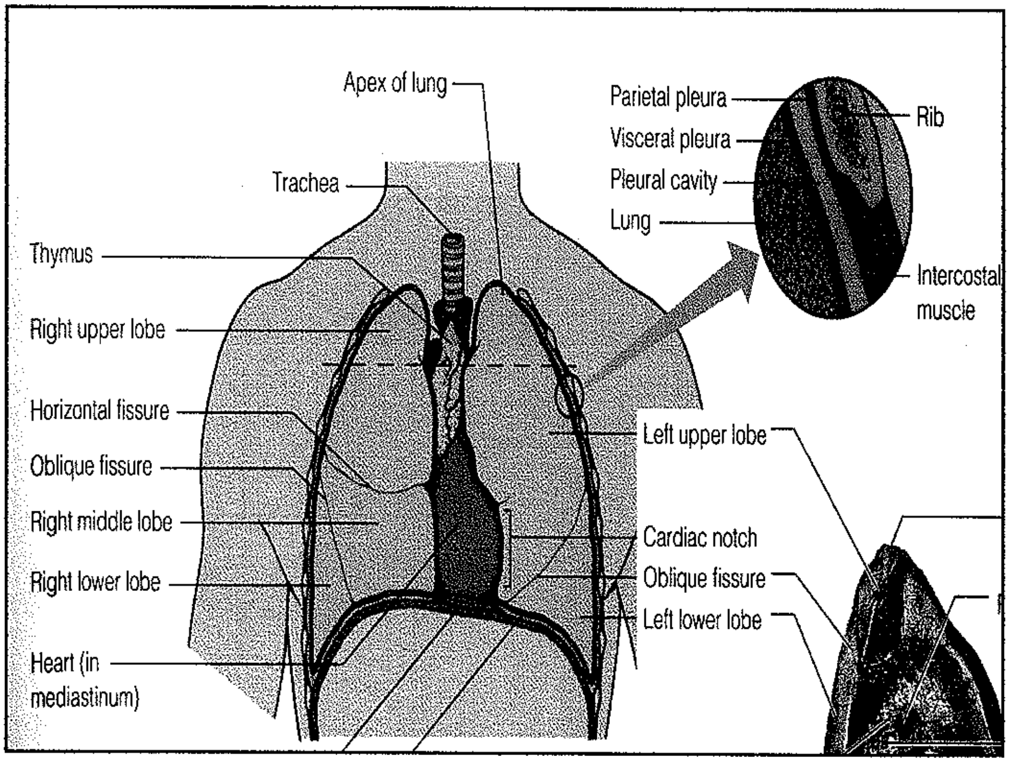
Entire Section was an Excerpt From UC Berkeley Extension Training (Circa 1990)

California Air Resources Board and The Department of Health Services (1985), Report to the Scientific Review Panel on Asbestos.

Occupational Safety and Health Administration (1983), Occupational Exposure to Asbestos; Emergency Temporary Standard. Federal Register 48(215): 51086

Selikoff, Dr. Irving J. (1984), Twenty Lessons From Asbestos, A Bitter Harvest of Scientific Information. EPA Journal, USEPA Office of Public Affairs (A-107), Washington D.C.

ILLUSTRATION OF RESPIRATORY TRACT



Mesothelial cells line the outside of the lungs and the pleural and peritoneal cavities. Interaction of asbestos with these cells can result in either pleural or peritoneal mesothelioma.

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ASBESTOS RELATED DISEASES

INHALATION

Asbestosis
Lung Cancer
Mesothelioma

INGESTION

Digestive System
Organ Cancer

SKIN CONTACT

Asbestos Corns

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CAUSES OF DEATH FOR 17,000 INSULATORS, USA AND CANADA, 1967-76, COMPARED TO THE US MALE POPULATION (DR. SELIKOFF)

CAUSE OF DEATH	MALES, US	ASBESTOS WORKERS
All Causes	1658.9	2271
All Cancer	319.9	995
Lung	105.7	486
Pleural mesothelioma	0	63
Peritoneal mesothelioma	0	112
Cancer, esophagus	7.1	18
Cancer, stomach	14.2	22
Cancer, colon-rectum	38.1	59
Cancer, larynx	4.7	11
Cancer, mouth	10.1	21
Cancer, kidney	8.1	19
Cancer, all other sites	131.8	184
Non-infectious lung disease	59.0	212
Asbestosis	0	168
All other causes	1280.2	1064

EFFECT OF SMOKING AND ASBESTOS ON LUNG CANCER OF 8220 INSULATORS AND 73,763 CONTROLS WITH KNOWN SMOKING HISTORY, 1967-76 (HAMMOND)

GROUP	EXPOSED TO ASBESTOS	SMOKER	DEATH RATE*	RATIO
Controls	No	No	11.3	1.0
Insulators	Yes	No	58.4	5.2
Controls	No	Yes	122.6	10.9
Insulators	Yes	Yes	601.6	53.2

* Per 100,000 man-years

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TYPES OF ASBESTOS FOUND IN THE UNITED STATES

TYPES	PERCENT FOUND IN US PRODUCTS
Chrysotile	85
Amosite	10
Crocidolite	3
Actinolite	<1
Anthophyllite	<1
Tremolite	<1

ASBESTOS QUALITIES

(1) High Heat Stability
(2) Thermal and Electrical Insulation
(3) Ability to be Woven
(4) Stability in Acids and Alkalies
(5) High Tensile Strength and Stability
(6) Low Cost

SOURCES OF ASBESTOS-CONTAINING MATERIAL IN SCHOOLS

	NORMAL PERCENT ASBESTOS
FRIABLE	
Sprayed or Troweled Insulation	3-10
Pipe and Boiler Insulation	15-65
NON-FRIABLE	
Filter/Gaskets	20-50
Roof Tile	20-40
Wall Board (Flex Board)	20-40
Shingles	15-25
Pipe	20-35
Floor Tiles	15-20
Acoustical Tiles	1-30
Paints, Spackling Compounds	4-8
Joint Compounds	5-20
Duct Wrap	20-80
TEXTILES	
Stage Curtains	30-50
Welding Curtains	40-70
Gloves	20-30
Firefighting Gear	20-30
Fire Blankets	40-90

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MATERIAL	SUSPECTED ACBM	NOT COVERED BY AHERA RULE
Concrete		X
Surfacing Materials (e.g., Spray-Applied or Troweled-On Materials on Walls and Ceilings)	X	
Blackboards		X
Wall Board (Material Could be Gypsum, Transite, or Other Product)	X	
Pressed Wood		X
Thermal System Insulation	X	
Corrugated-Like Paper Product Used for Thermal System Insulation		
Wall or Ceiling Carpet		X
Gaskets in Heating and Air Conditioning Equipment	X	
Floor Tile (Includes Adhesives)	X	
Ceiling Tile and Panels	X	
Exterior Roofing Shingles		X*
Auditorium Curtains		X*
Cement Asbestos Water Pipe	X	
Chemical Lab Table and Desk Tops		X*
Fire Doors	X	
Fire Brick for Boilers	X	
Suspected ACBM Stored in School		X*
ACBM Cloth Adjoining Airducts	X	
Chemical Lab Gloves		X*
Fire Blanket		X*
Glass		X
Steel		X
Sheeting in Fume Hood	X	
Brake Shoes		X*
Kiln Bricks and Cement		X
Bunsen Burner Pad		X*

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* Could Contain Asbestos

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FRIABLE VS. NON-FRIABLE

FRIABLE – Materials which are powdery or which can be crumbled, pulverized, or reduced to powder in the hand -- readily releasing fibers with minimal mechanical disturbance.

NON-FRIABLE – Matrix-bonded products made by mixing fibers with various bonding agents (i.e., starch, glue, plastics, cement, asphalt).

NOTE: In some textile products, asbestos fibers and fibers of numerous other materials, both of organic and inorganic origin, are worked into yarn cords and can be woven, braided, or knitted. Most of these products are simply coated.

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NOTES ON NON-FRIABLE ASBESTOS CONTAINING MATERIALS

There are several types of non-friable asbestos-containing materials. These include vinyl asbestos tiles, transite wall panels, flue pipes, transite shingles (siding and roof tiles), counter tops, gaskets, filters and wire coverings.

All of these asbestos-containing materials are bound with the other materials in each product and do not give up asbestos fibers unless substantial abuse occurs. Following is a brief discussion of some of these asbestos-containing materials.

Vinyl Asbestos Tiles

VAT's contain 5-20% asbestos. Nine inch tiles usually contain asbestos and 12" tiles less often. The asbestos is normally below the vinyl layer. Asbestos fibers do not release into the air unless the tile is worn through or it is ground away to its substrate. Drilling or sanding the tiles or careless removal will also cause fiber release. Often times the adhesive layer on the back of the tiles contains asbestos. This material more readily release fibers.

Transite Panels

These are commonly found in laboratory fume hoods, behind stoves and ovens, around kilns, at welding booths, in heater or furnace rooms and as exterior siding. These materials do not release fibers unless they are cut with a saw, drilled, ground or otherwise reduced to powder.

Counter Tops

Many of the molded black counter tops found in science rooms, and sometimes home economics rooms, contain asbestos. The purpose of the asbestos is to prevent damage from hot or caustic materials. Again, these materials do not release fibers unless cut, drilled, sanded or otherwise pulverized into powder.

Transite Flue Pipe

These are found at heater, boiler and furnace vents where the units are gas fed. They do not release fibers unless they are abused as described above.

Transite Shingles and Siding

Shingle siding and roof tiles are commonly found on the exteriors of many school buildings. Once again, they do not release fibers unless substantially abused.

Asphalt Roofing

Built-up roofing felts often contain asbestos. These are non-friable in place, but may release fibers during repair or removal.

Gaskets, Filters and Wire Coverings

These materials are not commonly found in schools and do not present an exposure to asbestos unless an unusually large amount is found.

OPTIONS FOR CONTROLLING ACBM

METHOD	ADVANTAGES	DISADVANTAGES	APPROPRIATE APPLICATIONS	INAPPROPRIATE APPLICATIONS	GENERAL COMMENTS
Removal	Eliminates Asbestos Source Eliminates Need for Special Operations and Maintenance Program	Replacement With Substitute Material may be Necessary Porous Surfaces Also may Require Encapsulation Improper Removal may Raise Fiber Levels	Can be Used in Most Situations		Containment Barriers Needed Worker Protection Required Wet Removal is Required for all Types of Asbestos, (Amosite Will not Absorb Water or Water With Traditional Wetting Agents) Disposal may be a Problem in Some Areas Unusual Circumstances, Complex Surfaces, and the Presence of Utilities may Require Special Removal Techniques
Enclosure	Reduces Exposure in Area Outside Enclosure Initial Costs may be Lower Than for Removal Unless Utilities Need Relocating or Major Changes Usually Does not Require Replacement of Material	Asbestos Source Remains and Must be Removed Eventually Fiber Release Continues Behind Enclosure Special Operations Program Required to Control Access to Enclosure for Maintenance and Renovation Periodic Reinspection Required to Check for Damage Repair of Damaged Enclosure Necessary Fibers Released in Dry Form During Construction of Enclosure Long-Term Costs Could be Higher Than for Removal	ACM is Located in a Small Area (e.g., a Column) Disturbance or Entry Into Enclosed Area Unlikely	Damaged or Deteriorating Materials Causing Rapid Fiber Release Water Damage Evident Damage or Entry Into Enclosure Likely Ceiling to be Enclosed is Low	Containment Barriers Needed Use of Tools With HEPA-Filtered Vacuum Attachments Advisable Worker Protection Needed
Encapsulation	Reduces Asbestos Fiber Release From Material Initial Costs may be Lower Than for Removal Does not Require Replacement of Material	Asbestos Source Remains and Must be Removed Later If Material is not in Good Condition, Sealant may Cause Material to Delaminate Periodic Reinspection Required to Check for Damage or Deterioration Repair of Damaged or Deteriorating Encapsulated Surface Required Encapsulated Surface is Difficult to Remove and may Require Dry Techniques for Eventual Removal Long-Term Costs may be Higher Than Removal	Material Still Retains Bonding Integrity Damage to Material not Likely Material not Highly Accessible Material Granular - Cementitious After Removal of ACM, if the Substrate is Porous	Material Does not Adhere Well to Substrate Material is Deteriorating or Damaged, or Damage is Likely Water Damage is Evident Material is Fibrous, Fluffy	Containment Barriers Needed Worker Protection Needed Airless Sprayers Should be Used Previously Encapsulated Materials may Have to be Re-Encapsulated

RESPONSIBILITIES OF THE ASBESTOS COORDINATOR

1. Ensure that any activity that has to do with asbestos is done in compliance with all Federal, State, and Local regulations.

2. Ensure that all personnel are properly trained or accredited.

3. Ensure that short-term workers (outside contractors) are properly notified.

4. Ensure that employees and staff are properly notified.

5. Ensure that warning labels are posted in routine maintenance areas that contain ACBM.

6. Ensure that 6 month surveillances and 3 year reinspections are properly conducted, if performed by District.

7. Ensure that response actions are implemented in a timely fashion.

8. Ensure that all records related to asbestos activities are properly completed and maintained in a current state.

9. Ensure that the Management Plan is maintained in a current state.

10. Ensure that the Management Plan is available to employees and staff.

11. Know where the asbestos is in all buildings controlled by the District, and know its condition.

12. Certification letters of new buildings and/or materials are obtained from the manufacturer or contractor.

13. Potential for conflict of interest that may arise between accredited personnel that are hired by the District.

RECORD KEEPING REQUIREMENTS

Training (Names, Dates, Sources)

Minor and Major Fiber Release Episodes

Operations and Maintenance Activities

- Preventative Measures
- Cleaning
- Work Authorizations

Notification of Outside Service Contractors

Response Actions (Abatement of Asbestos)

List of Remaining ACBM After Response Action

Periodic Inspection (6 Month Surveillance)

3 Year Reinspection

Employee/Staff Notification

Miscellaneous

Do Not Discard Records

Update Every 30 Days

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BUILDING CERTIFICATION LETTERS

Certification letters for buildings built <u>after</u> October 12, 1988, should contain the following specific information:

1. Identify **each** building and location, and where on site. Include a site plan if possible.

2. Date of construction must be identified as being after October 12, 1988.

3. Statement by an **architect** or **project engineer** responsible for the construction of the building, that "no ACBM" was specified as a building material in any construction document of the building or to the best of his or her knowledge, no ACBM was used as a building material in the construction of the building.

4. Copies of certification letters must be in all copies of the Management Plans for each site.

5. **<u>Suggest requirement in contract for certification letters and retention of 10% final payment until receipt of letter.</u>**

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NEW MATERIALS

New materials added to buildings as a result of renovation.

1. Documentation is similar to the requirements for certification letters.

2. Include a copy of the blueprints indicating the areas of buildings renovated and the location of new materials.

3. Maintain a copy in the Management Plan.

4. **Suggest requirement in contract for certification letters and retention of 10% final payment until receipt of letter.**

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HOW TO PLAN AN ASBESTOS ABATEMENT PROJECT

Person	Responsibility
Asbestos Coordinator	1. Decide what you want removed.
Asbestos Coordinator	2. Decide the time period you can allow for it to be done. Be aware of notification periods.
Asbestos Coordinator	3. Determine the occupancy factor in or around the abatement area.
Asbestos Coordinator	4. Design the project. For privately owned buildings, you & Contractor may write the specifications, have the contractor design the project, or hire a consultant to do it for you. Most consultants and a few school people have received this training.
Asbestos Coordinator & Consultant	5. Assure compliance with all Federal, State, and Local regulations.
Asbestos Coordinator	6. Obtain competitive bids for work by at least three contractors. The bid form will be part of the specifications/bid package if designed by an asbestos consultant.
Asbestos Coordinator	7. Depending upon the size of the project, decide if an asbestos consultant is necessary for onsite oversight of the asbestos contractor.
Asbestos Coordinator & Consultant	8. At a minimum, obtain and keep the following documents: A. Supervisor Training B. Worker Training C. Respirator Training and Fit-Testing D. Contractor Notifications E. Disposal Records See the attached Table of Contents used by Entek, Inc., which outlines all items that are maintained during an asbestos abatement project.

Person	Responsibility	
Consultant	9.	Collect clearance air samples according to AHERA specifications. A person competent in air sampling techniques, with the proper equipment is necessary. The contractor **cannot** perform the clearance air sampling services.
Asbestos Coordinator	10.	Permanent records of the project shall be kept as a part of the ongoing Management Plan. Changes, as appropriate, shall be entered into the plan at each site, and in the district file. (School Districts only.)

ASBESTOS ABATEMENT COSTS

Asbestos abatement contractor costs are influenced by general and specific factors.

General Factors	Specific Factors
Quantity of Work	Access to Materials
Geographical Locations	Temperature
Lodging Costs	Types of Materials
Time of the Year	Types of Substrates
	Occupancy/Security

Considering the above factors, the following numbers can be considered starting points for asbestos abatement costs - removal only.

Soil Contamination	$ 1.50 - 2.00 sq. ft.
Floor Tile (Includes Mastic)	$ 3.50 - 4.50 sq. ft.
Ceiling Tiles and Panels	$ 2.00 - 2.50 sq. ft.
Transite Panels	$ 1.50 - 1.75 sq. ft.
Sprayed-on Insulation	$ 2.50 - 3.50 sq. ft.
Troweled-on Insulation	$ 6.50 - 8.00 sq. ft.
Drywall	$ 1.00 - 1.50 ln. ft.
Pipewrap (Glovebag)	$12.00 - 14.00 ln. ft.
Fireproofing	$12.00 - 14.00 sq. ft.
Boiler Wrap	$15.00 - 17.00 sq. ft.

Project Management by a third party asbestos consultant cost ranges from $400 to $600 per day. Air sampling costs are additional. Cost to prepare specifications range from $500 to $2,500.

Air Sampling Costs

PCM = Phase Contrast Microscopy

PCM Advantages
- Cost = $ 20.00 to $ 35.00 Each
- Turnaround Time - 1 to 3 Hours
- Availability - Field vs. Lab

PCM Disadvantages
- Counts all Fibers (Not Only Asbestos)
- Cannot see Small Fibers
- Will be Eliminated for Clearances by AHERA

TEM = Transmission Electron Microscopy

TEM Advantages
- Counts Only Asbestos Fibers
- Can see Much Small Fibers
- State-of-the-Art

TEM Disadvantages
- Cost = $75.00 to $175.00 Each
- Turnaround Time - 1 to 5 Days
- Availability - Only Fixed Labs

TABLE OF CONTENTS

GUIDANCE FOR CONTROLLING ASBESTOS-CONTAINING MATERIALS IN BUILDINGS

1985 EDITION

Exposure Evaluation Division
Office of Toxic Substances
Office of Pesticides and Toxic Substances
U.S. Environmental Protection Agency
Washington, D.C. 20460

Appendix J. Recommended Specifications and Operating Procedures for the Use of Negative Pressure Systems for Asbestos Abatement

J.1 Introduction

This appendix provides guidelines for the use of negative pressure systems in removing asbestos-containing materials from buildings. A negative pressure system is one in which static pressure in an enclosed work area is lower than that of the environment outside the containment barriers.

The pressure gradient is maintained by moving air from the work area to the environment outside the area via powered exhaust equipment at a rate that will support the desired air flow and pressure differential. Thus, the air moves into the work area through designated access spaces and any other barrier openings. Exhaust air is filtered by a high-efficiency particulate air (HEPA) filter to remove asbestos fibers.

The use of negative pressure during asbestos removal protects against large-scale release of fibers to the surrounding area in case of a breach in the containment barrier. A negative pressure system also can reduce the concentration of airborne asbestos in the work area by increasing the dilution ventilation rate (i.e., diluting contaminated air in the work area with uncontaminated air from outside) and exhausting contaminated air through HEPA filters. The circulation of fresh air through the work area reportedly also improves worker comfort, which may aid the removal process by increasing job productivity.

J.2 Materials and Equipment

J.2.1 The Portable, HEPA-Filtered, Powered Exhaust Unit

The exhaust unit establishes lower pressure inside than outside the enclosed work area during asbestos abatement. Basically, a unit (see Figure J-1) consists of a cabinet with an opening at each end, one for air intake and one for exhaust. A fan and a series of filters are arranged inside the cabinet between the openings. The fan draws contaminated air through the intake and filters and discharges clean air through the exhaust.

Portable exhaust units used for negative pressure systems in asbestos abatement projects should meet the following specifications.

J.2.1.1 Structural Specifications

The cabinet should be ruggedly constructed and made of durable materials to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. The cabinet must be appropriately sealed to prevent asbestos-containing dust from being emitted during use, transport, or maintenance. There should be easy access to all air filters from the intake end, and the filters must be easy

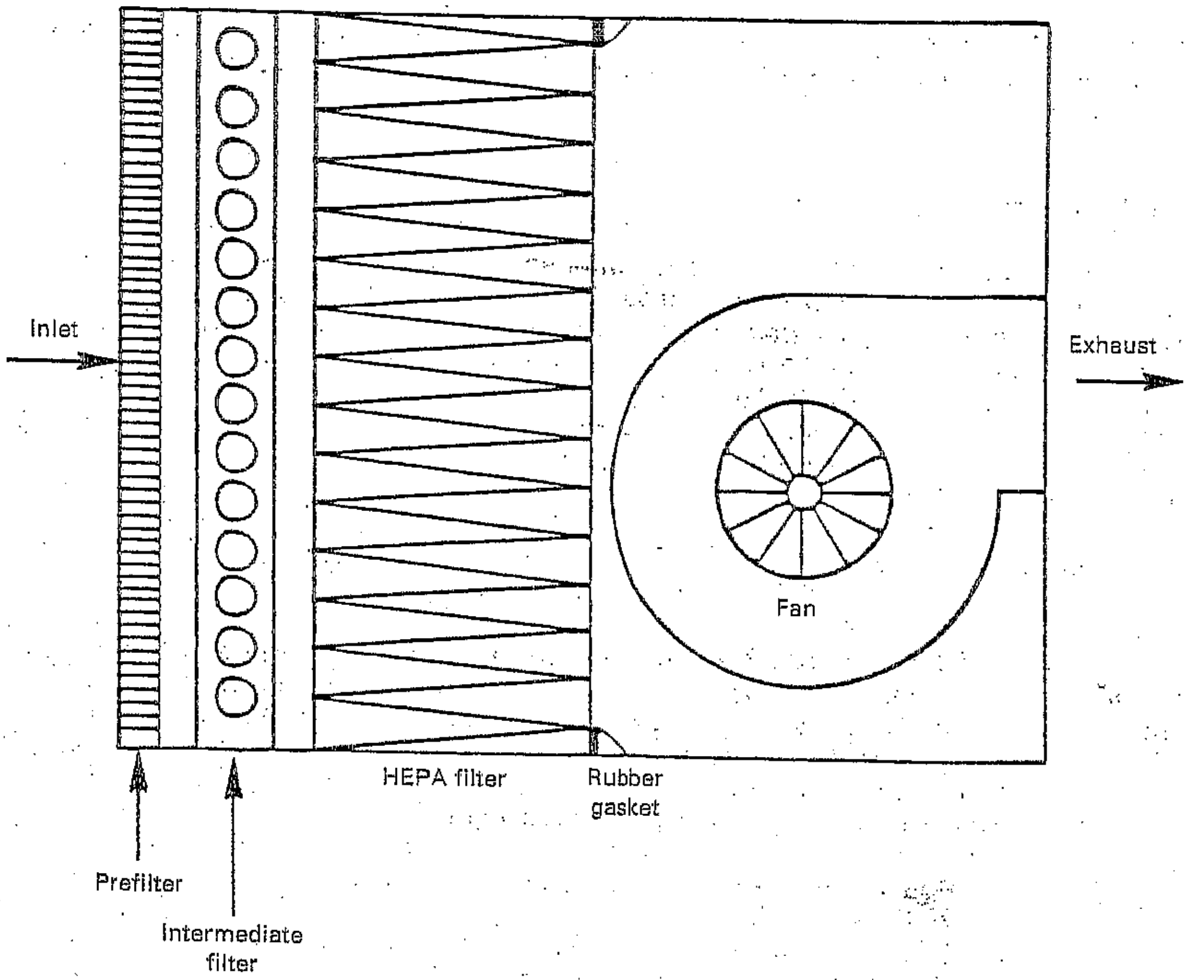

Figure J-1. An example of a HEPA-filtered exhaust unit. This scheme is one of several possible designs.

to replace. The unit should be mounted on casters or wheels so it can be easily moved. It also should be accessible for easy cleaning.

J.2.1.2 Mechanical Specifications

J.2.1.2.1 Fans

The fan for each unit should be sized to draw a desired air flow through the filters in the unit at a specified static pressure drop. The unit should have an air-handling capacity of 1,000 to 2,000 ft^3/min (under "clean" filter conditions). The fan should be of the centrifugal type.

For large-scale abatement projects, where the use of a larger capacity, specially designed exhaust system may be more practical than several smaller units, the fan should be appropriately sized according to the proper load capacity established for the application, i.e.,

$$\text{Total ft}^3\text{/min (load)} = \frac{\text{Volume of air in ft}^3 \times \text{air changes/hour}}{60 \text{ min/hour}}$$

Smaller-capacity units (e.g., 1,000 ft^3/min) equipped with appropriately sized fans and filters may be used to ventilate smaller work areas. The desired air flow could be achieved with several units.

J.2.1.2.2 Filters

The final filter must be the HEPA type. Each filter should have a standard nominal rating of at least 1,100 ft^3/min with a maximum pressure drop of 1 inch H_2O clean resistance. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame and cross-braced as required. The exact dimensions of the filter should correspond with the dimensions of the filter housing inside the cabinet or the dimensions of the filter-holding frame. The recommended standard size HEPA filter is 24 inches high x 24 inches wide x 11-1/2 inches deep. The overall dimensions and squareness should be within 1/8 inch.

A continuous rubber gasket must be located between the filter and the filter housing to form a tight seal. The gasket material should be 1/4 inch thick and 3/4 inch wide.

Each filter should be individually tested and certified by the manufacturer to have an efficiency of not less than 99.97 percent when challenged with 0.3-μm dioctylphthalate (DOP) particles. Testing should be in accordance with Military Standard Number 282 and Army Instruction Manual 136-300-175A. Each filter should bear a UL586 label to indicate ability to perform under specified conditions.

Each filter should be marked with: the name of the manufacturer, serial number, air flow rating, efficiency and resistance, and the direction of test air flow.

Prefilters, which protect the final filter by removing the larger particles, are recommended to prolong the operating life of the HEPA filter. Prefilters prevent the premature loading of the HEPA filter. They can also save energy and cost. One (minimum) or two (preferred) stages of prefiltration may be used. The first-stage prefilter should be a low-efficiency type (e.g., for particles 10 μm and larger). The second-stage (or intermediate) filter should have a medium efficiency (e.g., effective for particles down to 5 μm). Various types of filters and filter media for prefiltration applications are available from many manufacturers. Prefilters and intermediate filters should be installed either on or in the intake grid of the unit and held in place with special housings or clamps.

J.2.1.2.3 Instrumentation

Each unit should be equipped with a Magnehelic gauge or manometer to measure the pressure drop across the filters and indicate when filters have become loaded and need to be changed. The static pressure across the filters (resistance) increases as they become loaded with dust, affecting the ability of the unit to move air at its rated capacity.

J.2.1.3 Electrical

J.2.1.3.1 General

The electrical system should have a remote fuse disconnect. The fan motor should be totally enclosed, fan-cooled, and the nonoverloading type. The unit must use a standard 115-V, single-phase, 60-cycle service. All electrical components must be approved by the National Electrical Manufacturers Association (NEMA) and Underwriter's Laboratories (UL).

J.2.1.3.2 Fans

The motor, fan, fan housing, and cabinet should be grounded. The unit should have an electrical (or mechanical) lockout to prevent the fan from operating without a HEPA filter.

J.2.1.3.3 Instrumentation

An automatic shutdown system that would stop the fan in the event of a major rupture in the HEPA filter or blocked air discharge is recommended. Optional warning lights are recommended to indicate normal operation, too high of a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge). Other optional instruments include a timer and automatic shut-off and an elapsed time meter to show the total accumulated hours of operation.

J.3 Setup and Use of a Negative Pressure System

J.3.1 Preparation of the Work Area

J.3.1.1 Determining the Ventilation Requirements for a Work Area

Experience with negative pressure systems on asbestos abatement projects indicates a recommended rate of one air change every 15 minutes. The volume (in ft^3) of the work area is determined by multiplying the floor area by the ceiling height. The total air flow requirement (in ft^3/min) for the work area is determined by dividing this volume by the recommended air change rate (i.e., one air change every 15 minutes).*

$$\text{Total ft}^3/\text{min} = \text{Volume of work area (in ft}^3)/15 \text{ min}$$

The number of units needed for the application is determined by dividing the total ft^3/min by the rated capacity of the exhaust unit.

$$\text{Number of units needed} = [\text{Total ft}^3/\text{min}]/[\text{Capacity of unit (in ft}^3)]$$

J.3.1.2 Location of Exhaust Units

The exhaust unit(s) should be located so that makeup air enters the work area primarily through the decontamination facility and traverses the work area as much as possible. This may be accomplished by positioning the exhaust unit(s) at a maximum distance from the worker access opening or other makeup air sources.

Wherever practical, work area exhaust units can be located on the floor in or near unused doorways or windows. The end of the unit or its exhaust duct should be placed through an opening in the plastic barrier or wall covering. The plastic around the unit or duct should then be sealed with tape.

*The recommended air exchange rate is based on engineering judgment.

Each unit must have temporary electrical power (115V AC). If necessary, three-wire extension cords can supply power to a unit. The cords must be in continuous lengths (without splice), in good condition, and should not be more than 100 feet long. They must not be fastened with staples, hung from nails, or suspended by wire. Extension cords should be suspended off the floor and out of workers' way to protect the cords from damage from traffic, sharp objects, and pinching.

Wherever possible, exhaust units should be vented to the outside of the building. This may involve the use of additional lengths of flexible or rigid duct connected to the air outlet and routed to the nearest outside opening. Windowpanes may have to be removed temporarily.

If exhaust air cannot be vented to the outside of the building or if cold temperatures necessitate measures to conserve heat and minimize cold air infiltration, filtered air that has been exhausted through the barrier may be recirculated into an adjacent area. However, this is not recommended.

Additional makeup air may be necessary to avoid creating too high of a pressure differential, which could cause the plastic coverings and temporary barriers to "blow in." Additional makeup air also may be needed to move air most effectively through the work area. Supplemental makeup air inlets may be made by making openings in the plastic sheeting that allow air from outside the building into the work area. Auxiliary makeup air inlets should be as far as possible from the exhaust unit(s) (e.g., on an opposite wall), off the floor (preferably near the ceiling), and away from barriers that separate the work area from occupied clean areas. They should be resealed whenever the negative pressure system is turned off after removal has started. Because the pressure differential (and ultimately the effectiveness of the system) is affected by the adequacy of makeup air, the number of auxiliary air inlets should be kept to a minimum to maintain negative pressure. Figure J-2 presents examples of negative pressure systems denoting the location of HEPA-filtered exhaust units and the direction of air flow.

J.3.2 Use of the Negative Pressure System

J.3.2.1 Testing the System

The negative pressure system should be tested before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, the unit(s) should be started (one at a time). Observe the barriers and plastic sheeting. The plastic curtains of the decontamination facility should move slightly in toward the work area. The use of ventilation smoke tubes and a rubber bulb is another easy and inexpensive way to visually check system performance and direction of air flow through openings in the barrier. Another test is to use a Magnehelic gauge (or other instrument) to measure the static pressure differential across the barrier. The measuring device must be sensitive enough to detect a relatively low pressure drop. A Magnehelic gauge with a scale of 0 to 0.25 or 0.50 inch of H_2O and 0.005 or 0.01 inch graduations is generally adequate. The pressure drop across the barrier is measured from the outside by punching a small hole in the plastic barrier and inserting one end of a piece of rubber or Tygon tubing. The other end of the tubing is connected to the "low pressure" tap of the instrument. The "high pressure" tap must be open to the atmosphere. The pressure is read directly from the scale. After the test is completed, the hole in the barrier must be patched.

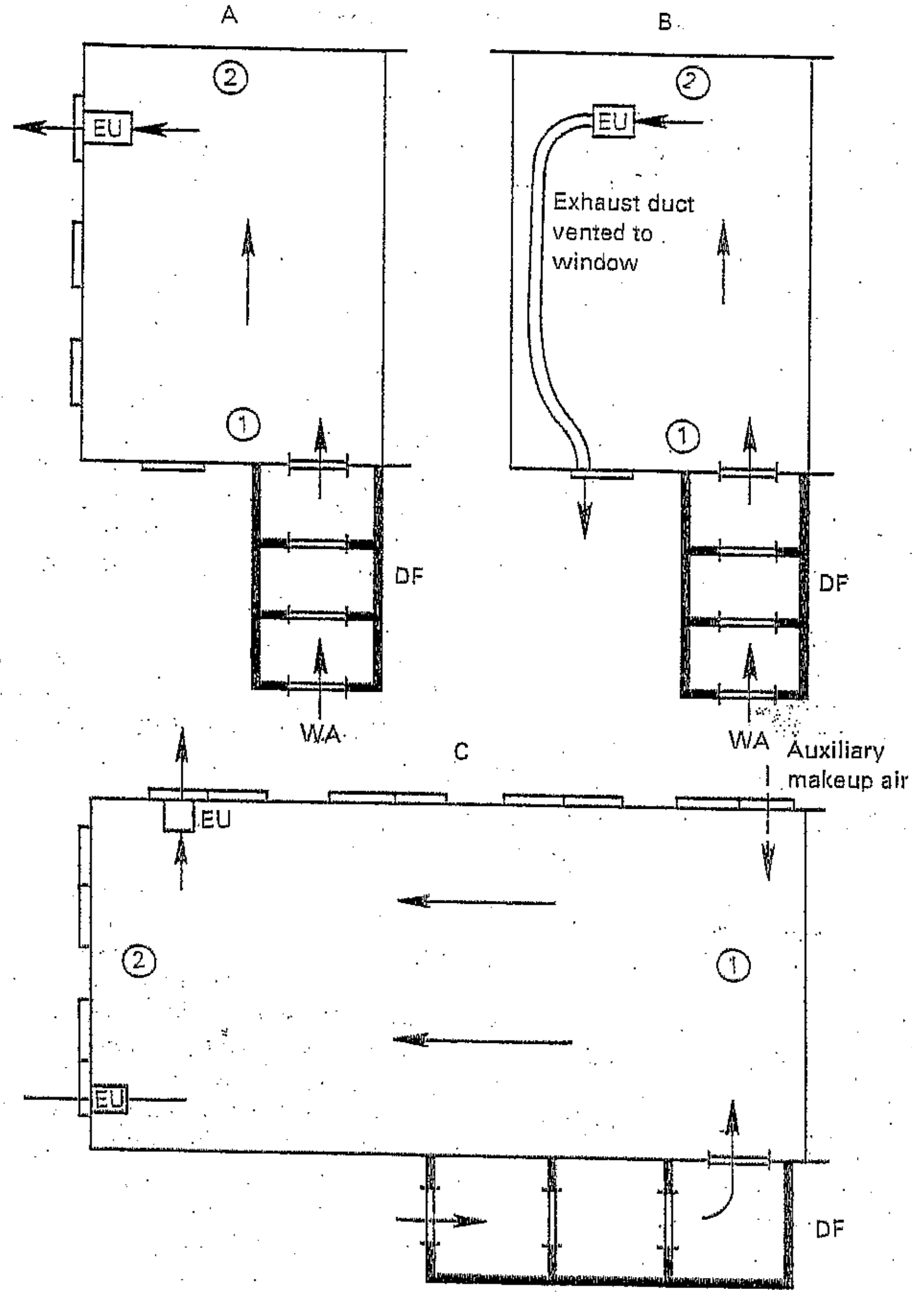

Figure J-2. Examples of negative pressure systems. DF, Decontamination Facility; EU, Exhaust Unit; WA, Worker Access; A, Single-room work area with multiple windows; B, Single-room work area with single window near entrance; C, Large single-room work area with windows and auxiliary makeup air source (dotted arrow). Arrows denote direction of air flow. Circled numbers indicate progression of removal sequence.

J.3.2.2 Use of System During Removal Operations

The exhaust units should be started just before beginning removal (i.e., before any asbestos-containing material is disturbed). After removal has begun, the units should run continuously to maintain a constant negative pressure until decontamination of the work area is complete. The units should not be turned off at the end of the work shift or when removal operations temporarily stop.

Employees should start removing the asbestos material at a location farthest from the exhaust units and work toward them. If an electric power failure occurs, removal must stop immediately and should not resume until power is restored and exhaust units are operating again.

Because airborne asbestos fibers are microscopic in size and tend to remain in suspension for a long time, the exhaust units must keep operating throughout the entire removal and decontamination processes. To ensure continuous operation, a spare unit should be available.

After asbestos removal equipment has been moved from the work area, the plastic sheeting has been cleaned, and all surfaces in the work area have been wet-cleaned, the exhaust units can be allowed to run for at least another 4 hours to remove airborne fibers that may have been generated during wet removal and cleanup and to purge the work area with clean makeup air. The units may be allowed to run for a longer time after decontamination, particularly if dry or only partially wetted asbestos material was encountered during removal.

J.3.2.2.1 Filter Replacement

All filters must be accessible from the work area or "contaminated" side of the barrier. Thus, personnel responsible for changing filters while the negative pressure system is in use should wear approved respirators and other protective equipment. The operating life of a HEPA filter depends on the level of particulate contamination in the environment in which it is used. During use, filters will become loaded with dust, which increases resistance to air flow and diminishes the air-handling capacity of the unit. The difference in pressure drop across the filters between "clean" and "loaded" conditions (ΔP) is a convenient means of estimating the extent of air-flow resistance and determining when the filters should be replaced.

When ΔP across the filters (as determined by the Magnehelic gauge or manometer on the unit) exceeds 1.0 inch of H_2O, the prefilter should be replaced first. The prefilter, which fan suction will generally hold in place on the intake grill, should be removed with the unit running by carefully rolling or folding in its sides. Any dust dislodged from the prefilter during removal will be collected on the intermediate filter. The used prefilter should be placed inside a plastic bag, sealed and labeled, and disposed of as asbestos waste. A new prefilter is then placed on the intake grill. Filters for prefiltration applications may be purchased as individual precut panels or in a roll of specified width that must be cut to size.

If the ΔP still exceeds 1.0 inch of H_2O after the prefilter has been replaced, the intermediate filter is replaced. With the unit operating, the prefilter should be removed, the intake grill or filter access opened, and the intermediate filter removed. Any dust dislodged from the intermediate filter during removal will be collected on the HEPA filter. The used intermediate filter should be placed in a sealable plastic bag (appropriately labeled) and disposed of as asbestos waste. A new replacement filter is then installed and the grill or access closed. Finally, the prefilter on the intake grill should be replaced.

The HEPA filter should be replaced if prefilter and/or intermediate filter replacement does not restore the pressure drop across the filters to its original clean resistance reading or if the HEPA filter becomes damaged. The exhaust unit is shut off to replace the HEPA filter, which requires removing the prefilter first, then opening the intake grill or filter access, and finally removing the HEPA filter from the unit. Used HEPA filters should be placed in a sealable plastic bag (appropriately labeled) and disposed of as asbestos waste. A new HEPA filter (structurally identical to the original filter) should then be installed. The intake grill and intermediate filter should be put back in place, the unit turned on, and the prefilter positioned on the intake grill. Whenever the HEPA filter is replaced, the prefilter and intermediate filter should also be replaced.

When several exhaust units are used to ventilate a work area, any air movement through an inactive unit during the HEPA filter replacement will be into the work area. Thus, the risk of asbestos fiber release to the outside environment is controlled.

Any filters used in the system may be replaced more frequently than the pressure drop across the filters indicates is necessary. Prefilters, for example, may be replaced two to four times a day or when accumulations of particulate matter become visible. Intermediate filters must be replaced once every day or so, and the HEPA filter may be replaced at the beginning of each new project. (Used HEPA filters must be disposed of as asbestos-containing waste.) Conditions in the work area dictate the frequency of filter changes. In a work area where fiber release is effectively controlled by thorough wetting and good work practices, fewer filter changes may be required than in work areas where the removal process is not well controlled. It should also be noted that the collection efficiency of a filter generally improves as particulate accumulates on it. Thus, filters can be used effectively until resistance (as a result of excessive particulate loading) diminishes the exhaust capacity of the unit.

J.3.2.3 Dismantling the System

When a final inspection and the results of final air tests indicate that the area has been decontaminated, all filters of the exhaust units should be removed and disposed of properly and the units shut off. The remaining barriers between contaminated and clean areas and all seals on openings into the work area and fixtures may be removed and disposed of as contaminated waste. A final check should be made to be sure that no dust or debris remain on surfaces as a result of dismantling operations.

RECOMMENDED DECONTAMINATION PROCEDURE

An adequate decontamination area consists of a serial arrangement of connected rooms or spaces. All persons without exception should pass through this decontamination area for entry into and exit from the work area for any purpose. Parallel routes for entry or exit are not recommended; if such routes exist they will eventually be used.

Decontamination Area

1. Outside Room (Clean Area): In this room the worker leaves all street clothes and dresses in clean working clothes (usually disposable coveralls). Respiratory protection equipment is also picked up in this area. No asbestos contaminated items should enter this room. Workers enter this room either from outside the structure dressed in street clothes, or naked from the showers.

2. Shower Room: This is a separate room used for transit by cleanly dressed workers entering the job from the outside room, or by workers headed for the showers after undressing in the equipment room.

3. Equipment Room (Contaminated Area): Work equipment, footwear, additional contaminated work clothing are left here. This is a change and transit area for workers.

4. Work Area: The work area should be separated by polyethylene barriers from the equipment room. If the airborne asbestos level in the work area is expected to be high, as in dry removal, an additional intermediate cleaning space may be added between the equipment room and the work area.

Decontamination Sequence

1. Worker enters outside room and removes clothing, puts on clean coveralls and respirator, and passes through into the equipment room.

2. Any additional clothing and equipment left in dirty room required by the worker is put on. (When the work area is too cold for coveralls only, the worker will usually provide himself with additional warm garments. These must be treated as contaminated clothing and left in the decontamination unit.)

3. Worker proceeds to work area.

4. Before leaving the work area, the worker should remove all gross contamination and debris from the overalls. In practice this is usually carried out by one worker assisting another.

5. The worker proceeds to equipment room and removes all clothing except respiratory protection equipment. Extra work clothing may be stored in contaminated end of the unit. Disposable coveralls are placed in a bag for disposal with other material. The worker then proceeds rapidly into the shower room. Respiratory protection equipment should be removed last to prevent inhalation of fibers during removal of contaminated clothing.

6. After showering, the worker moves to the clean room and dresses in either new coveralls for another entry or street clothes if leaving.

7. Respirators are picked up, cleaned, and wrapped by protected workers in a separate area by washing. The respirators are then brought to the clean room by an outside worker. The cleaners then exit through the shower units as usual.