486291

ADMINISTRATIVE RECORD

EXHIBITS TO MEMORANDUM OF POINTS AND AUTHORITIES IN SUPPORT OF PLAINTIFF'S APPLICATION FOR PRELIMINARY INJUNCTION AND EMERGENCY NOTICE TO CLASS MEMBERS

Exh. No.	Date	Description
1.	1977	Performance Report, Industrial Chemicals (had to put in new mill to solve pollution problems
2.	10/7/83	Memo to Bettacchi from Ciampa re Monthly Report 9/83
3.	9/12/56	Letter to Buyers from Wake (IH) (small asbestos increase in ore produces large increase in asbestos dust)
4.	4/19/77	Memo to Wood from Yang re Tremolite content of Zonolite products
5.	5/24/77	Demonstrative ex. made from: Memo to Brookes from Wood re Tremolite in Vermiculite (risk lung 5X, label no, highest exposure for attic insulation!!, will be banned, label would limit liability but increase claims)
6.	1962-1998	Copy of Document of U.S. Census Bureau entitled "Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998"
7.	1993-1998	Copy of Document of U.S. Census Bureau entitled "Expenditures to Owner-Occupied Properties by Type of Job: 1993 to 1998" and "Expenditures to Rental Properties by Type of Job: 1993 to 1998"
8.	1988 – 1999	Copy of Document of U.S. Census Bureau entitled "Expenditures for Improvements and Repairs of Residential Properties Second Quarter 1999" with attached Tables showing Expenditures for Maintenance and Repairs and Improvements for 1988 to 1999
9.	8/8-9/56	MT Board of Health, Report on IH Study of Zonolite Co.
10.	7/20/59 (?)	Letter to Bleich from Cairns MD: analysis of chest x-rays of Libby employees
11.	6/14/61	Grace letter from Lovick to Western Mineral Products Co.: our experience re effect of dust on employee health
12.	10/6/64	Chicago Daily News: Suspect asbestos a Cancer Source
13.	5/11/64	MT Board of Health letter to Bleich: report on dry mill section of plant (very poor housekeeping, knowledge of Asbestos toxicology

14.	12/23/69	--Demonstrative graph: Workers with Disease 1969 --Study to Determine Relationship Between Years of Employment and X-ray Findings (by Kostic) --Grace memo from Lovick: follow-up should be left to personal physician
15.	 3/11/69 3/31/69	Demonstrative ex. consisting of: --Memo to Sterret from Kostic with article from Washington Safety Report (maybe we should apply label to defend against liability claims --Memo to Kostic from Dugan (label may incur liability)
16.	10/23/91	Demonstrative ex. made from: Deposition of Junker (don't send warning letter to schools because they would sue; don't say bad things about your own company)
17.	11/1/85	Grace memo re lung cancer risk assessment (30,000 people)
18.	3/11/76	Memo to Brown from Locke re recent sampling (>2, 5, need binder remedy)
19.	9/17/80	EPA, Friable Asbestos-Containing Material in Schools; Proposed Identification and Notification, 45 Fed. Reg. 182, p. 61969
20.	6/86	EPA Airborne Asbestos Assessment Updated (June 1986), p. 72.
21.	3/83	EPA Blue Book, Guidance for Controlling Asbestos-Containing Materials in Buildings (March 1983). P. 1-1.
22.		Withdrawn
23.	7/83	Chronic Advisory Panel on Asbestos Report to the U.S. Product Safety Commission (July 1983), I-VI.
24.	11/80	NIOSH Pamphlet No. 81-103, Workplace Exposure to Asbestos (November 1980), p. 3.
25.	2/88	EPA Report to Congress of asbestos-containing material in public buildings, February 1988, p. 5.
26.	3/79	EPA Orange Book, Asbestos-Containing Material in School Buildings: A Guidance Document (March 1979), Part I, p. 1.
27.	8/10/94	OSHA Fed. Reg., Vol. 59, No. 153, August 10, 1994, at p. 40978.
28.	7/11/77	Demonstrative exh. made from: Memo re Request for Technical Service—evaluate 10 attic test samples (all 10 samples >4.5)
29.	4/1/80	Letter to Ray from Woods re testing, protocols
30.	3/25/80	Memo to McCord from Eaton re Consumer Products (user exposure)

31.		--Demonstrative ex. re Zonolite (no need for mask, pours cleanly) w/color photo of Zonolite bag --Original doc: Zonolite booklet "Modern Miracle of Insulation"
32.	11/60	-Demonstrative ex.: Zonolite ad (just pour, level, leave; safe non-irritating to lungs) -Zonolite ad from Western News (pour, level, leave) -How To Do It: Zonolite Insulation Handbook (safe non-irritating to lungs)
33.		EPA, Guidance for Controlling Asbestos (Purple Book)
34.		EPA, Managing Asbestos in Place (Green Book)

PERFORMANCE REPORT

03665096

oup Industrial Chemicals RCA No. 12-2

sion Construction Products Date Approved April 3, 1975

Reporting Unit U.S. Zonolite Operations

($000)	(1) Amount of Expenditure	(2) Average Grace Capital Employed	(3) 1977 Net Income	(4) Percent Return on GCE
(1) RCA Projection	$10,200	$38,077	$4,572	12.0%
(2) Actual	9,799 (a)	27,201	4,035	14.8
Variance/Fav/(Unfav)				
(3) Amount	$ 401	$10,876	$ (537)	2.8% Pts.
(4) Percent	3.9%	28.6%	(11.7)%	

183.40

RCA #12-2, entitled "Overrun - New Vermiculite Mill - Libby, Montana", requested to spend an additional $2,600,000 (for a total expenditure of $10,200,000) to complete the replacement of Construction Products Division's (CPD) vermiculite mill in Libby, Montana. The objectives of this project were (a) to increase Zonolite vermiculite milling capacity from 310,000 tons in 1970 to 426,000 tons annually by 1977, (b) to improve milling productivity and thereby lower direct manufacturing costs, and (c) to comply with federal and state pollution requirements.

After two years (1975 and 1976) of start-up problems and process design modifications at the new Libby mill, Zonolite's vermiculite milling capacity is presently estimated at 450,000 tons annually or 24,000 (5.6%) ahead of RCA #12-2 projections. The Enoree, South Carolina milling capacity is estimated at 122,000 tons or 12,000 (10.9%) above RCA #12-2, while the Libby, Montana operation has an estimated annual capacity of 328,000 tons or 12,000 tons (3.8%) favorable to RCA projections. In 1977, the new Libby mill produced 1,005 tons of vermiculite concentrate per day (TPD) which was 53 TPD (5.6%) favorable to RCA #12-2 projections. This favorable operating performance is primarily due to improved mill reliability (% On-Stream Time of 96.1% versus 92.0% as projected in RCA #12-2) and a mill feed rate of 250 tons per hour (TPH), which is 15 TPH (6.4%) ahead of RCA projections.

not including mining of costs.

In addition to exceeding the RCA output objectives, the direct manufacturing costs at the Libby mill were $11.851 per ton of concentrate produced which was $2.737 (18.8%) favorable to the RCA #12-2 estimate of $14.58 per ton. This favorable cost performance is primarily attributable to the 5.6% increase in daily output, coupled with lower reagent consumption resulting from the process design improvements made to the mill feed preparation circuits as part of the RCA #12-2.

The pollution problems which were identified in RCA #12-2 (i.e., excessive levels of fugitive dust from the dry screening circuits, particulate emissions from the ore dryer stacks, and mill tailings (waste) being carried by the spring run-off into the Kootenai River) have been eliminated. If Zonolite had not been actively working to solve these pollution problems at Libby, a forced shutdown of the facilities would have occurred in 1977.

(a) As of December 31, 1977, $9,799,000 (96.1%) of the authorized $10,200,000 has been spent. An additional $401,000 will be spent in 1978 for further mill improvements bringing total spending to $10,200,000.

EXHIBIT 183.40

15077967

EXHIBIT Emergency Notice

mill use would be new asbestos standard new permits would be required existing anticipated standard. 0.6 %

While the pollution related objectives of RCA #12-2 have been resolved, Zonolite is presently faced with tightening government standards covering exposure to asbestos fibers. Vermiculite concentrate contains naturally occurring trace quantities (less than 0.2%) of fibrous tremolite asbestos. ~~As~~ Since all forms of asbestos including tremolite, are classified as carcinogens, Zonolite's mines, expanding plants, products, and customers are subjected to a host of regulations being promulgated by the Occupational Safety and Health Administration (OSHA), Mine Safety and Health Administration (MSHA, Consumer Products Safety Commission (CPSC), the Environmental Protection Agency (EPA) and others including a variety of state level agencies. At the present time all of Zonolite's products and operations satisfy existing regulatory standards covering exposure to asbestos. The new mill at Libby has been an important factor in meeting these standards. While research continues to work toward further reducing tremolite from the vermiculite concentrate and our products, Zonolite remains subject to all asbestos regulations.

In 1977, the Zonolite business generated net income (Grace Share) of $4,035,000 on net sales of $65,483,000 for a 14.8% return on average Grace Capital Employed of $27,201,000. While this 14.8% return on GCE is 2.8 percentage points favorable to the 12.0% return as projected in RCA #12-2, the actual 1977 sales volume is approximately 18.3% below RCA #12-2 estimates. Since the RCA was prepared, Zonolite has been operating in a severely depressed construction economy. Nonresidential building activity in 1977, which represents approximatly 56% of Zonolite net sales, is estimated to be 32.1% below 1974 levels. The length and severity of this downturn was not anticipated by CPD management, nor by any of the major economic forecasters (i.e., F. W. Dodge, Data Resources, and Grace's Business Economics Group) at the time RCA #12-2 was prepared. Despite this precipitous drop in construction activity, Zonolite net sales have increased at an average annual rate of 9.9% from 1974 to 1977, while net income grew at an average annual rate of 78.8% over the same period. This rapid growth in net income is primarily due to the resolution of Libby ~~new~~ mill start-up problems and a 57.5% improvement in Libby productivity (from 638 tons per day in 1974 to 1,005 tons per day in 1977).

The following table presents key data for U.S. Zonolite Operations for actual results since 1973 and forecasted performance over 1978B - 1982F.

(See table on the following page)

03665098

U.S. Zonolite Operations ($000)

Key Data

Line No.	Year	(1) Net Sales	(2) Net Income (Grace Share)	(3) Average Capital Employed GCE	(4) Average Capital Employed TCE (Incl.Cap. Leases)	(5) % Return on GCE	(6) % Return on TCE (Incl.Cap. Leases)
(1)	1973A	$46,639	$2,479	$23,908	$24,662	10.4%	10.6%
(2)	1974A	49,307	706	26,522	28,867	2.7	2.9
(3)	1975A	53,240	1,153	27,115	29,119	4.3	4.2
(4)	1976A	55,755	1,512	27,369	29,247	5.5	5.4
(5)	1977A	65,483	4,035	27,201	29,079	14.8	14.1
(6)	1977 Per RCA #12-2	78,454	4,572	38,077	40,385	12.0	11.8
(7)	1978B	70,863	3,730	30,642	32,520	12.2	11.7
(8)	1979F	79,576	4,301	33,584	35,462	12.8	12.3
(9)	1980F	88,485	5,024	35,918	37,786	14.0	13.5
(10)	1981F	98,585	5,591	37,891	39,769	14.8	14.3
(11)	1982F	110,118	6,009	39,931	41,809	15.0	14.6
	% Variance Fav/(Unfav) 77A vs. 77						
(12)	Per RCA #12-2	(16.5)%	(11.7)%	28.6%	28.0%	2.8% Pts.	2.3% Pts.
	% Average Annual Change Fav/(Unfav)						
(13)	1973A - 1977A	8.9%	13.0%	(3.3)%	(4.2)%		
(14)	1977A - 1982F	11.0	8.3	(8.0)	(7.5)		

Zonolite net sales are forecasted to increase at an average annual rate of 11.0% reaching $110,118,000 in 1982, while net income is projected to be $6,009,000 in 1982 for a 14.6% return on TCE of $41,809,000. The forecast reflects an improving construction economy throughout the forecast period. In addition, the energy shortage will continue to stimulate demand for building insulation products. At the time the 1978 Budget and Forecast was prepared, the sales of Zonolite insulation products were not expected to reach the 1977 volume levels until 1980 and Zonolite's return on TCE was not expected to exceed 14.0% before 1981. Although shortages of competing insulating materials contributed to Zonolite's high volume of insulation product sales in 1977, we now believe our forecasts are conservative. If sales of insulation products in 1978 continue at 1977

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record levels, then Zonolite's net income could reach $4,700,000 in 1978 for a 14.7% return on TCE of $32,520,000. However, at this time, it remains extremely difficult to predict when insulation sales will peak and what, if any, impact the pending energy legislation in Congress will have on Zonolite's insulation products.. Finally, sales on non-construction related products, particularly agricultural/horticultural products, are expected to provide growth opportunities for Zonolite based upon trends such as increased leisure time and continuing interest in ecology.

15077970

0641949

GRACE

Construction Products Division

W. R. Grace & Co.
62 Whittemore Avenue
Cambridge, Mass. 02140

(617) 876-1400

October 7, 1983

TO: R. J. Bettacchi

FROM: G. N. Ciampa

SUBJ: Monthly Report - September 1983

Business Summary

Polycel Products - Total shipments during the month of 69.0M lbs are 15.9% behind budget but are 11.3% ahead of September 1982.

Strong sales in Texas and the Central region in Professional accounted for the majority of the overrun.

Sales through our consumer and industrial reps were strong enough (31.0M lbs.) to offset the aerosol sales underruns in the Central and Eastern regions.

Wall Insulation Products - ZMI sales volume of 212.0M bags were 9.8% ahead of last September and 7.6% ahead of budget. Year to date sales volume of 1643M bags are 3.3% ahead of September 1982 and 5.0% ahead of budget.

Thermo-stud sales of 582 MBF were disappointing after strong sales in July and August; we felt September would be even better. Sales volume for the month were 34.4% behind last September and behind budget by 52.2%. Year to date sales volume is even with last year but behind budget 35.9%.

Attic Insulation - Sales volume of 88.0M bags are for the sixth straight month below 1982 levels. Year to date sales volume is 18.5% below last year.

See product volume summary chart on next page for detailed analysis of monthly and year to date volumes.

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EXHIBIT
2
Emergency Notice

Market and Competition

Polycel Products

In mid-September we launched a major program aimed at regaining business in Texas. We are offering competitive prices and extended payment to twenty-seven target accounts.

We're on the right track - we have sold 4.0M lbs. in a short period of time. Eagle Insulators, Inc. has taken advantage of the program and ordered 1.2M lbs. Their purchases in 1983 prior to this were only 1.2M lbs. versus 13.2M lbs. thru September 1982. We also regained Diversco's business in Dallas. They ordered 1.8M lbs. under the program. When they were a full time customer in 1981, they purchases over 10.0M lbs.

Owens Corning management have approved Polycel One for sale through their sixty-five supply centers. Polycel is the only foam sealant in an aerosol can that they have allowed their supply centers to sell. We have received orders already for 120 cases from the Louisville and Cincinnati centers.

We participated in several dB Plus acoustical sealant seminars put on at the Owens Corning branches in Columbus and Cincinnati. These seminars were a joint effort between Mike Ragan's people and the Owens Corning branch managers. As a result of the effort O.C. is stocking dB Plus. They were successful in securing distribution in Louisville and Cincinnati.

Polycel One is being advertised by Cotter/True Value in October in the following magazines: BETTER HOMES AND GARDENS, FAMILY CIRCLE, MECHANICS ILLUSTRATED, POPULAR SCIENCE, POPULAR MECHANICS, SPORTS ILLUSTRATED, (World Series Preview) and OUTDOOR LIFE. Also the True Value direct mail circular going out in October to 20.3 million homes will also feature Polycel. The advertising we are receiving is an example of co-op advertising at its best. For a fraction of what it would actually cost, our product will be brought before over 100.0 M people in October.

M. Toben has received an order for a new consumer account in the Northwest. T & A has ordered 1400 cans of PC5's and an order is pending from the Angels centers in Southern California.

The industrial business appears to be picking up. We have lowered our price in two areas of the country to keep from losing business. We also introduced a 5% sales increase in PC8's effective 9/15/83. Now that the fall weather has arrived we should expect to see a surge over the next three months.

In September leads received from the JULY BUILDER magazine were sent out to our certified contractors and distributors. Also a copy of the leads and letters sent to our customers was sent out to the Polycel specialists for follow up.

Wall Insulation

Central Regional Management has agreed to change over to the revised T-clip system. New clips and the new channel have already been shipped to the Milwaukee plant.

Two new T-clip jobs were started in September. One job is in Waco, Texas and that is a 2 1/2 inch job and the second, a 2 inch job in Florida.

We signed the Dryvit agreement and have returned it to them. We are waiting at this point for Dryvit's approval and we can begin to actively pursue this business in Phoenix, Arizona and in Southern California. There are currently 100.0M board feet of material aging at the South Gate facility.

Another OCF Supply Center has been added to the Thermostud distributor list. The supply center in Atlanta purchased a half truckload of Thermostud for their warehouse and began marketing the product in September. This is the first OC supply center in the Southern Region to begin marketing Thermostud.

A slide presentation explaining the revised Thermostud T-clip system has been distributed to the regional offices as an aid to helping the sales force introduce the revised system to distributors.

The ZMI incentive program ended in September. We know the program was successful and a detailed analysis will follow.

We continue to get reports that EPS scrap is winning in obtaining acceptance at the contractor level over ZMI. We are developing sales tools to aid in defeating this low price competitor.

The 1984 Sweet's catalogs for the Thermostud system with the new T-clip and channel as well as ZMI have been completed and are printed.

Attic Insulation

Overall, poor insulation sales at the retail level have affected attic insulation. Even the best campaign dosen't seem to be able to compete with 80 and 90 degree temperatures. With many stores carrying last year's inventory and consumers who aren't interested we have a product which is behind last year by 20%.

Research and Development

Polycel Products

In October we will begin the market test of the new improved A-1 catalyst. We are producing one hundred PC60-D's and one PC3600. These will be distributed around the country to specific accounts. We will attempt to observe the operation of as many of the A-1 catalyst tanks in the field as possible.

The private label 9.5 board foot two-component kit continues to elude us. The latest delivery date is October 15th. Since we have been promised this for the last four months, I don't put a lot of faith in this event occurring.

In Texas we experienced several failures of the new refill valve. The problem with the valve has been identified and steps have been taken to correct it. We have also contacted our original European valve supplier. They have sent us pricing and samples of valves which we will evaluate.

0641952

We are going to have to identify another source of aerosol cans. Southern Can has to date never met many of their promised ship dates. It is especially important during this season that they do meet those dates.

Wall Insulation

A wall has been constructed for the guarded hot box test on the Thermostud system with the T-clip. We should know in October what the in-place performance is of the Thermostud system with the T-clip. We can compare this to these performance results from our computer model.

As stated earlier we are requesting research help to determine the static charges of ZMI and EPS scrap. If our sales force can show proof that EPS scrap's high static change prevents it from completely filling blockcores we may be able to deter sales of EPS scrap without lowering ZMI prices. In addition we plan to have some thermographs produced of separate block walls filled with EPS scrap and ZMI. This should graphically reveal that ZMI is a superior product in filling and insulating the cores of a black wall.

G. N. Ciampa

GNC:jmm

WR0007988

Copy Rec'd 7/31/83

06046312

September 12, 1956

Mr. Dohrman H. Byers, Ass't Chief
Toxicological Section
Public Health Service
1014 Broadway
Cincinnati 2, Ohio

Dear Dohrman:

I appreciate receiving your letter of September 5, concerning the samples I sent collected from the Zonolite Company and your comments on the asbestos situation. However, I believe that in my letter I should have mentioned a circumstance that might change your thinking on this somewhat, in that, even though the ore being treated by the Zonolite Company may have from 8 to 21 percent asbestos content at this time, a very small increase in asbestos content causes several factors increase in dust concentration. In other words, when nearly pure zonolite or vermiculite is being run, the dust concentration is at a pretty constant level. With a very small increase, say, of 5 or 10 percent in the asbestos content, the dust concentration goes up by several hundred per cent. Under these circumstances, the percentage asbestos in the dust in the air would be considerably more than the percentage in the material being processed.

At the first opportunity, I plan to make some analyses, or attempt to make some analyses of the increase in dust concentration with the increase in asbestos content. The company at this time, I believe, estimates the asbestos content of their ore by comparing a sample of material taken off certain size screens with bottles of prepared material in fixed quantities by color. The bottles are laboriously prepared by simply picking out certain number of pieces of asbestos, which is white in comparison to the relatively brown color of the vermiculite, mixing this with a certain number of particles of the same size of vermiculite, and obtaining a certain color. This appears to be about the only method they have of estimating the quantity of asbestos in the material. They take these estimates quite regularly from each lot of ore that is being processed.

I would appreciate any further information you may happen to run across concerning this matter.

Sincerely yours,

20156270

Benjamin F. Wake
Acting Industrial Hygiene Engineer
Disease Control Division

BFW/hsd

EXHIBIT
3
Emergency Notice

CAMBRIDGE **CONFIDENTIAL** MID APR 20 1977

TO: E. S. Wood

DATE: April 19, 1977

FROM: Julie C. Yang

SUBJECT: Tremolite Content in ZONOLITE® Products

CC: H. C. Duecker
H. A. Eschenbach
F. W. Eaton
W. R. Hanlon
R. M. Vining
B. R. Williams
J. W. Wolter
C. C. Ou
S. C. Vaughan
File: 71-046

OBJECTIVE:

The objective of this study is to determine the tremolite content in all ZONOLITE products made of both Libby and Kearney vermiculites. In a few cases, repetitious analyses were made for product used on job-sites, so that correlation can be made with the fiber counting results.

METHOD

When tremolite is determined from the product as received, in most products tremolite was not found by conventional analytical methods. The trace amount can be determined only when intensive concentration techniques are employed. Tremolite determinations are then made from the fractions by quantitative x-ray diffraction analysis and with the aid of petrographic microscopic examination.

1. Terra-Lite Vermiculites, Verxite, Redi-Earths and Metro-Mires

The schematic method of analysis and the results have been reported in T&A 50110 with limited distribution. They are also reported here as shown in schemes 1, 2, and 3.

2. Scott Turf Builder

The method of concentration was very similar to that of Terra-Lite Vermiculite scheme #1, except in the water flotation step. A longer soaking period was needed to solubilize all the nutrients present, which was approximately 50% of the total weight.

3. ZIC, Attic Fill, Masonry Fill

Same concentration method as Terra-Lite (scheme #1).

EXHIBIT 4 Emergency Notice

4. MONOKOTE

Analysis of tremolite in MONOKOTE was the most difficult and time-consuming procedure. The glass fibers were screened off, plaster of Paris was dissolved in water about 50-100 times the weight, expanded vermiculite was floated off, and all the washings were combined, filtered and dried. The filter paper and the organic matter were then burnt off; the remaining residue was x-rayed for the tremolite analysis. Detailed separation and concentration procedure is shown in scheme #4.

5. ZONOLITE 3300

Separation and concentration techniques are similar to that of MONOKOTE, but dilute acid (in HCl) was used to digest the portland cement binder instead of using large excess of water for solubilizing plaster of Paris. The procedure is shown in scheme #5.

RESULTS

A. Tremolite Content in ZONOLITE Products

Kearney

ID No.	Product Description		% Tremolite		
1	ZIC K-4 Kearney		5.466		
2	ZIC K-4/5 B		1.715		
4	Masonry Fill K-4		1.605		
9	Masonry Fill K-3		.0504		
11	MK-4 Kearney 3		<0.08		
13	MK-5 Kearney 3		<0.08		
17	Terra-Lite Kearney		4.319		
18	Terra-Lite T.R.		0.016		
20	Metro Mix 200 T.R.	(as rec'd)	0.398	(dried)*	.477
21	Redi-Earth T.R.	(as rec'd)	0.048	(dried)	.071
23 (5)	Verxite Carrier Grade #4, Kearney (St.Louis)		0.083	(<0.008)	
26	Metro-Mix 300, T.R.	(as rec'd)	0.081	(dried)	0.121
27	Metro-Mix 350, T.R.	(as rec'd)	0.156	(dried)	0.259

*Metro-Mixes and Redi-Earths were computed both in as-received basis and oven-dried basis since the product has substantial amount of moisture.

by

No.	Product Description	% Tremolite	
0	MK-4 (L-3) West Chicago	< 0.10	
6	Masonry Fill (L4D-18) West Chicago	0.01	
9	Terra-Lite, W. Chicago	0.035	
25	Attic Fill (L-2) W.Chicago	.013	
28	Redi-Earth (L) Santa Ana	(as rec'd) .031	(dried) .051
14	Redi-Earth (L) W. Chicago	<0.02	
15	Metro-Mix 200 (L) W. Chicago	(as rec'd)0.034	(dried)<.043
12	Zonolite 3300 (L-3) W. Chicago	<0.007	
3	Concrete Aggregate (L4D-18) W. Chicago	0.344	
16	Scott Turf Builder (L) Dark	<0.009	
22	Scott Turf Builder (L) Light	<0.009	

B. Tremolite Content in Zonolite Job-site Samples

ID No.	Product Description	Location	% Tremolite
8	ZK Roof Deck (K 4/5 B)	Montgomery, Ala.	2.828
9	Masonry Fill (K-3)	Columbus, Ohio	0.050
28	Redi-Earth (L-4)	Forest Service, Santa Ana	0.031 (.051)*
51	Monokote-5 (L-3)	San Diego	<0.106
54	Masonry Fill (K-4)	W.Palm Beach, Fla.	2.86
55	ZIC (K-4)	Edison H.S., Miami, Fla.	0.476
58	Masonry Fill (L-3)	Mashburn & Coe Bldg., Oklahoma	0.250
57	Monokote-4 (L-3)	Hyatt Regency, Dallas	0.240

*oven-dried basis

DISCUSSION and COMMENTS

1. Some of the Kearney products showed high "tremolite" content since x-ray diffraction method cannot distinguish massive tremolite (Hornblende?) and fibrous tremolite. Microscopically, most of the Kearney material showed trace or absence of fibers.

2. Tremolite fibers can be reduced if a screened vermiculite is used such as in verxite. We have observed that most of the fibers are concentrated in the fines.

To: E. S. Wood
From: J. C. Yang
April 20, 1977

3. The percentage of tremolite in several samples was expressed in less than a certain value which indicated that tremolite fiber was not detected by our x-ray method. The limit of detection for tremolite by x-ray diffraction technique is about 0.2%.. When concentration factors were taken into consideration, the possible maximum tremolite content in each sample was indicated in the analyses.

4. Most of the Monokote showed undetectable tremolite content except #57, an MK-4 product used at Hyatt Regency in Dallas, which showed a 0.24% tremolite; the value has been double checked and is real.

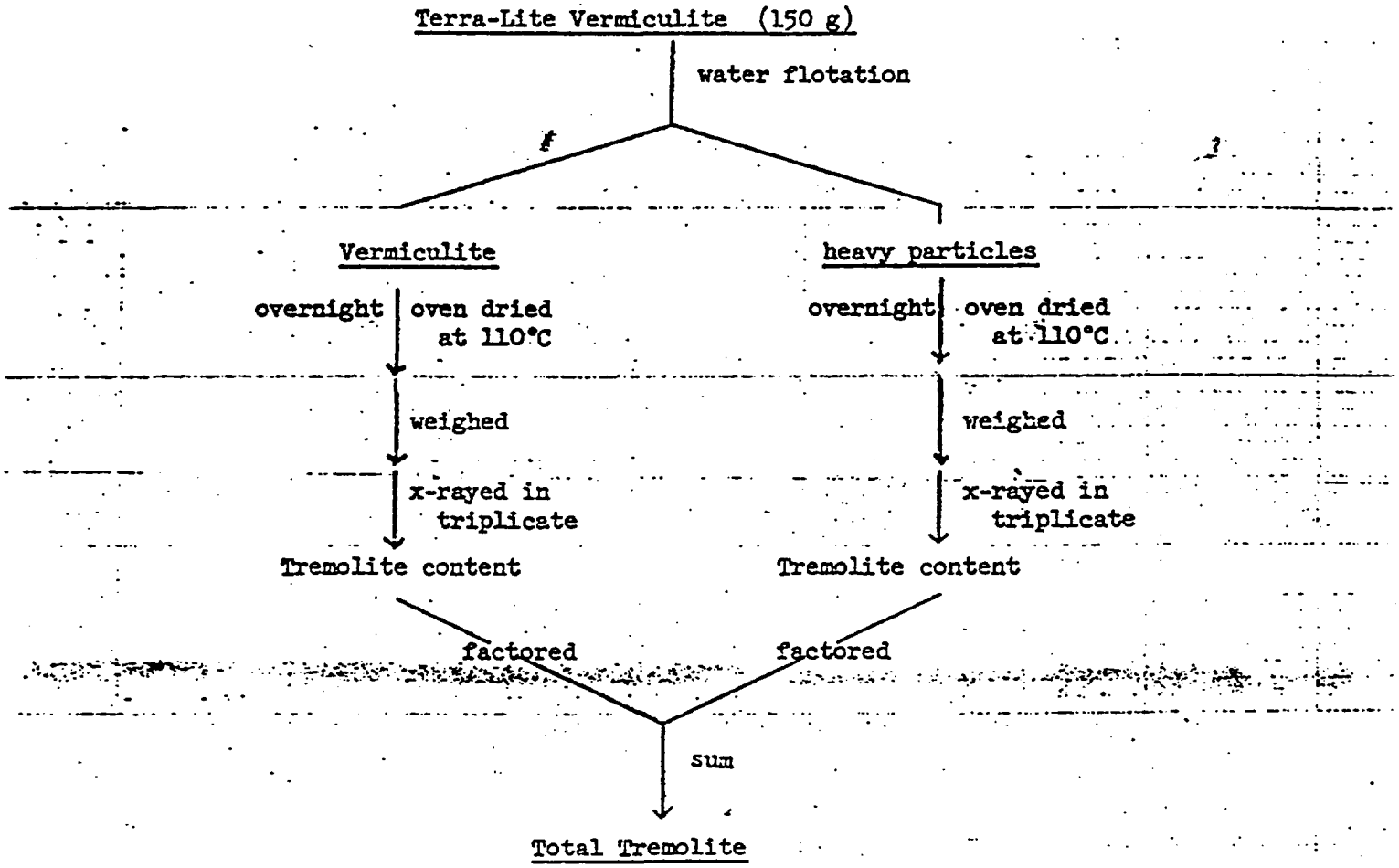
Julie C. Yang

Julie C. Yang

JCY:mlr

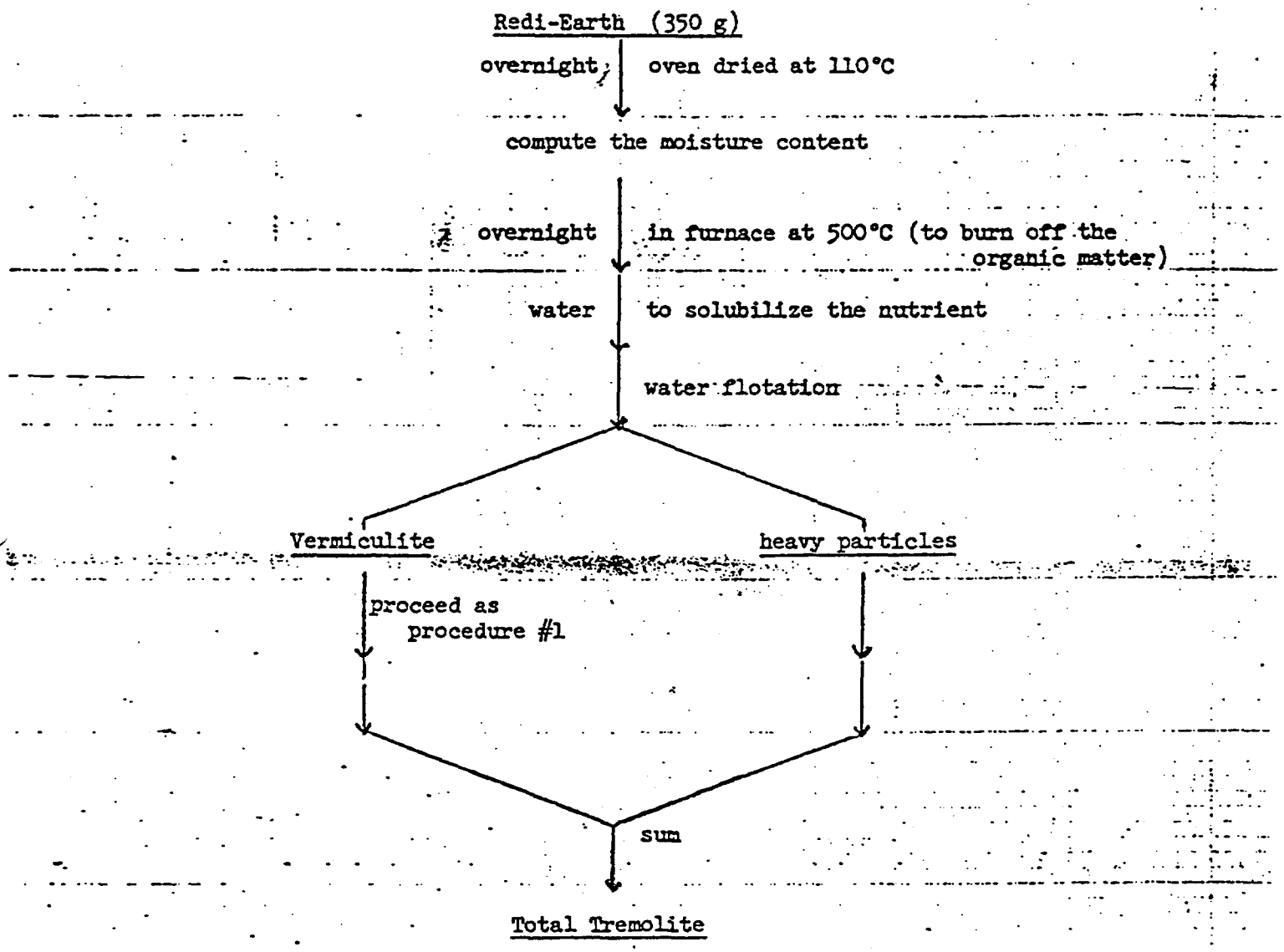
1. SCHEMATIC DIAGRAMS FOR TREMOLITE ANALYSIS

1. Tremolite Determinations in Terra-Lite Vermiculite



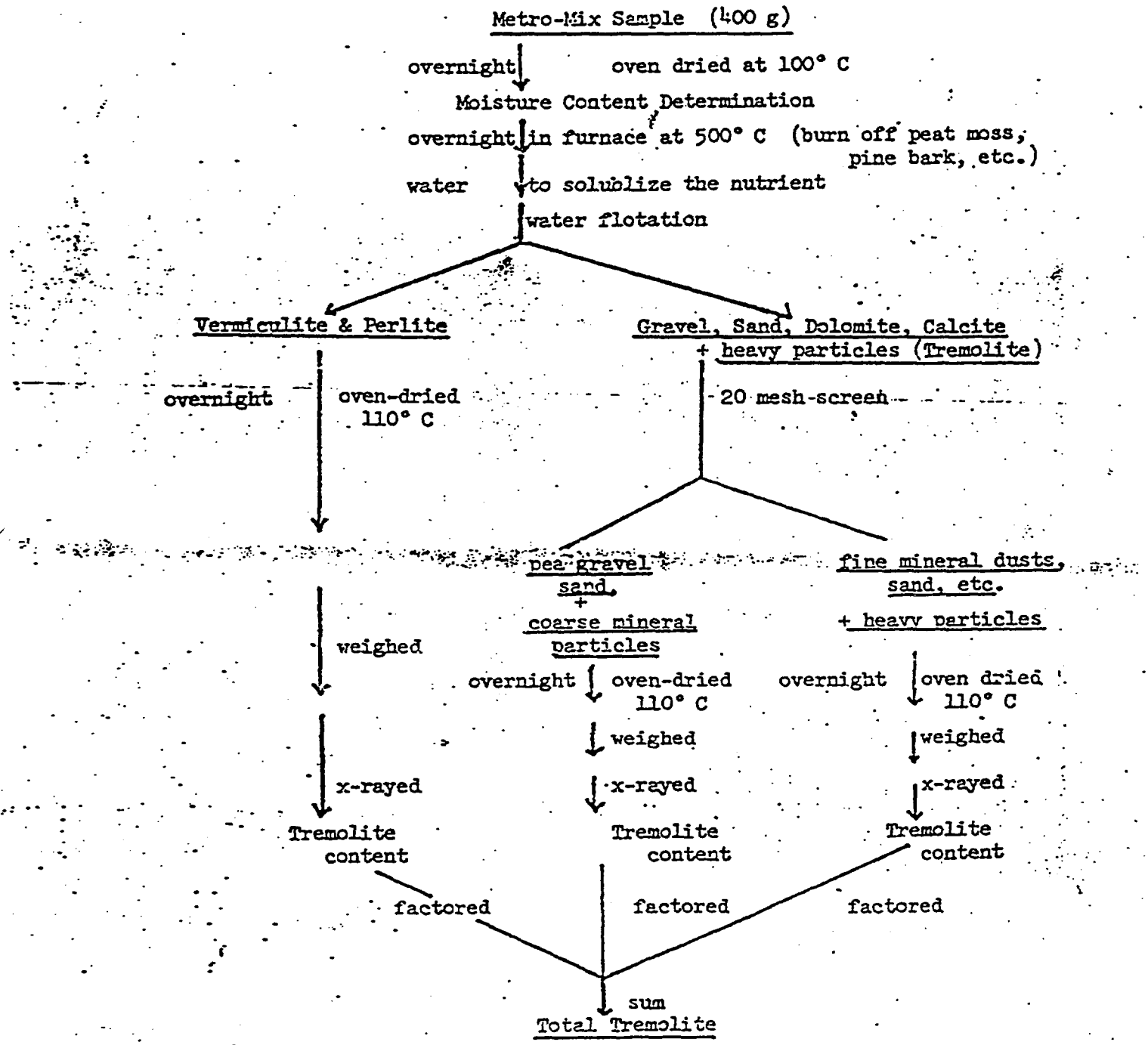
Julie C. Yang
April 19, 1977

2. Tremolite Determination in Redi-Earth



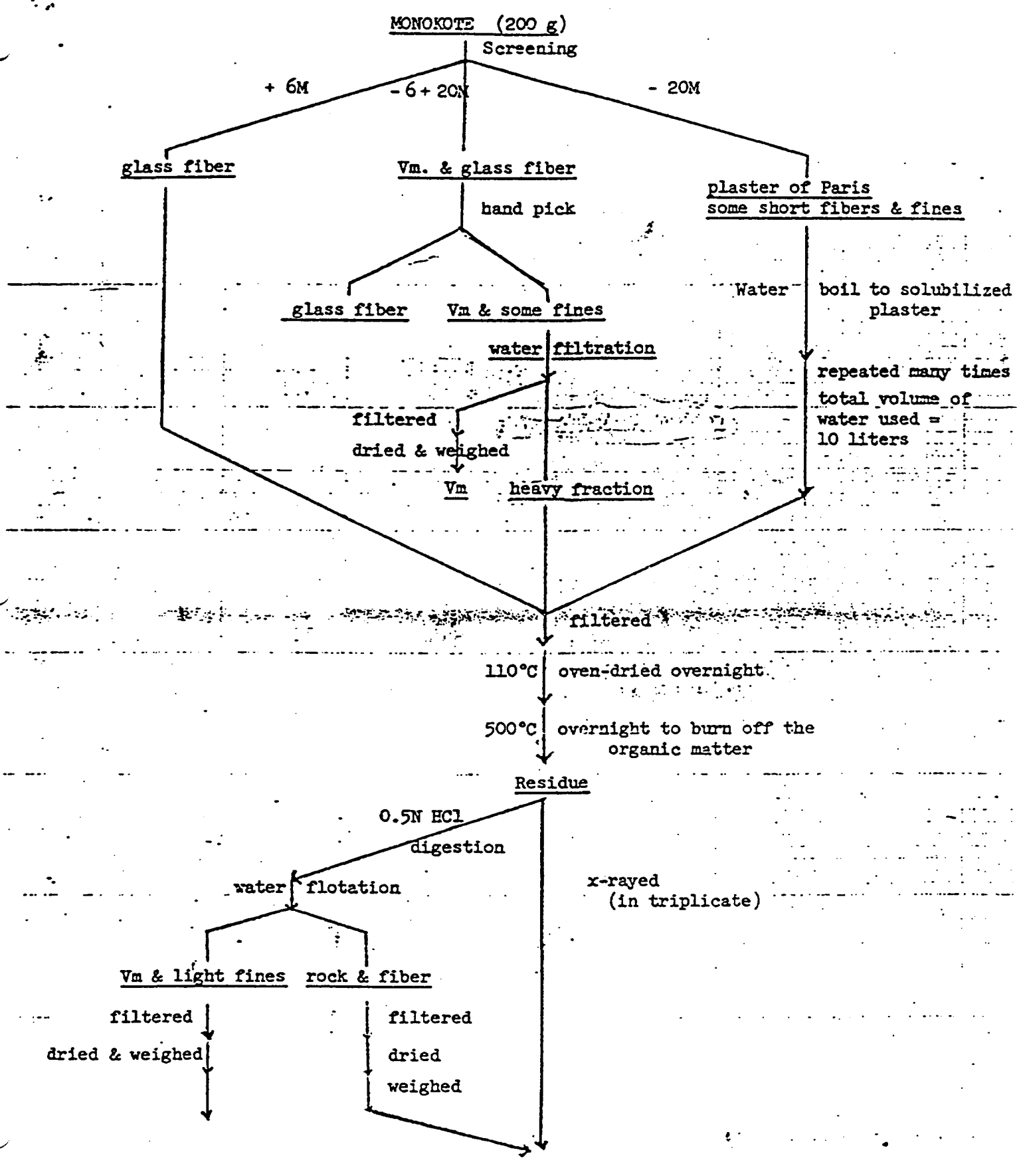
Julie C. Yang
April 19, 1977

3. Tremolite Determinations in Metro Mix



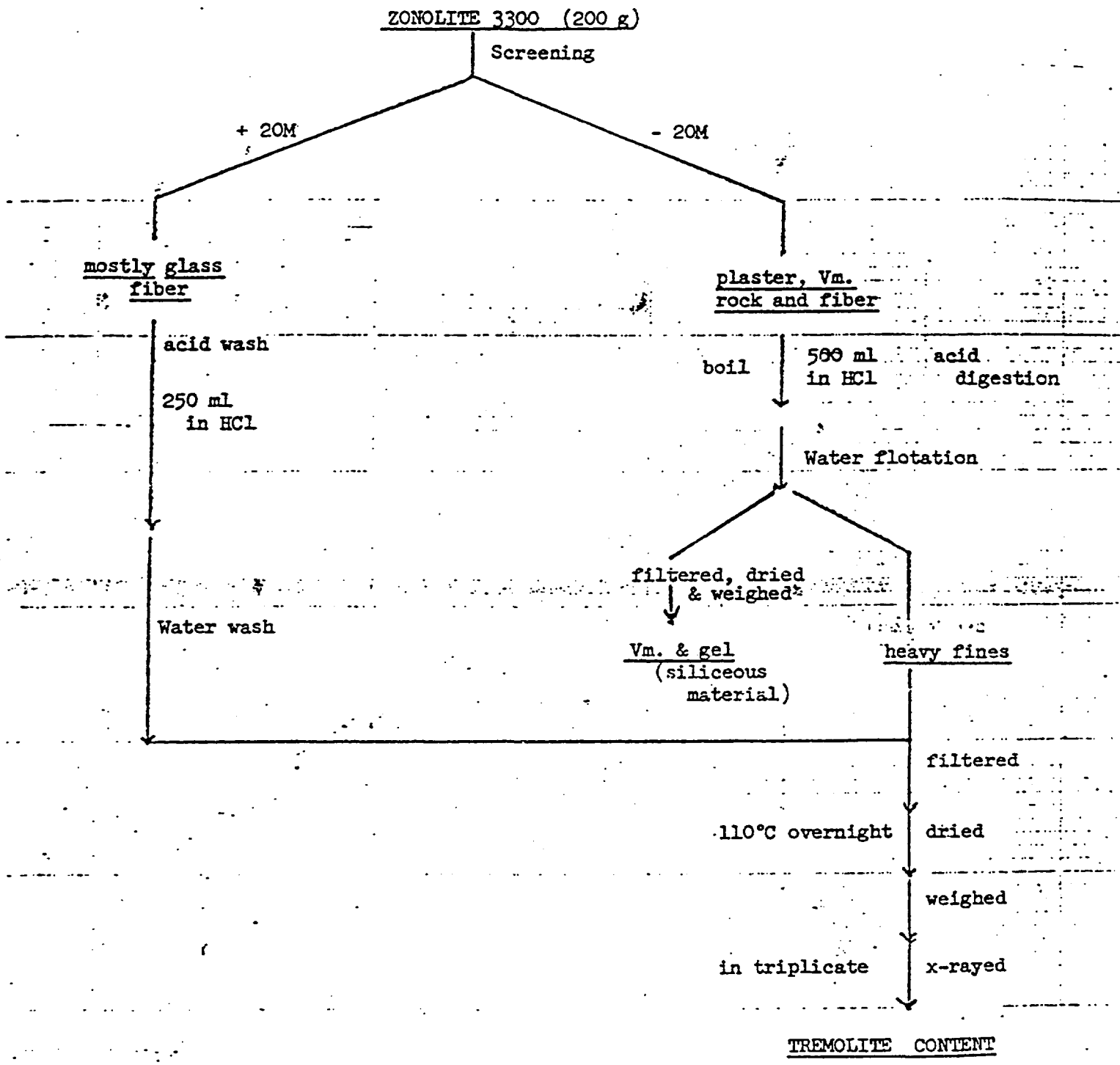
Julie C. Yang
April 19, 1977

4. TREMOLITE DETERMINATION IN MONOKOTE



Julie C. Yang
April 19, 1977

5. TREMOLITE DETERMINATION IN ZONOLITE 3300



Julie C. Yang
April 19, 1977

GRACE

Construction Products Division

PERSONAL AND CONFIDENTIAL

03629668

To: C. E. Brookes
C. N. Graf

May 24, 1977

From: E. S. Wood

Subj: Tremolite in Vermiculite

cc: R. M. Vining
B. A. Blessington
H. C. Duecker
W. R. Hanlon
W. F. McCord
L. Rosenblatt
B. R. Williams
J. W. Wolter

The purpose of this memorandum is to discuss in some the nature of the tremolite problem as it impacts our vermiculite business, and also to outline our plans for dealing with the problem. These plans are based on extensive product testing, analysis of alternative configurations of the Zonolite business, and consultation with legal counsel, including the Corporate Legal Division.

THE PROBLEM

Tremolite is present as a tramp mineral in our vermiculite deposits, and while most of it is separated from the vermiculite in the milling process, small amounts are carried to expanding plants and ultimately into finished products. Tremolite is classified as asbestos and regulated by the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the Mining Enforcement and

EXHIBIT 5 Emergency Notice

EXHIBIT 123.12

15101908

Cal. 6 of 13 (R 12/10/96)

May 24, 1977

The purpose of this memorandum is to discuss . . . the tremolite problem as it impacts our vermiculite business.

* * *

[former Libby employees'] risk of lung cancer is five times the national average . . .

* * *

Based on the advice of corporate general counsel, we have decided not to affix labels on . . . expanded products using Libby ore . . .

* * *

Zonolite Profitability Impact . . .10-50% reduction in sales volume that would result from a requirement to label our products . . .

* * *

Harm to customers . . . The highest level of exposure is for Attic insulation [with] concentrations of upwards of 15 f/ml . . . in simulated tests . . .

* * *

Product bans . . . We forecast that our vermiculite consumer products, namely Attic Insulation . . . will eventually be banned by the Consumer Products Safety Commission . . .

* * *

A decision to label our consumer products would eliminate the risk of future liability, while exacerbating the risk of claims . . .from past use of the product.

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EXHIBIT
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Safety Administration (MESA), the Consumer Product Safety Act (CPSA), and the Toxic Substances Control Act (TSCA) as a carcinogen. Although we have been working since 1971 to reduce tremolite in our product, in our expanding plants, and in our mills, we have felt until now that tremolite was misclassified by OSHA and others as a form of asbestos. This was based on our understanding of the difference in physical characteristics of tremolite compared to other fibrous forms of commercial asbestos, as well as outside studies such as the animal study sponsored by Johnson & Johnson on a tremolite talc which showed no carcinogenicity.

Two recent developments have changed our views on this subject. First, an in-house study of mortality rates among ex-employees at Libby indicates that their risk of lung cancer is five times the national average. In this connection, we have experienced asbestosis in 41.5% of the workers (with over 10 years' service) in Libby, as well as in 28% of the workers (with over 10 years' service) exposed to Libby ore in the expanding plants. (The experience at Libby is confused because all of the aforementioned workers were exposed to high dust count levels in the old dry mill. The present Libby dust environment with the new mill represents a major change in this respect. Fiber counts have dropped from a level of above 30 f/ml on the average to a level below 5 f/ml. Also, the expanding plant employees mentioned have also been exposed to commercial asbestos in the manufacture of MK for a number of years.) Secondly, with respect to national safety regulations, the prior distinctions between "commercial asbestos" and "non-commercial asbestos" (tramp contaminants) are being erased as the general nature of the hazard of exposure to fibrous materials is more thoroughly studied.

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A great deal of controversy exists over what constitutes a safe level of exposure to a carcinogen. Most people would agree that safe levels are very difficult to establish. One view, taken by most regulating agencies, is that since no safe level can be unequivocally demonstrated, carcinogens must be eliminated where there are acceptable substitutes. Where the carcinogen cannot be eliminated by substitution, exposure must be controlled at the lowest level which can be technically achieved and reliably monitored. The opposing group makes a strong case that no unusual health risks have been rigorously documented for asbestos exposures below 5 f/ml (8-hour time weighted average), much less the present standard of 2 f/ml, or proposed standard of .5 f/ml. In the presence of such controversy it is difficult to determine what posture is appropriate for us in establishing limits of exposure for our employees and customers. A more detailed discussion of the health hazards associated with asbestos exposure is contained in Appendix I.

The exposure problems that we have seen to date are limited to the fibrous type of tremolite that occurs in the Libby deposits. The tremolite associated with our deposits in and around Enoree, South Carolina is largely non-fibrous. Since we have no evidence of asbestosis or other excess health risk associated with asbestos exposure among employees working in South Carolina, we do not believe that the levels of exposure to our employees or customers utilizing material from South Carolina creates a health hazard of any kind. In the case of material from Libby, we believe that lower levels of exposure are required to assure the safety and well-being of our employees. Moreover, regulations already proposed, when put into effect, will mandate lower levels.

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PROPOSED ACTIONS

1. Fiber Control

As a result of the existing and expected regulations, we are moving ahead on a faster than planned schedule with requests for $1,271,000 in fiber control capital spending originally budgeted through the end of 1978 for the Libby mill and various vermiculite expanding plants. We will also request authorization to spend $298,000 over and above that which was budgeted, again principally for fiber control projects. The individual projects are listed in detail in Appendix II.

Insofar as fiber reduction is concerned, our experience to date indicates that removal of tremolite fibers at the mill is a preferred method of reducing employee and customer exposure levels. Immediate temporary steps have been taken to reduce the level of fines which have been recycled into the ore shipped from Libby. It is too early to assess the benefit of these changes, although taken alone they are not expected to eliminate the need for a fiber reduction program at the expanding plants and a fiber-binding program for consumer products. The cost of permanent equipment to collect and dispose of these fines is included in the overall Libby fiber reduction program discussed below.

The present MESA standard in effect at Libby is 5 f/ml (8-hour TWA). The Federal Metal and Non-Metal Mine Safety Advisory Committee has recommended that MESA lower the present standard to 2 f/ml, although the timing of such a change is uncertain. Our objective is to bring all Libby fiber counts below 2 f/ml by January 1, 1978. To meet this objective we will be proceeding with $718,000 in capital spending over the next few months (budgeted

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at $605,000 in the 1977 capital budget). Included in this amount will be $331,000 of spending against RCA 12-2 (budgeted for this year at $204,000) for mill-related fiber and dust segregation, collection and disposal equipment. The remaining $387,000 (budgeted at $401,000 for 1977) will be directed at mine area dust control and vehicular dust control equipment. Authorization for this spending is being requested under separate RCA's and shop orders.

For the long term, research is being carried on at North Carolina State, aimed at improved separation techniques that appear to be effective in clean-up of our finer grades (No. 3 and No. 4). Unfortunately, this approach does not seem to be effective for the coarse grades (No. 1 and No. 2) which are used almost exclusively for Attic Insulation (hence the need for a binder development for Attic Insulation). Laboratory scale results indicate that a reduction of over 90% in the level of fibrous tremolite in fine grades may be achievable. This would appear to be the preferred long-term solution to tighter fiber exposure levels both at our expanding plants and in the customer use environment for the greatest volume of our products ($28.3 million out of a total $35.5 million of expanded vermiculite sales and ore sales to outsiders using Libby ore in 1977).

A series of changes primarily in ore handling facilities will be made at eight expanding plants which do not presently meet the OSHA standard of 2 f/ml (8-hour TWA). These changes will total $943,000 of capital as follows: Denver ($50,000); Newark ($114,000); Phoenix ($110,000);

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Dallas ($50,000); Portland ($107,000); Dearborn ($197,000); and Omaha ($315,000). Since the steps taken to reduce fiber counts to 2 f/ml, with proper plant maintenance, can generally bring fiber counts below 1 f/ml with appropriate peripheral equipment, we expect to achieve a level of 1 f/ml at all expanding plants by mid-1978. An additional $93,000 of capital will be required for peripheral equipment to meet 1 f/ml at the following plants: Easthampton ($17,000); St. Louis ($26,000); Little Rock ($50,000). These changes will be handled through a series of individual plant RCA's or shop orders, with the exception of Omaha spending which has already been approved under RCA E76-317 ($247,000 approved by the President on November 26, 1976), and RCA E76-311 ($68,000 approved by the CPD President on September 27, 1976). Excluding Omaha, the expanding plant capital spending totals $721,000 versus budgeted 1977 and 1978 figures totaling $666,000.

In part, these changes are being undertaken now since they represent relatively small capital increments (above what would be required to reach the present mandatory levels) that will yield substantially lower exposure levels to our employees. However, it is clear that the levels which we propose meeting will eventually be embodied in stricter state and federal standards. Moreover, it is clear that the Federal Government policy for the long run will be directed to achieving the lowest level which is technically feasible and which does not have an adverse impact on the economy as a whole.

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Standards as low as .1 f/ml have been proposed by the National Institute for Safety and Health (NIOSH). While this was a proposal that has been made without regard for its economic impact or technical feasibility, it is indicative of the general philosophy behind control of substances defined as carcinogens.

2. Product Labeling

Based on the advice of corporate general counsel, we have decided not to affix asbestos warning labels on any of our expanded products which, in their normally intended use, do not expose customers to fiber levels above those permitted by OSHA. Thus, no products made from South Carolina ore will require labeling. Subject to the results of additional job-site tests, no present expanded products using Libby ore will require labeling, with the possible exception of industrial grades for which we may not be able to identify and test all end uses. This policy is consistent with the posture of Johns-Manville, the largest supplier of asbestos products in the U.S. and a leader in the field of asbestos safety and health precautions. Effective July 1, 1977, all new packaging purchased will include a general dust warning label printed on the package.

In the case of consumer products, we are operating under the presumption that the present controversy over regulation of materials containing asbestos will be resolved by the Consumer Product Safety Commission (CPSC) in favor of a complete ban on consumer products containing asbestos fibers unless they can be shown to be "bound". Recent action of the CPSC

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in proposing a ban on drywall joint compounds containing asbestos, artifical fireplace logs using free asbestos fibers, and spackling compounds containing tremolitic talcs tends to support our presumption of an eventual ban on unbound asbestos-containing consumer products.

Equipment is being installed at 14 key plants at a projected cost of $130,000 (average of $9,300 per plant) using individual, locally approved shop orders. This equipment will permit us to apply a binder for our two major consumer products -- Attic Insulation and Horticultural Vermiculite. Simultaneously with the installation of the equipment, we are in the process of choosing an appropriate binder and level of treatment with the objective of reducing the use exposure for these products to a level of 1 f/ml maximum exposure and .2 f/ml on an 8-hour time weighted average basis. These are levels chosen because we think they are technically achievable and are close (within a factor of 2) to the level which NIOSH proclaims to be the lowest level which can be reliably monitored.

It should be emphasized that these steps are being taken to comply with the extremely stringent projected regulations, and not because we feel that the use of these products creates a serious risk for consumers.

Considering the brief and irregular pattern of use, we do not believe that asbestos exposure from our products causes an increased risk of health problems. However, there is a fringe of expert opinion, most prominently and articulately represented by a well-publicized expert from Mt. Sinai (Dr. Selikoff) suggesting that even brief exposures, presumably at high levels, can later produce mesothelioma. Mesothelioma is a rare form

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of lung cancer linked to asbestos exposure. For this reason, and the expected stiff regulation of asbestos-containing materials in consumer products, we feel that it is prudent to develop a treatment for our consumer products, even though it is anticipated this will increase our cost of manufacture by up to 15%.

Even though we will not be labeling most of our products, we intend to notify customers who inquire that small amounts of tremolite are present in our end products with the exception of our mixed products. In the case of mixed products (MONOKOTE and soil mixes), tremolite is detectable only through the use of internally developed analytical procedures which require elaborate techniques not commonly recognized or employed in the scientific community for detection of asbestos. For this reason, we are taking the position with all but authorized government authorities that our mixed products are "non-asbestos" products. Obviously, in responding to government inquiries we intend to provide specific data, which we have, that identifies trace levels of tremolite even in mixed products. It is our belief, for purposes of the law, that the amount of fibrous tremolite present in our mixed products is de minimis.

Requests for written statements concerning the presence of asbestos in our products from customers will be answered by indicating that we have small amounts of tremolite present in the product and by referring them to the OSHA regulations covering asbestos-containing products.

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ZONOLITE PROFITABILITY IMPACT

Comparative financial analyses have been completed for the present Zonolite business and several alternative configurations which could be forced by future regulatory activity and/or our ability to meet future fiber standards. The base case and alternative case assumptions and financial comparisons are presented in Appendix III. The following table summarizes key financial statistics for: 1.) the Zonolite 1977 budget and forecast, prepared in October 1976; 2.) a 1977 re-estimate completed in January 1977 reflecting adjustments to sales and gross margins based on the economic outlook at that time (used as the "base case" in Appendix III); 3.) a "most likely" future case reflecting additional capital spending for fiber control, additional costs for binder treatment in certain products, withdrawal of certain consumer products such as Attic Insulation in the U.S., and labeling of the remaining consumer products (Case B in Appendix III).

($000)	1977			1980		
	Budget	Base Case	Case B(1)	Budget	Base Case	Case B
Net Sales	$65,719	$63,495	$57,303	$92,639	$92,281	$80,232
Operating Profit	5,201	4,183	3,033	8,278	8,512	6,065
Profit After Tax	2,779	2,556	2,018	5,305	5,373	3,758
Total Capital Employed	$31,573	$30,891	$29,937	$37,613	$37,215	$34,328
% Return on TCE	9.0%	8.5%	7.0%	14.3%	14.6%	11.2%

(1) Case B presented in 1977 is for comparative purposes only. The full-year impact of assumptions in Case B would not actually be experienced in 1977.

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Our projections indicate that even with the loss of our consumer business (assuming the Canadian Attic Insulation business continues) Zonolite continues to be a viable business albeit at lower than forecasted returns.

More selective internal use of South Carolina ore in place of Libby ore can largely eliminate the 10-50% reduction in sales volume that would result from a requirement to label our products as containing asbestos. The reduction in sales from labeling is primarily the result of our being the first labeled product on a construction job site which would force contractors to comply with impractical OSHA regulations.

ALTERNATIVE APPROACHES

Considering the large potential liability that results from the sale of products that contain even a small amount of contaminant defined by the government as a carcinogen, it is reasonable to question whether there are alternatives to the proposed action. Our exposure to law suits cannot be ignored. In addition, we are forecasting a continued demand for no return capital to be invested in the business in order to meet increasingly tighter standards for asbestos fiber exposure, independent of whether a proven risk exists or not. Two obvious alternatives would be to seek divestment of the business or to close Libby and retrench to South Carolina where the health issues are minimal (but not eliminated).

Divestment of Zonolite has been considered in the past and been judged impractical. It is felt that no buyer could be found, capable of continuing to operate the business (with adequate capital resources) to give us an acceptable price for the business as compared to other alternatives.

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Closing of Libby and retrenching to South Carolina would require a drastic change in the basis on which the business is run. It is likely that we would be operating a regional business in the East, Midwest, and Southeast, rather than the present national business for Zonolite products. This alternative, if required, would be expected to produce a high return but substantially lower after-tax profits. For example, our projection for 1980 for a regional business, without Libby, shows after-tax profit of 2.6 million dollars giving a 15.2% return on the 17.2 million dollar Total Capital Employed. (This case is presented as Case C in Appendix III.) Large asset write-offs and interim operating losses would be incurred to convert to this regional business basis.

We now believe the most likely case for 1980, retaining Libby, but recognizing the possible loss of consumer businesses to be a 3.8 million dollar after-tax profit, generating an 11.2% return on 34.3 million dollars of Grace Capital Employed.

Our forecast indicates that continuing to operate Libby and continuing to conduct a national business is a preferred alternative unless large amounts of capital are required to meet drastically tightened asbestos fiber exposure levels. Our best estimate is that a 1 f/ml standard for Libby would require 3.6 million dollars of additional capital. A tightening of the OSHA regulations covering our expanding plants to a level of .1 f/ml would require 6 million dollars of additional capital. Based on our present assessment of what is technically required, a move to the standards of .1 f/ml in the expanding plants and 1.0 f/ml in Libby would make it uneconomical to continue operating Libby.

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In the absence of such extreme (and unlikely) tightening of standards, our projections indicate that the best course is continued operation of Zonolite from two mine locations.

RISKS

There are seven specific risks associated with tremolite in our workplaces and products which we assess as follows:

1. Harm to customers.

We do not feel that our products create a hazard for normal end uses. The highest level of exposure is for Attic Insulation and Masonry Insulation. The high concentrations of upwards of 15 f/ml (15 minute maximum) for Attic Insulation and 12 f/ml (15 minute maximum) for Masonry Insulation that were observed in simulated tests early in 1976 have not been confirmed by the results of more recent testing in actual field use. (The present OSHA ceiling limit is 10 f/ml for any 15 minute period.) The maximum concentration in the case of Masonry Insulation observed in recent testing was 3.65 f/ml (15 minute maximum) and in the case of Attic Insulation was 4.28 (15 minute maximum). However, we have observed very large variations in simulated test results such that further improvement in Attic Insulation, in particular, may be necessary to be assured that we reliably fall below 10 f/ml maximum exposure during use. Due to the products' short and irregular periods of use, it seems unlikely that we would exceed the 2 f/ml, 8-hour time weighted average, OSHA standard with Attic Insulation or Masonry Insulation.

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All other products appear to be well below permitted levels, in most instances by a good margin. (See Appendix IV for representative test results.)

2. Harm to employees.

The present level of exposure for our Libby employees (up to 5 f/ml TWA), while materially better than the harmful exposures before the new wet mill, still represents concern to us. Therefore, we will be undertaking an employee education program as well as further reduction in the fiber levels to 2.0 f/ml, in order to reduce the risk of harm to our Libby employees' health.

The reduction to 1 f/ml in the expanding plants, which we expect to accomplish by mid-1978, should give us a comfortable margin of safety in concluding that there is very low risk to our employees in the expanding plant work environments.

The risk to expanding plant employees using South Carolina ore, as well as to the mine/mill employees in South Carolina, is negligible.

3. Product bans.

There is a high risk that our products will be banned in several significant uses.

We forecast that our vermiculite consumer products, namely Attic Insulation, Horticultural Vermiculite, and Pool Base, will eventually be banned by the Consumer Product Safety Commission, and this has been assumed in the 1980 financial projections (Appendix III). We place our chances at 50:50 of binding the tremolite such that we could effectively argue that no fibers will be released during use.

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There is also a high risk (30%) during the next 18 months that MONOKOTE fireproofing will be considered to fall within the ban in selected states (California, New York, Minnesota, Massachusetts, and Illinois) of fireproofing products containing asbestos, although it would appear that this is an unintended ban. Legislators in those states simply failed to consider trace tramp minerals when wording the prohibition against a product containing <u>any</u> asbestos for sprayed applications. We are actively working on a vermiculite free fireproofing material for introduction in mid-1978.

4. <u>Label requirements</u>.

We believe that a decision to affix asbestos warning labels to our products would result in substantial sales losses. This view is shared by Johns-Manville in the case of their labeled construction products. It is further supported by J-M's experience with their tremolite talcs.

Based upon advice from corporate counsel, our products do not require labels if the OSHA limits are not exceeded in their intended use. This is also J-M's position for their own products. We believe that all of our products fall below the limits established by OSHA and that we will be able to continue to fall below more stringent standards being projected, thus avoiding the need to label our products.

Secondly, any change in interpretation which would require a labeling of selected products, such as Masonry Insulation, can probably be avoided by redistribution of the cleaner South Carolina ore and withdrawal from selected isolated territories.

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Continued programs aimed at cleaning up the product should allow us to meet the projected tighter limits that may be imposed by OSHA in 1978 and 1980.

5. Increasingly restrictive standards and higher capital requirements to meet the more stringent future standards.

We believe there is a very high risk that standards will become more restrictive requiring additional capital for continued operation of Libby and of expanding plants using Libby ore. In addition to the 1.9 million dollars which we propose to spend between now and mid-1978 to comply with asbestos fiber safety standards, an additional one million dollars is expected to be needed by 1980 in order to meet a projected OSHA standard of .5 f/ml.

There is a risk, which we place at less than a 20% chance, that additional investment of up to 10 million dollars would be required in order to reach a level of 1 f/ml at Libby ($3.7 MM) and .1 f/ml at expanding plants using Libby ore ($6.3 MM). Such a development would probably result in a decision to close Libby and the retrenchment of our business to a regional basis supplied entirely out of South Carolina. (See Appendix III, Case C for details of the financial impact of a decision to close Libby.)

6. Adverse publicity

There is a risk that Grace will attract adverse publicity from national media concerning the presence of asbestos in vermiculite. This

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information is already being circulated within government agencies, such as OSHA and has been reported on a local basis in connection with the Louisa County dispute over the mining of vermiculite ore. Future steps, such as the development of a case for continued sale of Attic Insulation to the Consumer Product Safety Commission, will increase the risk of widespread adverse publicity.

7. General liability to employees, customers, and the public.

Liability to employees is limited by the Workmen's Compensation Laws. However, we should expect increased Workmen's Compensation rates in Libby as the number of disabilities increase among employees who have been exposed in the past to the high fiber concentrations of the old dry mill. Liability among expanding plant employees and the South Carolina mine/mill employees appears minimal.

The risk of liability to customers is heightened by the decision not to label our products. Under the strict liability criteria, we may be liable to customers who can demonstrate they (1) were exposed to asbestos fibers and (2) sustained personal harm. Based on advice of corporate counsel, this risk is categorized as moderate. Moreover, it seems unlikely that bona fide cases of personal harm could be well documented considering the pattern of use and exposure levels of our customers.

General public liability, stemming from the sale of consumer products, is a low-level risk with very high potential liability if it develops. While we have no evidence of any adverse effect of our products on consumers, neither can we offer convincing evidence that they are ab-

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solutely safe. Making such a case is handicapped by the number of "experts" who claim that there is no safe level with the inference that any exposure is potentially hazardous. This leaves us open to liability without a good defense over a broad range of alleged hazards. A decision to label our consumer products would eliminate the risk of future liability, while exacerbating the risk of claims (mostly not bona fide) from past use of the product.

E. S. Wood

ESW/CGR
Attachments

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APPENDIX I

MEDICAL EVIDENCE ON THE EFFECT OF ASBESTOS EXPOSURE

Exposure to high concentrations of asbestos fibers results in increased risk to health of three different types:

Asbestosis is a scarring of the lungs that is a chronic condition appearing first in chest x-rays, usually after 5 or more years of exposure. It can be reliably diagnosed from x-rays and is specifically identified with exposure to asbestos fibers.

Lung cancer (bronchogenic carcinoma) can develop as a result of exposure to asbestos fibers or to other causes (such as smoking). It is difficult to diagnose due to the long latency period between initial exposure to asbestos and development of symptoms. Furthermore, since there are a number of causes of lung cancer, it is more difficult to establish a cause-effect relationship between exposure to asbestos fibers and lung cancer. Nonetheless, a great deal of work has been done which convincingly indicates a relationship between an excess risk of lung cancer and exposure to high concentrations of asbestos (above 5 f/ml). A combination of exposure to high concentrations of asbestos fibers and smoking is more damaging than either alone. One study among asbestos workers has shown that smokers have eight times the risk of lung cancer than non-smokers have.

Mesothelioma is a rare form of cancer which can occur either in the lungs or in the stomach. It can be specifically diagnosed only by taking a biopsy of the affected organ. It is specifically associated with asbestos exposure. Around 85% of cases diagnosed as mesothelioma occur in patients who have a history of exposure to asbestos.

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Although there is disagreement between experts on this point, the determination of an increased risk of asbestosis may also be indicative of an increased risk of lung cancer.

For purposes of assessing the risk to our employees, the only practical indicator is the incidence of confirmed cases of asbestosis. This is due to the extreme difficulty of determining the cause of cancer in any group of people considering the long latency period and general lack of specificity between lung cancer and any single cause. The exception to this would be cases of mesothelioma. However, we have no reports of mesothelioma even at Libby.

As a result of the particular philosophy employed by government agencies to regulate carcinogens, as well as the experimental difficulty of establishing safe levels, very little scientific work is available to help identify the health risk posed by exposure to low levels of asbestos fibers (under 5 f/ml).

There are three sources of information outside CPD which purport to indicate that asbestos fibers cause increased health risks even at low concentrations.

The first is a study among hard rock miners in Idaho (Gillam et al.) which indicates an increased risk of lung cancer in the presence of asbestos fiber exposures of around 0.24 f/ml. However, this study is confounded by the presence of other potentially carcinogenic materials, notably arsenic-containing compounds and radon daughters. A still unpublished study of a larger group of the same miners (McDonald et al.) has indicated no increased

mortality risk from silicosis. This particular evidence of a hazard associated with low level exposures would seem to be seriously impugned.

A second purported indication of the hazard associated with low exposure levels is an increased risk of lung cancer among relatives of asbestos miners. However, more recent measurements indicate that fiber exposures in home environments of asbestos workers can be high and therefore this probably does not represent a low level exposure environment.

The third collection of evidence is of mesothelioma (not other asbestos-related diseases) in individuals and in animals exposed to high concentrations for brief periods of time (as little as 8 hours). The cases in men are few in number typically involving one or two individuals with unknown but probably very high exposure concentrations. Due to the small number of cases, definite cause-effect relationships cannot be drawn. The cases among animals are at extremely high dosage levels in species which are especially sensitive and, therefore, extrapolation to the effects on man are not well-founded.

In spite of the lack of hard evidence, there is a respected group of professional researchers who express the opinion that exposure to levels as low as 2 f/ml (8-hour TWA) create an increased risk of cancer in man after 30 or more years of exposure.

Results of our own in-house epidemiological studies indicate that conditions which existed in the old dry mill in Libby (34 f/ml TWA) and in unregulated expanding plants using Libby ore (29 f/ml TWA) created a health hazard to our employees. Among present employees with 10 or more

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years of service who would have been exposed to the conditions in the old Libby dry mill, 41.5% exhibit asbestosis. Moreover, there is a five-fold increased risk of lung cancer among retired and ex-employees who worked in the Libby mine (as compared to the general population).

We are encouraged by the absence of any new cases of asbestosis found at the last annual check-up at Libby.

Among expanding plant employees, the high employee turnover and variety of past exposures make conclusions difficult. Among 9 employees with 10 or more years' service in plants which have not used Libby ore, there is no incidence of asbestosis, even though several of these plants have previously used commercial asbestos in some products. Among 14 employees with ten or more years of service in expanding plants which have used Libby ore, 28% exhibit asbestosis. However, any cause-effect conclusions are confounded by the fact that all of these plants have used commercial asbestos in the past.

Chest x-rays for the 77 employees at our Enoree mine/mill give no indication of adverse health effects from exposure to the lower level of tremolite fibers (0.8 f/ml) found in South Carolina. While there is incidence of positive chest x-rays in 12 employees (16% of total), only one case is consistent with exposure to asbestos. That particular employee worked for a great number of years exposed to commercial asbestos in another Zonolite location. Of the 12 positive chest x-rays, 5 stem from previous cotton spinning mill exposure which produces "brown lung" disease. There is no indication of excess mortality due to lung cancer among the South

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Carolina mine employees. Since the South Carolina mine has only operated for 29 years, there is still the possibility of extremely long latency periods before excess mortality would be observed.

As very little published medical evidence exists for tremolite exposures, as opposed to the commercial forms of asbestos, we have sponsored animal studies on tremolite and a mixture of vermiculite and tremolite to determine whether tremolite is carcinogenic. The test animals have concluded 400 days of treatment and are scheduled to terminate after 730 days. While no definite conclusions can be drawn from the results to date, indications are that our tremolite creates less of a problem than commercial asbestos. As we have not yet completed the "critical" period of the animal studies, between 370 and 450 days, the lack of a significant difference in mortality between the test animals and the control group is not yet meaningful. Results of this study should be complete and available by October 1978.

We have sought and obtained advice from several outside professionals with respect to what tremolite levels create a hazard.

Dr. William E. Smith of Fairleigh Dickinson University has responded (Appendix V), indicating that notwithstanding the "new evidence" presented by OSHA and NIOSH there is no convincing evidence of an excess risk to health from low level asbestos fiber exposures (below 5 f/ml).

Dr. MacMahon, Professor of Epidemiology at Harvard University, has questioned the conclusions of a leading epidemiologist, Dr. Selikoff of Mt. Sinai, that exposures to low levels are potentially hazardous. More-

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over, he indicates that an unpublished study of shipyard workers in the Pearl Harbor Navy Yard who have been tracked since 1943, indicates no excess risk of cancer mortality contradicting the evidence presented by Selikoff. He derides Selikoff's statements with respect to low exposure level hazards as being unprofessional and not well-founded scientifically.

Dr. Enterline of the University of Pittsburgh has proposed a mathematical model which closely fits the observed relationship between mortality rate and time of exposure among the group of 17,000 shipyard workers studied by Selikoff. We are in the process of using this model to predict the effect of exposure levels of 1 or 2 f/ml. Even assuming that tremolite fibers are as biologically active as commercial chrysotile asbestos (an unduly pessimistic assumption), preliminary indications are that the increased mortality risk from lung cancer as a result of a 50-year exposure to 2 f/ml is only 10% above those not exposed to asbestos fibers.

Discussions with Johns-Manville revealed that two "modern" asbestos fabricating plants (one in Texas and one in California), built in 1956-57, show no cases of asbestos-related disease among their employees. Exposures at these plants have been consistently below 10 f/ml (8-hour TWA), probably in the 2-5 f/ml range, with exposures during the 70's consistently below 2 f/ml. This suggests no excess health risk at concentrations up to 5 f/ml (8-hour TWA).

Amidst such conflicting scientific opinion, any conclusions which we draw must necessarily contain large elements of personal judgment and at least some level of uncertainty. Nevertheless, we must establish levels of

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exposure calculated to protect both employees and customers from excess health hazards. Accordingly, we have concluded that in a regulated and monitored environment such as our plants, a reduction in exposure to 1 f/ml creates a worthwhile margin of safety over the present OSHA standard of 2 f/ml for our employees. A level of 1 f/ml is not expected to have an adverse health effect. A level of 2 f/ml, while probably not hazardous, does not have an acceptable margin of safety and will be reduced if economically feasible. No customers or employees will be exposed knowingly to concentrations above a level of 2 f/ml without adequate warning of the potential hazards involved. Johns-Manville also selects 2 f/ml as a limit below which there is "no excess risk of asbestos-related disease" (compared to those who are not exposed to asbestos).

In unmonitored environments, involving daily use of our products, such as construction sites, a typical exposure from our products of .5 f/ml (TWA) is not considered a hazard.

With the exception of mixed horticultural products, exposure levels for users of our product are above background levels. It is not likely that any improvement which we may make will reduce the exposure of users to levels as low as background. However, our long-range objective will be to reduce customer exposure levels to "the lowest limit at which asbestos fiber concentrations can be reliably monitored". According to NIOSH, this level is .1 f/ml on an 8-hour time weighted average basis and .5 f/ml for any 15-minute period.

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APPENDIX II

CAPITAL SPENDING SUMMARY

TREMOLITE FIBER COMPLIANCE

($000)

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	Capital Amount	Capital Budget 1977	Capital Budget 1978
Expanding Plants - OSHA @ 1.0 f/ml & 5.0 f/ml			
Denver - Ore Handling	$ 50	$	$ 85
Newark - Ore Handling	114	80	
Phoenix - Ore Handling	110		85
Dallas - Dust Cont. on MK and SM	50	35	
Portland - Ore Storage & Handling	107	101	
Dearborn - Ore Storage & Handling	197	192	
Easthampton - Rock Handling	17	18	
St. Louis - Vent System	26	33	
Little Rock - Ore Handling	50	37	
TOTAL EXP. PLANTS - OSHA	721	496	170
Expanding Plants - Product Binder Equipment			
14 Plants @ $9,300 per plant	$ 130	-	-
Libby - To Achieve 2.0 f/ml[a]			
Mill			
RCA #12-2	331	204	
Mine	225	225	
Hauling & Loading & Screen Plant Trucks	162	176	
TOTAL AT LIBBY	$ 718	$ 605	$ -
TOTAL SPENDING	$1,569	$1,101	$ 170

(a) See page 2 for Libby detail.

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RRB/cer

GRACE

Construction Products Division

03629693

PERSONAL and CONFIDENTIAL

March 28, 1977

To: W. R. Hanlon
B. R. Williams
J. W. Wolter
W. R. Wright
R. E. Schneider
F. W. Eaton
R. H. Locke
H. A. Eschenbach
W. F. McCord
R. C. Abernathy
R. R. Benanto
H. C. Duecker
B. A. Blessington

From: E. S. Wood

Subj: Guidelines for Handling of Tremolite Contamination In our Mines, Plants, and Products

cc: R. M. Vining
L. Rosenblatt
W. M. Bush, Jr.
O. M. Favorito
R. L. Oliverio/Libby

Plans have now been laid for handling a variety of external developments related to tremolite asbestos in our mines, expanding plants, products, and customer environments. We must now proceed to implement some of the work plans which have been developed.

Please plan to attend a meeting at 8:30 AM in the Directors' Conference Room on Thursday, March 31st. The purpose of this meeting will be to discuss what actions we will be taking over the next twelve months.

By way of background, you should know our position on several important legal and business issues. The following are three key points:

1. We will not expose our customers and employees to environments which have been formally defined as hazardous by the U. S. Government without proper caution as to the nature of the hazard. We will take all reasonable and practical steps to minimize or eliminate unreasonable risks which may be associated with the manufacture and use of our products including, where appropriate, instructions for proper use of our products.

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2. The tremolite asbestos fiber count limits in effect and enumerated in OSHA (or MESA) regulations will be the guide to whether a health hazard exists. If the product in reasonable use exposes the user to counts in excess of OSHA limits, caution labels will be affixed to the product.

3. Customer, user, or government agency inquiries with respect to tremolite in our plants, products, or use environments will receive straightforward and candid responses with respect to the data and measurements which we have gathered and which are relevant to their respective situations.

As you know, there is a great deal of controversy both in the medical and governmental communities as to what constitutes a hazard and what appropriate regulatory steps should be taken. This is particularly true for products used by consumers. We have reason to believe that this issue will be clarified by the Consumer Products Safety Commission within the next several months. By that time we want to have any tremolite asbestos fibers in our consumer products "bound" and fiber counts in their intended use below 0.2 f/ml (8 hr TWA) and 1.0 f/ml (15 min. maximum). You should be aware that this is a rapidly changing situation and that requirements are still unpredictable.

Attached is an agenda for our meeting of Thursday, March 31st.

Chip

E. S. Wood

ESW/CGR
Attachment

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AGENDA

for

Thursday, March 31, 1977

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1. Legal and Medical Issues

   a. CPA

   b. OSHA/MESA

   c. General Obligations

2. Continuing data gathering requirements and responsibilities

   a. Plants and mines

   b. Users

   c. "No asbestos" case for MONOKOTE vs. Glass Fibers in key states

3. Financial and engineering requirements/work plans

   a. Immediate and short-term -- authorized to proceed

      (1) Water treatment for Terra-Lite Vermiculite and Attic Fill

      (2) Remove and dispose of "fines" at Libby

      (3) Define cost (capital and operating) and effectiveness of binders for AF, TV and MF

      (4) Determine effectiveness of air elutriation by pilot trials

      (5) Engineering design for items in b.

   b. Appropriations to be justified and requested:

      (1) Installation of permanent binder addition equipment in expanding plants

      (2) Get all expanding plants to 2.0 f/ml (8 hr TWA) by 1/1/78

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(3) Get Libby to 2.0 f/ml (8 hr TWA) by 1/1/78

(4) Get all expanding plants to 1.0 f/ml (8 hr TWA) by 7/1/78.

4. Customer, governmental, and media communications

a. Grace policy on comments to media -- DON'T DO IT, LET NY HANDLE.

b. Responsibility and guidelines for customer and governmental communications

(1) Salesmen and plant managers -- verbal communications

(2) Product and Q.C. managers -- routine written customer and governmental communications covered by guidelines

(3) General Sales Managers -- unusual governmental and customer communications covered by guidelines

(4) Exec. VP -- any communication not covered by guidelines.

5. R&D Work Plans

a. Vermiculite free substitutes

(1) MONOKOTE

b. Modifications for commercial use

(1) MF treatment to 1.0 (TWA); ~~5~~.0 (Max.)

(2) AF treatment to 0.1 (TWA); ~~2~~.0 (Max.) 6.5

(3) TV treatment to 0.1 (TWA); ~~2~~.0 (Max.) 6.5

(4) Thin ZIC RD design

(5) Bark ash sources for MM products

(6) 3300 for high humidity urethane foam fireproofing

(7) External fireproofing

(8) Other?

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c. Modifications to have "on the shelf"

(1) Vermiculite free Redi-Earth

(2) High yield (200% on vermiculite) ZIC

(3) Glass free MONOKOTE for decks

(4) Vermiculite free MM.

6. Document Contingency Plans

a. Remaining air and product assay samples

b. Revised customer and press releases

(1) MONOKOTE withdrawal

(2) AF withdrawal

(3) AF labeling

c. Financial Impact Cases

(1) Eliminate inconsistencies

(2) Document and issue summaries

(3) Additional years?

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DETAILS OF LIBBY FIBER REDUCTION SPENDING

	Capital Amount	1977 Capital Budget
MILL		
RCA #12-2		
Final Cleaner System 20 x 65	$100	$ 90
Modif. of Dryer Cyclone & Disp. System	40	
Wash & Screen Hammermill Product	25	
Skip Dust Collection	55	55
Screen Plant Baghouse Disposal	20	
Dust Disposal at Mud Dam	10	
Screen Plant Truck Dump Disposal	12	12
Screen Plant Shuttle Truck Dust Collection	12	
Screen Plant Control Room & Conveyors	11	11
Dust Wall - Transfer Point	3	3
Permanent Dust Disposal from Dryer BH	10	
Mill Lab Vent	5	5
Rework Dryer Belt BH System	20	20
Seal Between Dryer & Wet Mill	8	8
TOTAL MILL	$331	$204
MINE		
Paving - Garage Area	50	50
Paving - Transfer Point Area	50	50
Revamp Mobile Equip. Air. Cond.	75	75
Dust Control - Drills	20	20
Mine Vacuum Station	10	10
Wash Rack - Garage Area	20	20
TOTAL MINE	$225	$225
HAULING, LOADING, MISC. VEHICLES		
Temporary Dust Truck & Hopper	$ 15	$
Screen Plant Super Sucker	10	
Haul Truck Enclosures	22	22
Dust Control - Load Out	15	15
Permanent Dust Disposal Truck	100	
TOTAL	$162	$ 37
Unidentified Projects		139
TOTAL LIBBY @ 2.0 f/ml	$718	$605

RRB:cgr
5-24-77

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APPENDIX III

GRACE

Construction Products Division

03629699

TO: E. S. Wood

May 6, 1977

FROM: R. R. Benanto

SUBJECT: Zonolite Study - Financial Impact of Contingency Plans

CC: Distribution List

The following pages summarize the assumptions, and financial impacts of the various case assumptions developed during the Zonolite Contingency planning study performed in March. For each case, the impact on the following areas are presented:

1.) Overall case assumptions
2.) Market & Product Impacts
3.) Impact on Mines & Ore Allocation
4.) Expanding & Polystyrene Plant Impact
5.) Selling Expenses
6.) Capital Spending
7.) Summary of Financial Implications

All cases are compared to the Zonolite "Base Case" in 1977 and 1980. The "Base Case" reflects the 1977 Budget & Forecast adjusted for the re-estimate in BPD/Ag sales and margins made in January, 1977.

Ron

R. R. Benanto

RRB:mhr
Att.

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CASE A - Major Labelling Program and Withdrawal of All Consumer Products

I. Overall Case Assumptions

A. Fiber Counts to 1.0 OSHA (12/77) and 2.0 MESA (12/77)
B. Withdraw all Consumer Products
C. Lose Canada
D. Label all Libby Products except ZIC, MK, and Mixed Horticultural.

II. Market & Product Impacts

A. Withdrawal

Withdrawal from the Attic business results in simultaneous withdrawal of all Glass Fiber sales and a significant impact on dealer Plainboard sales (ranging from 20% loss in 1977 to 31% in 1980).

Withdrawal from Horticultural Consumer market results in total loss of consumer Terra-lite and mixed product sales. These consumer sales losses are partially offset by increases (20% in 1977 and 30% in 1980) in horticultural perlite sales to consumer through substitution of perlite.

B. Labelling

Only products produced from Libby ore would be labelled. The estimated impact of labelling products varies from product to product and is summarized as follows:

Masonry Fill - 20% drop in volume in 1977 and continued declines of 10% per year until by 1980 the volume is only 50% of 1977B volume.

Plaster Ag - 50% drop in 1977 and another 50% drop in 1978 so that by 1980 the volume is only 25% of 1977 volume.

Misc. Expanded - An immediate drop of 10% in 1977, but a gradual rebound in volume of 4% per year so that by 1980 Misc. Expanded volume is only 2% off of the Base Case.

Ag Bag & Bulk - Declines from 30% off of Base Case volume in 1977 to 70% below Base Case volumes in 1980.

Terralite (Professional) - Decline of 50% in 1977 and an additional 20% off of 1977 volume by 1980. However, this impact is also partially offset by improved Horticultural Perlite sales to the professional market (20% in 1977 and 30% in 1980) and a 10-15% increase in non-labelled Horticultural Professional mixes (eg. Metro-mix). The latter favorable impact results from additional substitution of vermiculite with perlite and mixed products.

C. Ore Sales

Licensees - Demand reflected downward, particularly in coarse sizes, to reflect their withdrawal of Attic Fill. Finer size demand was left unchanged (primarily MK and ZIC) with the exception of a slight overall negative impact due to Masonry Fill.

Independents - Unchanged.

Scott - Due to Scott's desire to avoid labelling Turf-Builder, Scott demand would fall by 30% in 1977 and continue to decline to 20% of Base case levels by 1980. The basic assumption here is that Scott would attempt to maintain their "natural" image and avoid labelling by substituting as much South African or Virginia Vermiculite ore as they could obtain. In addition, Scott has the ability to convert to a polyurethane process as a substitution and already produces such a product with an existing plant.

Gypsum Companies - Labelling impact reflects a 5% reduction in demand from 1977 to 1981.

Canada - Loss of all Canadian ore shipments precipitated by their withdrawal from Attic Fill.

III. Impact on Mines & Ore Allocation

In order to minimize the impact of lost sales due to labelled products made from Libby ore, the ore allocation plan reflects a maximization of the South Carolina mine output. Virtually all Masonry Fill demand was shifted to be supplied by South Carolina (except for Portland), so that the labelling impact on Masonry Fill in Case A was minimized. However, this required the transfer of approximately 23,000 tons to S.C. from Libby, in 1977 and over 26,000 tons by 1980. By 1980, the shift in Masonry Fill alone brought Enoree's output to 135,000 tons, or full capacity. Although some Ag Bag & Bulk & Terra-lite could be temporarily transferred from Libby to S.C. until 1978, for consistency, the 1977 volumes reflect only transferring Masonry Fill. Masonry Fill was chosen as the primary beneficiary of the ore allocation switch based on its more favorable margin contribution per ton of ore versus Ag Bag & Bulk, the extent of the impact on Masonry Fill due to labelling, and the amount of Masonry Fill currently being supplied from Libby.

South Carolina mine volume is reflected at 120,000 tons in 1977 (versus 96,000 tons in 1977 Budget) and in 1980 is at full capacity of 135,000 tons. Actually it becomes capacitated in late 1978. Overhead levels have not been adjusted at Enoree and its DMC is assumed to stay at Budget & Forecast levels. The most favorable impact at Enoree is the impact of the additional tonnage on depletion.

Libby volume is dramatically affected under the Case A allocation scheme. From a 1977 Base Case of 229,000 tons, Libby loses the following volumes: 34,500 tons of Canada, 23,000 tons of Masonry Fill shifted, 16,000 tons of Attic Fill, 8,000 tons lost to Scott, and 22,500 tons lost due to labelling. Libby's Case A 1977 volume is 125,000 in 1977 and 128,000 tons in 1980 (volume growth in non-labelled products is offset by continuing impact of volume lost due to labelling).

At these low volume levels, it was estimated that Libby's DMC would still be able to remain at the $26.50/ton budgeted level of DMC. However, fixed overhead expense reductions were not sufficient to offset Libby's gross margin loss due to volume and resulted in net-income after-tax losses of approximately $750,000 in 1977 and 1980. However, even with these operating losses, Libby would generate approximately $750,000 to $1,000,000 in cash from operations for these years before any capital expenditures, which would be minimal due to the low volume levels. Libby would not receive any depletion credits in these years under these circumstances.

In order to operate at such low volume levels, Libby would be forced to operate the mill on a 4-day week for 37 weeks of the year and would be shut down for 15 weeks during the year. This analysis did not account for other potential negative affects caused by the resultant high turnover of management and skilled personnel that would likely follow from such an operation.

Overhead Expense Levels would be reduced by $886,000 in 1977 as follows:

Factory Overhead	- $622,000	- Reduction in the Overhead Dept. ($366K) depreciation ($47K), non-standard expense ($78K), and mine and mill supervision ($100K).
G&A	- $145,000	- Reductions in engineering and clerical headcount.
R&D	- $119,000	- Reduction in Prospecting & mill process research costs.

IV. Expanding & Polystyrene Plant Impact

With the exception of closing the L.A. plant (assumed in all cases, including the Base Case), no expanding or polystyrene plants were assumed to be closed in Case A.

V. Selling Expenses

Case A selling expense reductions amounted to $1,070,000 in 1977, including $900,000 in BPD and $170,000 in Ag/Hort. These reductions reflect sales headcounts, marketing headcount, and other selling expense reductions (e.g., advertising).

VI. Capital Spending

A. Expanding Plants

The 1977 Capital Budget and Forecast included $1.0 mm in Capital Spending, sufficient to bring seven expanding plants within a 2.0 f/ml OSHA standard. To meet the 1.0 f/ml standard assumed in this case, an additional $200,000 capital over the Base Case Capital Spending has been reflected. However, this was offset by Capital Spending reductions of approximately $600,000 per year over 1977 to 1981 at the expanding plants. These reductions reflect cancellation of the need for most expansion projects (e.g., furnace capacity expansion) and the stretching out of major replacements (e.g., furnace replacements).

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B. Libby

The $515,000 capital required to meet a 2.0 f/ml standard for MESA had also already been reflected in the Base Case capital. In addition, due to the very low volume levels at Libby, major reductions in projected capital spending plans were assumed. These total $5,000,000 over the 1977-1980 period and include eliminations of mine garage, haul truck capacity increases, mill process improvements and capacity increases (e.g., #5 unit), office expansion, etc. These reductions also reflect delays in the need for major replacements of mining equipment scheduled over the forecast period.

The impact of these capital spending reductions at the plants and Libby on Net Fixed Assets amount to $664,000 less than Base Case in 1977 and $6,270,000 less in 1980.

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VII. Summary of Financial Implications ($000)

	Variance Fav/(Unfav) vs. Base Case			
	1977		1980	
A.) Gross Sales (Impact in 1977)	Amount	%	Amount	%
BPD (attic $3,638; Glass $623; Poly $544 and Ag Products $932)	$ (6,037)	(12.2)%	$(10,318)	(14.4)%
AG (Terra-Lite $1,542; Mixer $705)	(2,563)	(24.6)	(4,638)	(30.6)
Ore (Scott $300; Canada $1,835)	(2,784)	(44.5)	(5,578)	(61.2)
TOTAL	$(11,384)	(17.2)%	$(20,534)	(21.4)%
B.) Gross Margin on Net	(4,640)	(17.3)	(8,903)	(22.1)
C.) Factory Overhead (primarily Libby reductions)	622	5.5	2,281	16.8
D.) Operating Expense (BPD/Ag Selling $1,070 and the remainder at Libby)	1,334	10.1	2,513	13.8
E.) Pre-Tax Profit	(2,684)	67.8	(4,109)	48.3
F.) Taxes				
Before ITC and Depletion	1,359	67.5	2,117	48.5
ITC	(23)	(6.2)	(140)	(49.1)
Depletion After-Tax	82	33.7	(462)	(47.2)
TOTAL TAXES	$ 1,418	100.0%	$ 1,515	48.9%
G.) Net Income After-Tax	$(1,266)	(49.5)%	(2,594)	(46.0)%
H.) TCE				
Working Capital Due to Lower Sales	1,349		2,767	
Net Fixed Assets	664		5,270	
TOTAL	$ 2,013	6.5%	$ 8,037	21.6%
I.) % Return on TCE	(3.8)% Pts.		(4.8)% Pts.	

A more detailed comparison is shown following the case discussions in Exhibit 1-3.

CASE B - Selective Consumer Product Withdrawal; Labelling all other Consumer Products.

I. Overall Case Assumptions

A. OSHA to 1.0 f/ml by 12/77 and 0.5 f/ml by 12/80
MESA to 2.0 f/ml by 12/77

B. Withdraw only Attic, Pool Cushion, Glass Fiber, and Santoquin.

C. Label all other consumer products; Ag/Bag if on Libby.

D. Avoid labelling by bringing tremolite in products to lower levels, e.g., treatment, use of South Carolina ore, etc.

E. Canada stays in Attic business.

II. Market & Product Impacts

A. Withdrawal

Withdraw from Attic business results in simultaneous withdrawal of Glass Fiber and a significant impact on dealer Plainboard sales (same as CASE A).

Withdrawal of Pool Cushion and Santoquin have no impact on other Ag sales.

B. Labelling

Only consumer Products and Ag Bag & Bulk from Libby ore would be labelled. Labelling impact is summarized below:

Ag Bag & Bulk - Same as CASE A.

Terra-lite Consumer - 15% reduction versus Base Case in 1977 and eventually 50% of Base Case volume by 1980. Offset by 30% increase in Hort. Perlite.

Soil Mixes - Consumer - 15% reduction versus Base Case in 1977 and down to 25% off Base Case volume by 1980.

C. Treated Products

To avoid labelling, Masonry Fill, Misc. expanded, and Plaster Aggregate are treated with a water or water/oil solution to achieve fiber standards in finished products. This treatment results in 6.0% yield penalty on coarse Libby ore sizes and 3.0% penalty on Libby sizes 3 & 4.

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D. Ore Sales

Licensees, Independents, Gypsum Co. - As in CASE A.

Canada - Base Case levels.

Scott - South Carolina ore more available than in CASE A (see Ore Section III below), and allows Scott demand to be met totally from South Carolina. However, it is assumed that they will continue to use more South African ore and at best Zonolite retains 22,000 tons (versus 26,000 tons in 1977 Budget) of Scott business through 1981.

III. Impact on Mines & Ore Allocation

Since the treatment of Libby ore for Masonry Fill precludes the CASE A need to shift Masonry Fill to South Carolina ore, the South Carolina mine has capacity available to meet all O. M. Scott ore demand. (Without this move, Scott demand would be only 8,000 tons in 1980 on Libby ore while 1980 demand would be 22,000 tons if supplied with South Carolina ore).

The South Carolina mine demand will thus, continue to be high with it reaching 116,000 tons in 1977 and 132,000 tons (or full capacity) by 1980. DMC and overhead levels are as assumed in CASE A. Also, as in CASE A, the additional volume results in increased tax depletion at Enoree versus the Base Case.

Libby volume is at 177,000 tons in 1977 (versus a Base Case of 229,000 tons) and grows to 208,000 tons in 1980. The 52,000 ton reduction versus the Base Case in 1977 results from volume losses in: Attic Fill 16,000 tons, and Outsiders (excl. Canada) 10,000 tons. The reduction also reflects the shift of 26,000 tons of Scott ore to South Carolina.

At these volume levels, Libby's DMC is estimated to remain at 1977 Budget & Forecast levels. In 1977, Libby's net income would be a loss of $422,000 but by 1980, Libby would generate a net income of $500,000 with the volume reaching 208,000 tons. However, the Libby operation would still represent a substantial cut-back. In 1977, the mill would operate a 5-day week for 41½ weeks (or a 4-day week for the full year) and still face a 2½ month shutdown. Once again, as in CASE A, there has been no attempt to quantify the potentially negative impact of such a cut-back operation on turnover of valuable skilled and management people. By 1979, or 1980, the volume levels would once again be sufficient to represent just about a full-scale operation with only a 3-4 week shutdown required.

Overhead expense levels would be reduced by $276,000 in 1977 as follows:

Factory Overhead:	- $187,000	-	Reductions in Overhead dept.
R&D	- $ 89,000	-	Mill Process Research cut-backs.

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IV. Expanding & Polystyrene Plant Impact

Same as CASE A.

V. Selling Expenses

Same reduction in 1977 as CASE A, however, due to additional sales growth (Masonry Fill, consumer Ag/Hort) selling expenses have been assumed to increase commensurably with sales.

VI. Capital Spending

A. Expanding Plants

To meet a 1.0 f/ml standard by 1978 and a 0.5 by 1980, a total of $1.2 million over the $1.0 mm included in the Base Case has been reflected in capital spending. However, this $1.2 million is offset by an average of $300,000 per year in decreased capital spending at expanding plants over the four-year period due to delays in capacity expansion projects and replacement furnace delays resulting from the lower sales volumes.

B. Libby

The $515,000 capital required to meet a 2.0 f/ml standard for MESA has already been reflected in the Base Case capital. However, the reduced volumes at Libby would enable significant capital spending decreases over the 1977-1981 period. These reductions are estimated to be $1,500,000 over the four-year period and represent the haul truck capacity increases, No. 5 circuit, mill office expansion and delays in the need to replace mining equipment.

The impact of these capital spending reductions on Net Fixed Assets amount to $180,000 in 1977 and $1,200,000 in 1980.

VII. Summary of Financial Implications ($000)

	Variance Fav/(Unfav) vs Base Case			
	1977		1980	
A.) Gross Sales (Impact in 1977)	Amount	%	Amount	%
BPD (Attic $3,638, Glass Fiber $623; Poly $544; and Ag Products $370)	$(5,175)	(10.4)%	$ (9,365)	(13.0)%
Ag (Pool Cushion $270, Mixes $129, T.L. - $93, Ag Bag/Bulk $108)	(751)	(7.2)	(1,760)	(11.6)
Ore	(563)	(9.0)	(1,355)	(14.9)
TOTAL	$(6,489)	(9.8)%	$(12,480)	(13.0)%
B.) Gross Margin on Net	$(2,466)	(9.2)%	$ (4,681)	(11.6)%
C.) Factory Overhead (primarily Libby)	187	2.0	503	3.7
D.) Operating Expense	1,129	8.5	1,731	9.5
E.) Pre-Tax Profit	$(1,150)	(29.1)%	$ (2,447)	(28.7)%
F.) Taxes				
Before ITC & Depletion	569	28.3	1,261	28.9
ITC	(30)	(8.1)	(30)	(10.5)
Depletion After-Tax	73	30.0	(399)	(40.8)
TOTAL TAXES	$ 612	43.7%	$ 832	26.8%
G.) Net Income After-Tax	$ (538)	(21.0)%	$(1,615)	(30.1)%
H.) TCE				
Net Working Capital due to Lower Sales	$ 774		$ 1,687	
Net Fixed Assets	180		1,200	
TOTAL	$ 954	3.1%	$ 2,887	7.8%
I.) % Return on TCE	(1.5)% Pts.		(3.4)% Pts.	

A more detailed comparison is shown following the Case discussions in Exhibits 1-3.

03629709

CASE C - Withdrawal of Consumer Products and Most Unfavorable Outside Regulatory Action.

I. Overall Case Assumptions

A. Fiber Counts to 0.1 f/ml (OSHA) by 12/80 and MESA to 1.0 f/ml by 12/80.

B. Withdraw consumer products, and temporarily lose MK before substitution by 7/78 in California.

C. Lose Canada

D. Close Libby and reformulate to husband ore or go to regional "Zonolite as is" strategy around Enoree orh only.

After withdrawal of consumer products, the loss of Canada, and high capital impact needed to meet more stringent OSHA and MESA standards ($10 million) resulting in closings of many expanding plants, the resultant low volumes of Libby ore would no longer make continued operation there feasible. Therefore, by 1980, CASE C resulted in an Enoree only situation. This situation was analyzed under (1) a national strategy and (2) a regional strategy and is presented in the following pages.

15101949

CASE C - National Strategy

I. General Scenario

Zonolite would be limited to vermiculite ore shipped from Enoree and would be capacitated at 130,000 tons. Thus the scarce resources were utilized on products and plants contributing the most favorable Zonolite margin per ton of concentrate. In addition, it was assumed that certain products would be reformulated with vermiculite substituted or extended (e.g., high yield ZIC) to stretch the limited ore capacity.

II. Market & Product Impacts

A. Reformulation

Concrete Aggregate - Reformulated to contain a high yield ZIC. This reformulation would cover the 1980 Base Case Sales volume with 50% of the ore required. Sales price and margin (except impact of ore freight and cost from Enoree) were left unchanged from Base Case. This may be a somewhat conservative assumption since it implies that a high yield additive would replace vermiculite and cost as much as $0.70 per 4 cu.ft. bag in 1980 dollars.

MONOKOTE - MONOKOTE is dramatically impacted in this case due to the withdrawal from California and the subsequent ripple effect of this into the other regions. In California, MONOKOTE volume would fall by 83% in 1978 but then double by 1980 so that the non-vermiculite product amounted to only 31% of 1980 Base Case volume in California. The Texas, Midwest, Southern, and Florida regions would all be impacted by the California withdrawal in 1978 by about a 30% reduction from Base Case. Growth from there to 1980 would only be about 5% with a substitute product so that in these regions, 1980 volume would be 2/3 of 1980 Base Case. Eastern Region volume impact would be off by 43% from Base Case volumes in 1980. In all Regions, the substitute product was assumed to retain the same price and margins as a vermiculite product.

Soil Mixes - All consumer soil mixes and Professional soil mixes would be reformulated without vermiculite and result in a 10% volume loss versus Base Case in 1980 as a result of the reformulation. Prices and margins would be the same as Base Case. This also may be conservative since it implies that a bark ash substitute for example, would be just as costly as vermiculite. However, there would be long-term supply questions associated with bark ash.

B. Withdrawal

Attic, (and its impact in Poly sales), Terra-lite Consumer, Pool Cushion, Santoquin would all be withdrawn.

C. Mine Capacity Constraint Impact on Demand

Masonry Fill demand would still be met nationally from plants remaining open (see Section IV). However, ore capacity constraints necessitated using price as a mechanism to reduce demand and thus, the overall gross sales impact on Masonry Fill. (Masonry Fill was chosen due to its price sensitivity and relatively low margin contribution per ton of concentrate). Overall, Masonry Fill sales are off $1,270,000 (14.4%) versus 1980 Base Case, resulting from 4% higher prices ($0.10 per bag) and overall volum being down by 18%. This volume decline was 30% at areas where plants were closed and 6% at open plants due to the higher prices.

Ag Bag & Bulk demand would be met at Base Case volumes with the exception of the Pacific and Texas Regions where it would be discontinued.

D. Outside Ore Sales

No outside ore sales would be continued. The Enoree mine capacity would be applied totally to internal product usage. In addition, the Canadian business is assumed closed in this case.

III. Impact on Mines

All Zonolite vermiculite needs would be supplied from Enoree. Enoree's DMC per ton, Overhead, and Capital Spending levels were all kept at Base Case for 1980. However, the ore freight impact and favorable DMC of S.C. vs. Libby were reflected in the Zonolite margins.

S. C. volume was assumed to be capacitated in 1980 at 130,000 tons. A subset of CASE C (national strategy) would have been to identify the capital cost and benefits of a S.C.mill expansion, but this was not investigated in this study.

Total 1980 Base Case mine volume shipped to expanding plants would have been 242,000 tons. This amount was reduced to 130,000 tons as follows:

Total 1980 Base Case mine Shipments to Expanding Plants	242,000 tons
Withdrawal of Attic	(19,900)
" of Consumer T.L. and mixes & Other Ag.	(7,300)
Impact of High Yield ZIC	(40,300)
Substitution for MK & Soil Mixes	(36,600)
Ag Bag & Bulk from Texas & Pacific	(6,700)
Masonry Fill Lost to Closed Plants	(7,000)
Yield Impact	5,800
	130,000

IV. Expanding & Polystyrene Plant Impact

The following plants were assumed closed based on their relative margin contribution, overhead levels, and the estimated capital requirement to comply with a 0.1 f/ml OSHA restriction by 1980.

	Capital Required to get to 0.1 f/ml
Tampa	$ 83.0
Dearborn	440.0
Muirkirk	232.0
Minneapolis	220.0
Denver	208.0
Omaha	459.0
L. A.	328.0
Newark	293.0
San Antonio	275.0
	$2,538.0

Demand at the closed plants was assumed to be met from the nearest operating plant for vermiculite and non-vermiculite substitute products. This inter-plant transfer freight penalty amounts to $800,000 in 1980, or, $0.44/bag (ranging from $.20/bag to serve Tampa to $0.83/bag to serve Denver) on a total of 1.8 million bags. This number is reflected in sales deductions and accounts for the higher level (5.5% vs 4.1% in other cases) of deductions as a % of Net Sales.

Also note that due to the minimal impact on Poly sales (only the dealer effect on Plainboard, approximately 9% of total Poly Sales) no poly plants were assumed to be closed.

V. Operating Expenses

Selling Expenses

The same cut-back in selling expenses as used in CASE A was used to reflect the withdrawal from consumer products. Although CASE C (national strategy) is $11,025,000 lower in sales versus CASE A, no additional selling expense reductions were assumed since: a) $3.7 million of the reduction is due to Outside Ore Sales and Ag Bag & Bulk which have no directly identifiable selling expense, b) $7.6 million of the loss is due to MONOKOTE and the Base Case selling expense levels have been assumed to reflect the attempt to recapture market position lost due to the California MK withdrawal and substitution.

G&A

G&A reductions versus Base Case reflects the elimination of Libby in 1980 ($1,256,000) and an additional unidentified $300,000 reduction due to reduced number of plants and sales.

R&D

R&D reductions versus Base Case reflect the elimination of Libby in 1980 ($243,000). Although sales are less and major R&D effort to find vermiculite substitutes occurred before 1980, other R&D expense is left at Base Case levels to reflect: a) ongoing new product development, b) continued R&D expense to monitor substitutions, and c) the fact that most sales decreases are not in areas where heavy R&D expenditures have occurred.

VI. Capital Spending

Libby Capital Spending, of course, has been eliminated due to its closing. Enoree & Poly plant capital spending levels were left at Base Case amounts. The major capital spending impact versus the Base Case occur at the expanding plants.

	Fav/(Unfav)	
	Total Spending vs. Base Case over 1977-1980 ($000)	1980 Net Book Value Impact ($000)
Capital to achieve 0.1 f/ml at Retained Expanding Plants	$(4,636)	$(3,969)
Eliminated Capital Spending at Closed Plants	2,100	1,858
Delays beyond 1980 in Exp. Plant Expansion	700	530
Net Book Value of Closed Plants	-	350
Total Exp. Plants	$(1,836)	$(1,231)
Libby Capital Spending	6,856	10,805
Total Zonolite	$ 5,020	$ 9,574

In addition to the above, closing Tampa and eliminating the national ore hopper car fleet servicing Libby, capitalized leases totalling $933,000 (after-tax cost of interest $39,000) would be discontinued.

03629714

VII. Summary of Financial Implications ($000)

	Variance Fav/(Unfav) vs: Base Case 1980 Amount	%
A.) Gross Sales (Impact in 1980)		
BPD (Attic $5,280; MK $7,607; Poly $1,366; Glass Fiber $1,985; MF $1,270, Ag Prod- $1,658)	$(19,166)	(26.7)%
Ag (Consumer $3,221)	(2,380)	(15.7)
Ore Sales	(9,119)	(100.0)
TOTAL	$(30,665)	(31.9)%
B.) Deductions		
Due to volume	$ 802	20.6%
Transfer Freight	(800)	-
	$ 2	- %
C.) Gross Margin on Net	$(14,484)	(36.0)%
D.) Factory Overhead (Libby $4,590; closed plants ($1,149)	6,139	45.2
E.) Operating Expenses (BPD/Ag Selling $1,900; Libby G&A $1,256,000; Div. OH $300)	3,699	20.4
F.) Other Expense	39	100.0
G.) Pre-Tax Profit	$ (4,607)	(54.1)%
H.) Taxes		
Before ITC & Depletion	2,373	54.4
ITC	(112)	(39.3)
Depletion	(477)	(48.7)
TOTAL TAXES	1,784	57.5
I.) Net Income After-Tax	$ (2,823)	(52.5)%
J.) TCE		
Working Capital Due to Lower Sales	$ 4,181	
Net Fixed Assets (Section VI)	10,507	
Deferred Taxes	(1,087)	
Other Assets	82	
	$ 13,683	36.8%
K.) % Return on TCE	(3.6)% Pts.	

15101954

CASE C - Regional Strategy

03629715

I. General Scenario

Zonolite would be limited to vermiculite ore shipped from Enoree and would be capacitated at 130,000 tons. The limited vermiculite resource was utilized by applying it to existing vermiculite products (no re-formulations or extenders) and utilizing the highest contribution plants and minimizing the capital expenditures required to meet a 0.1 f/ml OSHA standard. The net effect was to localize the Zonolite business to the most profitable expanding plants located closest to the Enoree ore source. Therefore, the regional strategy included the entire Southern and Florida regions and the larger plants extending into the East and Midwest Regions. NO Inventory Transfers were assumed. If a plant was closed, then no attempt was made to ship into the vacated market from nearby plants with the exception of Professional soil mixes, which continued to serve the areas now met from TR, West Chicago, and Jacksonville.

II. Market & Product Impacts

A. Consumer Product Withdrawal

Attic (and its impact on Poly & Glass Fiber), Terra-lite consumer, Consumer soil mixes, Pool Cushion, and Santoquin would all be withdrawn. Unlike Case C (National Strategy), consumer soil mixes were not reformulated. Horticultural Perlite to Consumer market increase vs. Base Case by 30% in 1980 to offset loss of vermiculite business.

B. Impact of Plant Closing on Sales

BPD - Base Case volume and prices were used at all plants remaining open. Demand from closed plants was not filled. Therefore, remaining BPD sales amounted to Base Case levels in the Southern & Florida Regions plus the portion in Midwest and Eastern Regions retained with the remaining plants. Total sales in Texas and Pacific were taken out and all Attic and Glass Fiber sales for BPD, of course, were withdrawn in all regions. The impact of plant closings by product are as follows:

BPD Vermiculite (ex. Attic)	1980 ($000) Base Case	1980 ($000) Case C (Reg)	% Variance due to plant closings Fav/(Unfav)
Concrete Aggregate	$13,739	$8,477	(38.3)%
Masonry Fill	8,790	5,109	(41.9)
MONOKOTE (No re-formulation)	16,233	6,820	(42.0)
Misc. Exp.	2,410	1,023	(57.6)
Dealer Conc.	553	279	(49.5)
Plaster Agg.	342	174	(49.1)
Mine Sealant (all met from New Castle)	1,589	1,589	-
Other BPD Vermiculite	83	-	-
Ag Products (Texas & Pacific Region Plants closed)	2,894	-	(100.0)
BPD Vermiculite	$46,633	$23,554	(49.5)%

03629716

BPD Poly

Insulperm sales were retained in the Southern and Florida Regions and reduced in relation to Concrete Aggregate losses in the East and Midwest. No sales in Pacific and Texas. 1980 Reduction of $1,323,000 or 30.2%.

Billets & Other Poly sales were retained in the Southern and Florida Regions and reduced in relation to plant closings in other regions. No sales in Pacific and Texas.

Plainboard sales were reduced due to impact of Attic withdrawal and plant closings in East and Midwest. Sales retained in total in Florida and Southern Regions. Total sales eliminated in Texas and Pacific Regions. 1980 Reduction - $2,590,000 or 33.2%.

Custom molded - All Pacific Region sales eliminated in amount of $750,000.

Ag/Hort

Terra-Lite - Consumer Products withdrawn in total. Professional Terra-lite retained in South and Florida and reduced in relation to plant closings in East and Midwest. 1980 Reduction - $1,785,000 or 45.1%. $1,130,000 of total reduction was due to elimination of consumer products, $655,000 of reduction due to plant closings or 23.2% of Base Case Professional sales.

Soil Mixes - Consumer soil mixes withdrawn in total without substitution and resulted in the only reduction in Soil Mixes of $1,454,000. Professional soil mixes were retained without reformulation at Base Case volumes and would continue to be made from West Chicago, Jacksonville, TR, and New Castle (mixing capacity expansion done in 1979). Therefore, Professional mixes would continue to be sold in all areas as in Base Case even though some areas would no longer have expanding plants and would require a greater degree of direct shipments to customers. Because of this increase in freight cost to customers, no increase in Professional soil mix demand over the Base Case due to decrease in Professional Terra-Lite has been reflected as was done in CASE A.

CPBA & Ag Bag & Bulk were reduced as a result of plant closings. These impacts are reduction of $576,000 (27.8%) in Ag Bag & Bulk and $171,000 (21.4%) in CPBA versus the Base Case.

III. Impact on Mines

All Zonolite vermiculite needs would be supplied from Enoree. Enoree DMC per ton, overhead, and Capital Spending levels were all kept at Base Case for 1980. However, the ore freight impact and favorable DMC of S.C. vs. Libby, were reflected in the Zonolite margins.

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S.C. volume was assumed to be capacitated in 1980 at 130,000 tons. A sub-set of CASE C (regional strategy) would have been to identify the capital cost and benefits of a S.C. mill expansion, but this was not investigated in this study.

Total 1980 Base Case mine volume shipped to expanding plants would have been 242,000 tons. This amount was reduced to 130,000 tons as follows:

Total 1980 Base Case Mine Shipments to Expanding Plants	242,000 tons
Withdrawal of Attic	(19,900)
" of Consumer T.L. and mixes & Other Ag.	(7,300)
" from Pacific Region	(38,800)
" from Texas Region	(13,800)
Plant Closings in Eastern & Midwest Region	(32,200)
	130,000

IV. Expanding & Polystyrene Plant Impact

The following 19 plants were assumed closed under a regional Zonolite strategy:

	Capital Required to meet 0.1 f/ml ($000)
Dearborn	$440.0
Weedsport	125.0
Easthampton	232.0
Muirkirk	232.0
Minneapolis	220.0
Denver	208.0
Omaha	459.0
Milwaukee	158.0
L. A.	328.0
Newark	293.0
Portland	315.0
Phoenix	313.0
Santa Ana	213.0
Oklahoma City	123.0
San Antonio	275.0
Dallas	417.0
Houston Poly	-
Auburn Poly	-
South Gate Poly	-
	$4,351.0

Elimination of the above plants leaves all expanding & Poly plants in the Southern and Florida Regions along with Trenton, High Point, and New Castle from the East and St. Louis, Wilder, and West Chicago in the Midwest. Also remaining would be the New Castle and Milwaukee Poly plants. The plants remaining total 18 (14 vermiculite and 4 Polystyrene).

03629718

V. Operating Expenses

Selling Expenses

Selling expenses reflect regional selling expenses at CASE C sales levels (10.5% of BPD net sales and 13.0% of Ag/Hort and 11.9% overall). In addition, divisional selling expenses totalling $1.3 million (versus Base Case of $2.4 million) have been added to reflect continuing divisional marketing and sales management under the modified regional strategy. This number was not calculated as a percentage of sales but was derived based on input from BPD sales and marketing management.

G&A

G&A expense includes Enoree at Base Case levels ($425,000) and $1,802,000 reflecting 4.2% of net sales, consistent with Zonolite's Base Case G&A expenses as a percentage of net sales (excluding Libby expenses of $1,256,000).

R&D

R&D expenses include Enoree and LOU at Base Case levels ($302,000) and $472,000 reflecting 1.1% of Case C net sales, a percentage relationship consistent with Base Case R&D levels relative to BPD and Ag net sales.

VI. Capital Spending

Capital Spending at Libby, closed expanding and poly plant, and delayed expansion projects at remaining plants were all taken away versus Base Case capital levels. The offset to there decreases includes capital spending to meet a 0.1 f/ml OSHA standard at remaining plants. Capital Spending and Net Book Value Impact vs. the Base Case follows:

	Fav/(Unfav)	
	Total Spending vs: Base Case over 1977-1980	1980 Net Book Value Impact
Capital to Achieve 0.1 f/ml at Retained Expanding Plants	$(3,244)	$(2,617)
Eliminated Capital Spending at Closed Plants	4,481	3,254
Delays beyond 1980 in Expansion Projects	434	202
Net Book Value of Closed Plants	-	1,512
Libby Capital Spending	6,856	10,805
Total Zonolite	$8,527	$13,156

In addition, closing Libby allows elimination of capitalized leases on national ore hopper car fleet and total value of $683,000 ($28,000 after-tax cost of interest).

03629719

VII. Summary of Financial Implications ($000)

	Variance Fav/(Unfav) vs: Base Case 1980	
A.) Gross Sales (Impact in 1980)	Amount	%
BPD (Consumer withdrawals - $7,870; Plant Closings - $29,480)	$(37,350)	(52.0)%
Ag (Consumer - $3,321; closings $1,214)	(4,535)	(29.9)
Ore	(9,119)	(100.0)
	$(51,004)	(53.0)%
B.) Gross Margin on Net	(21,386)	(53.1)
C.) Factory Overhead (Libby $4,590 and Plants - $2,651)	7,841	57.7
D.) Operating Expenses (Selling - $5,426; G&A 3,004 & R&D $671)	9,101	50.1
E.) Other Expense	39	100.0
F.) Pre-Tax Profit	(4,405)	(51.8)%
G.) Taxes		
Before ITC & Depletion	$ 2,269	52.0%
ITC	(183)	(64.2)
Depletion	(477)	(48.7)
	$ 1,609	51.9%
H.) Net Income After Tax	$(2,796)	(52.0)%
I.) TCE		
Working Capital Due to Lower Sales	$ 6,912	
Net Fixed Assets (Section VI)	13,839	
Deferred Taxes	(800)	
Other Assets	82	
Total	$20,033	53.8%
J.) % Return on TCE	0.6 Pts.	

A more detailed comparison is shown following the Case discussion in Exhibits 1-3.

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SCHEDULE I

SUMMARY OF CASE ASSUMPTIONS ON PRODUCTS

03629720

	CASE A	CASE B	CASE C Regional	CASE C National
Attic Insulation	Withdraw →			
Concrete Aggregate	No Impact →			High Yield Conc.
Masonry Fill	Label Libby	Treat Libby	Sales Losses due to Plant Closings	Plant Closings
MONOKOTE	No Impact →			Mkt. Losses & Reformulations.
Misc. Expanded	Label Libby	Treat Libby		No Impact
Dealer Concrete	No Impact →			No Impact
Plaster Aggregate	Label Libby	Treat Libby		No Impact
Terra-Lite - BPD	Drop Cons. Label Libby	Label Consumer		Drop Consumer.
Soil Mixes - BPD	Drop Cons.	Label Consumer		Drop Consumer
Pool Cushion	Withdraw →			
Ag Bag/Bulk - BPD	Label Libby	Label Libby	Plant Closings	Plant Closi
Mine Sealant	No Impact →			
Other BPD Vermiculite	No Impact →			
Insulperm	No Impact →		Parallels Concrete	No Impact
Plainboard	Impact of Attic Loss →			
Billets	No Impact →		Sales Losses due to Plant Closings	No Impact
Custom	No Impact			No Impact
Other Poly	No Impact			No Impact
Nails	No Impact →		Parallels Concrete	No Impact
All Other BPD	Drop Glass →			
Terra-lite	Drop Consumer; Label Prof.	Label Consumer	Drop Consumer	Drop Consumer.
Soil Mixes	Drop Consumer; Inc. Prof.	Label Consumer	Drop Consumer	Drop Consum & Reformula
CPBA	Label	Label	Plant Closings	Label
Pool Cushion	Withdraw →			
Ag Bag & Bulk	Label Libby	Label Libby	Plant Closings	
Verxite	No Impact →			
Santoquin	Withdraw →			
Other as Verm.	Drop Cons.	No Impact	Drop Cons. →	
Perlite (Hort.)	Increase	Inc. Cons.	Inc. Consumer	No Impact
Ore to O.M. Scott	Decrease	Decrease	Discontinued →	
" " Gypsum Cos.	Decrease	Decrease	Discontinued →	
" " Canada	Discontinued	Inc. G. S.	Discontinued →	
" " Other Outsiders	Decrease	Decrease	Discontinued →	

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GROSS SALES COMPARISON

($000)

Schedule 2

	1977			1980				
	BASE CASE	CASE A	CASE B	BASE CASE	CASE A	CASE B	CASE C NAT. STRAT.	CASE C REG. STRAT.
Attic Ins.	$3,638	$ -	$ -	$5,280	$ -	$ -	$ -	$ -
Concrete Agg.	8,962	8,962	8,962	13,739	13,736	13,736	13,739	8,477
Masonry Fill	6,374	6,318	6,374	8,790	8,700	8,790	7,520	5,109
Monokote	11,092	11,092	11,092	16,233	16,233	16,233	8,626	6,820
Misc. Exp.	2,004	1,818	2,004	2,410	2,384	2,410	2,410	1,023
Dealer Conc.	476	476	476	553	553	553	553	279
Plaster Ag.	272	211	272	342	199	342	342	174
Terralite	533	189	508	632	134	540	446	-
Soil Mixes	934	660	900	1,110	775	1,060	790	-
Pool Cushion	33	-	-	40	-	-	-	-
Ag Bag/Bulk	936	655	655	1,112	560	560	-	-
Mine Sealant	500	500	500	1,589	1,589	1,589	1,589	1,589
Other BPD Vermiculite	63	63	63	83	83	83	83	83
Sub-Total BPD Vermiculite	35,817	[illegible],944	[illegible],806	51,913	44,946	45,899	36,098	23,554
Insulperm	2,554	[illegible],554	[illegible],554	4,379	4,379	4,379	4,379	3,056
Plainboard	5,802	5,258	5,258	7,810	6,444	6,444	6,444	5,220
Billets	480	480	480	692	692	692	692	116
Custom	507	507	507	750	750	750	750	-
Other Poly	943	943	943	1,414	1,414	1,414	1,414	744
Sub-Total BPD Poly	10,286	9,742	9,742	15,045	13,679	13,679	13,679	9,136
Nails	1,198	1,198	1,198	1,793	1,793	1,793	1,793	1,260
All Other BPD	2,330	1,710	1,710	3,145	1,160	1,160	1,160	596
Total BPD	49,631	43,594	44,456	71,896	61,578	62,531	52,730	34,546
Terralite	2,427	885	2,334	3,954	890	3,391	2,824	2,169
Soil Mixes	4,023	3,318	3,899	5,127	4,200	4,775	4,614	3,673
CPBA	531	425	425	800	660	659	800	629
Pool Cushion	270	-	-	355	-	-	-	-
Ag. Bag & Bulk	1,485	1,339	1,339	1,933	1,484	1,484	1, 933	1,357
Verxite	222	222	222	284	284	284	284	284
Santoquin	50	-	-	72	-	-	-	-
Other Ag. Verm.	57	40	57	380	70	375	70	70
Sub-Total Ag. Verm.	9,064	8,229	8,276	12,905	7,588	10,968	10,525	8,182
Perlite	1,361	1,633	1,398	2,253	2,932	2,430	2,253	2,441
All Other Ag.	-	-	-	-	-	-	-	-
Total Ag.	10,425	7,862	9,674	15,158	10,520	13,398	12,778	10,623
Ore to O. M. Scott	1,171	874	1,061	1,708	297	1,246	-	-
Ore to Gypsum Cos.	1,193	1,133	[illegible],133	1,698	1,330	1,330	-	-
Ore to Canada	1,835	-	[illegible],966	2,892	-	3,047	-	-
Ore to other outsiders	2,061	1,469	1,537	2,821	1,914	2,141	-	-
Total Ore	6,260	3,476	5,697	9,119	3,541	7,764	-	-
Total Zonolite	$66,316	$54,932	$59,827	$96,173	$75,639	$83,693	$65,508	$45,169

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PROFITABILITY & RETURN ON TCE COMPARISON

Schedule 3

ZONOLITE

($000)

03629722

	1977			1980				
	BASE CASE	CASE A	CASE B	BASE CASE	CASE A	CASE B	CASE C NAT. STRAT.	CASE C REG. STRAT.
Gross Sales	$66,316	$54,932	$59,827	$96,173	$75,639	$83,693	$65,508	$45,169
Sales Deductions	2,821	2,230	2,524	3,892	3,125	3,461	3,890	2,258
Net Sales	63,495	52,702	57,303	92,281	72,514	80,232	61,618	42,911
Direct Mfg. Cost	36,646	30,493	32,920	52,012	41,148	44,644	35,833	24,028
Gross Margin	26,849	22,209	24,383	40,269	31,366	35,588	25,785	18,883
G.M. on Gross %	44.7%	44.5%	45.0%	45.8%	45.6%	46.7%	45.3%	46.8%
G.M. on Net %	42.3%	42.1%	42.6%	43.6%	43.3%	44.4%	41.9%	44.0%
Factory O.H.	9,397	8,775	9,210	13,581	11,300	13,078	7,442	5,740
Gross Profit	17,452	13,434	15,173	26,688	20,066	22,510	18,343	13,143
Selling	8,419	7,349	7,379	11,500	9,600	10,100	9,600	6,074
G & A	4,101	3,956	4,101	5,231	4,724	5,000	3,675	2,227
R & D	749	630	660	1,445	1,339	1,345	1,202	774
Operating Expense	13,269	11,935	12,140	18,176	15,663	16,445	14,477	9,075
Operating Profit	4,183	1,499	3,033	8,512	4,403	6,065	3,866	4,068
Other Inc./(Exp.)	(227)	(227)	(227)	(39)	(39)	(39)	-	-
Pre-Tax Profit	3,956	1,272	2,806	8,473	4,364	6,026	3,866	4,068
Taxes on Income (Before ITC & Depletion)	2,014	655	1,445	4,364	2,247	3,103	1,991	2,095
ITC	371	348	341	285	145	255	173	102
Depletion Credits	243	325	316	979	517	580	502	502
Total Taxes	1,400	(18)	788	3,100	1,585	2,268	1,316	1,491
Profit After Tax	$ 2,556	$ 1,290	$ 2,018	$ 5,373	$ 2,779	$ 3,758	$ 2,550	$ 2,577
Total Capital Employed	$30,891	$28,872	$29,937	$37,215	$29,178	$34,328	$23,532	$17,182
% Return on TCE	8.5%	4.7%	7.0%	14.6%	9.8%	11.2%	11.0%	15.2%

15101963

APPENDIX IV

RESPIRABLE TREMOLITE FIBER EXPOSURES FOR
ZONOLITE FINISHED PRODUCTS IN INTENDED USES

03629723

Product	Grade of Ore Used	8 Hour TWA Exposure (f/ml) Using S.C. Ore (f/ml)	8 Hour TWA Exposure (f/ml) Using Libby Ore (f/ml)	Maximum 15 Minute Exposure (f/ml) Using S.C. Ore (f/ml)	Maximum 15 Minute Exposure (f/ml) Using Libby Ore (f/ml)
STANDARDS					
Present OSHA		2.0	2.0	10.0	10.0
Proposed OSHA		0.5	0.5	5.0	5.0
Proposed NIOSH		0.1	0.1	0.5	0.5
PURE VERMICULITE					
ATTIC INSULATION	#1	-	0.58	-	4.28
	#2	-	N/A 1.32	-	N/A 5.28
MASONRY INSULATION	#3	0.03	0.07	0.21	3.11
		.02	0.19 0.13	0.61	3.65 9.12
ZIC - CHARGER MAN	#3	-	0.55	-	1.14
	#4	0.02	0.45	0.14	1.66
	#4/5	0.02	-	0.11	-
HORTICULTURAL VERMICULITE					
Professional Use	#2	-	1.06	-	1.62
	#3	0.07	N/A 1.65	0.16	N/A 1.93
Consumer Use	#3	<0.05	<0.035	<0.29	<0.14
Sports Turf Builder	#4		.04		.11
MIXED PRODUCTS					
MK 4 - NOZZLE	#3	N/A .11	≤0.18	N/A .25	≤0.29
MK 5 - NOZZLE	#3	≤0.10	≤0.31	≤0.25	≤0.52
REDI-EARTH - Professional Use	#3	0.02	0.04	0.07	0.07
Consumer Use	#3	0.02	<0.04	0.29	<0.14
[illegible] (mixed)	[illegible]		.26 (.29)		.91 (1.14)
[illegible] Potting (5/25) (7/14 attic) [illegible]			5.1/12		
① [illegible] to Sun Gard					
② [illegible] Sun Gard					
③ MK-4 Nozzle SC 3 nozzle (.50, .28)					

ESW/CGR
5-12-77

Fairleigh Dickinson University
RUTHERFORD TEANECK MADISON

FLORHAM-MADISON CAMPUS
285 Madison Avenue
Madison, New Jersey
Area Code 201
377-4700

APPENDIX V

31 March 1977

Dr. Heyman C. Duecker
Vice President-Research
Construction Products Division
W.R. Grace & Company
62 Whittemore Avenue
Cambridge, Mass. 02140

03629724

Dear Dr. Duecker:

This responds to your letter of the 18th in which you ask for comment on a NIOSH report of December 1976 that recommends a revision of the asbestos standard to 0.1 fiber $> 5\mu$ per cc.

As I read this document, it does not present evidence for hazard from either a 5 fiber or 2 fiber per cc standard. Essentially, it argues that risks from low level exposures to asbestos are indicated by reports of mesotheliomas associated with brief or with non-occupational exposures, such as "household" exposures of persons living in the houses of asbestos workers, but levels of such exposures are not stated. That "household" exposures have been substantial was indicated by Dr. Selikoff at a Conference on Environmental Cancer that I attended in Washington last week.

The NIOSH report mentions mesotheliomas in individuals with history of asbestos exposure for only one day. Such cases could, of course, be unrelated to asbestos, as indicated in the NIOSH statement (Page III-7) that approximately 15 per cent of mesotheliomas are not known to be related to exposure to asbestos.

An earlier NIOSH report (Gillam et al) has been cited as showing tumor response to low levels of asbestos. In referring to this, the 1976 NIOSH report (III-10) states: "In a study of a group of miners exposed to amphibole fibers in the cummingtonite-grunerite ore series, Gillam et al (1976) have demonstrated mortality from malignant respiratory disease three times that of the general population."

Referring to the same study, a 1975 OSHA report said: "Gillam et al (1975), studying the mortality and reviewing the chest x-rays of 439 underground metal miners exposed to an asbestiform mineral, found three times the risk of malignant respiratory disease than expected. The fiber concentrations averaged 0.24 fibers/ml." (Federal Register, Oct. 9, 1975 pages 47652-47665. Refer to page 47656).

The claim by Gillam et al for an increased incidence of cancer in the cited miners has not been born out by a more extensive study by McDonald et al (copy attached).

You no doubt have a copy of the above cited 1975 OSHA document. On an enclosed copy of it, I have marked paragraphs that attempt to quantitate exposures to asbestos in relation to occurrence of asbestosis and/or cancer. It should be noted that the level of exposure in the cited British factory in the period 1933-1968 was an estimated level and that no evidence is offered that a 2 fiber level had actually been achieved in the period after 1968.

The 1976 NIOSH report (II-7, II-Table 6) cites a study by Wagner on inhalation exposures of rats to various preparations of asbestos and notes that tumors were found after exposures of only one day. A copy of Wagner's paper is attached. It states that the one-day exposure was 7 hours exposure to dusts containing 9.7 to 14.7 mg per cubic meter of the tested preparations of asbestos.

In March 1976, NIEHS held a 3-day Conference on Extrapolation of Data from Animals to Man. A report on that conference by its chairman is enclosed. I attended that conference and enclose copies of 3 papers that seem of particular pertinence.

The first is a paper by Rall (Director, NIEHS) which addresses the question of threshold levels for carcinogens.

The second is a paper by Enterline and Henderson "A Model for Extrapolating to Low Levels of Asbestos Exposure."

The third is by Hardin Jones. He brings out the point that thresholds for carcinogens should be viewed not only in terms of yield of tumors but also latent period, i.e. that safe levels can be achieved by considering exposures with latent periods longer than the life span.

I understand that CONSAD Research Corp., contractor for inflationary impact study on proposed revision to asbestos standard, is also looking at technical feasibility and economic implications of a 0.1 fiber per cc limit.

Trusting that these remarks may be of interest,

Very sincerely,

William E. Smith

William E. Smith, M.D.
Director
Health Research Institute

WES/elc

Enclosures

See addendum (page 3)

Addendum

03629726

The enclosed papers from the NIEHS Conference on Extrapolation of Data from Animals to Man are offered merely to provide detail on some current thinking on that subject.

Perhaps a "bottom-line" attitude that seems to be developing in the regulatory agencies was expressed last week by Eula Bingham at the conference I covered in Washington. Dr. Bingham, the new Asst. Secretary of Labor for Occupational Safety and Health, said, according to my notes, "We are ignorant as to whether there is a safe level for carcinogens. The lowest feasible level seems to be the prudent path."

On this theme, the NIOSH document that you sent me contains a statement on page VI-2 that the asbestos standard "should be set at the lowest level detectable by available analytical techniques, an approach consistent with NIOSH's most recent recommendations for other carcinogens."

This approach, or enactment of "zero" levels for carcinogens, would, of course, mean that investment of time and money to achieve any particular level would be precarious, since improvements in sensitivity of analytical techniques could unpredictably change the picture.

Enclosed is an announcement of a seminar in Washington on 12-13 April on Federal Regulation of Environmental Carcinogens. The list of speakers may suggest someone that you could contact for comment or advice. Paul Kotin from Johns-Manville is scheduled to give the lead-off address.

Would it be agreeable for me to send a copy of this letter to Dr. Allan Harvey at R.T. Vanderbilt Co. ?

CES

15101966

15101972

TABLE I — TREMOLITE LEVELS IN BUILDING PRODUCTS END USES

Product (Ore)		SOUTH CAROLINA Product Assay %	Fiber Count Date - Location Min.	Max.	TWA	LIBBY Product Assay %	Fiber Count Date - Location Min.	Max.	TWA	Product Assay %	Fiber Count Date - Location Min.	Max.	TWA
			TO BE SCHEDULED				3/8/77 - Dallas**				3/11/77 - Freemont		
MK 4 (#3)	Mixer	<0.08 %				<0.10 %	≤0.093	≤0.285	≤0.116		<0.15	0.12	0.031
	Nozzle						≤0.190	≤0.285	≤0.176		<0.16	<0.30	<0.018
	Clean-up						-	-	-		<0.19	2.13	0.250
							3/11/77 - Burbank				1/26/77 - Westminster		
MK 4 (#3)	Mixer						<0.19	0.13	0.019		<0.05	0.19	0.069
	Nozzle						0.16	0.38	0.196		0.05	0.21	0.078
	Clean-up						-	-	-		-	0.03	0.024
			3/2/77 - Montgomery**				3/9/77 - San Diego**						
MK 5 (#3)	Mixer	<0.08	≤0.07	≤0.07	≤0.058	<0.11*	≤0.23	≤0.38	≤0.248				
	Nozzle		≤0.05	≤0.25	≤0.102		≤0.29	≤0.52	≤0.311				
	Clean-up		-	-	-								
			3/3/77 - Columbus				3/10/77 - Oklahoma City						
Masonry Fill (#3)		0.05*	0.10	0.21	0.027	0.25*	<0.19	3.11	0.071				
			3/16/77 - W. Palm Beach				TO BE SCHEDULED						
Masonry Fill (#4)		2.86*	<0.17	0.61	0.018	0.01							
			3/16/77 - Miami				TO BE SCHEDULED						
ZIC (#4)	Charger	0.48*	<0.05	0.14	0.020								
	Mixer		<0.04	0.06	0.017	0.34							
	Deck		<0.06	0.12	0.061								
			3/2/77 - Montgomery										
ZIC (4/5 blend)	Charger	2.83*	<0.05	0.11	0.017								
	Mixer		-	-	-	-	-	-	-				
	Deck		-	-	-								
							3/9/77 - Oklahoma City						
ZIC (#3)	Charger						0.12	1.14	0.546				
	Mixer	-	-	-	-	-	<0.09	0.31	0.085				
	Deck						-	-	-				
							TO BE SCHEDULED						
3300 (#3)		-	-	-	-	<0.07							
							TO BE SCHEDULED						
Mine Sealant (#3)		-	-	-	-								

* Samples assayed of products actually used on job site.

**New fiber count technique used to eliminate gypsum fibers.

03629732

ESW/CGR
4-4-77

15101973

TABLE II – TREMOLITE LEVELS IN HORTICULTURAL PRODUCTS END USES

Product (Ore)	SOUTH CAROLINA Product Assay-%	Prof. Fiber Count Date - Location Min.	Max.	TWA	Consumer Fiber Count Date - Location Min.	Max.	TWA	LIBBY Product Assay-%	Prof. Fiber Count Date - Location Min.	Max.	TWA	Consumer Fiber Count Date - Location Min.	Max.	TWA
Hort. Verm. (#2)	-	-	-	-	-	-	-	0.035*	3/11/77 - Cambridge 0.81	1.62	1.063	-	-	-
Hort. Verm. (#3)	4.32,0.016**	3/11/77 - Cambridge <0.16	0.16	0.070	3/11/77 & 3/18/77-Cambr. <0.14	<0.29	<0.05	0.049*	TO BE SCHEDULED -	-	-	3/10/77 & 3/18/77-Cambridge <0.14	<0.14	<0.035
Redi-Earth (#3)	0.048*	3/12/77 - Cambridge <0.04	0.07	0.018	3/11/77 & 3/18/77-Cambr. <0.14	0.29	0.015	<0.02*	3/12/77 - Cambridge 0.07	0.07	0.035	3/10/77 & 3/18/77-Cambridge <0.14	<0.14	<0.035
Metro-Mix 200 (#3)	0.398*	3/10/77 - Cambridge -	<0.03	<0.015	-	-	-	<0.034*	3/10/77 - Cambridge <0.03	0.07	0.018	-	-	-
Metro-Mix 300 (#3)	0.081*	TO BE SCHEDULED			-	-	-	-	-	-	-	-	-	-
Metro-Mix 350 (#3)	0.156*	TO BE SCHEDULED			-	-	-	-	-	-	-	-	-	-
Turf Builder (#4 light)	-	-	-	-	-	-	-	<0.009*	-	-	-	-	0.15	0.037
Turf Builder (#4 dark)	-	-	-	-	-	-	-	<0.009*	-	-	-	-	0.17	0.043
Verxite (#4 Carrier Grade)	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-

03629733

* Samples assayed of products actually used on simulated job site.

**Professional vermiculite was 4.32%; Consumer v[illegible]iculite was [illegible]16%.

ESU/CCR

03629734

D. Masonry Fill (FWE)

From visiting job sites and talking with masonry contractors, 1 hour is generally the maximum time spent pouring MF. Pouring conditions vary from job-to-job and from contractor-to-contractor. A few conditions are as follows:

1. Lay block/brick part way - Pour MF.
2. Lay block and pour MF at scaffold height. Several men pouring so as not to tie up scaffold.
3. Lay all block/wall, fill w/MF and Cap.

The following are jobs sampled:

Construction	# Bags	# Men	Total Time/ Da. (Min.)	Location
Block Core	28	2	41	West Palm Beach
Block Core	33	1	85	Columbus, GA.
Brick Cavity	100	1	34	Oklahoma City
Block Core	75	2	71	Dallas

TWA = $\frac{1}{8}$

FWE:mem
4-4-77

15101974

TABLE IV – GUIDELINES FOR RESPONDING TO REQUESTS REGARDING ASBESTOS IN OUR PRODUCTS

03629735

15101975

	SOUTH CAROLINA		LIBBY	
	Frequency	Amount	Frequency	Amount
MONOKOTE	Most samples contain no detectable tremolite; Occasionally one may contain tremolite	Negligible	Most samples contain no detectable tremolite; Occasionally one may contain tremolite	Negligible
ZIC	Samples contain tremolite; Predominantly non-asbestos form	Small	Samples contain tremolite	Minute
MF	Samples contain tremolite; Predominantly non-asbestos form	Small	Samples contain tremolite	Minute ?
AF	Samples contain tremolite; Predominantly non-asbestos form	-	Samples contain tremolite	Minute
Ind	Samples contain tremolite; Predominantly non-asbestos form	Small	Some samples may contain tremolite	Very small ?
TV	Samples contain tremolite; Predominantly non-asbestos form	Small	Samples contain tremolite	Minute
RE	Some samples may contain tremolite; Predominantly non-asbestos form	Minute	Most samples contain no detectable tremolite; Occasionally one may contain tremolite	Negligible
MM	Some samples may contain tremolite; Predominantly non-asbestos form	Minute	Most samples contain no detectable tremolite; Occasionally one may contain tremolite	Negligible

15101976

DEFINITIONS:

Small	1.0 - 6.0%
Very Small	0.5 - 1.0
Minute	Less than 0.5
Trace	Detectable, but not quantifiable
Negligible	Not detected by normal analytical procedures in the sample as manufactured.

03629736

ESW/CGR
3-30-77

TABLE V - MK-4 W/LIBBY #3 03629737 3/3H77

DATE (1977)	JOB SITE LOCATION	JOB	FIBER COUNT (f/mf) MIN.	MAX	TWA	COMMENTS
			≤0.117	≤0.235	≤0.116	
	HYATT REGENCY	MIXER	~~0.0~~	~~0.073~~	~~0.058~~	
3/8	DALLAS	NOZZLE	0.0	~~0.19~~	0.118	
			≤0.120	≤0.235	≤0.176	
	SO. COUNTY HALL	MIXER	0.0<0.15	0.12	0.031	
3/10	OF JUSTICE	NOZZLE	<0.16	<0.30	<0.180	
	FREMONT CALIF	CLEAN UP	0.0<0.19	2.13	0.250	
	CALIF FEDERAL	MIXER	0.0<0.19	0.13	0.019	
3/11	SAVINGS & LOAN	NOZZLE	0.16	0.38	0.196	
	BURBANK CALIF					
	WESTMINSTER	MIXER	0.0<0.05	0.19	0.069	
1/26	COURT BLDG	NOZZLE	0.05	0.21	0.078	
	WESTMINSTER CA.	CLEAN UP	—	0.03	0.024	

15101977

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

All Sizes of Residential Properties

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1962	11,024	4,843	6,181	4,442	890	2,622	930	1,739
First Quarter	2,050	1,027	1,023	654	94	447	113	369
Second Quarter	3,240	1,329	1,911	1,448	213	864	371	463
Third Quarter	3,051	1,382	1,669	1,146	235	614	297	523
Fourth Quarter	2,683	1,105	1,578	1,194	348	697	149	384
1963	11,407	5,010	6,397	4,690	1,142	2,424	1,124	1,707
First Quarter	2,132	1,014	1,118	835	164	501	170	283
Second Quarter	2,985	1,273	1,712	1,303	320	632	351	409
Third Quarter	3,487	1,500	1,987	1,387	391	630	366	600
Fourth Quarter	2,803	1,223	1,580	1,165	267	661	237	415
1965	11,442	4,999	6,443	4,736	1,209	2,560	967	1,707
First Quarter	2,420	1,156	1,264	949	155	645	149	315
Second Quarter	2,939	1,299	1,640	1,186	285	618	283	454
Third Quarter	3,440	1,437	2,003	1,467	410	719	338	536
Fourth Quarter	2,643	1,107	1,536	1,134	359	578	197	402
1966	11,691	4,803	6,888	4,976	1,202	2,895	879	1,912
First Quarter	2,134	942	1,192	921	235	576	109	272
Second Quarter	2,744	1,302	1,442	1,112	320	523	268	330
Third Quarter	3,932	1,458	2,474	1,707	310	1,069	328	767
Fourth Quarter	2,881	1,101	1,780	1,236	337	726	173	543
1967	11,687	4,431	7,256	5,321	1,146	3,118	1,057	1,935
First Quarter	2,055	852	1,202	898	136	627	135	305
Second Quarter	3,415	1,225	2,190	1,595	319	907	368	595
Third Quarter	3,345	1,298	2,047	1,446	345	723	378	602
Fourth Quarter	2,872	1,055	1,817	1,383	345	862	176	434
1968	12,703	5,186	7,517	5,314	1,261	3,077	976	2,202
First Quarter	2,182	865	1,317	902	156	621	125	416
Second Quarter	3,498	1,430	2,068	1,547	412	742	393	522
Third Quarter	4,036	1,675	2,361	1,692	463	933	296	669
Fourth Quarter	2,987	1,217	1,770	1,174	231	781	161	596
1969	13,535	5,479	8,055	5,885	1,094	3,409	1,382	2,170
First Quarter	2,299	941	1,358	1,001	128	679	194	357
Second Quarter	3,796	1,467	2,329	1,820	464	882	474	509
Third Quarter	4,446	1,778	2,668	1,863	325	1,015	523	805
Fourth Quarter	2,994	1,293	1,701	1,201	177	832	192	499
1970	14,770	5,895	8,875	6,246	1,411	3,539	1,296	2,629
First Quarter	2,666	1,047	1,619	1,193	154	914	125	426
Second Quarter	4,232	1,673	2,559	1,816	385	987	444	743
Third Quarter	4,196	1,848	2,349	1,620	381	813	426	729
Fourth Quarter	3,676	1,328	2,348	1,617	491	825	302	731
1971	16,299	6,361	9,939	6,818	1,685	3,699	1,433	3,120
First Quarter	2,781	1,082	1,699	1,163	260	780	125	536
Second Quarter	4,553	1,662	2,890	2,040	497	1,050	493	850
Third Quarter	5,036	2,139	2,897	1,894	399	993	502	1,002
Fourth Quarter	3,930	1,477	2,453	1,721	529	879	313	731
1972	17,498	6,717	10,781	7,526	1,378	4,447	1,701	3,255
First Quarter	3,152	1,192	1,961	1,330	187	938	205	631
Second Quarter	4,839	1,760	3,079	2,314	465	1,124	728	766
Third Quarter	5,224	2,154	3,070	2,136	434	1,152	551	934
Fourth Quarter	4,283	1,612	2,671	1,747	292	1,233	222	925

EXHIBIT
6
Emergency Notice

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

All Sizes of Residential Properties

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1973	18,512	7,924	10,588	7,386	1,360	4,694	1,332	3,202
First Quarter	3,447	1,269	2,178	1,646	303	1,214	129	532
Second Quarter	4,676	2,104	2,571	1,786	436	916	434	785
Third Quarter	5,487	2,489	2,998	2,066	349	1,139	578	932
Fourth Quarter	4,902	2,061	2,842	1,889	273	1,424	192	953
1974	21,114	8,491	12,622	8,060	1,529	4,836	1,695	4,563
First Quarter	4,112	1,700	2,412	1,414	186	1,053	175	998
Second Quarter	5,363	2,225	3,137	2,006	390	1,076	540	1,131
Third Quarter	6,411	2,426	3,985	2,442	473	1,371	598	1,543
Fourth Quarter	5,228	2,140	3,088	2,199	480	1,337	382	890
1975	25,239	9,758	15,481	10,997	1,971	6,844	2,182	4,484
First Quarter	4,312	1,759	2,553	1,875	195	1,406	274	678
Second Quarter	6,867	2,477	4,390	3,124	439	1,982	703	1,266
Third Quarter	7,603	2,820	4,783	3,371	832	1,783	756	1,413
Fourth Quarter	6,456	2,701	3,755	2,627	505	1,674	448	1,128
1976	29,034	11,379	17,655	12,314	3,493	6,367	2,454	5,341
First Quarter	5,656	2,211	3,445	2,470	492	1,612	367	975
Second Quarter	8,616	3,348	5,268	3,767	879	1,818	1,069	1,501
Third Quarter	7,465	3,317	4,149	2,556	719	1,309	528	1,592
Fourth Quarter	7,297	2,503	4,793	3,521	1,402	1,629	490	1,273
1977	31,280	11,344	19,936	14,237	2,655	8,505	3,077	5,699
First Quarter	5,902	2,354	3,548	2,552	254	1,883	415	996
Second Quarter	8,636	3,072	5,564	4,298	1,145	2,062	1,092	1,266
Third Quarter	9,580	3,278	6,303	4,290	670	2,445	1,175	2,013
Fourth Quarter	7,161	2,641	4,521	3,097	587	2,115	395	1,424
1978	37,461	12,909	24,552	16,458	3,713	8,443	4,302	8,094
First Quarter	6,282	2,143	4,140	2,655	620	1,737	297	1,484
Second Quarter	10,747	3,549	7,198	5,093	1,208	2,495	1,390	2,106
Third Quarter	11,172	3,970	7,202	4,828	1,008	2,366	1,454	2,374
Fourth Quarter	9,260	3,247	6,012	3,882	876	1,845	1,161	2,130
1979	42,231	14,950	27,281	18,285	3,280	9,642	5,363	8,996
First Quarter	7,671	2,571	5,098	3,508	493	2,435	580	1,590
Second Quarter	11,755	4,152	7,603	5,324	1,408	2,021	1,895	2,279
Third Quarter	12,133	4,434	7,700	4,965	614	2,611	1,740	2,735
Fourth Quarter	10,674	3,793	6,880	4,489	766	2,575	1,147	2,392
1980	46,338	15,187	31,151	21,336	4,183	11,193	5,960	9,816
First Quarter	9,217	2,985	6,232	4,271	499	2,367	1,406	1,960
Second Quarter	12,534	4,188	8,346	5,875	1,065	2,700	2,110	2,471
Third Quarter	12,981	4,331	8,650	5,744	1,386	2,824	1,534	2,906
Fourth Quarter	11,606	3,683	7,923	5,445	1,232	3,302	911	2,478
1981	46,351	16,022	30,329	20,414	3,164	11,947	5,303	9,915
First Quarter	8,723	2,941	5,781	4,101	520	3,188	392	1,681
Second Quarter	12,835	4,357	8,478	5,732	670	3,133	1,928	2,746
Third Quarter	13,606	5,019	8,587	5,378	947	2,629	1,801	3,209
Fourth Quarter	11,187	3,704	7,483	5,204	1,026	2,997	1,182	2,279
1982	45,291	16,810	28,481	18,774	2,641	10,711	5,423	9,707
First Quarter	8,187	3,332	4,855	3,261	387	2,031	843	1,594
Second Quarter	12,835	4,511	8,323	5,930	868	3,198	1,865	2,393
Third Quarter	11,639	4,597	7,042	4,264	695	2,217	1,352	2,778
Fourth Quarter	12,630	4,370	8,260	5,319	690	3,265	1,364	2,941

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

All Sizes of Residential Properties

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1983	49,295	18,128	31,167	20,271	4,739	11,673	3,859	10,895
First Quarter	8,887	3,510	5,377	3,902	294	2,995	613	1,475
Second Quarter	12,837	4,481	8,356	5,800	2,655	2,358	787	2,556
Third Quarter	16,133	5,300	10,833	7,116	1,299	3,757	2,061	3,716
Fourth Quarter	11,439	4,837	6,602	3,454	492	2,564	398	3,147
1984	69,784	28,894	40,890	27,822	6,007	14,486	7,329	13,067
First Quarter	11,895	4,805	7,090	5,097	1,136	3,323	638	1,993
Second Quarter	20,539	8,679	11,860	7,526	1,368	3,298	2,860	4,334
Third Quarter	20,196	8,884	11,312	7,535	1,895	3,295	2,345	3,777
Fourth Quarter	17,154	6,526	10,628	7,664	1,608	4,570	1,486	2,963
1985	80,267	35,358	44,909	28,775	3,966	17,599	7,211	16,134
First Quarter	15,935	7,232	8,704	5,573	565	4,157	851	3,131
Second Quarter	19,805	9,374	10,432	7,132	1,059	3,698	2,375	3,300
Third Quarter	21,706	9,267	12,439	8,027	1,154	4,464	2,409	4,412
Fourth Quarter	22,821	9,486	13,336	8,043	1,187	5,281	1,575	5,292
1986	91,274	35,971	55,303	38,608	7,377	21,192	10,040	16,695
First Quarter	17,542	7,603	9,939	6,689	1,043	4,483	1,162	3,250
Second Quarter	23,074	8,234	14,839	11,098	2,130	5,855	3,113	3,742
Third Quarter	28,603	11,318	17,285	11,572	2,386	4,904	4,283	5,713
Fourth Quarter	22,055	8,816	13,239	9,249	1,817	5,950	1,481	3,991
1987	94,087	38,231	55,856	39,980	9,557	21,642	8,780	15,876
First Quarter	18,020	7,763	10,257	7,234	1,328	4,234	1,672	3,024
Second Quarter	23,783	8,828	14,955	11,360	3,076	5,801	2,482	3,596
Third Quarter	27,712	10,267	17,445	12,094	3,222	5,895	2,977	5,351
Fourth Quarter	24,572	11,374	13,198	9,293	1,932	5,711	1,650	3,905
1988	101,117	40,885	60,232	43,339	11,333	22,703	9,303	16,893
First Quarter	18,511	9,147	9,363	6,400	873	3,964	1,563	2,963
Second Quarter	28,747	10,416	18,331	13,704	4,085	6,202	3,416	4,627
Third Quarter	30,282	12,189	18,093	13,039	3,959	7,016	2,065	5,054
Fourth Quarter	23,577	9,133	14,444	10,196	2,416	5,521	2,258	4,248
1989	100,891	42,689	58,202	39,786	6,828	23,129	9,828	18,415
First Quarter	19,349	8,184	11,165	8,025	1,491	5,195	1,341	3,139
Second Quarter	24,589	9,462	15,126	10,755	1,444	6,504	2,806	4,373
Third Quarter	30,890	13,096	17,794	11,726	2,349	6,182	3,195	6,068
Fourth Quarter	26,063	11,947	14,116	9,279	1,544	5,248	2,486	4,836
1990	106,773	51,305	55,468	37,253	8,561	21,920	6,771	18,215
First Quarter	22,311	10,330	11,979	7,964	1,879	5,162	924	4,016
Second Quarter	27,314	12,722	14,592	10,552	2,486	5,902	2,163	4,040
Third Quarter	30,154	14,318	15,836	10,349	2,410	5,621	2,319	5,487
Fourth Quarter	26,995	13,934	13,061	8,387	1,785	5,237	1,365	4,673
1991	97,528	49,840	47,688	30,944	7,914	16,076	6,954	16,744
First Quarter	18,847	11,230	7,617	4,770	671	3,240	860	2,847
Second Quarter	24,904	11,808	13,096	10,125	2,647	5,269	2,207	2,972
Third Quarter	28,842	13,698	15,144	8,991	2,805	3,738	2,448	6,153
Fourth Quarter	24,934	13,104	11,830	7,058	1,790	3,830	1,438	4,771
1992	103,734	45,154	58,580	40,186	6,783	22,700	10,704	18,393
First Quarter	18,658	8,674	9,986	7,324	1,652	4,843	828	2,661
Second Quarter	30,436	13,583	16,853	11,474	1,646	5,867	3,960	5,379
Third Quarter	27,587	11,970	15,615	10,423	2,143	4,780	3,501	5,192
Fourth Quarter	27,055	10,928	16,127	10,966	1,342	7,210	2,414	5,162

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

All Sizes of Residential Properties

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1993	108,304	41,699	66,606	45,797	12,757	24,782	8,259	20,809
First Quarter	19,709	8,840	10,869	7,719	1,277	5,510	931	3,150
Second Quarter	28,422	10,193	18,229	11,863	3,848	5,248	2,767	6,366
Third Quarter	31,528	11,412	20,115	14,167	3,972	7,036	3,158	5,948
Fourth Quarter	28,645	11,253	17,392	12,048	3,659	6,987	1,402	5,344
1994	115,030	42,953	72,077	48,828	9,647	28,673	10,509	23,248
First Quarter	21,191	8,564	12,627	9,900	2,725	5,554	1,621	2,727
Second Quarter	30,988	10,811	20,177	14,518	3,158	7,350	4,009	5,659
Third Quarter	32,297	11,890	20,407	13,240	2,344	7,946	2,949	7,167
Fourth Quarter	30,553	11,688	18,866	11,171	1,419	7,823	1,929	7,695
1995	111,683	42,047	69,636	44,726	7,936	26,893	9,897	24,910
First Quarter	21,777	7,877	13,900	10,032	1,049	7,435	1,549	3,868
Second Quarter	31,139	11,213	19,927	13,399	3,223	7,621	2,554	6,528
Third Quarter	32,054	12,269	19,784	11,576	2,644	5,853	3,078	8,208
Fourth Quarter	26,713	10,688	16,025	9,719	1,020	5,983	2,716	6,306
1996	114,919	36,997	77,922	53,456	12,035	30,064	11,357	24,465
First Quarter	21,116	7,195	13,921	9,419	1,896	6,376	1,148	4,502
Second Quarter	29,591	10,096	19,495	14,207	2,997	8,666	2,543	5,288
Third Quarter	34,087	9,767	24,320	15,490	3,768	7,649	4,073	8,830
Fourth Quarter	30,126	9,940	20,186	14,340	3,374	7,374	3,592	5,846
1997	118,569	38,576	79,993	55,530	11,042	33,046	11,442	24,463
First Quarter	21,016	6,123	14,893	10,540	1,411	7,827	1,302	4,353
Second Quarter	32,564	10,868	21,696	16,088	3,891	7,538	4,659	5,607
Third Quarter	36,566	12,413	24,153	15,794	3,364	8,916	3,513	8,359
Fourth Quarter	28,422	9,171	19,252	13,108	2,375	8,765	1,968	6,144
1998	120,661	39,326	81,335	53,868	10,092	32,784	10,992	27,467
First Quarter	22,693	7,175	15,518	11,070	1,790	7,376	1,904	4,448
Second Quarter	35,707	11,116	24,591	17,673	3,660	10,899	3,114	6,918
Third Quarter	33,128	11,599	21,528	12,954	1,898	6,974	4,082	8,575
Fourth Quarter	29,134	9,436	19,698	12,172	2,744	7,535	1,893	7,525

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

1 to 4 Unit Owner Occupied

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1962	7,105	2,832	4,273	3,021	669	1,731	621	1,252
First Quarter	1,272	532	740	486	63	339	84	254
Second Quarter	2,060	832	1,228	893	167	486	240	335
Third Quarter	2,098	865	1,233	858	175	487	196	375
Fourth Quarter	1,675	603	1,072	784	264	419	101	288
1963	7,852	2,875	4,977	3,690	878	1,885	927	1,287
First Quarter	1,292	503	789	587	113	358	116	202
Second Quarter	2,226	792	1,434	1,127	293	518	316	307
Third Quarter	2,448	900	1,548	1,068	303	476	289	480
Fourth Quarter	1,886	680	1,206	908	169	533	206	298
1965	7,750	2,726	5,024	3,895	959	2,122	814	1,129
First Quarter	1,444	538	906	755	99	553	103	151
Second Quarter	2,088	754	1,334	1,019	250	520	249	315
Third Quarter	2,434	829	1,605	1,205	372	537	296	400
Fourth Quarter	1,784	605	1,179	916	238	512	166	263
1966	7,934	2,378	5,556	4,220	992	2,498	729	1,336
First Quarter	1,444	439	1,005	817	218	516	83	188
Second Quarter	1,940	729	1,211	991	265	491	235	220
Third Quarter	2,709	764	1,945	1,401	268	854	279	544
Fourth Quarter	1,841	445	1,395	1,011	242	637	132	384
1967	7,954	2,210	5,744	4,419	920	2,573	926	1,326
First Quarter	1,239	372	866	672	75	497	100	195
Second Quarter	2,389	652	1,737	1,301	270	697	334	437
Third Quarter	2,356	687	1,669	1,246	281	628	337	423
Fourth Quarter	1,970	499	1,471	1,200	294	751	155	271
1968	8,966	2,692	6,274	4,618	1,093	2,675	850	1,656
First Quarter	1,405	372	1,033	732	109	520	103	302
Second Quarter	2,556	769	1,788	1,370	378	625	368	418
Third Quarter	2,961	956	2,005	1,519	406	861	251	486
Fourth Quarter	2,043	596	1,448	997	201	669	127	450
1969	9,431	2,858	6,573	5,071	942	2,952	1,178	1,501
First Quarter	1,626	459	1,167	913	110	617	185	254
Second Quarter	2,955	879	2,076	1,663	422	795	447	413
Third Quarter	3,023	933	2,090	1,553	267	896	391	536
Fourth Quarter	1,826	587	1,240	942	143	644	155	298
1970	10,448	3,150	7,299	5,309	1,262	2,935	1,112	1,990
First Quarter	1,762	445	1,317	1,019	131	788	100	298
Second Quarter	3,118	981	2,137	1,533	341	794	397	605
Third Quarter	2,963	1,057	1,906	1,364	327	674	363	542
Fourth Quarter	2,606	667	1,939	1,393	462	678	252	546
1971	11,201	3,174	8,028	5,791	1,366	3,171	1,255	2,236
First Quarter	1,898	514	1,384	1,010	235	674	101	375
Second Quarter	3,368	884	2,483	1,817	429	943	446	666
Third Quarter	3,349	1,089	2,260	1,544	284	828	433	716
Fourth Quarter	2,586	686	1,900	1,420	418	727	275	480
1972	12,102	3,567	8,534	6,253	1,203	3,551	1,499	2,281
First Quarter	2,258	603	1,655	1,192	169	839	184	463
Second Quarter	3,489	970	2,518	1,914	417	874	623	605
Third Quarter	3,467	1,202	2,265	1,643	336	795	511	622
Fourth Quarter	2,888	792	2,096	1,505	282	1,043	180	591

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

1 to 4 Unit Owner Occupied

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1973	12,076	4,037	8,040	5,887	1,085	3,694	1,108	2,152
First Quarter	2,272	660	1,612	1,269	174	987	108	343
Second Quarter	3,215	1,115	2,100	1,577	406	784	387	523
Third Quarter	3,507	1,327	2,180	1,468	311	668	489	712
Fourth Quarter	3,083	935	2,148	1,574	194	1,254	125	574
1974	14,791	4,547	10,244	6,819	1,332	4,133	1,354	3,425
First Quarter	2,700	845	1,855	1,235	186	900	149	620
Second Quarter	4,084	1,330	2,754	1,834	370	1,006	458	920
Third Quarter	4,525	1,398	3,128	1,863	361	1,040	462	1,265
Fourth Quarter	3,481	974	2,507	1,887	415	1,187	285	620
1975	16,714	4,901	11,813	8,898	1,747	5,259	1,892	2,914
First Quarter	2,677	723	1,954	1,508	140	1,136	231	446
Second Quarter	5,029	1,372	3,658	2,645	422	1,595	629	1,013
Third Quarter	5,212	1,630	3,583	2,785	765	1,324	695	798
Fourth Quarter	3,795	1,176	2,619	1,960	419	1,204	337	658
1976	20,231	5,842	14,389	10,624	2,996	5,445	2,183	3,765
First Quarter	3,589	1,064	2,525	1,883	374	1,181	328	642
Second Quarter	6,203	1,717	4,486	3,421	824	1,592	1,005	1,066
Third Quarter	5,329	1,854	3,476	2,260	620	1,166	474	1,215
Fourth Quarter	5,109	1,207	3,902	3,059	1,177	1,506	376	843
1977	22,950	6,223	16,727	12,484	2,126	7,529	2,828	4,243
First Quarter	4,393	1,210	3,184	2,411	253	1,762	397	773
Second Quarter	6,234	1,807	4,426	3,439	821	1,634	984	987
Third Quarter	7,267	1,835	5,432	3,914	581	2,259	1,074	1,518
Fourth Quarter	5,056	1,371	3,685	2,719	471	1,874	374	966
1978	26,294	6,980	19,314	13,442	2,880	6,696	3,866	5,872
First Quarter	3,876	986	2,889	1,970	521	1,205	245	919
Second Quarter	7,592	2,216	5,377	3,795	667	1,776	1,352	1,581
Third Quarter	8,201	2,156	6,044	4,261	940	2,118	1,204	1,783
Fourth Quarter	6,625	1,622	5,003	3,415	753	1,597	1,065	1,588
1979	30,171	8,256	21,916	15,305	2,581	7,994	4,730	6,611
First Quarter	5,360	1,186	4,175	3,110	477	2,078	554	1,065
Second Quarter	8,258	2,322	5,935	4,152	963	1,502	1,686	1,783
Third Quarter	9,143	2,770	6,374	4,256	508	2,262	1,486	2,118
Fourth Quarter	7,410	1,978	5,432	3,788	632	2,152	1,004	1,645
1980	34,116	8,223	25,892	18,479	3,738	9,406	5,336	7,413
First Quarter	6,498	1,347	5,151	3,838	485	2,096	1,257	1,313
Second Quarter	9,355	2,279	7,076	5,159	859	2,340	1,960	1,917
Third Quarter	9,536	2,638	6,898	4,679	1,307	2,074	1,298	2,219
Fourth Quarter	8,727	1,960	6,767	4,803	1,086	2,897	820	1,964
1981	32,236	8,468	23,768	17,012	2,788	9,330	4,895	6,756
First Quarter	5,663	1,463	4,200	3,259	509	2,410	340	941
Second Quarter	8,929	2,292	6,637	4,747	529	2,397	1,821	1,890
Third Quarter	9,972	2,789	7,182	4,757	926	2,101	1,730	2,425
Fourth Quarter	7,672	1,923	5,749	4,250	825	2,422	1,003	1,499
1982	31,781	9,354	22,427	15,688	2,229	8,760	4,699	6,739
First Quarter	5,220	1,635	3,585	2,696	352	1,616	728	889
Second Quarter	8,873	2,475	6,398	4,663	756	2,261	1,646	1,735
Third Quarter	8,787	2,845	5,943	3,798	610	1,998	1,191	2,144
Fourth Quarter	8,900	2,399	6,501	4,530	511	2,885	1,134	1,971

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

1 to 4 Unit Owner Occupied

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1983	34,358	9,481	24,877	17,280	4,277	9,569	3,434	7,597
First Quarter	5,548	1,598	3,950	3,086	268	2,272	546	863
Second Quarter	9,520	2,724	6,796	4,948	2,353	1,950	646	1,848
Third Quarter	12,233	3,110	9,123	6,159	1,196	2,982	1,981	2,964
Fourth Quarter	7,058	2,049	5,009	3,087	460	2,366	261	1,922
1984	46,631	16,391	30,241	23,416	5,320	11,667	6,428	6,825
First Quarter	7,029	2,543	4,486	3,714	972	2,209	533	772
Second Quarter	12,982	4,872	8,109	6,238	916	2,886	2,436	1,872
Third Quarter	14,104	4,982	9,122	7,006	1,861	2,985	2,160	2,116
Fourth Quarter	12,517	3,994	8,523	6,458	1,572	3,587	1,299	2,065
1985	50,810	17,475	33,335	23,448	3,402	13,530	6,515	9,887
First Quarter	9,550	2,886	6,664	5,056	563	3,770	723	1,608
Second Quarter	13,752	5,283	8,469	5,994	1,025	2,818	2,151	2,475
Third Quarter	14,016	5,034	8,982	6,506	979	3,256	2,271	2,476
Fourth Quarter	13,492	4,272	9,220	5,892	836	3,687	1,370	3,328
1986	57,722	17,506	40,216	31,217	6,401	16,467	8,350	8,999
First Quarter	9,960	3,462	6,498	5,101	889	3,520	693	1,397
Second Quarter	15,860	4,677	11,183	8,932	1,992	4,109	2,831	2,251
Third Quarter	17,497	5,101	12,396	9,187	2,013	3,570	3,604	3,209
Fourth Quarter	14,406	4,267	10,140	7,998	1,507	5,268	1,223	2,142
1987	58,094	18,374	39,720	31,999	8,189	16,297	7,513	7,721
First Quarter	10,460	3,794	6,666	5,579	1,146	3,005	1,428	1,087
Second Quarter	15,776	4,529	11,247	9,000	2,396	4,402	2,201	2,247
Third Quarter	18,153	4,925	13,227	10,578	2,960	4,950	2,668	2,649
Fourth Quarter	13,705	5,126	8,579	6,842	1,687	3,940	1,215	1,737
1988	65,445	19,918	45,527	35,654	9,264	18,299	8,091	9,873
First Quarter	10,395	3,887	6,508	4,772	836	2,582	1,354	1,737
Second Quarter	20,128	5,612	14,516	11,654	3,534	5,139	2,981	2,862
Third Quarter	19,161	5,661	13,500	10,525	3,001	5,806	1,717	2,975
Fourth Quarter	15,761	4,758	11,003	8,704	1,894	4,771	2,039	2,300
1989	62,838	19,886	42,952	32,674	6,464	17,636	8,573	10,278
First Quarter	11,533	3,757	7,777	6,118	1,406	3,676	1,036	1,658
Second Quarter	16,694	4,300	12,393	9,287	1,438	5,191	2,657	3,107
Third Quarter	19,302	6,086	13,216	10,002	2,108	5,065	2,829	3,214
Fourth Quarter	15,309	5,743	9,566	7,267	1,512	3,704	2,051	2,299
1990	63,287	22,850	40,436	29,804	7,196	17,258	5,350	10,632
First Quarter	13,016	4,710	8,305	6,446	1,877	3,950	620	1,859
Second Quarter	16,920	6,146	10,774	7,978	1,656	4,584	1,737	2,796
Third Quarter	18,311	6,435	11,876	8,500	2,362	4,293	1,845	3,376
Fourth Quarter	15,040	5,559	9,481	6,880	1,301	4,431	1,148	2,601
1991	61,913	25,107	36,806	26,684	6,831	13,887	5,966	10,122
First Quarter	10,690	5,079	5,611	4,093	559	2,787	747	1,518
Second Quarter	18,356	6,811	11,545	9,263	2,647	4,581	2,034	2,282
Third Quarter	19,008	7,638	11,371	7,800	2,594	2,994	2,213	3,570
Fourth Quarter	13,858	5,579	8,279	5,528	1,031	3,526	971	2,751
1992	69,859	24,921	44,937	34,827	6,226	19,753	8,848	10,110
First Quarter	12,678	4,629	8,050	6,526	1,492	4,238	796	1,523
Second Quarter	21,816	7,888	13,928	10,566	1,625	5,429	3,512	3,362
Third Quarter	18,369	7,467	10,900	8,289	1,829	3,965	2,496	2,611
Fourth Quarter	16,998	4,939	12,059	9,446	1,281	6,121	2,044	2,614

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

1 to 4 Unit Owner Occupied

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1993	72,882	22,133	50,749	36,549	11,519	18,514	6,516	14,200
First Quarter	12,197	3,430	8,767	6,412	1,191	4,422	799	2,355
Second Quarter	19,330	5,841	13,489	9,446	3,040	4,072	2,334	4,043
Third Quarter	22,140	6,915	15,225	11,403	3,796	5,203	2,404	3,822
Fourth Quarter	19,216	5,948	13,268	9,288	3,492	4,817	979	3,980
1994	81,737	25,175	56,562	40,693	8,793	22,996	8,904	15,869
First Quarter	14,262	4,326	9,936	8,142	2,437	4,277	1,429	1,794
Second Quarter	23,342	6,553	16,789	12,878	2,962	6,472	3,444	3,912
Third Quarter	22,809	7,380	15,429	10,629	2,206	5,923	2,500	4,800
Fourth Quarter	21,323	6,915	14,408	9,045	1,189	6,325	1,531	5,363
1995	78,583	26,262	52,321	33,972	6,576	19,176	8,221	18,348
First Quarter	14,657	4,600	10,057	6,848	517	5,149	1,183	3,208
Second Quarter	23,799	7,932	15,867	10,573	2,904	5,521	2,148	5,295
Third Quarter	21,597	6,768	14,829	9,292	2,325	4,120	2,847	5,537
Fourth Quarter	18,530	6,962	11,568	7,259	829	4,387	2,043	4,309
1996	80,070	21,687	58,383	40,330	10,276	21,667	8,387	18,053
First Quarter	14,160	3,371	10,789	7,415	1,741	4,721	954	3,374
Second Quarter	21,866	6,265	15,601	11,407	2,739	6,746	1,922	4,194
Third Quarter	25,093	6,587	18,506	11,879	3,150	5,757	2,972	6,627
Fourth Quarter	18,951	5,464	13,487	9,628	2,645	4,444	2,539	3,859
1997	85,305	26,626	58,679	41,079	8,838	23,817	8,424	17,600
First Quarter	14,933	3,754	11,178	8,123	1,375	5,740	1,008	3,055
Second Quarter	23,621	7,398	16,223	11,826	2,767	5,282	3,777	4,397
Third Quarter	27,081	9,453	17,628	11,495	2,953	6,268	2,274	6,134
Fourth Quarter	19,671	6,021	13,650	9,635	1,743	6,527	1,365	4,014
1998	90,209	25,998	64,211	42,695	8,805	24,818	9,072	21,517
First Quarter	15,760	4,480	11,280	8,324	1,620	5,028	1,676	2,955
Second Quarter	26,809	7,331	19,478	13,882	3,252	8,096	2,534	5,596
Third Quarter	25,469	8,107	17,361	10,609	1,612	5,600	3,397	6,753
Fourth Quarter	22,171	6,079	16,092	9,879	2,321	6,094	1,464	6,213

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

1 Unit Owner Occupied

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1962	6,036	2,313	3,723	2,706	596	1,548	562	1,017
First Quarter	1,110	443	667	449	61	308	80	218
Second Quarter	1,761	693	1,068	803	157	434	212	265
Third Quarter	1,776	695	1,081	779	167	433	179	302
Fourth Quarter	1,389	482	907	675	211	373	91	232
1963	6,760	2,401	4,359	3,256	785	1,585	886	1,103
First Quarter	1,074	427	647	505	89	309	107	142
Second Quarter	1,904	668	1,236	955	256	399	300	281
Third Quarter	2,135	743	1,392	981	291	414	276	411
Fourth Quarter	1,647	563	1,084	815	149	463	203	269
1965	7,033	2,382	4,651	3,658	915	1,986	757	993
First Quarter	1,293	469	824	692	98	493	101	132
Second Quarter	1,925	680	1,245	962	250	495	217	283
Third Quarter	2,190	704	1,486	1,155	360	515	280	331
Fourth Quarter	1,625	529	1,096	849	207	483	159	247
1966	7,133	2,067	5,066	3,928	992	2,252	683	1,138
First Quarter	1,326	390	936	772	218	472	83	164
Second Quarter	1,691	627	1,063	871	265	395	212	192
Third Quarter	2,476	669	1,807	1,318	268	782	269	488
Fourth Quarter	1,640	381	1,259	966	242	604	120	293
1967	7,024	1,935	5,089	3,994	828	2,303	863	1,094
First Quarter	1,091	333	758	607	64	453	90	151
Second Quarter	2,135	572	1,563	1,182	238	629	314	381
Third Quarter	2,034	595	1,439	1,122	238	563	321	317
Fourth Quarter	1,764	435	1,329	1,084	288	658	138	245
1968	8,089	2,350	5,739	4,315	1,054	2,487	775	1,424
First Quarter	1,288	327	961	688	109	477	102	273
Second Quarter	2,322	668	1,655	1,269	353	574	342	386
Third Quarter	2,676	838	1,838	1,433	402	827	205	405
Fourth Quarter	1,803	518	1,285	925	190	609	125	360
1969	8,594	2,469	6,125	4,740	920	2,676	1,144	1,384
First Quarter	1,475	391	1,084	852	109	562	182	231
Second Quarter	2,718	762	1,955	1,578	407	737	434	378
Third Quarter	2,764	815	1,949	1,445	263	796	386	504
Fourth Quarter	1,637	500	1,136	865	142	581	143	271
1970	9,469	2,753	6,716	4,973	1,206	2,695	1,072	1,742
First Quarter	1,615	385	1,230	946	129	720	96	284
Second Quarter	2,854	864	1,990	1,461	329	750	383	528
Third Quarter	2,710	929	1,781	1,281	319	616	347	500
Fourth Quarter	2,290	576	1,715	1,285	429	610	246	430
1971	10,234	2,853	7,381	5,366	1,275	2,890	1,201	2,015
First Quarter	1,729	462	1,267	906	189	619	98	361
Second Quarter	3,089	812	2,277	1,703	429	861	413	574
Third Quarter	3,053	980	2,073	1,418	247	750	421	655
Fourth Quarter	2,363	599	1,764	1,339	410	660	270	425
1972	11,128	3,193	7,935	5,809	1,117	3,249	1,443	2,127
First Quarter	2,116	546	1,570	1,137	168	788	181	433
Second Quarter	3,227	879	2,349	1,782	397	785	600	568
Third Quarter	3,124	1,083	2,040	1,482	298	692	492	558
Fourth Quarter	2,661	685	1,976	1,408	253	984	171	568

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

1 Unit Owner Occupied

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1973	11,297	3,620	7,677	5,688	1,070	3,543	1,075	1,989
First Quarter	2,124	605	1,518	1,195	173	926	97	323
Second Quarter	2,962	994	1,968	1,544	402	769	374	424
Third Quarter	3,323	1,204	2,119	1,435	310	646	479	684
Fourth Quarter	2,888	817	2,071	1,513	186	1,203	125	558
1974	13,578	4,031	9,547	6,441	1,328	3,789	1,324	3,106
First Quarter	2,557	768	1,788	1,195	185	863	147	593
Second Quarter	3,684	1,180	2,504	1,666	369	865	432	838
Third Quarter	4,133	1,165	2,968	1,799	361	978	460	1,169
Fourth Quarter	3,204	918	2,286	1,781	413	1,083	285	506
1975	15,684	4,540	11,143	8,458	1,680	4,945	1,832	2,685
First Quarter	2,465	673	1,792	1,388	140	1,016	231	404
Second Quarter	4,703	1,232	3,470	2,517	416	1,515	586	954
Third Quarter	4,963	1,542	3,421	2,664	707	1,265	693	757
Fourth Quarter	3,553	1,093	2,460	1,889	417	1,149	323	570
1976	18,854	5,217	13,638	10,231	2,925	5,181	2,125	3,407
First Quarter	3,420	1,017	2,403	1,828	374	1,135	319	575
Second Quarter	5,897	1,555	4,342	3,299	767	1,549	983	1,043
Third Quarter	4,704	1,531	3,173	2,137	607	1,063	467	1,037
Fourth Quarter	4,834	1,114	3,720	2,968	1,177	1,434	357	752
1977	21,761	5,705	16,056	12,015	2,062	7,170	2,783	4,042
First Quarter	4,112	1,094	3,018	2,248	193	1,678	376	770
Second Quarter	5,968	1,631	4,337	3,386	819	1,592	976	951
Third Quarter	6,886	1,679	5,207	3,748	581	2,107	1,061	1,458
Fourth Quarter	4,796	1,301	3,495	2,632	469	1,794	370	863
1978	24,189	6,427	17,762	12,624	2,809	6,181	3,634	5,138
First Quarter	5,080	1,079	4,001	3,029	476	2,004	549	972
Second Quarter	7,926	2,162	5,763	4,071	955	1,458	1,658	1,692
Third Quarter	8,508	2,507	6,001	4,072	505	2,088	1,480	1,929
Fourth Quarter	6,766	1,855	4,911	3,505	616	1,939	949	1,406
1979	28,280	7,603	20,677	14,677	2,552	7,489	4,637	6,000
First Quarter	5,080	1,079	4,001	3,029	476	2,004	549	972
Second Quarter	7,926	2,162	5,763	4,071	955	1,458	1,658	1,692
Third Quarter	8,508	2,507	6,001	4,072	505	2,088	1,480	1,929
Fourth Quarter	6,766	1,855	4,911	3,505	616	1,939	949	1,406
1980	31,481	7,532	23,948	17,244	3,444	8,604	5,196	6,705
First Quarter	6,261	1,268	4,993	3,740	485	2,010	1,245	1,253
Second Quarter	8,201	2,057	6,145	4,518	567	2,068	1,883	1,627
Third Quarter	8,962	2,386	6,576	4,563	1,306	2,001	1,256	2,013
Fourth Quarter	8,057	1,821	6,235	4,423	1,086	2,525	812	1,812
1981	30,201	7,844	22,357	15,970	2,695	8,766	4,510	6,387
First Quarter	5,479	1,347	4,132	3,194	509	2,347	338	939
Second Quarter	8,184	2,157	6,027	4,262	519	2,230	1,513	1,766
Third Quarter	9,372	2,531	6,841	4,523	845	1,958	1,721	2,317
Fourth Quarter	7,165	1,809	5,357	3,991	822	2,231	938	1,365
1982	29,779	8,637	21,142	14,781	2,144	8,037	4,601	6,361
First Quarter	4,809	1,482	3,327	2,515	352	1,437	726	812
Second Quarter	8,530	2,321	6,210	4,555	756	2,188	1,611	1,655
Third Quarter	8,223	2,615	5,608	3,544	572	1,816	1,156	2,064
Fourth Quarter	8,217	2,220	5,997	4,167	463	2,596	1,108	1,830

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

1 Unit Owner Occupied

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1983	32,524	8,650	23,874	16,915	4,277	9,310	3,328	6,959
First Quarter	5,334	1,419	3,915	3,054	268	2,239	546	862
Second Quarter	9,048	2,432	6,615	4,913	2,353	1,926	635	1,702
Third Quarter	11,530	2,873	8,657	5,981	1,196	2,878	1,907	2,676
Fourth Quarter	6,612	1,926	4,686	2,967	460	2,267	240	1,719
1984	43,781	15,092	28,689	22,349	5,150	11,010	6,189	6,341
First Quarter	6,590	2,349	4,241	3,521	953	2,045	523	720
Second Quarter	11,956	4,439	7,517	5,913	915	2,641	2,356	1,604
Third Quarter	13,443	4,632	8,812	6,814	1,762	2,934	2,118	1,998
Fourth Quarter	11,792	3,672	8,120	6,101	1,520	3,390	1,192	2,019
1985	47,742	16,091	31,651	22,357	3,361	12,597	6,399	9,294
First Quarter	8,490	2,473	6,017	4,542	563	3,256	723	1,475
Second Quarter	13,091	4,932	8,160	5,821	1,025	2,668	2,128	2,338
Third Quarter	13,475	4,668	8,807	6,415	979	3,211	2,225	2,392
Fourth Quarter	12,686	4,018	8,668	5,579	794	3,462	1,322	3,089
1986	54,298	16,514	37,784	29,261	5,972	15,119	8,170	8,523
First Quarter	9,231	3,229	6,002	4,696	889	3,116	692	1,306
Second Quarter	15,164	4,458	10,706	8,654	1,927	3,970	2,757	2,052
Third Quarter	16,406	4,768	11,638	8,486	1,857	3,118	3,512	3,152
Fourth Quarter	13,498	4,060	9,438	7,425	1,299	4,916	1,210	2,013
1987	54,791	17,552	37,239	29,883	7,882	14,748	7,253	7,356
First Quarter	10,001	3,662	6,339	5,274	1,087	2,794	1,393	1,065
Second Quarter	15,045	4,271	10,774	8,569	2,379	4,020	2,170	2,205
Third Quarter	17,043	4,656	12,387	9,858	2,859	4,523	2,475	2,529
Fourth Quarter	12,702	4,962	7,740	6,182	1,556	3,410	1,215	1,558
1988	60,822	17,921	42,901	33,614	8,843	16,948	7,822	9,287
First Quarter	9,362	3,386	5,975	4,386	836	2,413	1,138	1,589
Second Quarter	18,683	4,980	13,703	10,898	3,273	4,688	2,937	2,805
Third Quarter	18,058	5,178	12,881	10,147	2,867	5,572	1,708	2,733
Fourth Quarter	14,719	4,377	10,342	8,182	1,868	4,276	2,039	2,160
1989	59,858	18,234	41,625	31,648	6,318	16,850	8,480	9,977
First Quarter	11,140	3,576	7,564	5,922	1,335	3,551	1,036	1,642
Second Quarter	16,015	3,948	12,068	9,045	1,376	5,100	2,569	3,023
Third Quarter	18,569	5,650	12,920	9,750	2,095	4,828	2,827	3,169
Fourth Quarter	14,134	5,060	9,074	6,931	1,512	3,371	2,048	2,143
1990	59,683	21,031	38,652	28,491	7,188	16,012	5,292	10,160
First Quarter	12,507	4,390	8,117	6,272	1,877	3,782	613	1,844
Second Quarter	15,844	5,670	10,174	7,485	1,651	4,113	1,721	2,690
Third Quarter	17,213	5,730	11,483	8,293	2,359	4,112	1,823	3,189
Fourth Quarter	14,119	5,241	8,878	6,441	1,301	4,005	1,135	2,437
1991	58,083	23,645	34,438	25,303	6,666	12,726	5,911	9,134
First Quarter	9,572	4,528	5,044	3,619	473	2,401	745	1,424
Second Quarter	17,315	6,538	10,776	9,024	2,619	4,398	2,007	1,752
Third Quarter	18,007	7,272	10,736	7,507	2,543	2,776	2,188	3,229
Fourth Quarter	13,189	5,307	7,882	5,153	1,031	3,151	971	2,729
1992	67,316	23,802	43,514	33,783	6,220	18,866	8,696	9,731
First Quarter	12,018	4,372	7,646	6,287	1,492	4,047	748	1,359
Second Quarter	21,084	7,475	13,610	10,304	1,619	5,245	3,440	3,306
Third Quarter	17,718	7,220	10,498	8,011	1,829	3,693	2,490	2,487
Fourth Quarter	16,496	4,735	11,760	9,181	1,281	5,881	2,019	2,580

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

1 Unit Owner Occupied

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1993	70,746	21,175	49,571	35,798	11,501	17,828	6,469	13,773
First Quarter	11,912	3,287	8,625	6,298	1,191	4,308	799	2,327
Second Quarter	18,803	5,595	13,208	9,298	3,029	3,966	2,303	3,910
Third Quarter	21,555	6,664	14,892	11,126	3,789	4,944	2,393	3,765
Fourth Quarter	18,476	5,629	12,847	9,076	3,492	4,610	974	3,771
1994	77,270	24,241	53,030	37,946	8,360	21,527	8,059	15,084
First Quarter	13,693	4,138	9,555	7,778	2,321	4,086	1,371	1,777
Second Quarter	21,212	6,240	14,973	11,237	2,648	5,816	2,772	3,736
Third Quarter	21,690	7,109	14,582	10,118	2,206	5,462	2,450	4,464
Fourth Quarter	20,675	6,755	13,920	8,814	1,184	6,164	1,466	5,106
1995	75,362	25,076	50,286	32,538	6,507	17,934	8,097	17,748
First Quarter	14,110	4,524	9,585	6,684	517	5,062	1,105	2,901
Second Quarter	23,046	7,580	15,466	10,313	2,869	5,311	2,132	5,154
Third Quarter	20,393	6,499	13,894	8,446	2,291	3,317	2,837	5,448
Fourth Quarter	17,814	6,474	11,340	7,095	829	4,243	2,023	4,245
1996	76,094	20,192	55,903	38,847	10,235	20,471	8,141	17,056
First Quarter	13,814	3,220	10,594	7,269	1,741	4,594	935	3,324
Second Quarter	20,535	5,917	14,619	10,634	2,706	6,139	1,788	3,985
Third Quarter	23,734	5,936	17,798	11,540	3,142	5,490	2,908	6,259
Fourth Quarter	18,011	5,119	12,892	9,404	2,645	4,248	2,511	3,488
1997	82,216	25,537	56,679	39,467	8,365	22,806	8,296	17,212
First Quarter	14,273	3,548	10,725	7,725	1,375	5,375	975	3,000
Second Quarter	22,719	7,079	15,641	11,262	2,603	4,905	3,754	4,379
Third Quarter	26,272	9,199	17,073	11,045	2,643	6,172	2,230	6,028
Fourth Quarter	18,952	5,711	13,241	9,435	1,743	6,355	1,337	3,806
1998	87,243	25,094	62,149	41,342	8,784	23,602	8,956	20,807
First Quarter	15,323	4,316	11,007	8,173	1,620	4,903	1,650	2,834
Second Quarter	25,938	7,135	18,803	13,299	3,252	7,556	2,491	5,503
Third Quarter	24,722	7,873	16,849	10,344	1,612	5,338	3,395	6,505
Fourth Quarter	21,260	5,770	15,490	9,525	2,300	5,805	1,420	5,965

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

Rental, Vacant and Seasonal Properties

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1962	3,919	2,011	1,908	1,421	221	891	309	487
First Quarter	778	495	283	168	31	108	29	115
Second Quarter	1,180	497	683	555	46	378	131	128
Third Quarter	953	517	436	288	60	127	101	148
Fourth Quarter	1,008	502	506	410	84	278	48	96
1963	3,555	2,135	1,420	1,000	264	539	197	420
First Quarter	840	511	329	248	51	143	54	81
Second Quarter	759	481	278	176	27	114	35	102
Third Quarter	1,039	600	439	319	88	154	77	120
Fourth Quarter	917	543	374	257	98	128	31	117
1965	3,692	2,273	1,419	841	250	438	153	578
First Quarter	976	618	358	194	56	92	46	164
Second Quarter	851	545	306	167	35	98	34	139
Third Quarter	1,006	608	398	262	38	182	42	136
Fourth Quarter	859	502	357	218	121	66	31	139
1966	3,757	2,425	1,332	757	210	397	150	576
First Quarter	691	503	188	104	18	60	26	84
Second Quarter	804	573	231	121	56	32	33	110
Third Quarter	1,223	693	529	307	42	215	49	222
Fourth Quarter	1,040	656	384	225	95	90	41	159
1967	3,733	2,221	1,512	902	226	546	131	610
First Quarter	816	480	336	226	60	130	35	110
Second Quarter	1,026	574	453	294	50	210	34	158
Third Quarter	989	611	378	200	64	94	41	178
Fourth Quarter	902	557	345	182	51	111	20	163
1968	3,737	2,494	1,243	696	168	402	126	547
First Quarter	777	493	284	170	(NA)	(NA)	(NA)	114
Second Quarter	942	661	281	177	(NA)	(NA)	(NA)	104
Third Quarter	1,075	719	356	173	(NA)	(NA)	(NA)	183
Fourth Quarter	944	621	322	176	(NA)	(NA)	(NA)	146
1969	4,104	2,621	1,483	814	152	457	204	669
First Quarter	673	482	191	88	17	62	9	103
Second Quarter	840	588	253	156	42	88	27	96
Third Quarter	1,423	845	578	310	58	119	132	269
Fourth Quarter	1,167	706	461	260	35	189	37	201
1970	4,322	2,746	1,576	937	149	604	185	639
First Quarter	904	601	302	174	(NA)	(NA)	(NA)	128
Second Quarter	1,115	692	422	284	(NA)	(NA)	(NA)	138
Third Quarter	1,233	790	443	256	(NA)	(NA)	(NA)	187
Fourth Quarter	1,070	661	409	224	(NA)	(NA)	(NA)	185
1971	5,098	3,187	1,911	1,027	319	529	179	884
First Quarter	883	568	315	153	(NA)	(NA)	(NA)	162
Second Quarter	1,185	778	407	222	(NA)	(NA)	(NA)	184
Third Quarter	1,687	1,050	637	350	(NA)	(NA)	(NA)	287
Fourth Quarter	1,344	792	552	301	(NA)	(NA)	(NA)	251
1972	5,397	3,150	2,246	1,273	175	896	202	974
First Quarter	894	589	305	137	(NA)	(NA)	(NA)	168
Second Quarter	1,350	789	561	400	(NA)	(NA)	(NA)	161
Third Quarter	1,757	952	805	493	(NA)	(NA)	(NA)	312
Fourth Quarter	1,395	820	575	241	(NA)	(NA)	(NA)	334

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

Rental, Vacant and Seasonal Properties

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1973	6,436	3,887	2,549	1,499	275	1,000	224	1,050
First Quarter	1,175	609	566	377	129	227	21	189
Second Quarter	1,461	989	471	209	30	132	47	262
Third Quarter	1,980	1,162	818	598	38	471	89	220
Fourth Quarter	1,820	1,126	694	315	79	170	67	379
1974	6,323	3,943	2,378	1,242	197	704	341	1,137
First Quarter	1,412	855	557	178	0	153	26	378
Second Quarter	1,279	895	383	172	20	70	82	211
Third Quarter	1,886	1,028	857	579	112	331	136	278
Fourth Quarter	1,746	1,165	581	312	65	150	97	270
1975	8,525	4,857	3,668	2,099	224	1,585	290	1,570
First Quarter	1,635	1,036	599	367	54	270	43	232
Second Quarter	1,838	1,105	733	479	17	387	75	254
Third Quarter	2,391	1,190	1,200	586	66	459	61	615
Fourth Quarter	2,662	1,525	1,136	667	86	469	112	469
1976	8,803	5,537	3,266	1,690	497	922	271	1,576
First Quarter	2,067	1,147	920	587	118	430	38	333
Second Quarter	2,413	1,631	782	346	55	226	64	436
Third Quarter	2,136	1,463	673	296	99	143	54	377
Fourth Quarter	2,188	1,296	891	462	225	123	114	430
1977	8,330	5,121	3,209	1,753	529	976	249	1,456
First Quarter	1,509	1,144	364	141	1	121	19	223
Second Quarter	2,402	1,265	1,137	859	323	428	108	279
Third Quarter	2,314	1,443	871	376	89	186	101	496
Fourth Quarter	2,106	1,270	836	378	115	241	21	458
1978	11,167	5,929	5,238	3,016	832	1,747	436	2,222
First Quarter	2,406	1,156	1,250	685	100	532	53	566
Second Quarter	3,155	1,333	1,822	1,297	541	719	38	524
Third Quarter	2,972	1,814	1,157	567	68	248	250	591
Fourth Quarter	2,633	1,625	1,009	468	123	248	96	542
1979	12,060	6,694	5,365	2,980	699	1,648	633	2,385
First Quarter	2,309	1,385	924	399	16	357	26	525
Second Quarter	3,497	1,830	1,667	1,172	444	519	209	495
Third Quarter	2,990	1,664	1,326	709	105	349	254	617
Fourth Quarter	3,264	1,815	1,448	701	134	423	143	747
1980	12,222	6,963	5,259	2,856	445	1,787	624	2,403
First Quarter	2,719	1,638	1,080	433	13	271	148	647
Second Quarter	3,179	1,909	1,270	716	206	360	150	554
Third Quarter	3,446	1,693	1,752	1,065	79	750	235	687
Fourth Quarter	2,879	1,723	1,156	642	146	405	90	514
1981	14,115	7,554	6,561	3,402	376	2,617	408	3,159
First Quarter	3,060	1,478	1,582	842	12	778	52	740
Second Quarter	3,906	2,065	1,841	985	142	736	107	856
Third Quarter	3,634	2,230	1,404	620	22	528	71	784
Fourth Quarter	3,515	1,781	1,734	955	201	575	179	779
1982	13,510	7,455	6,054	3,087	412	1,951	724	2,968
First Quarter	2,966	1,697	1,270	565	35	414	115	705
Second Quarter	3,962	2,036	1,926	1,267	112	937	218	659
Third Quarter	2,852	1,752	1,100	466	85	220	161	634
Fourth Quarter	3,730	1,971	1,759	789	179	380	229	970

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

Rental, Vacant and Seasonal Properties

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1983	14,937	8,647	6,290	2,991	462	2,104	425	3,299
First Quarter	3,339	1,912	1,427	815	25	723	67	612
Second Quarter	3,317	1,757	1,560	852	302	408	142	709
Third Quarter	3,900	2,190	1,710	957	103	774	80	753
Fourth Quarter	4,381	2,788	1,593	367	32	198	137	1,225
1984	23,153	12,504	10,649	4,407	688	2,819	901	6,242
First Quarter	4,866	2,262	2,604	1,383	164	1,115	105	1,221
Second Quarter	7,558	3,807	3,751	1,288	453	411	424	2,462
Third Quarter	6,092	3,903	2,190	529	34	310	185	1,661
Fourth Quarter	4,637	2,532	2,104	1,206	37	982	187	898
1985	29,457	17,883	11,574	5,327	564	4,068	695	6,247
First Quarter	6,385	4,346	2,040	517	2	387	128	1,523
Second Quarter	6,053	4,090	1,963	1,138	34	880	224	825
Third Quarter	7,690	4,233	3,457	1,521	175	1,208	138	1,936
Fourth Quarter	9,329	5,214	4,115	2,151	352	1,594	205	1,964
1986	33,551	18,465	15,087	7,390	976	4,725	1,689	7,696
First Quarter	7,582	4,141	3,441	1,588	155	964	470	1,853
Second Quarter	7,214	3,558	3,656	2,166	138	1,746	283	1,491
Third Quarter	11,106	6,217	4,890	2,386	373	1,334	678	2,504
Fourth Quarter	7,649	4,550	3,100	1,251	311	682	258	1,849
1987	35,992	19,856	16,136	7,980	1,369	5,345	1,267	8,155
First Quarter	7,560	3,969	3,591	1,655	181	1,229	244	1,936
Second Quarter	8,007	4,299	3,708	2,359	680	1,399	280	1,349
Third Quarter	9,559	5,342	4,218	1,516	262	946	308	2,702
Fourth Quarter	10,866	6,247	4,619	2,451	245	1,771	434	2,168
1988	35,672	20,967	14,705	7,686	2,069	4,404	1,213	7,019
First Quarter	8,115	5,260	2,855	1,628	37	1,382	209	1,227
Second Quarter	8,620	4,804	3,816	2,051	552	1,063	437	1,765
Third Quarter	11,121	6,527	4,594	2,515	958	1,210	348	2,079
Fourth Quarter	7,816	4,375	3,441	1,492	522	750	220	1,949
1989	38,053	22,803	15,250	7,112	364	5,493	1,255	8,137
First Quarter	7,816	4,427	3,389	1,908	85	1,519	305	1,480
Second Quarter	7,895	5,162	2,733	1,468	6	1,313	149	1,266
Third Quarter	11,588	7,010	4,578	1,724	241	1,117	366	2,854
Fourth Quarter	10,754	6,204	4,550	2,012	32	1,544	435	2,537
1990	43,487	28,454	15,032	7,448	1,364	4,664	1,421	7,584
First Quarter	9,295	5,620	3,674	1,518	2	1,212	304	2,157
Second Quarter	10,394	6,576	3,818	2,574	830	1,318	426	1,244
Third Quarter	11,843	7,883	3,960	1,849	48	1,328	474	2,111
Fourth Quarter	11,955	8,375	3,580	1,507	484	806	217	2,072
1991	35,615	24,733	10,882	4,260	1,083	2,189	988	6,622
First Quarter	8,157	6,151	2,006	677	112	453	113	1,329
Second Quarter	6,548	4,997	1,551	862	0	688	173	690
Third Quarter	9,833	6,060	3,773	1,190	211	744	235	2,583
Fourth Quarter	11,076	7,525	3,551	1,530	759	304	467	2,020
1992	33,875	20,233	13,643	5,359	557	2,947	1,856	8,283
First Quarter	5,980	4,045	1,936	798	160	605	32	1,138
Second Quarter	8,620	5,695	2,925	908	21	438	448	2,017
Third Quarter	9,218	4,503	4,715	2,134	314	815	1,005	2,581
Fourth Quarter	10,057	5,989	4,068	1,520	61	1,089	370	2,548

Expenditures for Residential Improvements and Repairs by Property Type, Quarterly 1962-1998
Not Seasonally Adjusted in Millions of Dollars

Rental, Vacant and Seasonal Properties

	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Additions	Alterations	Outside Adds/Alts	Major Replacements
1993	35,423	19,566	15,857	9,248	1,238	6,268	1,742	6,609
First Quarter	7,512	5,410	2,102	1,307	86	1,088	132	795
Second Quarter	9,093	4,352	4,740	2,418	808	1,176	433	2,323
Third Quarter	9,388	4,498	4,890	2,764	177	1,833	754	2,127
Fourth Quarter	9,430	5,306	4,124	2,760	167	2,170	423	1,364
1994	33,293	17,778	15,515	8,135	854	5,676	1,605	7,380
First Quarter	6,929	4,238	2,691	1,758	289	1,277	193	933
Second Quarter	7,646	4,258	3,388	1,640	197	879	565	1,748
Third Quarter	9,489	4,510	4,979	2,611	139	2,023	449	2,368
Fourth Quarter	9,230	4,772	4,458	2,126	230	1,498	398	2,332
1995	33,100	15,785	17,315	10,754	1,361	7,717	1,676	6,562
First Quarter	7,120	3,277	3,844	3,184	532	2,286	366	659
Second Quarter	7,340	3,281	4,059	2,826	319	2,101	407	1,233
Third Quarter	10,457	5,502	4,955	2,284	319	1,733	231	2,671
Fourth Quarter	8,183	3,726	4,457	2,459	191	1,596	673	1,998
1996	34,850	15,310	19,539	13,126	1,760	8,397	2,969	6,413
First Quarter	6,956	3,824	3,132	2,004	155	1,655	194	1,128
Second Quarter	7,725	3,831	3,894	2,800	258	1,920	621	1,094
Third Quarter	8,994	3,180	5,814	3,610	618	1,892	1,101	2,204
Fourth Quarter	11,175	4,475	6,699	4,712	729	2,930	1,053	1,987
1997	33,264	11,949	21,314	14,451	2,204	9,229	3,019	6,863
First Quarter	6,084	2,369	3,715	2,417	36	2,087	293	1,298
Second Quarter	8,944	3,471	5,473	4,263	1,125	2,255	883	1,210
Third Quarter	9,485	2,960	6,525	4,299	411	2,649	1,240	2,225
Fourth Quarter	8,751	3,149	5,601	3,472	631	2,237	603	2,130
1998	30,452	13,328	17,123	11,173	1,287	7,966	1,920	5,950
First Quarter	6,933	2,694	4,238	2,745	169	2,348	228	1,493
Second Quarter	8,897	3,785	5,112	3,790	408	2,803	579	1,322
Third Quarter	7,659	3,492	4,167	2,345	286	1,374	684	1,822
Fourth Quarter	6,962	3,357	3,605	2,293	423	1,441	429	1,312

Table S1. Expenditures to Owner-Occupied Properties by Type of Job: 1993 to 1998

[Millions of dollars. Components may not add to totals because of rounding]

Type of Job [1]	*Owner-Occupied*						
	1993	*1994*	*1995*	*1996*	*1997*	*1998*	*Average relative standard error*
Total	72,882	81,737	78,583	80,070	85,305	90,209	5
Additions	11,519	8,793	6,576	10,276	8,838	8,805	15
Decks and porches	1,856	1,618	2,419	2,356	2,792	1,658	21
Attached garages	2,290	1,618	1,688	1,312	460	1,690	34
Rooms	7,372	5,556	2,468	6,608	5,587	5,458	22
Alterations	18,514	22,996	19,176	21,667	23,817	24,818	9
Plumbing	877	658	1,050	771	1,547	649	26
HVAC	955	1,591	1,232	1,940	1,902	1,683	29
Electrical	528	796	485	720	542	474	33
Flooring	1,791	2,202	2,000	2,952	2,508	3,213	18
Kitchen remodeling	1,564	1,379	1,716	2,038	3,141	2,593	20
Bathroom remodeling	2,246	3,643	2,501	2,609	3,675	4,749	26
Kitchen and bathroom remodeling	630	1,470	608	845	167	927	43
Finishing space	967	709	1,146	1,196	1,185	1,037	35
Interior restructuring	1,275	2,855	2,249	3,318	3,187	2,993	26
Siding	977	1,245	550	685	1,134	673	55
Windows and doors	848	703	359	538	605	473	29
Other alterations	5,858	5,746	5,280	4,055	4,224	5,356	15
Outside Additions and Alteration	6,516	8,904	8,221	8,387	8,424	9,072	13
Detached buildings	577	1,895	1,271	1,868	2,038	2,335	30
Patios and terraces	520	775	484	983	1,323	668	34
Driveways and walkways	818	468	814	497	1,209	1,313	34
Fences	1,176	1,280	1,447	1,419	1,524	1,585	19
Other outside additions and alterations	3,427	4,486	4,204	3,621	2,329	3,171	20
Major Replacements	14,200	15,869	18,348	18,053	17,600	21,517	8
Plumbing	1,655	1,811	1,997	1,312	1,516	1,128	16
HVAC	3,331	2,815	5,014	3,719	4,487	4,027	16
Siding	1,169	978	1,056	1,849	1,077	1,555	37
Roofing	3,006	4,030	4,176	5,212	5,312	6,443	16
Driveways and walkways	760	875	438	457	537	1,138	32
Windows	1,838	2,487	2,435	3,030	2,739	3,904	23
Doors	958	1,157	1,020	986	982	1,068	19
Other major replacements	1,484	1,716	2,213	1,489	950	2,254	23
Maintenance and Repairs	22,133	25,175	26,262	21,687	26,626	25,998	6
Painting and papering	6,833	6,669	6,660	7,247	7,748	8,641	10
Plumbing	2,002	2,945	2,281	2,285	2,618	2,240	12
HVAC	1,680	1,687	1,692	2,044	1,375	1,845	12
Electrical	483	551	615	418	503	493	22
Siding	584	497	587	241	706	298	57
Roofing	2,707	2,439	2,902	1,670	2,666	2,297	17
Flooring	774	1,490	1,417	1,093	1,638	826	25
Windows and doors	351	855	726	515	853	797	22
Materials to have on hand	1,965	2,270	1,990	2,650	2,726	3,234	16
Other maintenance and repairs	4,752	5,771	7,392	3,523	5,793	5,326	11

NA Not applicable

[1] *The expenditures given for each specified type of job consist of those outlays which have been identified as being primarily of the specified type. Thus, expenditures for one type of job done incidental to another type are included under the latter classification. For example, the relatively minor cost of painting done in conjunction with a roofing job is included in the roofing category.*

EXHIBIT
7
Emergency Notice

Table S1. Expenditures to Rental[2] Properties by Type of Job: 1993 to 1998

[Millions of dollars. Components may not add to totals because of rounding]

Type of Job [1]	*Rental* [2]						
	1993	*1994*	*1995*	*1996*	*1997*	*1998*	*Average relative standard error*
Total	35,423	33,293	33,100	34,850	33,264	30,452	5
Additions	1,238	854	1,361	1,760	2,204	1,287	31
Decks and porches	607	104	264	679	1,143	407	64
Attached garages	222	156	307	79	161	53	80
Rooms	409	594	789	1,002	899	827	30
Alterations	6,268	5,676	7,717	8,397	9,229	7,966	17
Plumbing	329	835	1,304	1,121	1,343	819	22
HVAC	304	469	640	697	1,139	694	38
Electrical	158	274	399	594	686	728	49
Flooring	853	592	937	975	1,153	1,530	29
Kitchen remodeling	#	#	#	#	#	#	(NA)
Bathroom remodeling	#	#	#	#	#	#	(NA)
Kitchen and bathroom remodeling	792	537	1,549	2,037	1,539	1,809	36
Finishing space	$	$	$	$	$	$	(NA)
Interior restructuring	1,595	358	1,143	761	583	193	70
Siding	$	$	$	$	$	$	(NA)
Windows and doors	758	769	518	473	786	397	34
Other alterations	1,477	1,842	1,226	1,738	2,000	1,797	26
Outside Additions and Alteration	1,742	1,605	1,676	2,969	3,019	1,920	23
Detached buildings	276	418	253	1,189	632	546	50
Patios and terraces	$	$	$	$	$	$	(NA)
Driveways and walkways	$	$	$	$	$	$	(NA)
Fences	364	151	140	372	308	176	46
Other outside additions and alterations	1,102	1,036	1,283	1,409	2,079	1,198	30
Major Replacements	6,609	7,380	6,562	6,413	6,863	5,950	16
Plumbing	1,335	1,024	1,056	927	1,249	1,377	19
HVAC	709	1,089	625	1,022	1,430	930	30
Siding	$	$	$	$	$	$	(NA)
Roofing	1,815	2,978	2,104	1,597	1,350	1,691	32
Driveways and walkways	$	$	$	$	$	$	(NA)
Windows	955	910	820	850	1,024	893	48
Doors	216	288	201	173	362	96	36
Other major replacements	1,578	1,089	1,756	1,842	1,447	963	26
Maintenance and Repairs	19,566	17,778	15,785	15,310	11,949	13,328	5
Painting and papering	5,732	4,777	4,250	4,879	3,600	4,010	9
Plumbing	2,111	1,483	1,801	1,468	1,382	1,093	16
HVAC	939	931	948	893	570	584	23
Electrical	446	242	740	456	551	349	30
Siding	613	763	775	458	384	700	45
Roofing	1,415	1,959	1,233	1,485	2,166	1,289	23
Flooring	892	1,050	1,010	860	698	1,657	19
Windows and doors	309	652	651	996	500	531	23
Materials to have on hand	222	556	330	320	282	582	30
Other maintenance and repairs	6,885	5,366	4,047	3,495	1,818	2,534	12

NA Not applicable
 # Expenditures included in the "Kitchen and bathroom remodeling" category
$ Expenditures included in the "Other" category.

[1] The expenditures given for each specified type of job consist of those outlays which have been identified as being primarily of the specified type. Thus, expenditures for one type of job done incidental to another type are included under the latter classification. For example, the relatively minor cost of painting done in conjunction with a roofing job is included in the roofing category.
[2] Includes rental, vacant, and seasonal properties.

EXPENDITURES FOR IMPROVEMENTS AND
REPAIRS OF RESIDENTIAL PROPERTIES
SECOND QUARTER 1999

Expenditures for improvements and repairs of residential properties in the second quarter 1999 were at a seasonally adjusted annual rate of $114.1 billion, according to estimates released today by the U.S. Commerce Department's Census Bureau. This estimate is 2(±10) percent above the first quarter estimate of $111.4 billion.

Spending on maintenance and repairs was at a seasonally adjusted annual rate of $38.2 billion in the second quarter 1999; improvements amounted to $75.8 billion.

More detailed data will appear in Current Construction Reports, C50/99-Q2, to be issued at a later date. This report will also provide a description of the reliability of the data, survey methodology, and the 90-percent confidence interval.

Questions regarding these data may be directed to Michael Davis or Joe Huesman, Construction Expenditures Branch, Manufacturing and Construction Division, telephone (301) 457-1605.

Table 1. Expenditures for Maintenance and Repairs and Improvements
Seasonally Adjusted Annual Rate in Billions of Dollars
(Detail may not add to total because of rounding)

Year and Quarter	Total Expenditures	Maintenance and Repairs	Total Improvements	Additions and Alterations	Major Replacements
1988					
1st quarter	92.0	42.7	49.3	33.7	15.6
2nd quarter	111.8	42.6	69.2	49.4	19.9
3rd quarter	102.1	42.3	59.8	44.1	15.7
4th quarter	95.9	35.9	60.0	43.3	16.7
1989					
1st quarter	96.8	38.2	58.6	42.1	16.5
2nd quarter	97.0	39.1	58.0	38.7	19.3
3rd quarter	104.0	45.5	58.5	39.8	18.7
4th quarter	104.5	46.6	57.9	39.2	18.7
1990					
1st quarter	110.4	48.2	62.2	41.0	21.3
2nd quarter	107.6	52.4	55.3	37.1	18.1
3rd quarter	103.6	50.4	53.2	36.2	17.0
4th quarter	107.1	53.7	53.4	35.9	17.4
1991					
1st quarter	93.7	52.6	41.1	24.7	16.4
2nd quarter	95.5	48.2	47.2	35.5	11.7
3rd quarter	100.3	48.8	51.6	31.6	20.0
4th quarter	97.8	50.3	47.6	30.0	17.6

EXHIBIT
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Emergency Notice

1992					
1st quarter	95.5	41.0	54.4	38.1	16.4
2nd quarter	115.2	55.1	60.0	40.0	20.0
3rd quarter	97.0	42.9	54.2	36.9	17.3
4th quarter	106.5	41.4	65.1	46.0	19.1
1993					
1st quarter	102.0	42.5	59.6	39.2	20.4
2nd quarter	105.8	40.9	64.9	41.4	23.5
3rd quarter	111.6	41.1	70.5	50.8	19.7
4th quarter	112.7	42.3	70.4	50.8	19.6
1994					
1st quarter	111.1	42.6	68.5	50.5	18.0
2nd quarter	114.3	42.6	71.7	50.8	20.9
3rd quarter	112.7	42.8	70.0	46.8	23.2
4th quarter	119.9	43.5	76.4	47.5	28.9
1995					
1st quarter	115.7	40.9	74.8	50.5	24.4
2nd quarter	114.7	42.7	72.0	46.7	25.3
3rd quarter	110.0	42.8	67.2	41.2	26.0
4th quarter	106.6	41.1	65.4	41.5	23.9
1996					
1st quarter	112.5	38.3	74.1	47.5	26.6
2nd quarter	108.7	37.9	70.8	49.6	21.3
3rd quarter	117.1	34.1	83.0	55.2	27.8
4th quarter	121.4	38.2	83.2	60.9	22.3
1997					
1st quarter	111.5	33.2	78.3	53.4	24.9
2nd quarter	119.7	40.3	79.3	56.2	23.1
3rd quarter	125.7	43.3	82.4	56.3	26.1
4th quarter	114.1	35.3	78.8	55.3	23.5
1998					
1st quarter	121.1	39.2	81.9	56.6	25.4
2nd quarter	130.3	40.6	89.7	61.4	28.3
3rd quarter	113.5	40.5	73.1	46.5	26.6
4th quarter	117.3	37.0	80.3	51.4	28.9
1999					
1st quarter	111.4	34.0	77.4	49.3	28.1
2nd quarter	114.1	38.2	75.8	48.1	27.7

Table 2. Expenditures for Maintenance and Repairs and Improvements
Not Seasonally Adjusted in Millions of Dollars
(Detail may not add to total due to rounding)

Year and Quarter	Total Expend-itures	Maintenance and Repairs	Total Improve-ments	Additions and Alter-ations	Major Replace-ments
All Residential Properties					
1998: Total	120,661	39,326	81,335	53,868	27,467
1st quarter	22,693	7,175	15,518	11,070	4,448

2nd quarter	35,707	11,116	24,591	17,673	6,918
3rd quarter	33,348	11,580	21,768	12,898	8,870
4th quarter	29,134	9,436	19,698	12,172	7,525
1999:					
1st quarter	20,632	6,195	14,438	9,604	4,833
2nd quarter	31,157	10,472	20,685	13,878	6,807
Relative Standard Error	6	10	7	8	13
All Owner-Occupied Properties					
1998: Total	90,209	25,998	64,211	42,695	21,517
1st quarter	15,760	4,480	11,280	8,324	2,955
2nd quarter	26,809	7,331	19,478	13,882	5,596
3rd quarter	25,689	8,289	17,601	10,553	7,048
4th quarter	22,171	6,079	16,092	9,879	6,213
1999:					
1st quarter	15,585	4,125	11,460	7,705	3,754
2nd quarter	23,142	6,393	16,749	11,450	5,298
Relative Standard Error	7	10	9	10	13
Owner-Occupied One-Unit Properties					
1998: Total	87,243	25,094	62,149	41,342	20,807
1st quarter	15,323	4,316	11,007	8,173	2,834
2nd quarter	25,938	7,135	18,803	13,299	5,503
3rd quarter	25,093	7,950	17,143	10,304	6,840
4th quarter	21,260	5,770	15,490	9,525	5,965
1999:					
1st quarter	15,025	3,926	11,099	7,475	3,624
2nd quarter	21,897	6,016	15,881	11,063	4,818
Relative Standard Error	8	11	9	10	13
Rental Properties(1)					
1998: Total	30,452	13,328	17,123	11,173	5,950
1st quarter	6,933	2,694	4,238	2,745	1,493
2nd quarter	8,897	3,785	5,112	3,790	1,322
3rd quarter	7,659	3,492	4,167	2,345	1,822
4th quarter	6,962	3,357	3,605	2,293	1,312
1999:					
1st quarter	5,047	2,070	2,978	1,899	1,079
2nd quarter	8,015	4,079	3,936	2,427	1,509
Relative Standard Error	14	20	22	25	35

(1) Includes rental, vacant, and seasonal properties.

Note: Quarterly relative standard errors are derived from an average of the most recent 4 quarters.

MONTANA STATE BOARD OF HEALTH

Helena, Montana

DIVISION OF DISEASE CONTROL

A

REPORT ON AN INDUSTRIAL HYGIENE STUDY

OF THE

ZONOLITE COMPANY

OF

LIBBY, MONTANA

August 8-9, 1956

Conducted by:

Benjamin F. Wake
Industrial Hygiene Engineer
Division of Disease Control

Distribution:

This report is confidential and is not for distribution except to the management of the Zonolite Company.

CONFIDENTIAL

EXHIBIT 9 Emergency Notice

PLAINTIFF'S EXHIBIT G-11

On August 8th and 9th, 1956, an industrial hygiene study was made of the Zonolite Company of Libby, Montana, to determine if any of the components of the operation of this company were detrimental to the health of the employees. The study was made after a discussion of industrial hygiene principles with Mr. R. A. Bleich, Division Manager, and Mr. D. Lovick, Assistant Manager. Mr. Walter Baker, Assistant Plant Manager, and Mr. Ted Wright, Repairman, acted as guides for the study.

The present study involved the conduction of an engineering investigation to evaluate the working environment and by making a determination of the environmental factors which might have a bearing on health. Consideration was also given to the ventilation and other protective measures already in use for the control of dust and other toxic materials.

The samples collected were analyzed and counted in accordance with accepted practice generally recommended by the U. S. Public Health Service, the American Conference of Governmental Industrial Hygienists, and other official agencies. Samples collected for dust counts were counted a few hours after they were collected and were analyzed for free silica in the U. S. Public Health Service Laboratory in Cincinnati, Ohio.

Description of Operations

The description of the operations of this company have been adequately discussed in previous reports. but, in general, they constitute an open cut mine, a transfer point from the mine to the mill, and various milling and sizing operations done on five floors of the company's mill, a short distance from the mine.

The operation, in general, is that of reducing in size the vermiculite ore which is mined in the open cut mine to various graded sizes which are best for the product which is ultimately an insulation material. In grading and sizing, various vibrating screens are employed to obtain the sizes necessary and to reduce the amount of extraneous material from the ore.

In the mining operations, approximately 17 men are employed per shift and, since the operation is almost wholly outdoor work, no samples for dust concentrations were collected in this area. At the transfer point from the mine to the mill, one man is employed and, although there is some dustiness, it was not felt to be significant and no samples were collected at this point.

In the mill proper, operations are divided into wet mill and dry mill production. In the wet mill, dustiness is quite low; however, in the dry mill the dust from the various sizing and grinding operations is quite high, as noted in the Table I.

PLAINTIFF'S EXHIBIT G-11(2)

The approximate population in the plant at the time of this study was 100 workers, as against 34 workers in 1944, when the last study of the plant was made. The population of the plant a few days before the study was considerably higher but, due to a reduction in the demand for the product, one shift was laid off.

PLAINTIFF'S EXHIBIT G-11(3)

TABLE I

DUST CONCENTRATIONS IN THE AIR

Sample No.	Location	Description	Concentration in mppcf*	Percent Free Silica
1	Wet mill	General air sample.	11.6	Not determined
2	Dry mill 5th floor	General air Sample	17.9	1.8 (rafter sample
3	Dry mill 4th floor	General air sample	51.8	Not determined
4	Dry mill 3rd floor	General air sample	28.7	1.0 (rafter sample
5	Dry mill 2nd floor	General air sample	48.3	Not determined
6	Dry mill 1st floor	General air sample	83.0	1.2 (rafter sample)

Note: Composite air sample all floors provided free silica determination of 1.3%.

Maximum allowable concentration:

Silica: High - (above 50% free S_1O_2) - 5 mppcf
Medium - (5 to 50% free S_1O_2) - 20 mppcf
Low - (below 5% free S_1O_2) - 50 mppcf

Dust (nuisance, no free silica - 50 mppcf

*millions of particles per cubic foot of air.

Concentrations

The concentrations of dust in the air, as determined in table I, vary considerably from a low of 11.6 to a high of 83 mppcf. These concentrations in relation to free silica are not excessive, although the concentrations on the fourth, second and first floor were at or above the maximum allowable concentration even for a nuisance dust with no free silica. On the basis of the asbestos content, no statement can be made, since at this time the asbestos content of the dust has not been determined. However, from visual observation and from information gained at the

plant, a small percentage increase in the asbestos content of the material being processed produces several times greater concentration of dust in the air. The maximum allowable concentration for asbestos is 5 mppcf, and when the concentration of asbestos in the dust samples collected has been determined, further comments on the concentrations will be made. At this time, however, and on the basis of the concentration of asbestos found in the dust, which varies from the company's records from 8 to 21%, it would appear that the maximum concentration of dust in the air should not be greater than 25 to 30 mppcf.

Toxicity

A review of the literature indicates that vermiculite or the dust from this material is not especially toxic and is generally included only as a nuisance dust. However, the asbestos dust in the dust in the air is of considerable toxicity, and is a factor in the consideration of reducing dustiness in this plant.

According to Drinker and Hatch(1), the pathologic changes produced by asbestos are not like those of silicosis. The asbestos fiber group about the neck of the small air sacs in the lungs, and stimulate the formation of a diffuse fibrosis. There is no definite migration or transportation of the dust particles to the lymph nodes and no formation of the fibris nodules. As the fibrosis increases, the reduction in lung area causes a serious decrease in lung capacity, or difficulty in breathing. Lanza(2) suggested that enlarged hearts noted frequently in the cases of secondary asbestosis may be the result of the increased work with the heart resulting from this condition. It takes more work to pump the blood through the asbestotic than through the normal lung.

Maximum Allowable Concentrations

In the study of an environment from the standpoint of exposure to harmful materials, the use of maximum allowable concentrations is helpful. Maximum allowable concentrations is defined as that concentration of any harmful material in a working atmosphere below which a worker's health will not be affected adversely. Maximum allowable concentrations have been established upon many of the common industrial poisons and they have been based on the results of corrolated engineering and medical studies in industries using these materials. Maximum allowable concentrations now in use as a criteria for the protection for the health of the workers are subject to change as additional information is accumulated. The concentrations used in this study are those recommended by the U. S. Public Health Service, the American Conference of Governmental Industrial Hygienists and the American Industrial Hygiene Association. All maximum allowable concentrations recorded are for prolonged exposures or those exposures for an eight-hour working day.

In the evaluation of the worker's exposure to any harmful material, cognizance of the amount of time spent by the worker in the contaminated atmosphere should be taken. For this reason an attempt was made to determine the amount of time a worker spent on all his jobs where they were not continuous. Weighted average exposures more nearly represent a workers actual exposure over an eight-hour day than

(1) Drinker, P., and Hatch, T.: Industrial Dust, McGraw-Hill Book Co, New York, 1954
(2) Lanza, A. J., McConnell, W. J. and Fehnel, J. W.: Effects of the inhalation of asbestos dust on the lungs of asbestos workers, "Public Health Reports", 50:1 of 1935.

PLAINTIFF'S EXHIBIT G-11(4)

does a single sample result representing an exposure for a short portion of an hour a day.

$$\text{Weighted Average} = \frac{\text{concentration of material x hours exposed}}{\text{hours worked}}$$

Conclusions and Recommendations

From observations made at the time of the study it would appear that the exhaust mechanism for allaying dust generated by the various vibrating machines and other moving parts in the dry mill, in particular, was well designed originally but under the handicap to which this exhaust mechanism is subjected it cannot and does not function properly. The following are several reasons why the dustiness in the dry mill is heavy and why the exhaust mechanism, as designed, does not function:

1. Dust vibrates almost continuously off the rafters which have become loaded and are continually loaded with dust generating from many sources.

2. Rubber connectors between the vibrating screens and the feed spouts are not tight, nor are they replaced when they vibrate off or they are worn out.

3. Rubber connectors between the vibrating screen and the exhaust ducts are either broken, missing, or are not placed on the ducts.

4. Exhaust from some of the vibrators is insufficient to control the dust generated, which, in all probability, is caused by an over-load of the system from other portions of the plant.

5. Backs are off many of the vibrators, making the exhaust mechanism provided ineffective and, in effect, making it wholly inoperative due to the large area from which the exhaust draws.

6. There are many holes in conveyor pipes in such places as stop gates, connections to vibrating screens, and dozens of other points where holes have been cut into the pipes at random locations, or where the pipes have broken by vibration or worn through by friction of the moving ore.

7. Hoods over many of the vibrators are broken, have not been replaced or are ineffective. It would appear that canvas or a resilient type cover over the vibrators would be more effective than rigid type hoods which have been provided.

8. Many of the transfer points from one belt to another are not exhausted and contribute a great deal of dust to the atmosphere.

9. Many of the dead ends in the exhaust system were left open permitting a large volume of air to be drawn in through openings where no control was necessary, thereby reducing the control velocity in volumes of air at more critical points.

10. In many locations it was obvious that the dust collection mechanism was full of dirt or dust and could not be expected to function satisfactorily because of many of the reasons already mentioned.

11. Many of the elevator housings and screw conveyor housings are open in

PLAINTIFF'S EXHIBIT G-11(5)

several places where holes have been cut for various reasons and the housing material removed and not replaced. These elevator housings and screw conveyor housings are particular offenders in production of dust.

12. It was noted during this study that holes were being cut in the exhaust ducts at random without any previous calculation as to the volume of air required, or the reduction of air volume to other locations. The junctions were often left exceedingly rough increasing the frictional resistance in the collection pipe.

13. In some of the locations, particularly on the vibrating screens on the top floor, it is obvious that a great deal of product is being withdrawn through the exhaust system by virtue of too much air being drawn through the system. It is quite probable that the reason for this pick-up of product is because of the imbalance created for the various reasons previously noted.

14. In summary, the foregoing points are illustrative of what would be poor policy in matters of maintenance and operation of this plant. The following recommendations are based on the observations presented and on the basis of the dust counts, silica content, and asbestos content of the dust. It will be recognized that the following recommendations are particularly broad and non-specific; until such a time as the general over-all maintenance and repair of existing duct work, both in the exhaust system and the ore feed pipes have been sufficiently repaired, no specific recommendations appear to be justified. General recommendations are as follows:

1. That all of the unnecessary openings in the entire exhaust system, both in the wet and dry mills be closed properly and a program of discriminatory cutting of pipes be initiated. All access doors, corners, etc., should be provided with tight seals and, of great practical importance, are so designed that they are easily closed and secured by quick-locking devices in place of the usual bolts and nuts. Access doors should be attached by hinges to avoid the frequent damage which occurs when ordinarily manhole plates are removed for inspection and maintenance work. An objective in designing the access should be to make it difficult to keep them open.

2. That all of the unnecessary openings in all of the ore transport ducts and in all the elevator housings and screw conveyors be tightly and completely closed and that all the broken portions of the system of the plant be adequately repaired.

3. That all of the covers on the backs of the vibrators be replaced and made as air tight as possible and that the hoods over the vibrators be repaired and replaced with a type material that will not disintegrate subject to vibration.

4. That all of the exhaust ventilation duct work be examindd foot by foot and all holes plugged and unnecessary openings, particularly at dead ends, be adequately closed and the entire system be cleaned of dust which has deposited in any portion of any of the exhaust pipes.

5. That all of the transfer points and points where ore is being deposited into open containers be adequately enclosed and provided with exhaust ventilation.

6. That a system of vacuum cleaning or other cleaning of the rafters in the entire mill be instituted after the other measures have been adequately

PLAINTIFF'S EXHIBIT G-11(6)

accomplished so that the dust load contributed by that dust falling off rafters will be eliminated. Full recognition should be given to the fact that direct control measures alone are usually not enough to insure safe working conditions. The method of operations, proper maintenance of equipment and of housekeeping are equally essential to maintain healthful conditions.

7. That until such time as the repair and maintenance of both the exhaust and ore conveying systems have been complete, all the men in the dry mill be provided with and required to wear an adequate respirator, as indicated in the accompanying list.

8. That the operators of the spray painting equipment be provided with a respirator approved by the Bureau of Mines for such operation as indicated in the enclosed pamphlet.

9. That it be initiated as a policy of the company to be particularly discriminating in the provisions for any holes or outlets to be cut in any exhaust ventilation duct or any ore conveying duct or apparatus and that, if any ventilation must be provided for any process, the quantity of ventilation required be adequately determined before any exhaust capacity is taken from existing lines and that the result of such capacity will be ascertained on all subsequent units when such capacity has been involved.

PLAINTIFF'S EXHIBIT G-11 (17)

JAMES M. CAIRNS, A. B., M. D., M. S. SURGERY
LIBBY, MONTANA

July 20, 1959

Mr. Raymond A. Bleich
Local Manager
Zonolite Company
Libby, Montana

Dear Mr. Bleich:

The following is a tentative analysis of chest X-Rays taken of the employees in your Company.

The examination consisted only of a flat X-Ray plate of each employee's chest. It is not accurate nor complete without a personal, physical differential diagnosis, which should be done on all cases showing any abnormal defects of the chest.

Many of the pictures read showed multiple defects, or disease. It was only in rare instances that a specific diagnosis of any disease was noted singly.

Statistical review of the above examinations is as follows:

1. Number of persons examined - 130
2. Number with normal chests - 82
3. Number with abnormal chests - 48

Statistical review of the Abnormal Chests:

a. Pleural Thickenings - 8 - Possibly history of pneumonia
b. Defects of the Diaphragm - 3
c. Interstitial Fibrosis - 26 - Possibly [illegible]
d. Skeletal Deformities (Bones, fractures, etc.) - 4
e. Metallic Objects - 1
f. Calcified Densities - 3 - Lymph nodes
g. Pneumoconiosis, or possible Asbestosis - 8
h. Bronchiectasis - 1
i. Abnormal Hearts, or Aortas - 7
j. Emphysema - 11 - Dilated lungs - Exaggeration of [illegible]
k. Tuberculosis (?) - 2
l. Malignant Lesions (?) - 1

EXHIBIT 10 Emergency Notice

PLAINTIFF'S EXHIBIT 19320 (1)

CHEST X-RAY EXAMINATIONS

ZONOLITE COMPANY EMPLOYEES

1959

1. NUMBER EXAMINED - 130

2. NORMAL CHESTS - 82

3. ABNORMAL CHESTS - 48 37

4. DIFFERENTIAL DIAGNOSIS - ABNORMAL CHESTS

a.	PLEURAL THICKENING - - -	8
b.	DEFECTS of the DIAPHRAGM -	3
c.	INTERSTITIAL FIBROSIS - -	26
d.	SKELETAL DEFORMITIES - - (Bone, fractures, etc.)	4
e.	METALLIC OBJECTS - - -	1
f.	CALCIFIED DENSITIES - - -	3
g.	PNEUMOCONIOSIS or Possible ASBESTOSIS - - -	7
h.	BRONCHIECSTASIS - - - -	1
i.	ABNORMAL HEARTS and AORTAS - -	7
j.	EMPHYSEMA - - - - -	11
k.	TUBERCULOSIS - - - -	2
l.	MALIGNANT LESIONS - - -	1

PLAINTIFF'S EXHIBIT 1932(2)

[illegible] against you.

Would you kindly advise if there has been any claim activity in your area.

Very truly yours,

JARDINE, STEPHENSON, BLEWETT & WEAVER

by [illegible]

JLB:rp

PLAINTIFF'S EXHIBIT 1932(3)

ZONOLITE COMPANY

MINERS AND MANUFACTURERS OF VERMICULITE PRODUCTS

CABLE ADDRESS "ZONOCO" CHICAGO, ILLINOIS

TELEPHONE 38 • LIBBY, MONTANA

June 14, 1961

Mr. C. A. Pratt, Vice President
Western Mineral Products Co.
4725 Olson Memorial Highway
Minneapolis 22, Minnesota

Dear Cap:

In reply to your letter of June 12 I am happy to outline our past experience in regard to the effect of dust in our mill upon our employees' health. This is a very complex and confusing thing and one from which it is difficult to draw any conclusions. I will outline our history on this in the hopes that it may be of some help to you.

As background to our experience, you know we have always had the problem of dust in our milling and handling of vermiculite. This problem has received considerable attention over the years and we have attempted to take whatever steps necessary to control the dust intensity where there would be an exposure to employees. We have met with varying degrees of success in various places in the operation.

Many studies have been made of the dust and dust problem by different people over the years in analyzing the problem. All studies have shown that in the operation there is no free silica present, but the minerals found in the deposit are silicates, micas and asbestos-like minerals. Silicosis is caused by free silica and not by the silicates. Asbestos, however, is a cause of asbestosis, which has been a matter of concern. There is a relatively large amount of asbestos dust presnet in our mill and this is difficult to control.

From a report written in 1956 by an Industrial Hygiene Engineer, Division of Disease Control, Montana State Board of Health, I quote the following on the dust toxicity: "A review of the literature indicates that vermiculite or the dust from this material is not especially toxic and is generally included only as a nuisance dust. However, the asbestos dust in the dust in the air is of considerable toxicity, and is a factor in the consideration of reducing dustiness in this plant."

PLAINTIFF'S EXHIBIT G-14.03

EXHIBIT Emergency Notice

We have never had a known case of silicosis among our employees. We have had employees with pulmonary diseases which does not necessarily mean anything, because from any group of 100 plus people there will be similar cases. Something over two years ago one of our mill employees who had been with us approximately 19 years obviously was have respiratory trouble. His foreman tried several times to have him go to a doctor but was unsuccessful. Finally this man became so bad off that there was a question whether he should be working at all. We finally told him that we wondered whether he should be working because of his obvious physical conditon and in fairness to him if he would go to the local doctor of his choice we would pay for his examination to get a report from the doctor. He went to one of the local doctors who diagnosed his case advanced pulmonary tuberclosis. He arranged for this man to be admitted to the State Tuberclosis Sanitarium in Galen, Montana. After a stay of 38 days at the sanitarium, this man was discharged and the final diagnosis of the man's case was, one, of "histoplasmosis", and two, of "questionable asbestosis." This man has never has never returned to work and we have tried to receive reports of results of physical examinations since his discharge but have never been successful even though this man has agreed to have the reports furnished to us and has signed the required release of information which medical ethics requires. During the time of his stay at Galen, of course, they conducted several x-ray and laboratory examinations and still only came up with a final diagnosis of "questionable asbestosis."

While Montana has for a good many years had an industrial accident law on the books, they never had an industrial disease law until the 1959 session of the legislature when such a law was passed. This law specified certain specific industrial diseases for which employers would be responsible. The only specified disease which we felt would apply to us was that of silicosis. The law stated that employers would not be responsible for anything which had been contracted by their employees prior to the date that the law became effective. However, they would be responsible for any contraction of disease after that date, or any aggravation of the conditions which existed in the employee due to industrial conditions which existed in a particular plant. In order to protect ourselves and place ourselves on record as to the condition of our employees as of the effective date of the law, we instituted a program whereby all of our employees would have x-rays at the local hospital.

We made arrangements with the hospital to schedule these x-rays and in turn we arranged to have the employees there at the stipulated time. All x-rays were interpreted by a Radiologist and a report written on each one.

There were 5 medical doctors on the staff at the local hospital at the time of this program in addition to the Radiologist, who actually lives in Kalispell and comes to Libby one day a week to interpret all x-rays taken at this hospital. We arranged a luncheon meeting with all of the doctors on the hospital staff, told them our problem and what we were after and asked their cooperation which was freely given. We polled all of our employees as to which doctor was their family physician so we would have that as a matter of record. After the x-rays had all been taken and interpreted, we went through the list and furnished each doctor with a list of the employees who had given us that particular doctor's name as their family doctor. Each doctor was then furnished with a copy of the report on those employees who were his patients. We then had all of our employees check with their own doctor to obtain the results of their x-ray examinations. The doctors agreed that this would be the best plan and they agreed to furnish the results of the examinations to the employees without any cost to them. Even in the cases where the x-ray showed everything to be normal, we had the employees check with their doctor. In this way Zonolite Company did not give any information to the employees as to their physical condition so we could not be responsible for or liable in any way for giving out information which might be construed as misleading.

In the case of the employees where their x-rays interpretation showed some intra-thoracic pathology, it was up to the doctors to determine whether further tests or examination or treatment should be given. In the event that it was, this was to be at the employee's responsibility and expense.

After all of the results of these x-rays were in, we again met with the doctors and with the radiologist and discussed what our situation actually was in regard to pulmonary diseases from our plant. The preliminary results of the interpretations made it appear that we had a high incidence of pulmonary disease among our employees. However, after the doctors had analyzed the results, the conclusion they came to was there was nothing to indicate that there was a higher incidence of pulmonary trouble among our people than there was among any other group in this geographical area. In other words, they felt that they could not come to any conclusion as to whether our mill operation presented an above-normal occurrence of respiratory trou[illegible] normally. The radiologist who had had industrial dise[illegible] Indiana could offer nothing [illegible]

In our analysis of the people who had intra-thoracic pathology of some kind, neither could we come to any conclusion. There were people where some condition of fibrosis or pulmonary emphysema showed up who had been with us only a very short period of time. Other people who had been with us over a period of a good many years and who worked in jobs where the dust exposure had been high showed up with entirely normal x-rays. There was no relationship to being a higher incidence among the old time employees than there was in the newer employees, so we could come to no conclusion either.

For quite a few years now our employees at the dry mill, loading station and other points in the operation where dust exposure is high have been required to wear respirators. The particular respirator which we furnish to our people is made by the Mine Safety Appliance Company and is called the "Dust-Foe." This respirator filter is one which has the approval of health authorities in this state and apparently those on the Federal level.

It has now been two years since the survey that we made by x-raying all of our people. At that time we discussed the possibility of again taking a blanket survey at some time in the future to compare results of people that were on the original survey and whether there had been any marked change when the follow-up was taken. However, we have not scheduled anything as yet. At that time it was the feeling of the Radiologist that a minimum of two years should elapse before the follow-up should be made, and it would probably be better to wait a longer period where there would be more likelihood of some conclusions showing up. It is probable, therefore, that in the next two or three years we may schedule a follow-up blanket survey so results can be compared.

Incidentally, there were 130 people on the payroll at the time that the original blanket x-ray was made.

Getting back to the problem of dust, there is of course asbestos present in the concentrates which we ship to our expanding plants. The amount of dust from this should be very small in the expanding process, however. It would seem that the greatest exposure to dust which would include the asbestos dust, to your people would be in the unloading of cars. There will be some help on this problem when we install "dedusting" units both in our mill and at our point of loading. Final design is now being made for these units and installation will be completed by the end of this summer.

E.P

These will not eliminate the dust problem in the concentrates, but we expect to cut it down considerably.

This has been a review of our situation. I hope it will be of some help to you. Our dust control problem receives continuing attention from our mill superintendent. It is one which we continually work on in trying to keep our ventilation as efficient as possible and whenever it is possible to make any improvements we try to do so. We usually receive a visit from an engineer from the State Board of Health about once a year and he usually makes recommendations to us which we try to carry out.

If there is any further help that we can give you, we will certainly be glad to try to furnish it. If there are any particular points on this discourse upon which I could elaborate further, please feel free to ask me to do so.

Sincerely yours

ZONOLITE COMPANY

By:

E. D. Lovick

EDL/jbr

06033686

JAK
AEW

For your info
HMD/10-8-'64

Suspect Asbestos A Cancer Source

NEW YORK (AP) — Medical specialists pointed a finger of suspicion Tuesday at asbestos as a cause not only of lung cancer, but also of another extremely rare form of fatal human cancer.

This cancer, known as mesothelioma, involves the lining of the abdominal and chest cavities.

Much of their evidence comes from autopsy studies of men working with asbestos as an insulation material.

But they said it also is possible that dust from products containing asbestos might be exposing people generally to some risk of cancers. How much risk there might be, they said they could not tell.

Asbestos—a mineral—is used not only for insulation but as a flooring material, in auto brake shoes, and in many other applications. Ordinary wear-and-tear, they said, might release dust into the atmosphere.

The report was presented to the American Public Health Assn. by Drs. Irving J. Selikoff and Jacob Churg of the Mount Sinai Hospital, New York, and E. Cuyler Hammond, SC.D., director of statistical research for the American Cancer Society. Dr. Hammond is known for his studies of cigarot smoking in relationship to lung cancer.

Chi. Daily News
Oct. 6, '64

03159

EXHIBIT
12
Emergency Notice

PLAINTIFF'S
EXHIBIT
6-20

06046342

State of Montana

State Board of Health

JOHN S. ANDERSON, M.D.
EXECUTIVE OFFICER AND SECRETARY

HELENA, MONTANA

May 11, 1964

Mr. R. A. Bleich, Manager
The Zonolite Company
Libby, Montana

Dear Mr. Bleich:

Enclosed are two copies of a recent study made of the dry mill section of your plant near Libby. It is expected that a follow-up will be done in September, 1964 to determine the dust control provided by the additional fan described and by improved housekeeping.

We appreciate the courtesy and cooperation of you and your staff in this matter.

Sincerely yours,

Benjamin F. Wake

Benjamin F. Wake
Industrial Hygiene Engineer
Division of Disease Control

BFW/bko

Encl.

PLAINTIFF'S EXHIBIT
G-17.1

EXHIBIT
13
Emergency Notice

On April 29, 1964 a study was made of the dry mill section of the Zonolite Mill at Libby, Montana to determine if compliance with previous recommendations for the control of dust had been achieved. The study was made in the company of Mr. Bud Vinion, after discussion of the plant operations with Mr. Kujawa, Plant Superintendent.

The study consisted of a review of the dust collection system and its improvement and the collection of five dust samples for counting to determine any improvement in the over-all dust control procedures.

Description of Operations

It was noted that a considerable change had been made in the ventilation system of the dry mill which appeared to reduce dustiness in some areas considerably. The backs to the screens had been replaced on nearly all machines and the rubbers on the screens were in good shape, generally, although a few were broken. Those that were broken were leaking dust badly.

The duct work to the ventilation system had been repaired and a new 35,000 cfm fan which discharged at ground level had been installed. According to Mr. Vinion, the plant expects, in addition, to have a southside fan (old 600) hooked up soon. This should improve the situation on the southside of the mill by reducing the considerable dustiness from some of the operations on that side. Priority should be given to this ventilation so that it is completed by the first of September, 1964.

It was noted that the rafters were heavily loaded with dust. Much of the high dust concentrations noted were due to this dust falling off the rafters and other places of deposit. It is unfortunate that the good work that has been done in the ventilation system is reduced by extremely poor housekeeping.

The second floor continues to need special attention and may be improved with the installation of the new fan system which was not in operation at the time of this study.

The third floor on the high grade side needs more work and should be gone over carefully to determine those areas which need special attention for the control of dust.

The elevator feed box on the half deck leaked dust badly and was a main contaminator of both the half deck and the second floor. A rubber was also missing on the connector to No. 210 screen and should be replaced. All screens should be inspected weekly and any missing screen backs or broken rubbers replaced immediately.

According to Mr. Vinion, the southside roll crusher and high grade circuit will have a separate ventilation system soon. As noted previously, this work should be given priority so that it is in and functioning before the first of September of 1964.

Concentrations

A review of Table I for Dust-In-Air indicates that even though there have been some reduction in dust concentration, there still remains a great deal of room for improvement to reach the maximum allowable concentration of 20 million particles per cubic foot of over-all dustiness. While it is recognized that the 20 million particles per cubic foot level does not reduce the asbestos dustiness to exactly 5 million particles per cubic (mppcf) foot, it is felt that over-all dustiness reduction to 20 mppcf will be suitable for the control of asbestos dust, since the 5 million particles per cubic foot figure is not a precise dividing line between a safe and unsafe condition but simply indicates a range at which control should be aimed.

TABLE I

Dust-in-Air for years noted
Concentrations in Millions of Particles per Cubic Foot of Air (MPPCF)

	1956	1959	1962	1963	1964
6th Floor	Not Determined	46.3	51.0	30.6	Not Determined
5th Floor	17.9	51.8	69.5	65.6	37.6
4th Floor	51.8	26.2	90.0	32.4	20.6
3rd Floor	28.7	24.8	60.5	32.8	22.0
2nd Floor	48.3	27.2	59.2	50.0	59.2
Half Deck	Not Determined	Not Determined	54.5	77.8	54.4
1st Floor	83.0	7.5	44.8 & 50.9	59.8 & 26.8	Not Determined

Maximum Allowable Concentration 20 MPPCF Total
Maximum Allowable Concentration 5 MPPCF Asbestos

* * * * * *

A constant effort should be made, however, to achieve the reduction in total dustiness so that the 5 million particles per cubic feet of asbestos laden air is achieved at some time in the future.

Toxicology

In a recent article published in the Journal of the American Medical Association, April 6, 1964 by Selikoff and others, it is indicated that the "Building trades insulation workers have relatively light, intermittent,' exposure to asbestos. Of 632 insulation workers, who entered the trade before 1943 and were traced through 1962, forty-five died of cancer of the lung or pleura, whereas only 6.6 such deaths were expected. Three of the pleural tumors were mesotheliomas; there was also one peritoneal mesothelioma. Four mesotheliomas in a total of 255 deaths is an exceedingly high incidence for such a rare tumor. In addition, an unexpectedly large number of men died of cancer of the stomach, colon, or rectum (29 compared with 9.4 expected). Other cancers were not increased; 20.5 were expected, 21 occurred. Twelve men died of asbestosis."

In addition, "The recent demonstration, by South African and British investigators of pleural and peritoneal neoplasms among individuals who had chance environmental exposure to asbestos many years before raises the very important question of possible widespread carcinogenic air pollution." It was also demonstrated that asbestos bodies were found in a man not employed in an industry but living next door to an asbestos factory. "Asbestos exposure in industry will not be limited to the particular craft that utilizes the material. The floating fibers do not respect job classifications. Thus, for example, insulation workers undoubtedly share their exposure with their workmates in other trades; intimate contact with asbestos is possible for electricians, plumbers, sheet-metal workers, steamfitters, laborers, carpenters, boiler makers, and foremen."

While the above situation does not apply specifically to the operations of your plant, the asbestos content of the material with which you are working appears to provide some serious potential for the development of disease if not properly controlled. In addition, the discharge of large volumes of asbestos-laden dust at ground level sets up a condition where all members of the plant can be exposed in addition to those who work in the dry mill. This presents a problem that needs to be dealt with in view of the information submitted and the findings on other workers employed using similar materials.

Conclusions and Recommendations

Based on the findings of this study and in view of past experience, it is recommended that a review of past studies be made to determine areas producing dustiness. In addition, the following recommendations are submitted:

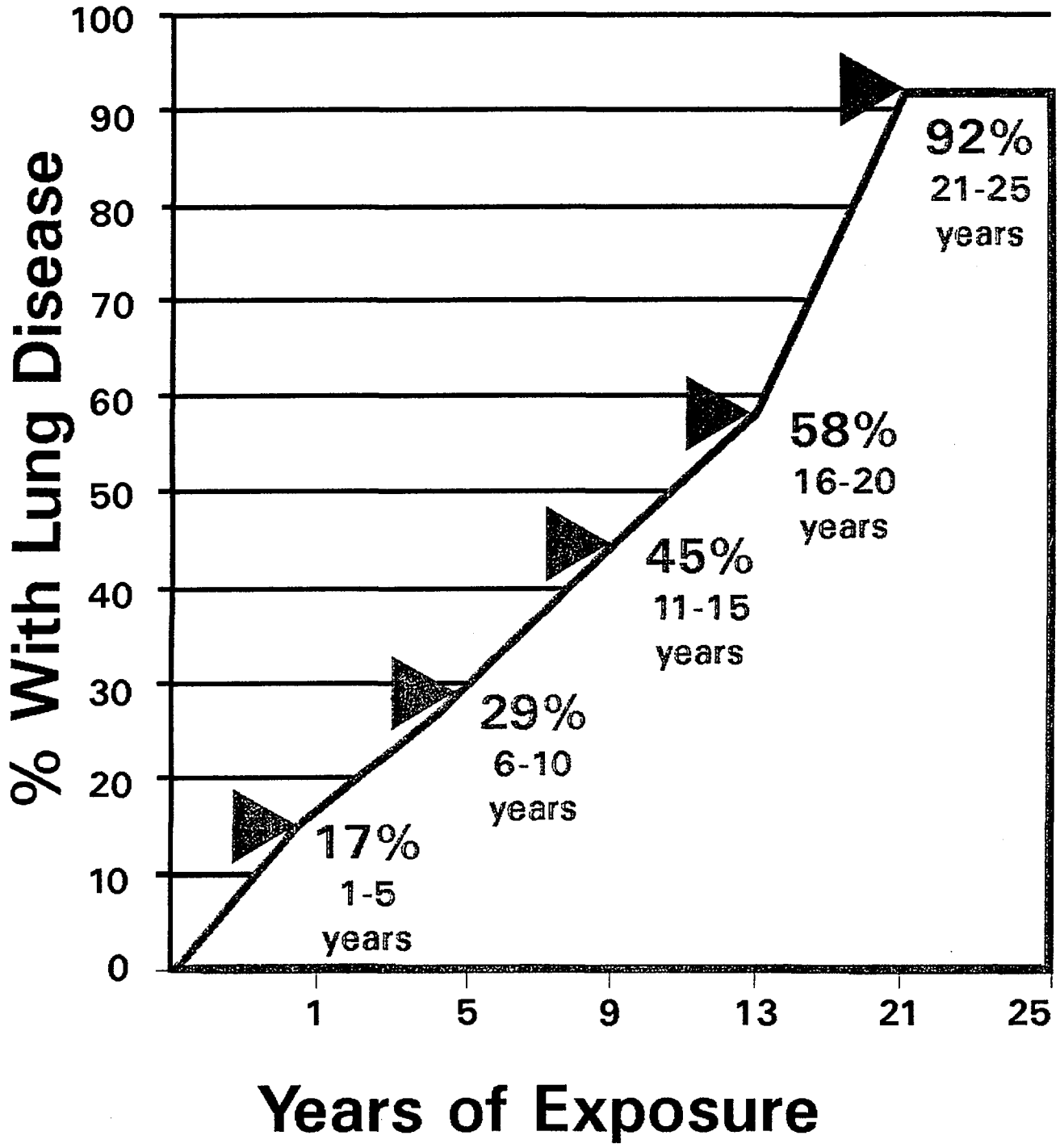
1. That a careful program of housekeeping be instituted so that dust collected on rafters does not reach the subsidence point. Careful cleaning of the floors should be done on a sufficiently frequent and routine basis as to prevent dust from falling off the rafters or from collecting on the floor to such a degree that this dust is a contributor to the overall load generated by the machines.

2. That a special priority be given to the installation of the additional fan described so that those areas not now sufficiently ventilated are brought under control by the first of September, 1964.

3. That the blower discharge--presently at ground level--be elevated to such a degree that re-entry is not so prevalent. It is expected that large volumes of dust will re-enter the building when the wind is in the right direction. It may also be desirable to consider collecting the exhaust dust by means of a cyclone or other suitable dust collecting device.

4. That continued effort be made by the company to determine the dust concentrations in the building by frequent sampling and analysis and by frequent observation of the dust collection systems to determine that they are operating at maximum efficiency.

Workers with Disease - 1969



Per Exh. 130.4 Grace Headquarters In-house Study

EXHIBIT
14
Emergency Notice

02146519

PERSONAL AND CONFIDENTIAL

STUDY TO DETERMINE

RELATIONSHIP BETWEEN

YEARS OF EMPLOYMENT, AGE, SMOKING HABITS

AND CHEST X-RAY FINDINGS

ZONOLITE/LIBBY EMPLOYEES

cc: H. A. Brown HAB
E. D. Lovick
R. A. Kulberg

EXHIBIT
130.4

Number of employees studies - 135

Number of employees showing lung disease - 45
(For purposes of this study, this includes those definitely showing lung disease as well as the "possible" or "suspected").

Those who now smoke as well as those who have kicked the habit are classified as smokers.

By "years worked" is meant the number of years worked at Zonolite/Libby.

TABLE A

Of the 45 who have lung disease:

24 smoke cigaretts
3 smoke pipe or cigar
15 smoked at one time but not now
3 never smoked

TABLE B

Of the 45 who have lung disease, years worked is as follows:

less than 1 year	0	
1-5 years	11	(or 17% of all employees in this g
6-10 "	6	(or 29%)
11-15 "	9	(or 45%)
16-20 "	7	(or 58%)
21-25 "	11	(or 92%)
26-30 "	1	(or 33%)

TABLE C

Age vs. years worked

AGE	less than 1 year	1-5 years	6-10 yrs.	11-15 yrs.	16-20 yrs	21-25 yrs	26-30 y
less than 20	0	2	0	0	0	0	0
20-25	1	9	1	0	0	0	0
26-30	0	15	3	0	0	0	0
31-35	0	12	3	0	0	0	0
36-40	0	8	2	2	4	0	0
41-45	0	3	4	3	2	1	0
46-50	0	5	4	8	3	2	0
51-55	0	8	1	2	2	3	1
56-60	0	4	3	4	0	6	1
61-65	0	0	0	1	1	0	1
	1	66	21				

02146521

TABLE D

Years Worked	Smokers Showing Lung Disease	Non-Smokers Showing Lung Dis	Smokers Showing Normal Lungs	Non-Smokers Showing Normal Lun
less than 1	0		1	0
1-5	11 25%		44	11
6-10	6 50%		12	3
11-15	9		9	0
16-20	7		4	0
21-25	10		2	0
26-30	1		1	1
44	44 ?	3	73	15
73				
15	42 56%	3 26%	75	15

TABLE E

AGE	Number of Employees Having Lung Disease	Number of Smokers in Each Age Group
less than 20	0	1
20-25	0	8
26-30	2	15
31-35	0	13
36-40	6	13
41-45	2	11
46-50	13	21
51-55	6	16
56-60	12	18
61-65	3	3

SUMMARY

The majority (88%) of employees at Libby smoke or have smoked. Of the 12% non-smoker group, only five have worked in excess of three years. There is no real group for control or comparison purposes. A true correlation between smoking and exposure to dusty work atmosphere, and its effects on the lungs, therefore, cannot be made.

Although 17% of our 1 to 5 years service group have or are suspect of lung disease, there is a marked rise (45%) beginning with the 11th year of service, climbing to 92% in the 21 to 25 years service gorup. This suggests that chances of getting lung disease increase as years of exposure increase.

It is noted that of the 45 employees who have or are suspect of lung disease:

2 have worked only 1 year
2 have worked only 2 years
3 have worked 3 years
3 have worked 4 years

It would be well to take a good look at our pre-employment chest X-Ray program to make sure applicants with lung conditions are not hired.

Peter Kostic

Peter Kostic

PK:jmd

NAME	AGE	YEARS WORKED	SMOKING HABITS	HOW LONG	WHAT NOW	X-RAY STATUS
	25	8 mo.	cigs. 1/2 pack/day	6 years	still does	normal
	62	14	cigs. 1 pack/day	45 years	still does	Fibrosis both lung fields
	36	1	cigs. 1/2 pack/day	7 years	still does	normal
	60	3	cigs. 1 pack/day	40 years	quit 1 yr. ago	pulmonary emphysema & fibrosis
	24	1	none	never	---	normal
	57	24	cigs. 1 pack/day	20 years	quit 17 yrs. ago	fibrosis both lungs
	28	1	cigs. 1/2 pack/day	12 years	still does	normal
	49	19	pipe smoker	15 years	quit 2 yrs. ago	normal
	57	22	cigs. 15/day	2 years	still does	fibrosis, both lungs.
	28	2	none	never	---	normal
	36	4	cigs. 45/day	21 years	still does	possible fibrosis & emphysema
	61	27	cigs. 6/day	25 years	still does	possible emphysema
	52	2	cigs. /?	4 years	still does	normal
	24	1	cigs. 1 pack/day	7 years	still does	normal
	54	3	cigs. 20-30/day	35 years	still does	normal
	52	12	cigs. 1 pack/day	30 years	still does	normal
	48	12	cigars 10/day	19 years	quit 4 yrs. ago	normal
	56	11	cigs. 1 pack/day	25 years	quit 4 yrs. ago	possible very minimal fibrosis
	31	1	cigs. 1/2 pack/day	14 years	still does	normal
	28	3	cigs. 2-1/2 packs/day	10 years	quit 6 mo. ago	normal
	42	21	cigs. 1 pack/day	15 years	still does	fibrosis, both lungs.

021.6522

NAME	AGE	YEARS WORKED	SMOKING HABITS	HOW LONG	WHAT NOW	X-RAY STATUS
	51	1	cigs 1/2 pack/day	20 years	quit 1-1/2 yrs. ago	normal
	36	20	cigs 1/2 pack/day	10 years	quit 6 mo. ago	fibrosis, left lung
	24	2	none	never	---	normal
	48	10	cigs 1 pack/day	30 years	still does	emphysema & fibrosis, lt. lu
	46	2	cigs 1/2 pack/day	30 years	still does	normal
	34	2	cigs 1 pack/day	15 years	still does	normal
	49	11	cigs 1 pack/day	23 years	quit 7 yrs. ago	normal
	54	4	cigs 1 pack/day	20 years	still does	fibrosis, both lungs
	51	23	cigs 1-1/2 packs/day	30 years	quit 6 mo. ago	possible fibrosis, both lungs
	48	1	none	never	---	normal
	42	9	cigs 1 pack/day	7 years	still does	normal
	54	32	cigs 3 packs/day	30 years	quit 8 years ago	normal (office work)
	33	4	cigs 1 pack/day	15 years	still does	normal
	45	11	pipe smoker	20 years	still does	normal
	46	23	cigs 1 pack/day	18 years	quit 10 yrs.ago	questionable fibrosis, both lungs.
	52	3	cigs 25/day	30 years	still does	poss. emphysema and questionable fibrosis
	38	4	cigs 1 pack/day	15 years	still does	normal
	22	3	none	never	---	normal
	41	10	none	never	---	normal
	47	15	cigs 1 pack/day	27 years	still does	fibrosis, both lungs
	45	1	cigs 1-1/2 pack/day	4 years	quit 2 yrs. ago	normal
	41	7	none	never	---	minimal fibrosis, both lungs

0214523

NAME	AGE	YEARS WORKED	SMOKING HABIT	HOW LONG	WHAT NOW	X-RAY STATUS
	42	14	cigs 1 pack/day	25 years	still does	normal
	55	21	cigs 1 pack/day	20 years	quit 5 years ago	fibrosis, both lungs
	31	1	cigs 10-15/day	10 years	still does	normal
	30	1	cigs 1/2 pack/day	5 years	still does	calcification, both lungs
	40	2	none	never	---	normal
	29	9	cigs 1-1/4 packs/day	10 years	still does	minimal fibrosis, rt. lung
	31	2	cigs 1/2 pack/day	2 years	still does	normal
	37	8	cigs 1-1/2 packs/day	15 years	still does	normal
	18	1	none	never	---	normal
	56	14	"never smoked much"	---	quit	questionable minimal fibrosis
	47	13	cigars & pipe	3 years	quit 3 years ago	normal
	28	5	cigs 1 pack/day	2 years	quit 9 yrs. ago	normal
	50	10	smokes cigars	?	still does	possible fibrosis, both lungs
	54	1	none	never	---	normal
	38	19	cigs 1 pack/day	20 years	still does	questionable minor fibrosis, left lung
	38	13	cigs 1 pack/day	12 years	still does	normal
	57	4	cigs 1 pack/day	45 years	still does	normal
	37	19	none	never	---	minimal fibrosis, both lungs
	56	9	---	---	quit 29 yrs. ago	minimal fibrosis, both lungs
	37	9	cigs 15/day	20 years	still does	normal
	48	15	cigs 3/day	35 years	still does	fibrosis, both lungs

0214652

NAME	AGE	YEARS WORKED	SMOKING HABIT	HOW LONG	WHAT NOW	X-RAY STATUS
	31	3	cigs 1 pack/day	12 years	still does	normal
	29	1	cigs 1 pack/day	14 years	still does	normal
	63	18	---	---	quit 8 yrs. ago	fibrosis, both lungs
	42	7	pipe smoker	25 years	still does	normal
	53	25	pipe smoker	10 years	quit 14 years ago	normal
	27	2	cigs 1 pack/day	8 years	quit 2 yrs ago	normal
	19	1	cigs 1 pack/day	5 years	still does	normal
	56	4	pipe smoker	30 years	quit 6 wks. ago	possible early emphysema
	23	2	cigs 1 pack/day	11 years	quit 1 year ago	normal
	47	12	cigs 12/day	30 years	still does	normal
	29	1	cigs	10 years	still does	normal
	52	20	cigs 1 pack/day	35 years	still does	normal
	28	2	cigs 1 pack/day	12 years	still does	normal
	56	25	cigs 1-1/2 packs/day	40 years	still does	normal
	53	2	cigs - "very few"	--	quit 34 yrs. ago	normal
	44	2	cigs 5-6/day	6 mo.	still does	normal
	39	2	cigs 1/3 pack/day	28 years	quit 1 year ago	normal
	32	6	cigs 2 packs/day	10 years	still does	normal
	47	5	cigs 2 packs/day	20 years	still does	minimal fibrosis both lungs
	32	3	cigs 15/day	10 years	still does	normal
	48	21	cigs 1/2 to 1 pack/day	30 years	quit 6 mo. ago	fibrosis both lungs

02146525

NAME	AGE	YEARS WORKED	SMOKING HABITS	HOW LONG	WHAT NOW	X-RAY STATUS
	39	2	was a cig smoker	15 years	quit 7 yrs. ago	possible early emphysema
	54	1	cigs 1 pack/day	30 years	still does	questionable fibrosis and emphysema
	25	2	cigs 15/day	5 years	still does	normal
	30	2	cigs 1-1/2 packs/day	10 years	still does	normal
	49	6	cigs 1 pack/day	15 years	quit 4 mo. ago	normal
	26	1	cigs 1 pack/day	12 years	quit 2 wks. ago	normal
	28	3	cigs 14/day	10 years	still does	normal
	43	11	was pipe & cigar smoker	15 years	quit 8 mo. ago	normal
	40	18	cigs 1 pack/day	20 years	still does	fibrosis, both lungs
	30	10	cigs 15/day	10 years	still does	normal
	?	7	none	never	---	normal
	31	1	cigs 25/day	10 years	quit 5 mo. ago	normal
	49	2	cigars 20 day	35 years	still does	fibrosis & emphysema both lung
	58	25	cigs 6/days	20 years	quit 6 yrs. ago	possible minimal fibrosis both lungs
	50	8	cigs 1 pack/day	25 years	still does	emphysema and minimal fibrosis both lungs
	60	3	cigs 1 pack/day	40 years	still does	emphysema both lungs
	56	23	cigs 1 - 1½ packs/day	25 years	still does	fibrosis left lung possible early emphysema
	34	1	none	never	---	normal
	34	2	cigs 1 pack/day	10 years	still does	normal
	34	10	none	never	---	normal
.ey, Donald A.	60	9	cigs 1 pack/day	15 years	quit 4 mo. ago	normal

021-6526

NAME	AGE	YEARS WORKED	SMOKING HAVITS	HOW LONG	WHAT NOW	X-RAY STATUS
	24	3	cigs 1 pack/day	10 years	still does	normal
	45	7	cigs 10-20/day	2 years	quit 6 years ago	normal
	56	7	cigs 1 pack/day	19 years	quit 28 years ago	normal
	37	13	none	never	---	tumor mass left lung
	36	1	cigs 1 pack/day	20 years	still does	normal
	28	1	cigs 1/2 pack/day	10 years	still does	normal
	49	17	smokes cigs	25 years	still does	fibrosis, both lungs
	35	6	cigs 1 pack/day	15 years	still does	normal
	49	19	cigs 1/2 pack/day	40 years	still does	possible emphysema, both lungs
	42	18	cigs 1 pack/day	30 years	quit 11 years ago	normal
	47	12	cigs 1 pack/day	29 years	quit 1 year ago	fibrosis, both lungs
	31	2	cigs 1 pack/day	13 years	still does	normal
	47	1	cigs 1-1/2 packs/day	15 years	still does	normal
	29	1	cigs 18/day	15 years	still does	normal
	23	4	cigs 15/day	7 years	still does	normal
	32	15	cigs 1 pack/day	3 years	quit 4 years ago	normal
	58	15	"moderate" cigarette smoker	40 years	still does	normal
	38	1	cigs 1-1½ packs/day	10 years	still does	normal
	56	24	cigs 1-1/2 packs/day	40 years	still does	fibrosis, both lungs
	54	14	cigs 5-6, cigars 2/day	36 years	still does	normal
	23	6	cigs 1 pack/day	8 years	still does	normal

02146527

NAME	AGE	YEARS WORKED	SMOKING HABITS	HOW LONG	WHAT NOW	X-RAY STATUS
.	59	26	smoked at one time	?	quit 20 years ago	normal
r.	24	5	cigs 1/2 pack/day	5 years	still does	normal
	52	19	cigs 2-3 /day	?	still does	emphysema and fibrosis both lungs
	56	15	cigs 2 packs/day	43 years	still does	emphysema and fibrosis both lungs
	49	11	cigs 1 pack/day	10 years	quit 2 yrs. ago	fibrosis both lungs
	52	3	cigs 1 pack/day	30 years	still does	normal
	43	3	cigs 1 pack/day	10 years	quit 10 years ago	normal

02146528

02146529

ZONOLITE DIVISION

RECEIVED
DEC 29 1969
CONSTRUCTION PRODUCTS DIVISION

TO H. A. Brown DATE December 23, 1969

FROM E. D. Lovick SUBJECT Radiological Interpretation of X-Rays - Libby Employees

H. A. B.

CC: Peter Kostic

I have received a copy of Larry Parks' letter of December 16 as well as letters from both you and Peter Kostic. I have talked with the radiologist who interprets our X-rays concerning the advisability of having these followed up at six-month intervals rather than twelve-month intervals. He was rather surprised that this would be recommended for he says that he does not believe anything could be accomplished by these being taken at six-month intervals.

The thing that we are looking for in these is such that any change is very gradual as has been pointed out. Even a different in technique can change the apparent results of what the interpretation of the X-rays is. He did state that it is possible for tumors or such that can be rather fast-growing to show up at 6-month intervals, but not the fibrotic conditions which we are concerned with. What Mr. Parks may not realize is that results of these interpretations are also turned over to the employees' personal physician and in the event that their personal doctor feels that further checkups or examinations should be given, arrangements are made for these people to follow up on their own initiative. This year there have been several cases of employees being sent to Spokane for additional examinations. It has always been our contention that this is the way it should be handled.

Peter points out in his letter that we don't know what to do inthe event there is a change any way. I believe that this is correct. My opinion would be that there should be no change in the annual schedule.

Dr. Little stated that it would be possible for him to recommend specifically that some of these people have a follow-up rather than relying on the employee's personal doctor. Even in the event that he did this, it would seem to me that we should still have to leave it up to the employee's personal physician to to see that the follow-up is made at whatever time is recommended if it is to be in less than a year.

Ed

EDLovick/jbg

K 2.1.3

LIBBY 1969 PRIOR

DS BOX 50

From the desk of
H. A. BROWN

To:

02146518

Set-up meeting
with Parke.

"It would be well at this time, with the advice of counsel, to consider applying a warning or precautionary label on all containers of products containing vermiculite

Before any labeling . . . we should indeed study . . . the consequences . . . By warning people or inadequately warning people we may be incurring liability . . .

To: R. W. Sterrett

Date: March 11, 1969

From: Peter Kostic

cc: R. M. Vining
C. F. Dugan
R. A. Kulberg

The following article which appeared in the March issue of Safety Engineering is for your information. I think it would be well at this time, with the advice of counsel, to consider applying a warning or precautionary label or statement on all containers of products containing vermiculite. This may aid our defense in cases of product liability claims. The attached extra copies are for distribution as you wish.

Peter Kostic

PK:vag

One disturbing factor in mesothelioma is the rather indirect exposure a number of its victims had. In some cases studied in London, 31 had worked with asbestos, but *nine merely lived in the household* of an asbestos worker! Eleven people lived within ½ mile of an asbestos factory!

Early in 1968, Dr. Maxwell Borow reported in the "Journal of the American Medical Association" on 17 mesothelioma cases in New

06191709

TO: Peter Kostic

DATE: March 31, 1969

cc: R. W. Sterrett
R. M. Vining
R. A. Kulberg

Re: Labeling of Vermiculite

Reference is made to your memorandum of March 11 concerning the article from Safety Engineering.

Before any labeling of containers of products containing vermiculite is done we should indeed study carefully the content of the labeling and the consequences of putting a label on the package. By warning people or inadequately warning people we may be incurring liability to which we would not otherwise be subject.

I do not believe that vermiculite could be classified today as a poisonous substance for which labeling may be required.

Charles F. Dugan

CFD/MS

EXHIBIT
15
Emergency Notice

CAMBRIDGE

To: R. W. Starrett

Date: March 11, 1969

From: Peter Kostic

cc: R. M. Vining
C. P. Dugan
R. A. Kulberg

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PK:vag

Peter Kostic
Peter Kostic

■ Congressman Edward J. Patten of New Jersey has introduced HR 2503, "a bill to promote the safety of workers engaged in making asbestos products for shipment in commerce, and for other purposes." It is substantially the same as the Asbestos Safety bill he introduced September 14, 1967.

Last year when hearings were conducted on the proposed occupational Health and Safety Act, Dr. Irving J. Selikoff of the Mt. Sinai School of Medicine testified in favor of the bill before the House Select Subcommittee on Labor. He is one of this country's greatest experts on asbestosis, his research covering not only workers in asbestos, but members of their families and persons living near asbestos plants or facilities using asbestos products.

Dr. Selikoff told of studies he had made of some 632 members of two New York-New Jersey Asbestos Workers Union locals. According to medical yardsticks, over a 19-year period, 203 should have died. In fact, 255 did die. Of that number, 37 could have been expected to die of cancer. In fact, 95 died of cancer.

In addition, a disease which was considered so rare it was not separately coded in the International Classification of Causes of Death has been unmistakeably associated with asbestos and the number of cases has increased significantly. This is *mesothelioma*—a highly malignant tumor.

PLAINTIFF'S EXHIBIT
6-55

One disturbing factor in mesothelioma is the rather indirect exposure a number of its victims had. In some cases studied in London, 31 had worked with asbestos, but nine merely lived in the household of an asbestos worker! Eleven people lived within ½ mile of an asbestos factory!

Early in 1968, Dr. Maxwell Borow reported in the "Journal of the American Medical Association" on 17 mesothelioma cases in New Jersey. Fifteen were asbestos workers, two lived near an asbestos factory.

Dr. Selikoff's statement told of other studies in South Africa. There were additional remarks by these doctors regarding the possible exposure of all construction workers and of the bystander who unknowingly breathes in the poisonous dust.

The call of Congressman Patten against asbestosis has not gone unheeded. Johns-Manville, the U.S. Public Health Service, the International Association of Heat & Frost Insulators and Asbestos Workers, and the Mt. Sinai School of Medicine have joined together in an effort to eliminate or at least measurably reduce the exposure of some 200,000 asbestos workers. This will certainly result in greater protection to the entire construction industry and the general public too.

06191709

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cc: R. W. Sterrett
R. M. Vining
R. A. Kulberg

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Charles F. Dugan

Charles F. Dugan

CFD/MS

PLAINTIFF'S EXHIBIT G-55.5

10/23/91 DEPOSITION OF ROBERT JUNKER

P.84

Q. When you got that letter, do you know if you or Mr. Moran ever sent a letter out to the owners of the buildings and schools and hospitals?

A. No, we didn't.

Q. You didn't send a letter out?

A. What would be the reason for that? We would have everybody and his uncle trying to find out if they could sue us. That would be asking for – that would be murder.

* * *

Q. Just so I understand, you didn't send a letter out advising buidling owners about asbetsos health problems –

A. Absolutely not.

Q. – because you thought they would sue you?

A. What?

Q. Because you thought maybe they would sue you?

A. Well, wouldn't you? You would be suing everybody that you know, wouldn't you? You would get every case you could get to sue, and you know you would . . .

* * *

P.97

Q. Mr. Junker, do you remember whether Grace told you to quit giving out vermiculite in the form of a letter, or was that in a telephone call, or what?

A. That, I don't' remember. That, I don't remember for sure. I doubt that it was a letter because don't think that was the kind of thing they wanted to get spread all over the place, but –

Q. Why don't you think that's the kind of thing they want to spread all over the place?

A. Well, it's business.

* * *

Q. Why don't you think this is the kind of letter that Grace wants to spread around?

[OBJECTION]

A. You may be a good lawyer, but you would be a very poor businessman to want to spread detrimental things around about he company you work for, because that's what that would be. You don't tell the world about your shortcomings in the business world if you can help it.

Q. You didn't send a letter out [to the owners of buildings and schools and hospitals]?
A. What would be the reason for that? We would have everybody and his uncle trying to find out if they could sue us.

A. You may be a good lawyer, but you would be a very poor businessman to want to spread detrimental things around about the company you work for . . . You don't tell the world about your shortcomings

EXHIBIT 110 Emergency Notice

NO. 90-1760-H

H. WALLY SHIPLEY and FAYE SHIPLEY; WELDON COOK and BILLYE COOK; VIRGEL LEON ZIMMERMAN and RUTH ZIMMERMAN; HERBERT WILLIAMS and INEZ WILLIAMS; ARTHUR JAMES DAVIS; and J. R. GENTLE	*	IN THE DISTRICT COURT OF DALLAS COUNTY, TEXAS
VS.	*	
ARMSTRONG WORLD INDUSTRIES INC., ET AL.	*	160TH JUDICIAL DISTRICT

- - -

ORAL DEPOSITION

OF

ROBERT JUNKER

- - -

ANSWERS AND DEPOSITION OF ROBERT JUNKER, produced as a witness at the instance of the Plaintiffs, taken in the above-styled and -numbered cause on the 23rd day of October, 1991, at 1:30 p.m., before Sherri B. Garza, a Certified Shorthand Reporter in and for the State of Texas, at the home of Mr. Robert Junker, 10129 Rockmoor Drive, in the City of Dallas, County of Dallas, State of Texas, in accordance with the Notice issued and the agreements hereinafter set forth.

COPY

1 A. No, I don't remember how we did it. Probably
2 sent it to the dump somewhere.
3 Q. When you got that letter, do you know if you
4 or Mr. Moran ever sent a letter out to the owners of the
5 buildings and schools and hospitals?
6 A. No, we didn't.
7 Q. You didn't send a letter out?
8 A. What would be the reason for that? We would
9 have everybody and his uncle trying to find out if they
10 could sue us. That would be asking for -- that would be
11 murder.
12 MS. CLARK: Object.
13 A. And as an attorney, you should know that.
14 MS. CLARK: I object to the
15 responsiveness of the answer.
16 Q. Just so I understand, you didn't send a
17 letter out advising building owners about asbestos health
18 problems --
19 A. Absolutely not.
20 Q. -- because you thought they would sue you?
21 A. What?
22 Q. Because you thought maybe they would sue you?
23 A. Well, wouldn't you? You would be suing
24 everybody that you know, wouldn't you? You would get
25 every case you could get to sue, and you know you would,

1 you personally, if that letter was sent out telling you
2 how asbestos had ruined your building, and you better go
3 to Grace and get all the money you can because that's a
4 big conglomerate, and you better get on the gravy train.
5 I never heard of anybody saying something like that.
6 Nobody in his right mind would write a letter like that,
7 nobody.
8 MS. CLARK: Mr. Junker, what you need
9 to do is respond to his question. I
10 understand you've gotten upset and that this
11 is taking a while. We've been here over two
12 hours now. But I object to the
13 responsiveness of the answer. What you need
14 to do, and we'll be through quicker, if
15 you -- and I don't want you to be upset, but
16 you need to answer his question and -- answer
17 his question, but try to refrain from
18 discussion beyond that.
19 THE WITNESS: Some things I can't
20 refrain from, and that's one of them.
21 MS. CLARK: I understand, but why
22 don't we try to proceed, so we can get this
23 finished.
24 THE WITNESS: Let's get it over with.
25 MS. CLARK: We've gone for two hours

1 now.

2 MS. O'CONNELL: Can I ask, Counsel,

3 how much longer do you think you have?

4 MR. WORTHINGTON: Not much longer.

5 I appreciate your advice.

6 We can get through with this a lot

7 quicker if you just answer the questions and

8 move on.

9 THE WITNESS: You don't take an

10 answer.

11 MS. O'CONNELL: One thing I think

12 would be helpful is if you tried not to

13 repeat your questions. I think he feels he's

14 answered many of the things you're asking,

15 and you're asking him the same thing over

16 again.

17 (Interruption in proceedings.)

18 Q. Mr. Junker, when you got the letter from

19 W. R. Grace advising the company to quit using asbestos,

20 did you and Mr. Moran or anyone else ever talk about

21 whether you should let all the building owners know about

22 that letter?

23 A. No.

24 Q. Did you ever think that perhaps you should

25 write a letter to everyone?

1 A. No. It never entered my mind or his or
2 Grace's, I'm sure.
3 Q. Why did you not want to send out such a
4 letter?
5 MS. CLARK: I object. You've asked
6 this question.
7 A. That's asking for the same thing I said
8 before.
9 Q. I didn't understand your answer. I want to
10 make sure I understand.
11 A. I said every building owner would bring suit.
12 MS. CLARK: Wait a minute, Mr. Junker.
13 I think he said it never entered his
14 mind to send such a letter. They never
15 discussed sending such a letter, and I think
16 that this is, you know, entering into an area
17 that's totally not related to any issue in
18 this lawsuit, so I object, and I think you
19 should move on because we've been here over
20 two hours.
21 THE WITNESS: Don't keep mentioning
22 that. Let's get it over with.
23 MR. WORTHINGTON: Off the record a
24 second.
25 (Discussion off the record.)

1 Q. Mr. Junker, do you remember how you got an
2 inkling, to use your word, that asbestos could cause
3 health problems to workers?
4 A. By reading the articles on it, on asbestosis.
5 Q. Were those in -- what kind of documentation?
6 A. I think one of them was in Reader's Digest.
7 Some of it was in the newspapers, wherever.
8 Q. Did W. R. Grace ever send you a memo about
9 the health problems with asbestos?
10 A. Not until that one.
11 Q. Not until the one that advised you to quit
12 using it altogether?
13 A. Right. I don't think so. I don't remember.
14 Q. When you got that stop-using-asbestos letter
15 from Grace, did you and Mr. Moran ever talk about what the
19
16 economic impact of that would be on your company?
17 A. Oh, I'm sure we did, yeah, yeah.
18 Q. What did y'all talk about, Mr. Junker?
19 A. The loss of profits. The loss of gross
20 profit.
21 Q. You think removing asbestos would result in a
22 loss of profits?
23 A. Yeah.
24 Q. Why is that?
25 A. We wouldn't be selling it. Any time you take

1 a good gross profit product off the line, off the market,
2 and refrain from selling it, you're bound to be -- have
3 less sales. You've got to make it up somewhere, so we
4 went to work on trying to make it up with Monokote and
5 other vermiculite sales and so on and so forth.
6 Q. Once the company stopped putting asbestos in
7 their products, did Grace continue to sell nonasbestos
8 Monokote and Zonolite?
9 A. As far as I know, they did. Texas
10 Vermiculite did.
11 Q. Was the company still profitable with
12 nonasbestos products?
13 A. Yeah. We were making money. That was a good
14 year financially, good -- the economy was up in those
15 years.
16 Q. Do you remember at all what year that was,
17 Mr. Junker?
18 A. No, not specifically.
19 Q. Do you know which decade that was?
20 A. That we stopped using it?
21 Q. Yes.
22 A. Well, no, I don't remember specifically what
23 decade it was either.
24 Q. But the same year that you pulled out the
25 asbestos was a good year to your company?

1 A. Well, it wasn't as bad as we had thought it
2 might be.
3 Q. What kind of substitute or alternative --
4 A. And I think it was late in the year that it
5 happened, too, if I recall.
6 Q. Do you remember what the company used to
7 replace asbestos with in the Zonolite and Monokote
8 products?
9 A. No, except maybe more of the gypsum and
10 bentonite and stuff like that.
11 Q. Were Storbeck & Gregory and your other
12 customers continuing to buy your material after you took
13 the asbestos out?
14 A. Yeah. Those that were doing fireproofing
15 did.
16 Q. Do you know, Mr. Junker, whether a bag of
17 asbestos-containing MK-3 Monokote fireproofing cost more
18 or less than a bag of nonasbestos-containing Monokote
19 fireproofing?
20 A. Oh, it's bound to cost a little more with the
21 asbestos in it because asbestos isn't exactly cheap.
22 Q. Do you know what the price difference would
23 have been?
24 A. No, because I don't know what they make it
25 out of now.

1 Q. Well, back in the year that the company
2 stopped using asbestos in their Monokote, do you remember
3 if the Monokote without the asbestos cost more than ten
4 cents or more than twenty cents than the asbestos bag?
5 A. We got a good price for Monokote, a real good
6 price. Ten cents wasn't that much money in those days for
7 a Monokote bag because it was an expensive product, so I
8 don't know. It could have been a 25 cents difference. I
9 don't really know.
10 Q. You understand that the bag of MK-3 had
11 asbestos in it; is that right?
12 A. I think it did.
13 Q. And the bag of MK-5 did not have raw
14 asbestos, right?
15 A. As I remember, yeah.
16 Q. Do you know if the bag of MK-5 cost more or
17 less than the bag of MK-3 back in the '70s?
18 A. I don't remember. Oh, I doubt that it cost
19 less.
20 Q. The MK-5 cost less?
21 A. No, I doubt that it does.
22 Q. You think it cost more, then?
23 A. Especially nowadays.
24 Q. But back in the '70s, you think it cost more?
25 A. I don't know. I really don't know.

1 Q. It didn't make a big impression on you in
2 terms of the price difference between the asbestos and
3 nonasbestos bag of Monokote?
4 A. You mean selling it or making it?
5 Q. Both.
6 A. Well, every time I made a product, I analyzed
7 the cost to make it and gave it to Mike and told him, this
8 is what we can make it for. And then he, with other
9 people, would decide what we should get for it and make a
10 decent profit, all of us together, and that's the way we
11 worked it. And I just don't remember what we came up with
12 because I don't remember what we put in that we did not
13 put in when there was asbestos, but probably more of those
14 products, those raw materials.
15 Q. Just so I understand, Mr. Junker, you don't
16 remember today whether the bag of MK-5 cost more or less
17 than the bag of MK-3?
18 A. I would say it cost more.
19 Q. Do you remember how much at all the
20 difference was?
21 A. No.
22 MS. CLARK: I object. It's been asked
23 and answered.
24 And you can stand on your answer that
25 you've already given, Mr. Junker, and you

1 don't have to keep trying to answer the same
2 question, if you would like to do that.
3 Because I think it has been asked and
20
4 answered, Mr. Worthington.
5 Q. Do you know if the difference was a nickel or
6 a dime?
7 MS. CLARK: I object. It's been asked
8 and answered.
9 A. I said that before. I don't know. I said it
10 might be a quarter, and it could be even more than that.
11 I don't know. You don't remember those kind of things. I
12 was figuring up the cost on 25, 30, 40 products, and I do
13 not remember what it cost to make this or that or the
14 other thing all the time. I wrote it down, and its
15 analysis and everything, but that's all I did.
16 Q. I just have two more lines of questioning,
17 Mr. Junker, and then we're done. First of all, I want to
18 ask you a few questions about vermiculite. All right?
19 A. All right.
20 Q. Have you ever heard of the word "tremolite"
21 asbestos?
22 A. Is that with asbestos in it -- vermiculite
23 with asbestos?
24 Q. I'm asking you. I'm not going to testify for
25 you.

1 A. I've never heard of the cestolite (phonetic)
2 or whatever.
3 Q. Tremolite?
4 A. Oh, tremolite, no. I have never heard of
5 that. I think one of these girls mentioned it, and I had
6 never heard of it.
7 Q. By "one of these girls," you mean one of
8 these lawyers?
9 A. Yeah.
10 THE WITNESS: Oh, pardon me. You are
11 not girls; you are lawyers.
12 Q. Did you ever understand in the '50s, '60s or
13 '70s, that vermiculite from Libby, Montana had a form of
14 asbestos in the ore?
15 A. Yes. Yes, we did. We knew it. We found out
16 about it from Grace. We used to give it out to people to
17 fill up their yards, raise low spots, but we stopped
18 giving it out. We would not let anybody take it home for
19 that reason.
20 Q. When did you stop giving it out?
21 A. I don't know. I don't remember the year.
22 Q. When you say "give it out," do you mean give
23 it out to just people?
24 A. Yeah, they would pick it up in bags and take
25 it home and fill in low spots.

1 Q. For their houses?
2 A. Yeah, their yards.
3 Q. Why did you no longer give them the
4 vermiculite?
5 A. Because Grace told us that.
6 Q. Told you what?
7 A. That there was a certain amount of asbestos
8 in vermiculite.
9 Q. Did anyone from Grace ever tell you that
10 tremolite asbestos was a definite health hazard at the
11 Libby, Montana plant and also in the expanding plants?
12 A. Not specifically, no.
13 Q. Did they ever tell you that in a general way?
14 A. Well, yeah, they did, by telling us not to
15 give any out.
16 Q. Again, if you don't know, that's fine, but do
17 you remember at all what decade that was, or what year
18 that was?
19 A. I remember what's his name took that out to
20 his house out in Farmers Branch from Chicago.
21 THE WITNESS: You know, Elaine's
22 husband.
23 MRS. JUNKER: Oh, Howard?
24 THE WITNESS: Howard.
25 MRS. JUNKER: That's been 20 years

1 ago, or more than that.
2 THE WITNESS: Not when he took it out
3 to his house.
4 MRS. JUNKER: It's been a long time
5 ago. Good grief, it was a long time ago.
6 A. So it was the '60s. The decade was the '60s.
7 Q. You think it was in the 1960s?
8 A. Yeah.
9 Q. But you're not real sure, are you?
10 A. She's sure.
11 MRS. JUNKER: No, I'm not sure.
12 A. He came down in the middle '50s and built a
13 home.
14 MS. CLARK: Wait. He's given you an
15 answer, and that's his best estimate, and I
16 don't think you can ask him if he's sure or
17 not sure. He said that it's based on his
18 memory, and that's his best estimate, so I
19 think the answer should stand.
20 A. We stopped letting people take it home.
21 MR. WORTHINGTON: Sandra, with all due
22 respect, I don't know if he said the '50s,
23 '60s or '70s. I don't know what he said.
24 MS. CLARK: He said the '60s.
25 MRS. JUNKER: He said he didn't

1 remember.
2 MR. WORTHINGTON: So you say the '60s.
3 She says -- that's why I'm asking these
4 questions, because I don't know the answer.
5 MS. CLARK: No, you said -- well,
6 anyway. I instruct him not to answer. The
7 record can speak for itself. You can go on
8 to a different question.
9 Q. Mr. Junker, do you remember whether Grace
10 told you to quit giving out vermiculite in the form of a
11 letter, or was that in a telephone call, or what?
12 A. That, I don't remember. That, I don't
13 remember for sure. I doubt that it was a letter because I
14 don't think that was the kind of thing they wanted to get
15 spread all over the place, but --
16 Q. Why don't you think that's the kind of thing
17 they want to spread all over the place?
18 A. Well, it's business.
19 MS. CLARK: That's calling for
20 speculation. He can't testify what Grace
21 wanted or didn't want. He's just merely
22 speculating about that, and you are asking
23 him to speculate what someone else or some
24 other group of people may have wanted to do,
25 Roger, and that's an improper question.

001521

GRACE

Construction Products Division

TO: K. T. O'Reilly - Grace/NY DATE: November 1, 1985

FROM: R. C. Walsh

CC: O. M. Favorita

As we discussed yesterday, one way to think about lung cancer risk relating to exposure to vermiculite containing tremolite is to look at the total work population involved in the application of our products.

In my memo to Felix Larkin of September 13, Exhibit IV showed a risk assessment analysis based on a "man years" approach. The analysis showed that one can calculate just over one-tenth of an excess lung cancer case as a result of ten years of application of our products.

Yesterday, I translated the man years approach to a working population approach and came up with some 30,000 people. The following shows the derivation of the number.

(See following page)

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EXHIBIT 17 Emergency Motion

ALL-STATE LEGAL SUPPLY CO

GRACE

Construction Products Division

TO: K. T. O'Reilly - Grace/NY

DATE: November 1, 1985

FROM: R. C. Walsh

CC: O. M. Favorito

As we discussed yesterday, one way to think about lung cancer risk relating to exposure to vermiculite containing tremolite is to look at the total work population involved in the application of our products.

In my memo to Felix Larkin of September 13, Exhibit IV showed a risk assessment analysis based on a "man years" approach. The analysis showed that one can calculate just over one-tenth of an excess lung cancer case as a result of ten years of application of our products.

Yesterday, I translated the man years approach to a working population approach and came up with some 30,000 people. The following shows the derivation of the number.

(See following page)

PLAINTIFF'S EXHIBIT
G-133.6
ALL-STATE LEGAL SUPPLY CO

GRACE

CONSTRUCTION PRODUCTS DIVISION

MAR 11 1976

CONFIDENTIAL

March 11, 1976

What do u mean by "snowballs"?

Copies to: [illegible]

To: H. A. Brown

From: R. H. Locke

Subj: Recent Sampling in Connection with Omaha Citations 4 and 5 (Product and Waste)

1. Sampling Conclusions: Based upon these very few, hurried tests which would be nice to verify between plants and with more job sites,

   A. Both Concrete Aggregate and Monokote are under 2 fibre, probably due to outdoor use with free air circulation. Only Dallas product has been tested, however, and there may be plant to plant variations in addition to the job site variations.

   B./C. Both Attic Fill and Masonry Fill exceed the 2 and 5 fibre levels. This necessitates a binder development program or other remedy.

   D. Horticultural appears to be no problem.

   E./F. Wetting stoner rock appears to put us below the 2 fibre level on waste disposal.

   Other. The above represent over 80% Libby output. Industrial (not tested but 5% of Libby) probably approximates Attic and Concrete Aggregate depending upon ore size, application geometry, and ventilation.

2. Using the Omaha extension to 31 December 1976 for action on items 4 and 5, a Binder Development Program should be initiated immediately. If the program is unsuccessful, uneconomic, requires extensive plant modifications to implement or runs into timing problems, back-up measures will be necessary.

   Such back-up programs might include: Reformulating Attic Fill; Restricting Masonry Fill to S.C. #4 with freight cost penalty in northern markets, or substitution of perlite from expanding plants so equipped; Acceleration of wet mill clean-up potential; Low-vacuum furnace settings; Teflon binding; Air allutriation; and other. Some of the above are unlikely. However, back-up is the point.

   A review of the West Chicago stoner discharge water spray should be possible soon.

   Last, it should be noted the potential exists that OSHA might inspect another plant and a different Regional Office might issue deadlines on product or rock earlier than the extended Omaha deadlines (the [illegible] September 30, 1977 deadline for 2 fibre). In that e[illegible] conceivably be cited as a precedent for uniformity at 31 December 1976 and 30 September 1977.

10042596

"Both Attic Fill and Masonry Fill exceed the 2 and 5 fibre levels. This necessitates a binder development program or other remedy"

EXHIBIT 18 Emergency Notice

DETAIL

1. Sampling.

Sampling of selected products was done during the last two weeks of February. The samples are not representative of all plants and of all uses of Libby products, but several conclusions may be drawn.

A. Concrete Aggregate and Monokote
(Sampling on jobsites with Dallas-made Libby #4 product)

Contractor employees opening bags, operating mixers, and disposing of bags received the highest exposures, but these were below the July 1st 2 fibre tolerance level (highest exposures were 1.0 to 1.5). Monokote gun operators (who routinely wear respirators) may be subject to 1.0 levels. Contractor employees cleaning up dried Monokote may receive levels between 2 and 5 fibres. The fibre concentrations on the roof (all less than 1 fibre) were probably a result of fibres from the ground mixer area.

In summary, it appears that application of Zonolite Insulating Concrete and Monokote do not create fibre exposures over 5 or 2 with two qualifying remarks; that (a) all sampling was out of doors or in wall-less buildings and (b) the Libby #4 product was from the Dallas plant exclusively (Reference: T&A #48871).

B. Attic Fill

Attic Fill, tested twice, in its current form creates fibre counts in excess of the 5 fibre level generally and in excess of the 10 fibre ceiling in some instances. Wetting with water to approximately 2½ quarts per 3 cu.ft. bag reduces fibre counts to approximately the 2 fibre level. Sampling of Attic Fill 18 hours and 18 months after application indicates essentially no airborne residual fibres in the attic area following prior applications of vermiculite (Reference: T&A #48878 and #48880).

C. Masonry Fill (Asphalt Treated)

Masonry Fill (asphalt treated), tested twice, creates fibre counts in excess of the 5 fibre level generally, and in excess of the 10 ceiling level in some instances. Compared with the Insulating Concrete and Monokote samples (also Libby #4), the geometry of filling a hollow wall from above may be the reason for the higher fibre counts. To some degree the expanding plant may also be part of the reason (Dallas D-18; Trenton Model A).

As was the case with Attic Fill, once pouring ceases, the fibre counts rapidly decline to nearly zero. (Reference: T&A #48880 and #48885).

A test will occur week of 15 to 19 March using the Attic Fill experiment above. If the "snowballs" [illegible] wet Attic Fill occur with Masonry Fill, pouring into block cores may be difficult.

10042597

"Attic Fill, tested twice, in its current form creates fibre counts in excess of the 5 fibre level generally and in excess of the 10 fibre ceiling in some instances."

GRACE

CONSTRUCTION PRODUCTS DIVISION

CONFIDENTIAL

MAR 11 1976

CONSTRUCTION PRODUCTS DIVISION
H. A. B.

7

March 11, 1976

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As was the case with Attic Fill, once pouring ceases, the fibre counts rapidly decline to nearly zero. (Reference: T&A #48880 and #48885).

A test will occur week of 15 to 19 March using Masonry Fill wetted like the Attic Fill experiment above. If the "snowballs" experienced with the wet Attic Fill occur with Masonry Fill, pouring into block cores may be difficult.

D. Horticultural tests on consumer use of Ready Earth and Terralite Vermiculite indicate essentially no airborne fibres, or less than 0.1 fibre (Reference: T&A #48890).

E. Dry Stoner Rock in Omaha creates fibre exposures between 2 and 5 fibres for an employee transporting it to the dumpster while he is doing it. His time weighted average may differ. The contractor employee disposing of the waste in the dumpster is exposed to less than 1 fibre (0.6) even though in close proximity at the dump (Reference: T&A #48877).

F. Wet Stoner Rock in W. Chicago; conclusions are hampered both by all West Chicago samples being Engineering type and by inconsistencies in the data versus Omaha. However, it appears the wetted rock may be well below the 2 fibre level for employee exposures (Reference: T&A #48872).

R. H. Locke

RHL/cgr

Federal Register

Wednesday
September 17, 1980

PLAINTIFF'S
EXHIBIT
3010

Part VI

Environmental Protection Agency

Friable Asbestos-Containing Materials in Schools; Proposed Identification and Notification

EXHIBIT
19
Emergency Notice

EXHIBIT
3010(5)

(C) the benefits of such substance or mixture for various uses and the availability of substitutes for such uses, and

(D) the reasonably ascertainable economic consequences of the rule, after consideration of the effect on the national economy, small business, technological innovation, the environment, and public health.

B. Identification and Notification

EPA proposes this Identification and Notification Rule under the authority of section 6(a)(3) of TSCA, which provides that EPA may impose on a chemical substance or mixture that presents an unreasonable risk:

A requirement that such substance or mixture be marked with or accompanied by clear and adequate warnings and instructions with respect to its use, distribution in commerce, or disposal or with respect to any combination of such activities. The form and content of such warning and instructions shall be prescribed by the Administrator.

Thus section 6(a)(3) explicitly authorizes EPA to require school officials to provide warnings to school employees of the location of asbestos and instructions on how to reduce exposures. The section implicitly authorizes EPA to require those officials to inspect for and identify friable asbestos-containing materials in school buildings to determine whether the schools are subject to the warning and instruction requirements.

The interpretation that section 6(a)(3) provides this implicit authority is essential if EPA is to implement the Congressional policy found in section 2 of TSCA that "adequate authority should exist to regulate chemical substances and mixtures which present an unreasonable risk of injury to health or the environment." A warning requirement under 6(a)(3) will reduce risk to the extent that persons exposed to the chemical, once warned, will either avoid using the chemical or take precautions to avoid unnecessary exposure. But a warning requirement will not reduce risks if those to whom the requirement applies are not obligated to determine whether they are actually subject to the requirement.

III. Findings

This section presents the proposed findings which the Administrator must make in order to regulate friable asbestos-containing materials under section 6(a) of TSCA.

A. Findings Required by Section 6(c)

This part presents the statement required by section 6(c) of TSCA.

1. *Health effects of and magnitude of exposure to asbestos.*

a. *Health effects.* This part summarizes EPA'S proposed findings on the health effects of asbestos. A detailed discussion of these findings is in the health effects section of the Technical Support Document.

The adverse health effects of asbestos exposure are serious. The primary evidence for these adverse health effects comes from numerous epidemiologic studies which have shown that inhalation of asbestos by humans increases risks of developing asbestosis, pleural and peritoneal mesothelioma (cancers of the linings of the thoracic and abdominal cavities), and cancers of the lung, larynx, oral cavity, esophagus, stomach, colon, and kidney. The epidemiologic evidence is supplemented by studies showing similar effects among laboratory animals.

The diseases caused by asbestos inhalation are irreversible. Asbestosis is a disease for which there is no effective treatment and which can lead to death. Pleural and peritoneal mesothelioma are virtually always fatal. Treatment of lung cancer is usually unsuccessful. The other types of cancers, amenable to medical treatment to varying degrees, may also lead to premature death.

There is a long induction or latency period for development of diseases resulting from asbestos exposure. Asbestosis and asbestos related cancers may not appear until 15 to 40 years after first exposure.

While exposure to asbestos alone produces a significant increase in the risk of lung cancer, epidemiologic research has shown that the combined effects of cigarette smoking and asbestos exposure produce a marked increase in the risk of lung cancer that is greater than the sum of the increases independently produced by the two agents.

Even after inhalation of asbestos has ceased, individuals continue to be exposed over their lifetimes to asbestos fibers. Not all inhaled fibers will reach or lodge in the lungs. Some fibers will be trapped in the nose before reaching the lungs and will be either swallowed or expectorated; other fibers are cleared after reaching the lungs and, similarly, swallowed or expectorated. Fibers up to 200 microns in length may penetrate to the lung alveoli. Many of these fibers will remain in the lungs for years and some will never be cleared. Fibers which are swallowed may eventually penetrate the gastrointestinal tract and be distributed throughout the body to tissues such as those in the brain and reproductive organs.

The epidemiologic data document injuries to health which have occurred at long and short-term occupational exposures. The epidemiologic studies have for the most part considered asbestos miners and millers, workers in asbestos-processing industries, and asbestos insulation workers. Exposures among these populations were generally long-term and at high airborne concentrations. Occupational exposures as brief as three months, however, have been shown to increase the risk of lung cancer and mesothelioma. One group of asbestos factory workers with less than three months of occupational exposure had a fourfold increase in lung cancer risk. Many of these studies also show a positive dose-response relationship; that is, higher exposures, whether measured in terms of duration or intensity or both, resulted in greater risks of disease.

There are also direct demonstrations of adverse health effects from nonoccupational asbestos exposure. Persons who merely lived in the same household as asbestos workers have developed pleural mesothelioma and signs of asbestosis. Persons living near asbestos mining areas, asbestos products factories, or shipyards have developed pleural mesothelioma.

b. *Magnitude of exposure in schools.* Airborne concentrations of asbestos in school buildings which have friable asbestos-containing materials ar frequently higher than asbestos concentrations in the ambient air. The specific airborne concentration in a given building at a given time depends on such factors as the condition and accessibility of the friable material, the amount of activity, and cleaning methods used in the building.

The prevailing concentration of asbestos (the concentration of asbestos present most of the time in occupied, active areas) in buildings which have exposed friable asbestos-containing materials is estimated to be between 58 nanograms per cubic meter (ng/m^3) and 270 ng/m^3, and may be as high as 500 ng/m^3. For comparison, the airborne concentration of asbestos in urban ambient air is usually below 10 ng/m^3.

"Peak" exposures can occur much in excess of the prevailing concentration of asbestos in buildings. These peaks will occur during damage, repair, renovation, or cleaning, when the friable asbestos-containing material is conducted or settled asbestos fibers are resuspended. Airborne concentrations as high as 17 fibers per cubic centimeter (f/cc) (equivalent to 567,00 ng/m^3) have been measured during removal of a small section of ceiling covered with friable asbestos-containing material, and simple maintenance and cleaning chores can lead to concentrations between 0.2 f/cc and 15 f/cc (6,600 to 500,000 ng/m^3).

The cumulative exposure incurred by someone using a building with friable asbestos-containing materials will be

PLAINTIF EXHIBI 5010(S)

rule on a school for which a specific set of actions is required. If a school contains friable materials, it will incur osts for inspection ($21), sampling $40), analysis ($129 for 3 samples analyzed by PLM), recordkeeping ($25), and notification of employees ($12.50 or $42.50, depending on whether the material contains asbestos. The average total cost for such a school is therefore $227.50 or $257.50.

However, for the majority of the schools the costs will be much less. If a school has no friable material, it need only inspect ($21), record the results of the inspection ($10), and notify its employees ($12.50) for a total average cost of about $43.50. A school which has previously been inspected and which contains no friable materials will incur a cost of only $22.50 for recordkeeping and notification.

b. *Total cost of compliance.* This section contains EPA's estimates of the number of schools which will be affected by each of the rquirements of the rule; the total cost of compliance is summarized in the following table.

This estimate of the total cost of compliance does not account for the financial assistance that the Department of Education will provide to local educational agencies through the Asbestos Hazard Detection Program. Because this program will pay for up to)% of the costs of complying with this egulation, EPA estimates that the actual total economic impact on local educational agencies may be significantly less than estimated here.

Table II.—*Compliance Costs*

Action	Unit cost	Schools affected	Total cost (in thousands)
Inspection	$21.00	44,000	$924
Sampling	25.00	5,600	140
Analysis	129.00	5,600	722
Recordkeeping:			
For schools with friable material	25.00	14,000	350
For schools without friable material	10.00	96,000	960
Notification:			
For schools with asbestos	42.50	10,300	438
For schools without asbestos	12.50	99,700	1,246
Recordkeeping (for school districts and private school organizations)	20.00	19,000	380
Total			5,160

There are approximately 91,000 public and 19,000 private elementary and secondary schools in the country. The 91,000 public schools are organized into about 16,000 school districts.

Many schools have already been spected (and where necessary, have mpled and analyzed) in response to State programs or to EPA's Technical Assistance Program. These schools will not have to repeat inspections, sampling, and analyses in order to comply with this rule. The number of public and private schools which remain to be inspected is approximately 44,000. This estimate may vary because inspections or sampling and analyses have in some cases been incorrectly carried out.

EPA's estimate that 44,000 public and private schools remain to be inspected is based on analysis of information obtained from State asbestos coordinators and from several well-documented State and local government reports. This information comes mainly from eleven States; of the 30,093 public schools in these States, 17,878 have been inspected. 40% of the public schools in these States have not been inspected. Assuming that this percentage is indicative of that of the nation as a whole, 36,400 public schools in the nation remain to be inspected. EPA does not have extensive data on private schools, but estimates that a similar ratio holds for private schools and public ones. Therefore, 40% of the private schools in the country, or 7,600 private schools, are estimated to require inspection.

Thus, a total of 44,000 public and private schools throughout the country will be affected by the inspection requirements. The total cost for compliance with these requirements will be 44,000 × $21 = $924,000.

EPA estimates that 5,600 public and private schools will be affected by the sampling and analysis requirements of the rule. Based on information obtained from its survey of public schools and State and local government reports, EPA estimates that 11,600 public schools have friable materials. Assuming that a similar percentage (12.7%) of private schools have friable materials, EPA calculates that 2,400 private schools (12.7% of 19,000) have such materials. The total number of public and private schools with friable materials is therefore 14,000.

However, 60% of these schools have already been inspected and the materials in them sampled and analyzed. If 40% of all schools have not already been inspected, sampled and analyzed, 5,600 schools still require sampling and analysis of friable materials. The cost of sampling and analyzing the friable materials found in these schools will be 5,600 × ($25 + $129) = $862,400.

All 110,000 public and private schools will be affected by recordkeeping requirements. However, the majority of schools will not contain friable materials and will incur only the lesser recordkeeping costs. EPA estimates that 14,000 schools will find friable materials and will therefore spend $25 each for recordkeeping; the remaining 96,000 do not have friable materials and will require only $10 each for recordkeeping. Thus the total cost for all schools to comply with the recordkeeping requirements of this regulation will be about (14,000 × $25) + (96,000 × $10) = $1,310,000.

Similarly, all schools will be affected by the requirement that employees be notified of the presence or absence of asbestos in their buildings, but the majority will incur only the lesser notification costs. EPA estimates that 100,000 schools will be found not to have asbestos-containing materials and will therefore need to spend only $12.50 each to notify their employees. The other 10,000 schools which do have asbestos-containing materials will incur costs of $42.50 each, making the total cost for all 110,000 public and private schools to notify their employees (10,000 × $42.50) + (100,000 × $12.50 = $1,684,000.

All 16,000 public school districts and about 3,000 private school organizations must also compile a record. The cost of preparing and maintaining 19,000 records is estimated to be $380,000.

5. Other EPA Statutes

Section 6(c) of TSCA also requires that if the Administrator determines that a risk of injury to health or the environment could be eliminated or reduced to a sufficient extent by actions taken under another Federal law administered by EPA, the Agency may not promulgate a rule under section 6(a) of TSCA to protect against the risk unless the Administrator finds it is in the public interest to use TSCA. EPA has found no other Agency administered statute that will enable it to eliminate or reduce the risks against which this rule protects.

B. Findings Required by Section 6(a)—(1) Unreasonable Risk

On the basis of the foregoing factual information and on the information in the rulemaking record, EPA has concluded that the presence of unidentified friable asbestos-containing materials in schools and the absence of notice of their presence and of instructions on reducing exposure constitute an unreasonable risk of injury to school children and school employees.

The presence of unidentified friable asbestos-containing materials in school buildings increases significantly the likelihood that peak exposures to asbestos will occur. Since peak exposures to asbestos in schools entail

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EXHIBIT

risks of serious injuries which may be reduced at extremely low costs. EPA finds that these exposures present an unreasonable risk and should be reduced accordingly.

Peaks will occur during distrubances of the friable material (either accidental or during repair or renovation operations) and during resuspension of previously released fibers by cleaning and maintenance operations (sweeping, dusting, vacuuming, etc.), or by general activities in the vicinity of fibers that have settled on floors and other surfaces.

The 10,300 schools which EPA estimates contain friable asbestos-containing material employ over twenty thousand custodians and other maintenance personnel. These custodians will sweep in areas containing friable asbestos. They will clean and dust in these areas; they will change lights in ceilings covered with friable asbestos-containing materials; they will undertake minor repairs and renovations. Without knowing that these areas contain asbestos, these custodians will undertake normal maintenance activities with no protection against unnecessary exposures, and they will risk serious injuries as a result.

Moreover, all of these activities which cause peak exposures further contaminate the building and increase the prevailing concentrations. Sweeping, dusting, and cleaning suspend previously released fibers and disperse them throughout the building. Minor repairs and distrubances to the friable asbestos-containing materials release additional fibers. Both types of activities will increase prevalent concentrations which, in turn, will increase the risk to the larger population of children, teachers, and school administrators who occupy the buildings.

Estimates based on the linear dose-response model and the numerous documented case histories of serious injuries resulting from brief short-term exposure provide ample evidence that these peak exposures that are occurring in schools present risks of serious injuries.

EPA finds that the requirements of this proposed regulation will reduce these risks. EPA believes that school officials and maintenance personnel, once informed of the risks of asbestos and of interim measures to avoid the risks, will act in their own best interests and the interests of school children to reduce the peak exposures as much as possible. If friable asbestos-containing materials in schools are identified, custodians will be able to avoid them during renovation projects and minimize the disruptions of them during routine maintenance. If the custodians are provided with information on the use of wetting agents and on proper work practices when conducting necessary repairs and renovations, they will be able to reduce fiber release during such operations and reduce risks to themselves and to others. Instructions on proper cleaning activities in contaminated areas, including wet mopping and wet dusting, will reduce risks caused by unnecessary resuspension of asbestos fibers that would otherwise occur.

Finally, once local school officials know of the presence of friable asbestos-containing materials in buildings, they can take steps to ensure that occupants of the building avoid areas which contain the materials or avoid activities which unnecessarily disturb the materials.

Thus, by identifying the friable asbestos-containing materials in school buildings and by implementing specific interim control procedures for reducing exposures, local school officials will reduce the risks of injury resulting from such exposures to school children, custodians, and other building occupants.

In addition to reducing peak exposures, the requirements of the regulation will reduce the prevalent level of fiber concentrations in schools by reducing the number of fibers contributed to this level by repeated distrubances and resuspension. However, EPA does not regard this reduction in prevalent exposures as sufficient to protect the health of children and other building occupants over the long term. Identifying friable asbestos-containing materials in school buildings is the first step in an overall two-stage asbestos abatement program for schools. EPA intends to proceed with the part of the program, which will provide for certain abatement actions, in late 1980. This first regulation will enable school officials to complete the necessary initial steps in the program in preparation for this abatement rule and will, in the interim, reduce certain risks that would otherwise occur.

As reviewed above, the economic impacts of the rule will be small. This regulation will impose costs upon all schools, but to varying degrees, as explained in the "Economic Effects" section above. In some instances, costs to individual schools may reach several hundred dollars. These costs are not unreasonable in view of the reduction in exposure to asbestos that will result from this rule. The identification of asbestos in schools, furthermore, is a prerequisite to making the ultimate abatement determinations and will, therefore, contribute to the reduction in risk that will result from abatement.

C. Analysis Under Section 9 of TSCA

Section 9(a) of TSCA requires EPA to review other Federal authorities to determine whether action under those authorities may prevent or sufficiently reduce unreasonable risks. EPA has reviewed other Federal authorities and finds that action under those authorities will not sufficiently reduce the risks addressed by this rule. Specifically, EPA has considered the regulatory authority of the Consumer Product Safety Commission (CPSC), the Occupational Safety and Health Administration (OSHA), and the Department of Education (ED).

Friable asbestos-containing materials in schools may be "consumer products" within the meaning of section 3 of the Consumer Product Safety Act (CPSA), 15 U.S.C. 2051. Section 12 and 15 of the CPSA provide authority under which the Commission might require asbestos inspection, identification or marking requirements.[8] Neither section is sufficient to prevent or reduce the risk of asbestos-containing materials in schools primarily because implementation of the section cannot be undertaken without identification of the specific manufacturers, distributors or retailers of the asbestos products for which regulation is sought. Section 12, 15 U.S.C. 2061, authorizes the Commission to file, in a United States District Court, an action against identified manufacturers, distributors, or retailers of an "imminently hazardous consumer product" for such relief as may be necessary to protect the public against the hazard.

Similarly, section 15 of the CPSA, 15 U.S.C. 2064, authorizes the Commission to order identified manufacturers, distributors or retailers of any product that presents a "substantial product hazard" to provide notice of the hazard to the general public or to persons to whom the manufacturer, distributor or retailer knows the product was delivered or sold.[9] Friable asbestos-containing materials were installed in over 10,000 schools between 1954 and 1973. It would be prohibitively difficult to determine which companies installed, sold, or purchased those asbestos materials. Often there are no installation

[8] Section 8 of the CPSA, 15 U.S.C. 2057, authorizes the Commission to issue rules to ban hazardous consumer products. Rules under Section 8, however, may only apply to consumer products manufactured after the effective date of the rule. In this rule EPA is concerned with existing asbestos products.

[9] In analyzing sections 12 and 15 of the CPSA, the EPA assumes that asbestos in schools meets the tests of either "imminently hazardous consumer product" or substantial product hazard."

United States
Environmental Protection
Agency

Office of Health and
Environmental Assessment
Washington, DC 20460

EPA/600/8-84/003F
June 1986

Research and Development

EPA

Airborne Asbestos Health Assessment Update

EXHIBIT
20
Emergency Notice

EPA/600/8-84/003F
June 1986

Airborne Asbestos Health Assessment Update

Environmental Criteria and Assessment Office
Office of Health and Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

TABLE 3-23. SUMMARY OF AVERAGE ASBESTOS AIR CONCENTRATION DURING INSULATION WORK[a] (Selikoff et al., 1979)

Research group	Average fiber concentration, f/ml: Light and heavy construction	Marine work
Nicholson (1975)	6.3	
Cooper and Balzer (1973)	2.7	6.6
Ferris et al. (1971)		2.9
Harries (1971)		8.9
Average concentrations of all visible fibers counted with a konimeter and bright-field microscope.		
Murphy et al. (1971)		8.0
Fleischer et al. (1946)		30-40
Estimates of past exposure based on current membrane-filter data.		
Nicholson (1976a)	10-15	

[a]Average concentrations of fibers longer than 5 μm evaluated by membrane filter techniques and phase-contrast microscopy.

Source: Nicholson (1976a).

different laboratories in the United States found that the average fiber concentration of asbestos dust in insulation work, between 1968 and 1971, ranged from about 3 to 6 f/ml. A similar study in the Devonport Naval Dockyard in Great Britain, with the same techniques, obtained 8.9 f/ml for the average of long-term sampling of asbestos concentrations measured during application of insulating materials aboard ship (Harries, 1971). In the research that led to these data, it was reported that peak exposures could be extremely high. It was not uncommon, for example, to get 2- to 5-minute concentrations of asbestos exceeding 100 f/ml during the mixing of cement. This mixing, however, would only be done perhaps once an hour, so that exposures measured during that hour, including the mixing, would seldom average more than 10 f/ml. Similar experiences were subsequently reported by Cooper and Miedema (1973), who stated, "Peak concentrations may be high for brief periods, while time-weighted averages are often deceptively low."

United States
Environmental Protection
Agency

Office of Pesticide
and Toxic Substances
Washington, DC 20460

March 1983

Toxic Substances

EPA

Guidance for Controlling Friable Asbestos-Containing Materials in Buildings

PLAINTIFF'S EXHIBIT 804

EXHIBIT 21
Emergency Notice

EPA Report Number 560/5-83-002
March 1983

GUIDANCE FOR CONTROLLING FRIABLE ASBESTOS-CONTAINING MATERIALS IN BUILDINGS

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

CHAPTER 1 — EXPOSURE TO ASBESTOS INSIDE BUILDINGS

The Environmental Protection Agency (EPA) has been concerned with the disease-causing potential of nonindustrial exposure to asbestos since the early 1970s. The concern derives from epidemiologic evidence linking airborne asbestos exposures by asbestos workers to various types of cancer and nonmalignant respiratory diseases, and from recognition that large quantities of asbestos have been found in building materials, insulation, and other products used in schools and other buildings. This chapter (1) summarizes information on the relationship between health effects and exposure to airborne asbestos; (2) describes federal regulations affecting asbestos emissions, the use of asbestos materials, and worker exposure levels; and (3) compares levels of airborne asbestos in buildings with those in asbestos workplace settings and outdoors. The purpose of the chapter is to place in perspective asbestos exposure levels and health risks likely to be experienced by occupants of buildings with asbestos-containing materials. The basic exposure-risk issues are summarized below.

Safe Level of Exposure: EPA and the scientific community believe that any level of exposure to asbestos involves some health risk, although the exact degree of risk cannot be reliably estimated. The risk of cancer is of greater concern at low exposure levels than the risk of asbestosis.

Special Concerns: Children and young adults who are exposed to asbestos have a greater chance than older people of developing certain asbestos-related diseases due to a longer remaining lifespan during which disease may develop. Also, smokers exposed to asbestos are at greater risk than nonsmokers with a similar level of exposure.

Federal Regulations Affecting Asbestos in Buildings: Current regulations restrict the use of asbestos in new buildings, specify work practices during removal of asbestos-containing materials from existing buildings, and require the identification of asbestos in schools. No exposure standards have been set for nonindustrial settings, and no regulations mandate corrective actions in buildings where asbestos-containing materials are found.

Relative Exposure Levels in Buildings: Prevalent levels of airborne asbestos inside buildings where asbestos-containing materials are present may exceed outdoor levels by a factor of 100. However, these indoor levels are lower by a factor of at least 1,000 than historic asbestos workplace levels where the occurrence of asbestos-related disease is well documented. When asbestos-containing materials are damaged, peak levels inside buildings may approach historic workplace levels.

Need for Action: The level of airborne asbestos in buildings with asbestos-containing materials represents a potential for exposure and risk of asbestos-related disease that cannot be ignored. The decision whether or not to take action and the selection among different courses of action are responsibilities of individual building owners.

1.1 Health Effects Related to Asbestos Exposure

Exposure to high levels of airborne asbestos is associated with a debilitating lung disease called asbestosis; a rare cancer of the chest and abdominal lining called mesothelioma; and cancers of the lung, esophagus, stomach, colon, and other organs. The relationship between exposure level and health risk is complex. The best available data on asbestos worker exposure indicate that the risks of asbestosis, lung cancer, and mesothelioma decrease in direct proportion to a decrease in total asbestos exposure (the average airborne asbestos

EXHIBIT 22 IS WITHDRAWN

Report to the
U.S. Consumer Product Safety Commission
by the

CHRONIC HAZARD ADVISORY PANEL ON ASBESTOS

JULY 1983

U.S. Consumer Product Safety Commission
Directorate for Health Sciences
Washington, D.C. 20207

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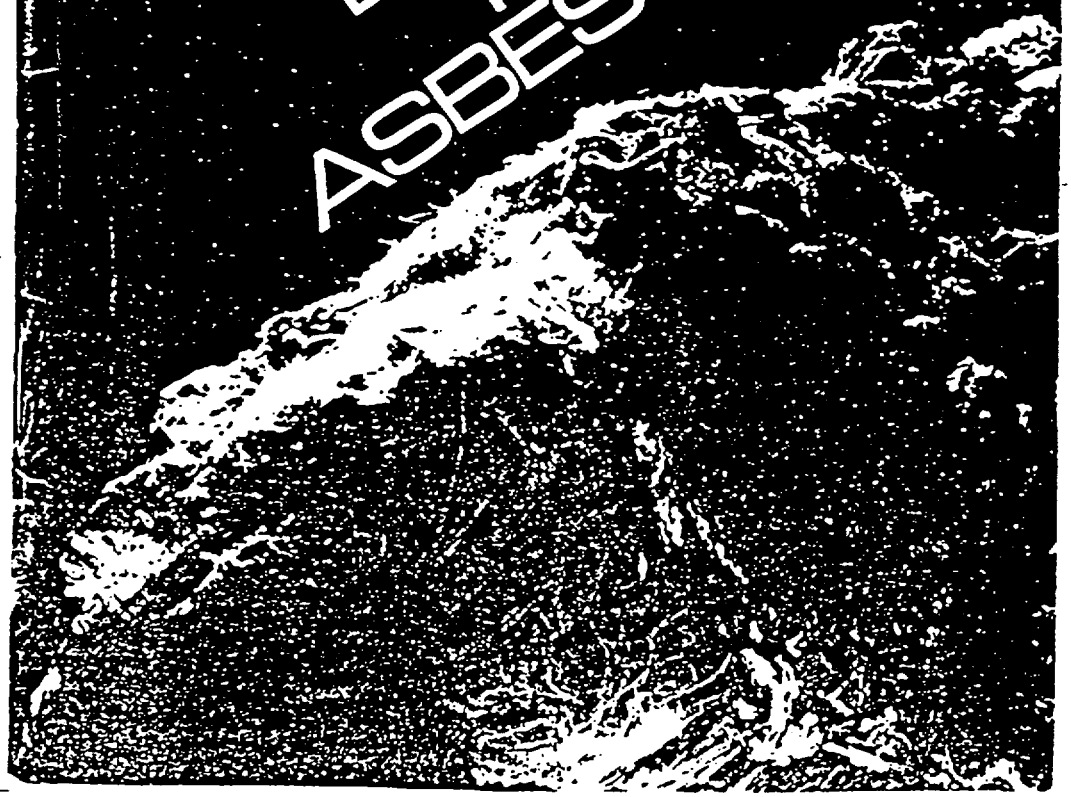
6. GENERAL CONCLUSION

Asbestos of many fiber types and fiber sizes is clearly linked to the production of cancer, with risk increasing as the amount of asbestos exposure increases; there is no evidence to support the existence of a dose below which there is no effect (threshold). Predictions of risk using responses observed at high exposure levels with varying fiber types to estimate responses to exposure at low levels or with shorter fibers are uncertain. From a public health standpoint, and in the absence of final clarification of the uncertainties, it is prudent to behave as if asbestos fibers may be carcinogenic at low exposure levels and at small particle sizes. However, the estimates of risk at low exposure levels, although uncertain, serve as important guidelines to the magnitude of the potential risk and, as such, are useful in the risk assessment process.

NIOSH

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

WORKPLACE EXPOSURE TO ASBESTOS



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WORKPLACE EXPOSURE TO ASBESTOS
Review and Recommendations

DHHS (NIOSH) Publication No. 81-103

NIOSH-OSHA
Asbestos Work Group
April 1980

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

November 1980

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

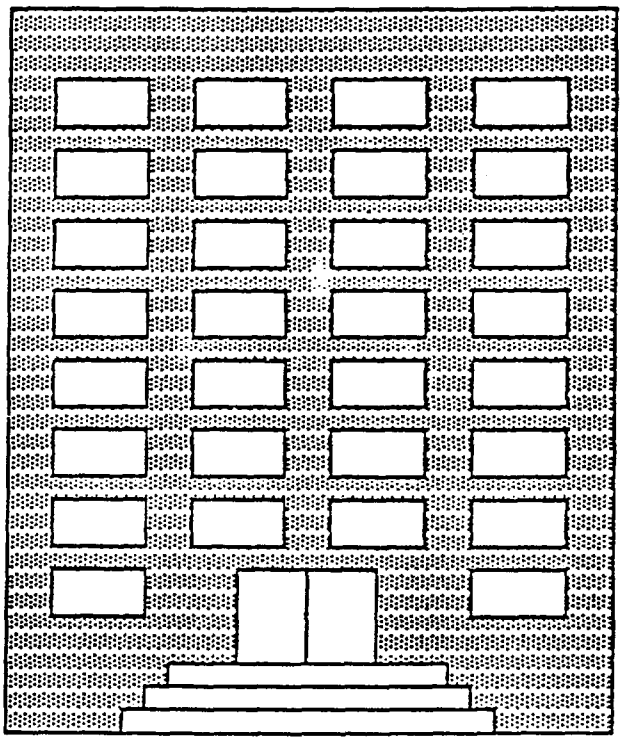
Available data show that the lower the exposure, the lower the risk of developing asbestosis and cancer. Excessive cancer risks, however, have been demonstrated at all fiber concentrations studied to date. Evaluation of all available human data provides no evidence for a threshold or for a "safe" level of asbestos exposure. Accordingly, the committee recommends that, to the extent uses of asbestos cannot be eliminated or less toxic materials substituted for asbestos, worker exposures to asbestos must be controlled to the maximum extent possible.

4. Inadequacy of Current 2,000,000-Fiber Occupational Standard. The committee concluded that a variety of factors demonstrates that the current 2,000,000-fiber standard is grossly inadequate to protect American workers from asbestos-related disease. First, the 2,000,000-fiber standard was designed in 1969 by the British Occupational Hygiene Society (BOHS) for the limited purpose of minimizing asbestosis. Disease prevalence data from the BOHS study population collected subsequent to 1969 strongly suggest that this standard is insufficient to prevent a large incidence of asbestosis. Second, all levels of asbestos exposure studied to date have demonstrated asbestos-related disease, and a linear relationship appears to best describe the shape of the dose-response curve. These considerations led the committee to conclude that there is no level of exposure below which clinical effects do not occur. Third, the absence of a threshold is further indicated by the dramatic evidence of asbestos-related disease in members of asbestos-worker households and in persons living near asbestos-contaminated areas. These household and community contacts involved low level and/or intermittent casual exposure to asbestos. Studies of duration of exposure suggest that even at very short exposure periods (1 day to 3 months) significant disease can occur.

Although various models can be and have been fashioned to postulate possible dose-response relationships involving asbestos, the committee believes that the limited current data preclude the creation of any one empirical curve to describe *the exact* dose-response relationship. Over the last three decades, measurement techniques for asbestos have changed in several crucial respects, and there have been no suitable methods available to date to compare the results of prior techniques to current methods.

EPA STUDY OF ASBESTOS-CONTAINING MATERIALS IN PUBLIC BUILDINGS

A Report To Congress



U.S. Environmental Protection Agency
Washington, D.C.
February, 1988

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found in persons living in the households of asbestos workers (Selikoff et al., 1982) or living near asbestos mining areas, asbestos product factories, or shipyards where there was heavy use of asbestos (USEPA, 1980; NRC, 1984). As is typically done for other carcinogens, health effects associated with low level nonoccupational exposure to airborne asbestos fibers in public and commercial buildings have been inferred by extrapolating data from laboratory and occupational studies (USEPA, 1986). However, as with many other environmental pollutants, the validity of extrapolating from high level exposure to low level exposure has never been demonstrated empirically.

Summary

Asbestos is known to be extremely hazardous, based upon studies of both laboratory animals and asbestos workers and their families. Several life-threatening diseases, such as lung cancer and mesothelioma, can be caused by exposure to airborne asbestos. No safe threshold has been established for asbestos. Effects at low levels of nonoccupational exposure have been estimated by extrapolation from higher levels although the validity of this approach has not been empirically demonstrated.

United States
Environmental Protection
Agency

Office of
Toxic Substances
Washington, D.C. 20460

C00090
March 1979

Toxic Substances

EPA

Asbestos Containing Materials in School Buildings:

Part 1

A Guidance Document

EXHIBIT
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Emergency Notice

Asbestos-Containing Materials in School Buildings:

A Guidance Document

Part 1

March 16, 1979

Dear School Officials:

Until recently exposure to asbestos was generally considered an occupational health hazard for asbestos workers. However, now we have learned of an equally serious exposure problem that can occur in all types of buildings in which certain asbestos-containing materials have been used for fireproofing, insulation, and decoration. Asbestos can be released from these materia and contaminate the building environment. Individuals w are then exposed to the asbestos could develop lung canc or cancers of other parts of the body. Unfortunately, detection of asbestos-related diseases is difficult sinc the latency period between exposure and appearance of th disease is sometimes as many as 20 to 40 years.

Since these materials are found in school buildings, we EPA are particularly concerned with the exposure of scho children. EPA has worked with the States to develop a program that responds to the need for accurate informati and guidance to deal with this difficult problem. The enclosed manuals are a major part of this program and ar being mailed to all public school districts. They were prepared to inform you of the health hazards associated with asbestos and outline the steps you and the schools your district can take to identify asbestos-containing materials and to protect students and school personnel from exposure.

Also participating in this EPA program are the Department of Health, Education, and Welfare, the Occupational Safet and Health Administration, and the Consumer Product Safet Commission. Through the Regional Offices located in majc cities across the country, EPA and these Agencies will provide assistance for the difficulties that you may encounter in undertaking a control program in your schools. We are operating several toll-free numbers that you can call to ask for information and assistance. A videotape that was prepared to supplement this manual wil also be available for your use.

A survey form is included in this manual. The form asks questions on the results of the control programs you conduct in your schools. Your participation in this part of the EPA program would be appreciated. By completing the form you will assist us in assessing the extent of th asbestos-containing material problem in the United States

I encourage you and your staff to review the enclosed manuals and inform the schools in your district of the EP program. A successful nationwide school asbestos program depends on your efforts and those of school officials across the country. We look forward to working with you in the important weeks and months ahead.

Sincerely,

Steven D. Jellinek
Assistant Administrator
for Toxic Substances

Chapter 1: Introduction: The Concern

Exposure to asbestos was initially associated with a chronic and debilitating lung disease called asbestosis. More recently exposure to asbestos has been associated with lung cancer, a rare cancer of the chest and abdominal lining called mesothelioma, and cancers of the esophagus, stomach, colon, and other organs. Asbestos also acts as a potent cancer-causing agent in combination with cigarette smoking. In all asbestos-related diseases there is a latency or induction period of many years between initial exposure and appearance of the disease.

In most cases asbestosis has followed long exposure to high levels of asbestos fibers. Therefore, asbestosis is not as significant a concern in schools as cancer risk. The potential for increasing cancer risk may exist at much lower and shorter exposures than those for asbestosis.

Under certain conditions, exposure to fibers released from asbestos-containing materials in buildings can reach levels considered potentially hazardous. Some asbestos levels measured in school buildings have even been shown to briefly exceed the current Federal workplace exposure level standards.

Why is there so much concern now?

EPA is concerned in view of the increasing knowledge of the potential of asbestos as a cancer-inducing agent at low-level exposures and the asbestos contamination that has been found in some schools. Another very important concern is that cigarette smoking can enhance the disease potential of asbestos exposure.

Is there a safe level of exposure?

EPA and the scientific community believe that any exposure to asbestos involves some health risk. No safe level of exposure (or threshold exposure level) has been established. Further, it is impossible at this time to confidently estimate the exact degree of risk associated with low-level exposures.

What is considered the best or safest approach to asbestos exposure?

Where possible all exposure to asbestos should be eliminated or controlled.

Are there special concerns about asbestos in schools?

The school children population differs from other non-occupational populations in age, population density, and behavior.

The exposure of children and adolescents to asbestos in the school building occurs early in their life span. Their remaining life expectancy provides a long development period for asbestos-related diseases.

A large number of students can be exposed at one time to asbestos that is released from asbestos-containing materials present in the school building. The duration of exposure is of concern since school children attend school daily for most of the year.

The school population is very active. Certain asbestos-containing materials can be damaged during school activities and as a result of the capricious behavior of students. When the material is damaged, asbestos fibers are released and exposure can occur. Many cases of badly damaged asbestos-containing materials have been found in schools.

Are there any Federal laws or regulations that protect school children from asbestos exposure in school buildings?

There are currently no Federal laws or regulations that protect children in school buildings where asbestos-containing materials are already present.

Is a medical examination necessary for persons exposed to asbestos in school buildings?

Medical examinations are not recommended in school exposure situations. It is difficult to detect asbestos-related diseases in children due to the long induction period before the disease appears. Individuals who have been exposed to asbestos should avoid smoking; and, of course, medical advice should be obtained for any specific concerns or symptoms.

Federal Register

Wednesday
August 10, 1994

Part II

Department of Labor

Occupational Safety and Health Administration

29 CFR Parts 1910, et al.
Occupational Exposure to Asbestos; Final Rule

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8-10-94
Vol. 59 No. 153

federal register

Wednesday
August 10, 1994

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Modification

Alternatives or modifications to listed control methods are allowed when the employer demonstrates that such a "modification" still provides equivalent worker protection. OSHA does not intend that changes in a control method which decrease the safety margin of a material or omitting a procedure be permitted by calling it a "modification." A "modification" means a changed or altered procedure, material which replaces a procedure, material or component of a required system. For example, a new test proven successful in detecting leaks might be substituted for required "smoke tests." Omission of a procedure or component, or a reduction in the stringency or strength of a material or component is not considered a "modification" under this section.

Presumed Asbestos-Containing Material (PACM)

In all three standards, "presumed asbestos containing material," "PACM" means thermal system insulation and sprayed on and/or troweled or otherwise applied surfacing material in buildings constructed no later than 1980. OSHA has found that these materials are "high risk" if asbestos-containing. OSHA bases this on the record, including the HEI Report which states that "thermal system insulation and surface treatments (fireproofing, acoustical and decorative finishes) stand out in importance for their potential for fiber release and subsequent exposure to [building] occupants" (Ex. 1–344, p. 4–5). Although these materials may have been installed in small quantities after 1980, OSHA finds that their installation is unlikely after that date.

Project Designer

OSHA has adopted a definition like that of EPA for a "Project Designer"—a person who has successfully completed the training requirements for an abatement project designer established by 40 USC 763.90(g).

Removal

"Removal" means all operations where ACM and/or PACM is removed from a building component, regardless of the reason for the removal. It includes those maintenance, repair, renovation and demolition activities where ACM and/or PACM removal is incidental to the primary reason for the project, as well as where removal of ACM and/or PACM is the primary reason for the project. Removal should be distinguished from "disturbance" which includes "cutting away" a small amount of ACM or PACM.

Regulated Area

"Regulated area" is included in all three standards. All three, like the 1986 standards, require the establishment of such an area where the employer believes that the PEL will be exceeded. Now, the construction and shipyard employment standards add that such area must be established also where Class I, II and III activities will take place, regardless of exposure levels. Also, the specific actions required of the employer to demarcate a regulated area are deleted from the definition, and are placed in the appropriate prescriptive paragraph, in this case paragraph (e)(6).

(3) Permissible Exposure Limits

Paragraph (c) General Industry, Construction and Shipyard Standards.

In all three standards, the eight hour time-weighted average permissible exposure limit is changed from an eight hour time weighted average (TWA) of 0.2 f/cc to a TWA of 0.1 f/cc in the revised final rules. As noted in the 1990 proposal and in the preamble discussion above, OSHA's decision to reduce the PEL across the board responds to the Court's directive to consider whether to establish operation-specific exposure limits, since the Court noted that on the record of the 1986 standards, it appeared feasible to reduce the PEL to 0.1 f/cc limit in many industry sectors. OSHA has rejected "operation-specific" PELs for the wide variety of operations that expose employees to asbestos. OSHA proposed and these final standards adopt required operation-specific work practices, in addition to an across-the-board PEL reduction to 0.1 f/cc. OSHA expects that the risk reduction accomplished by this two-pronged approach will be at least as great as would operation-specific PELs. First, the required controls are found to be capable of achieving maximum exposure reduction on an operation-by-operation basis. Second, since OSHA has found that specific work practices are feasible, the Agency expects a higher compliance rate and thus, greater risk reduction than if practices were not specified. Third, in operations where particular controls are specified, the PEL is a backstop; alerting employers where additional controls are needed or closer surveillance is required; in all operations the PEL is a measurable and comparable value, which cannot be exceeded without further action by the employer to reduce exposures.

At the time of the proposal in 1990, the question of whether the proposed PEL reduction would reduce a still significant risk had already been given a tentative answer by the Court. The D.C. Circuit Court of Appeals, in remanding the issue of lowering the PEL to the Agency, noted that based on the 1984 risk assessment, the excess risk stemming from average exposures of 0.1 f/cc "could well be found significant." BCTD v. Brock, 838 F.2nd at 1266." (55 FR at 29714).

In the proposal, OSHA stated that it believes "that compliance with proposed amendments to reduce the PEL to 0.1 f/cc as a time-weighted average measured over 8 hours would further reduce a significant health risk which exists after imposing a 0.2 f/cc PEL" (55 FR 29714, July 20, 1990). OSHA's 1984 risk assessment showed that lowering the TWA PEL from 2 f/cc to 0.2 f/cc reduced the asbestos cancer mortality risk from lifetime exposure from 64 to 6.7 deaths per 1,000 workers. OSHA estimated that the incidence of asbestosis would be 5 cases per 1,000 workers exposed for a working lifetime under the TWA PEL of 0.2 f/cc. Counterpart risk figures for 20 years of exposure are excess cancer risks of 4.5 per 1,000 workers and an estimated asbestosis incidence of 2 cases per 1,000 workers.

OSHA's risk assessment also showed that reducing exposure to 0.1 f/cc would further reduce, but not eliminate, significant risk. The excess cancer risk at that level would be reduced to a lifetime risk of 3.4 per 1,000 workers and a 20 year exposure risk of 2.3 per 1,000 workers. Consequently significant risk would be reduced substantially. However, OSHA concluded therefore that continued exposure to asbestos at the TWA permitted level and action level would still present residual risks to employees which are significant.

The Court did not ask and OSHA did not undertake to review its earlier risk assessment in the proposal. At the hearing in January, 1991, Mr. Martonik, spokesperson for OSHA was asked by Mr. Hardy, representing the Safe Building Alliance (SBA), if OSHA was planning to update the earlier risk assessment as part of this proceeding. Mr. Hardy stated that "a number of parties have suggested to OSHA that its risk assessment from 1984, as relied on in the 1986 final rule, is outdated" (Tr. 30). Mr. Martonik responded that "we will have to consider all information we receive and determine relevance in this rulemaking after the record is closed." (Ibid).

Other parties questioned OSHA's continuing reliance on the 1984 risk assessment. The Asbestos Information Association (AIANA) testified that "OSHA's 1984 risk assessment fails to take into account the scientific community's consensus that chrysotile

REQUEST FOR TECHNICAL SERVICE

CONFIDENTIAL

NUMBER: 67567 762701
GROUP: ZONOLITE
ACTUAL COST: $220.00
REPORTING DATE: July 11, 1976

EX 183.183

SUMMARY:

Ten samples were received from Weedsport, New York, and evaluated by standard methods. All tem samples exceeded 4.5 fibers per cc of air.

"All ten samples exceeded 4.5 fibers per cc of air."

"SIMULATED ATTIC FILL TESTS"

CONSTRUCTION PRODUCTS DIVISION

PAGE 1

REQUEST FOR TECHNICAL SERVICE

NUMBER: 67567
GROUP: Zonolite 762700
DATE: 7/11/77
CHARGE NO.: 71-046
REQUESTOR: F.W. Eaton
MARKETING or MANUFACTURING APPROVAL:
NAME: T.E. Hamilton
APPROVED: T.E. Hamilton (LP)

PROBLEM TITLE: Environmental Evaluation - Air - Fibrous Materials

SIGNIFICANCE: The evaluation of workplace air on a periodic basis is necessary to comply with the air sampling section of the OSHA Asbestos Standard.

SPECIFIC OBJECTIVE: Determine fiber counts for filter media.

SUGGESTED APPROACH: Phase contrast microscopy.

DEADLINE (Last dey information will be of value): 2 weeks

DETAILS OF PROBLEM: Evaluate 10 sim. attic test samples from Weedsport

ACCEPTED BY RESEARCH DEPT.: [illegible] DATE: 7/

ASSIGNED TO: M. Doyle

ADDITIONAL COPIES: Original to Library, H.C.Duecker, H.A.Eschenbach, E.S.Wood, J.W.Wolter, B.R.V[illegible] CPD-T&A, File: 71-046

CONFIDENTIAL

SIMULATED ATTIC FILL TESTS
SCREENED BY #3

GRACE

AIR SAMPLING RECORD SHEET

PLANT LOCATION: WEEDSPORT
CONTAMINANT: FIBER
SAMPLING BY: F.W. EATON
DATE: 7/6/77 - 7/7/77

SAMPLING CONDITIONS:
OUTSIDE: MID 70's SHOWERS
INSIDE DRAFT:
VISIBLE DUST:

HOUSEKEEPING:

Sample Number	Employee Name	Job Location and Description	Remarks	Pump Number	Pump Off	Pump On	Sampling Time	Flow Rate	Total Sampled Volume	Lab Evalua
8AS2-AF1	DUKE	POURING ATTIC	20-4CF PAPER BAGS	1CG-6			16	1.6		5.08
8AS2-AF2			VERY LITTLE DUST. SIMULATE TO SCREENED LOT	1CG-7			16	1.6		4.81

EXHIBIT 28 Emergency Notice

CONSTRUCTION
PRODUCTS
VISION

PAGE 1

REQUEST FOR TECHNICAL SERVICE

PROBLEM: 67567
GROUP: Zonolite 762700
DATE: 7/11/77
CLAIM NO.: 71-046
REQUESTOR: F.W. Eaton
MARKETING or MANUFACTURING APPROVAL
NAME: T.E. Hamilton
APPROVED: T. E. Hamilton (LP)

PROBLEM TITLE: Environmental Evaluation - Air - Fibrous Materials

SIGNIFICANCE: The evaluation of workplace air on a periodic basis is necessary to comply with the air sampling section of the OSHA Asbestos Standard.

SPECIFIC OBJECTIVE: Determine fiber counts for filter media.

SUGGESTED APPROACH: Phase contrast microscopy.

DEADLINE (Last day information will be of value): 2 weeks

DETAILS OF PROBLEM: Evaluate 10 sim. attic test samples from Weedsport

EXHIBIT
183.183

ACCEPTED BY RESEARCH DEPT.: [signature] DATE: 7/11/77

ASSIGNED TO: M. Doyle

ADDITIONAL COPIES: Original to Library, H.C.Duecker, H.A.Eschenbach, F.W.Eaton, R.M.Vin, E.S.Wood, J.W.Wolter, B.R.Williams, W.R.Hanlon, CPD-T&A, File: 71-046

CONFIDENTIAL

15083050 72-51

REQUEST FOR TECHNICAL SERVICE

CONFIDENTIAL

NUMBER:	67567 762701
GROUP:	ZONOLITE
ACTUAL COST:	$220.00
REPORTING DATE:	July 11, 1976

SUMMARY:

Ten samples were received from Weedsport, New York, and evaluated by standard methods. All tem samples exceeded 4.5 fibers per cc of air.

RELEVENT PRIOR TECHNICAL SERVICE:

CONCLUSIONS:

DATA AND ANALYSIS:

See attachment.

Maureen A. Doyle

M. A. Doyle

MAD:mlr

attachment

15083051

72-52

SCREENED [illegible] #3

GRACE

AIR SAMPLING RECORD SHEET

PLANT LOCATION WEEDSPORT
CONTAMINANT FIBER
SAMPLING BY F.W. EATON
DATE: 7/7/77

SAMPLING CONDITIONS:
OUTSIDE
INSIDE DRAFT
VISIBLE DUST

HOUSEKEEPING:

mple mber	Employee Name	Job Location and Description	Remarks	Pump Number	Pump Off	Pump On	Sampling Time	Flow Rate	Total Sampled Volume	Lab Evaluati
ASB-AF3	DUKE	POURING ATTIC	REMAINING 10 BAGS ON				8	1.6		11.22
ASB-AF4			TEST NO. 10ASB				8	1.6		10.15
			NOTE: MAN POURING CONCENTRATED							
			THAT TEST 18AS6&8 NOT AS							
			CLEAN AS 18AS2&4. COULD POSSIBLY							
			RAM INTO DIFFERENT CAM IN SILO							
			AS FURNACE OPERATOR HAD TO UP							
			HEAT AROUND TEST 18AS6.							
			IF THIS IS A FACT IT SHOULD							
			SHOW UP IN ACTUAL HOME ATTIC							
			TESTS 18AS-PR1&2 VS 18AS-PR3&4							

Additional Comments:

Laboratory Evaluation By: Maureen A. [illegible]
Date: 7/11/77

15083052

CONFIDENTIAL

76270

SIMULATED A - ALL TESTS
SCREENED L. SY #3

(1)

GRACE

AIR SAMPLING RECORD SHEET

PLANT LOCATION WEEDSPORT
CONTAMINANT FIBER
SAMPLING BY F. W. EATON
DATE: 7/6/77 - 7/7/77

SAMPLING CONDITIONS:
OUTSIDE MID 70's SHOWERS
INSIDE DRAFT
VISIBLE DUST

HOUSEKEEPING:

Sample Number	Employee Name	Job Location and Description	Remarks	Pump Number	Pump Off	Pump On	Sampling Time	Flow Rate	Total Sampled Volume	Lab Evaluation
AS2-AF1	DUKE	POURING ATTIC	20-4CF PAPER BAGS	ICG-6			16	1.6		5.08
AS2-AF2			VERY LITTLE DUST. SIMULAR TO SCREENED L#1	ICG-7			16	1.6		4.81
AS4-AF1			SAME AS 18AS2				17	1.6		4.78
AS4-AF2							17	1.6		3.30
/77										
AS6-AF1			SAME AS 18AS2 EXCEPT				18	1.6		9.50
AS6-AF2			NOT AS CLEAN				18	1.6		6.17
AS8-AF1			10-4CF PAPER BAGS.				8	1.6		11.22
AS8-AF2			REMAINING BAGS (10) SAMPLED				8	1.6		12.83
15083053			ON 18AS8-AF3 & Y PAGE 2							

Additional Comments: (1) ALL CYCLONE FINES REMOVED
(2) SCREENED OVER 14 MESH SCREEN
(3) CG-6 RIGHT SHOULDER ICG-7 LEFT.

Laboratory Evaluation By: Maureen A. Doyle
Date: 7/11/77

CONFIDENTIAL

762703

03831330

Construction Products Division

GRACE

Industrial Chemicals Group
W.R. Grace & Co.
62 Whittemore Avenue
Cambridge, Mass. 02140

(617) 876-1400

April 1, 1980

Mr. Dale Ray
Consumer Product Safety Commission
Economic Program Analysis Division
Room 656-B
Washington, D.C. 20207

Dear Mr. Ray:

This will confirm our conference call of March 12, 1980 in which we reviewed with you the results of testing performed by the Construction Products Division of W. R. Grace & Co to determine the extent of asbestiform tremolite fiber release associated with use of Grace vermiculite in consumer products. During our conversation, you requested that we set out the details of Grace's fiber exposure test methodology and test results and indicate the nature of Grace's fiber reduction efforts.

As you know, tremolite is a tramp mineral contaminant which is associated with vermiculite and which Grace has been attempting to reduce to the maximum extent feasible. Since 1970, Grace has invested over $15 million to extract worthless materials and contaminants and to reduce airborne fiber exposure in its vermiculite mining, milling and expanding operations. A substantial part of this investment was associated with the construction by Grace of a new vermiculite mill at its Libby, Montana mine which uses wet screening and other wet ore beneficiation processes designed to reduce the asbestiform tremolite contaminant associated with vermiculite.

Following startup of the new mill, in early 1975, Grace took further steps to reduce tremolite contamination by removing and disposing of selected fines which have a higher level of contamination, thereby reducing the level of contamination in its finished ore concentrate. Since that time, changes have been made in the exfoliation process equipment used at Grace's vermiculite expanding plants which

PLAINTIFF'S EXHIBIT 9039.0

15103485

EXHIBIT 29 Emergency Notice

process Grace vermiculite ore for use in both consumer and industrial products. These changes provided for further screening, separation, and removal of both fines and the heavier unexpanded residual high density material following exfoliation both of which may contain a higher level of asbestiform tremolite contamination than the finished product. By use of bag houses and other dust filtration equipment, including an air elutriation step, additional reduction of the tremolite fiber contamination of expanded vermiculite end product is accomplished.

Grace has taken the further step of developing a binding agent for its Zonolite(R) Attic Insulation product and has recently started up equipment at all its expanding plants to apply this binder to Attic Insulation to further reduce dust and exposure to asbestiform fibers during the use of this product.

As a result of these reductions in asbestiform tremolite contamination, we believe that consumer products containing vermiculite and sold by Grace do not generate unreasonable risks for users. This has been verified by Grace's fiber exposure tests of consumer products containing expanded Grace vermiculite ore. All measurements were made by the NIOSH-approved technique as set forth in 40 CFR Section 1910.1001, paragraphs (e) and (f), utilizing the membrane filter method at 400-450 X (magnification) (4 millimeter objective) with phase contrast illumination. The results of these tests were as follows:

Product	Fibers Detected
Terra-Lite(R) Vermiculite	None Detected
Redi-Earth(R)	None Detected
Lightweight Fertilizer (Scott's Turf Builder)	None Detected
Zonolite Attic Insulation	Some fibers detected during installation

The actual test protocols and results of the tests are shown in Annex A to this letter. No tests were performed on Pool Cushion (R), a Grace product, which is used for protection of the base of vinyl-lined above-ground swimming pools since this use occurs out-of-doors and, typically, involves no more than 3 to 12 bags of vermiculite, depending on the size of the pool.

The only Grace product whose use resulted in a detectable fiber exposure was Attic Insulation and, then, at low levels only during installation. Tests indicate no residual fiber release following installation. Since this product is unlikely to be used more than two or three times during an entire lifetime and, then, only for exposure times which would not be expected to exceed two hours in any one case, the lifetime dosage is several orders of magnitude lower than any promulgated government standard applicable to tremolite fiber exposure.

Grace is continuing to exert its best efforts to further reduce the asbestiform tremolite contamination associated with its vermiculite products to the maximum extent feasible. For example, beginning in May of this year, a new rock and tremolite removal circuit should be operational at the Libby mill. This circuit is expected to reduce the level of tremolite contamination in fine size vermiculite ore by 50%. Additional research is underway to develop a similar circuit for reduction of tremolite contamination in the coarser sizes of vermiculite ore used for Zonolite Attic Insulation. One promising separation technique is slot screening which, if successful, could reduce tremolite contamination in the coarse ore concentrate by over 50%.

We are rapidly approaching a point of diminishing return since the amount of asbestiform tremolite contaminant in the vermiculite ore presently shipped to the exfoliating plants averages only 0.5% on a dry weight basis. For expanded vermiculite products, the level of contaminant is on average at or below the lowest level of reliable detectability, 0.2% on a dry weight basis. Accordingly, the 50% reduction Grace expects to achieve in the fine ores by May and, ultimately, the coarse ore sizes is a reduction from an already very low contaminant level. With this background, it is clear to us that the task of further reducing the remaining residual contamination in unexpanded ore and expanded vermiculite products will show a rapidly escalating cost in relation to the benefits derived.

We trust that this information will be useful to you in connection with the CPSC's evaluation of the asbestos contamination issue.

Very truly yours,

E. S. Wood
Executive Vice President

Attachment

cc/ David C. Evans, Esq.

bcc/ B. A. Blessington
F. W. Eaton
R. M. Vining
C. E. Brookes
A. A. Eustis
C. N. Graf
O. M. Favorito

ANNEX A

USER EXPOSURE TO FIBROUS TREMOLITE IN VERMICULITE CONSUMER PRODUCTS

TEST DATA

I. TEST PROTOCOL

A. Horticultural Products

1. Consumer Use of Terra-Lite(R) Vermiculite[a]

(a) Mix and fill pots to simulate consumer preparation of a mix of 50% peat moss and 50% Terra-Lite vermiculite by scooping equal volumes of materials out of separate packages and depositing on work surface. Hand mix to reasonable uniformity and fill fifteen (15) 4" diameter flower pots in 15 minutes. Press down to firm up the soil to hold the plant.

After 8 days the 15 pots were brought into the work area where three separate procedures were performed. Fiber counts were taken during each of these three procedures. Five pots were used for each of the three procedures.

(b) Knock Out and Disposal-- To simulate the consumer who does not intend to reuse the soil. Invert the pot and rap on the working surface so that the soil drops out. Brush the mound of soil off the bench into a disposal container. Take a paper towel and wipe inside of pot so that is is clean for reuse and dispose of the paper towel. In this procedure, contents of five pots will be disposed of during the 15 minute test period.

(c) Knock Out and Reuse for Potting Other Plants - Simulate a consumer who will reuse the potting soil. Rap pot on workbench by hand and break up the lump of soil to

make it similar to its original free-flowing condition. Repeat this five times. Combine all soil into one pile; then proceed to refill pots by scooping the material back in and tamping it down. In this 15 minute test procedure, five pots will be filled.

(d) Knock Out and Blend with New Potting Soil - Simulate a consumer who will blend old with new potting soil. Rap pot on workbench by hand and break up the lump of soil to make it similar to its original free-flowing condition. Repeat procedure five times. Obtain additional potting soil to match the volume of the dried soil. Place new soil on top of the old soil and mix together by hand. Use this mix to fill pots. During this 15 minute test procedure, 10 pots are filled.

2. Consumer Use of Redi-Earth(R) Potting Soil[b]

(a) Same procedure as 1 (a) except substitute premixed Redi-earth for Terra-Lite Vermiculite as the soil medium.

(b) Same procedure as 1 (b).

(c) Same procedure as 1 (c).

(d) Same procedure as 1 (d).

B. Consumer Use of Lightweight Fertilizer[c]

1. General

A five building apartment complex was selected as the test site. With over 100,000 sq. ft. of grass area, the site allowed air sampling while fertilizing over an extended period of time.

The tests were conducted with two people: one filling the spreader hopper and fertilizing, and the other maintaining log sheets, time and pump calibrations.

2. Application of Lightweight Lawn Fertilizer

Two sampling pumps with filter cassettes located in the left and right breathing zones were worn by the applicator during the sampling/fertilizing period. The applicator filled the spreader hopper to within 2" of the top and refilled when the hopper was approximately 3/4ths empty. Using a new Model 35 Scotts spreader with guide markers, the applicator spread thirteen (13) bags of lawn fertilizer at the normal coverage application rate (5000 ft^2/bag).

C. Consumer Installation of Vermiculite Attic Insulation[d]

1. General

Vermiculite Attic Insulation is generally purchased in quantities of 10 - 100 bags per home to "retrofit" or "add to" existing insulation in an existing home. Seldom is vermiculite Attic Insulation installed in new construction. To determine consumer exposure to tremolite fibers, the following series of tests by home owners was intended to indicate actual exposures under a variety of conditions.

2. Area Engineering Samples

Engineering samples were taken as follows:

(a) Prior to installing vermiculite Attic Insulation, monitor attic space for 5 - 6 hours.

(b) Approximately two months after installing insulation, monitor attic space for 5 - 6 hours.

3. Pouring/Leveling Vermiculite Attic Insulation in a Home

Each test home utilized 40 - 70 bags (3 cubic feet each) of vermiculite Attic Insulation. The installer was monitored during the placement of insulation.

Initially, place 15 - 20 bags in the attic. The installer poured all bags and leveled insulation with a wooden hand screed or one with a handle to push insulation back into roof eaves. Additional bags were brought to the attic in lots of 15 - 20 bags as required.

NOTES:

(a) Terra-Lite vermiculite is composed of expanded #3 vermiculite ore from either Libby, Montana or Enoree, South Carolina.

(b) Redi-Earth is a potting soil consisting of a mixture of 50% peat moss and 50% expanded #3 vermiculite ore from either Libby, Montana or Enoree, South Carolina with plant nutrients added.

(c) Lightweight fertilizer utilizes expanded #4 vermiculite ore from either Libby, Montana or Enoree, South Carolina.

(d) Attic Insulation is composed of expanded #1 or #2 vermiculite ore available only from Libby, Montana.

(e) Pool Cushion which was not tested utilizes expanded #3 vermiculite ore from either Libby, Montana or Enoree, South Carolina.

II. RESULTS (See note 1)

	PERSONNEL AVE. EXPOSURE (f/cc)		PERSONNEL TWA EXPOSURE (f/cc)	
	South Carolina	Montana	South Carolina	Montana
A. HORTICULTURAL PRODUCTS (see Note 2)				
1. Consumer Use of Terra-Lite Vermiculite				
(a) Mix and Fill Pots	<0.29	<0.14	<0.073	<0.035
(b) Knock Out and Disposal	<0.14	<0.14	<0.035	<0.035
(c) Knock Out and Reuse	<0.14	<0.14	<0.035	<0.035
(d) Knock Out and Blend	<0.14	<0.14	<0.035	<0.035
2 Consumer Use of Redi-Earth				
(a) Mix and Fill Pots	<0.29	<0.14	<0.073	<0.035
(b) Knock Out and Disposal	<0.14	<0.14	<0.035	<0.035
(c) Knock Out and Reuse	<0.14	<0.14	<0.035	<0.035
(d) Knock Out and Blend	<0.14	<0.14	<0.035	<0.035
B. LIGHTWEIGHT FERTILIZER				
1. Application of Lightweight Fertilizer With Montana derived vermiculite		<0.03		<0.008

C. Home Installation of Vermiculite Attic Insulation

1. Engineering/Area Samples

Home	Type Home	No. Bags	Fiber Concentration (f/cc) Attic Before	After (see note 3)
F	Colonial	55	0.03 (see note 4)	<0.01
N	Cape	30	NO TEST	<0.01
S	Ranch	64	<0.01	<0.01
W	Colonial	70	<0.01	<0.01

2. Installer Personnel Samples

Home	Type Home	Personnel Exposure (f/cc) Ave	TWA (see note 5)
F	Colonial	2.597	0.649
N	Cape	0.971	0.243
S	Ranch	2.115	0.529
W	Colonial	1.746	0.436

NOTES:

1. The symbol < (less than) indicates no fibers were observed in the counted fields. As a measure of test precision, results are reported to be less than the value represented by one fiber if such had been detected in one of the observed fields.

According to NIOSH reports, the limit of reliable detectability for this test procedure is 0.5 f/cc exposure and 0.1 f/cc TWA. Values below 0.5 f/cc exposure and 0.1 f/cc TWA are not judged as detectable.

2. Each test of horitcultural products was repeated using products made from both Libby, Montana ore and Enoree, South Carolina ore. The Grace vermiculite ore used in making Attic Insulation originates from the Libby, Montana mine as does the ore purchased by O. M. Scott & Sons for use in its lightweight lawn fertilizer.

3. In addition to results tabulated, two additional tests indicate no fibers detected in attics insulated with vermiculite loose fill in one case six hours and in another case approximately nine years after installation.

4. In all home attics tested, vermiculite Attic Insulation was added as a retrofit insulation over existing glass, mineral wool or cellulose insulation. In home "F", a fiber was observed in the counted fields prior to pouring vermiculite Attic Insulation. Although length and aspect ratio fell within the fiber definition, it is believed to be airborne glass fiber from existing insulation. There was no vermiculite Attic Insulation in the attic when this prejob sample was taken.

5. In calculating the time-weighted average (TWA) exposure for consumers using Attic Insulation, it is assumed that the user would work in the attic pouring Attic Insulation for two hours in one eight-hour work day. Results in C. 1., indicate no further exposures after installation. The lifetime exposure and risk associated with the use of Attic Insulation is infinitesimally small compared to industrial exposures since the opportunity for exposure is rare (perhaps twice in a lifetime) compared to a permitted industrial exposure up to 2 f/cc during each eight-hour work day throughout a working lifetime. Therefore, comparison of TWAs between a rare and nonroutine exposure in the case of Attic Insulation and the OSHA industrial standard of 2 f/cc vastly overstates the potential hazard involved in the use of Attic Insulation.

PERSONAL & CONFIDENTIAL

GRACE

Construction Products Division
06175261

To: W. F. McCord/Ajax

Date: March 25, 1980

From: F. W. Eaton

Subject: Consumer Products

cc: O. M. Favorito
R. M. Viring
E. S. Wood

In my recent facility survey reports on St. Thomas and Ajax, comments were made concerning end user exposure to Tremolite Fibers and CPD's response to EPA and CPSC ANPR's. O. M. Favorito has discussed this issue with you and has agreed the accompanying attachments should be forwarded to you as general information. These attachments are:

1. User Fiber Exposure - Actual attic installations
2. User Fiber Exposure - Simulated attic, L-1 unscreeded, unbound
3. User Fiber Exposure - Simulated attic, L-1 screened (14 mesh) unbound
4. User Fiber Exposure - Simulated attic, L-1 screened (14 mesh) bound w/0.5% CMC @ 0.28 qts/cf
5. CPD's response to EPA and CPSC ANPR's respecting asbestos in consumer products.
6. Consumer products fiber exposure - test protocol and results.

Test data has documented that there is no user exposure to asbestos fiber (tremolite) in mixed horticultural products or light weight fertilizer containing Libby Vermiculite (O. M. Scott Turf Builder). CPD does have concern with attic insulation as shown in the test results. In CPD's response to EPA and CPSC ANPR's we have stressed and will continue to stress to CPD's advantage, two points on the final CPSC banning of consumer patching compounds and artificial emberizing materials. These are:

1. The ban applies only to intentionally - added respirable freeform asbestos and does not apply to products having unavoidable trace amounts (contaminates).

2. In the case of contaminantes, manufacturers must take steps to reduce asbestos to the maximum extent feasible.

In point # 1, asbestos (tremolite) in vermiculite is a contaminant and not intentionally added. In point # 2 CPD has and will continue to reduce to the maximum extent feasible by:

1. New Libby mill
2. New Rock rejection circuit at Libby - in process
3. Slot screening at Libby - Research and Development stage.

PLAINTIFF'S EXHIBIT 91560

EXHIBIT 30 Emergency Notice

CPD does have concern with [redacted] as shown in the test results

PERSONAL & CONFIDENTIAL

GRACE

Construction Products Division
06175361

To: W. F. McCord/Ajax

Date: March 25, 1980

From: F. W. Eaton

Subject: Consumer Products

cc: O. M. Favorito
R. M. Viring
~~E. S. Wood~~

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1. New Libby mill
2. New Rock rejection circuit at Libby - in process
3. Slot screening at Libby - Research and Development stage.

PLAINTIFF'S EXHIBIT
9156.0

4. Screen all consumer, industrial and horticultural expanded products.
5. Bind all L-1 & 2 attic insulation.

CG175382

Reduced rock content in concentrate, proper stoner adjustment and product screening to reduce unexpandable/heavy particles are the major contributors to reduced user fiber exposure to tremolite fibers. Binding of attic insulation shows some further fiber reduction but its biggest asset is to act as a dust suppressant. Process Engineering and Research are continuing binder efforts but I see little light at the end of this tunnel during the next 12 months.

If I can provide you with any additional test data such as Monokote, masonry fill etc., please advise.

F. W. Eaton

FWE/gm
Enclosures

bcc: Bill Sinacore/W. Chicago

ZONOLITE

pounded. When insulation decomposes, absorbs moisture, becomes infested with vermin, or loses its insulating efficiency after it is installed, it may have to be removed and replaced. That means cleaning out all the old insulation, putting in new insulation, and repairing the walls or ceilings. It means a lot of trouble and expense.

The only way to be sure that this will not happen to you is to select an insulation of proved permanence. Select Zonolite Insulation. Through rigorous testing and extensive usage over many years, Zonolite has proved that it fulfills completely all of the following requirements for good insulation. No other known material can equal such a record.

1. **Dual Insulation Value** . . . Insulates both by its air cell construction and its glittering, reflective surfaces.
2. **Uniform Tamper-Proof Density** . . . Same density installed in the home as when it leaves the factory.
3. **Complete Fill** . . . Fills walls solidly leaving no voids. Does not "ball-up" on rough obstructions, nails, wires, or pipes. Cannot be "fluffed up."
4. **Light in Weight** . . . A bag can be handled easily. A 3-inch layer of Zonolite adds only 1½ pounds per square foot of ceiling.
5. **Easy to Install** . . . No need for mask, gloves, or special equipment. It pours easily and cleanly. The average home can be insulated in just a few hours.
6. **Chemically Inert** . . . Contains no harmful chemicals. Will not disintegrate nor deteriorate. Will not corrode any material. Will not stain wall or plaster. Is practically moisture-proof.
7. **Fire-proof** . . . Not merely fire "resistant." It melts at about 2400° Fahrenheit.
8. **Vermin-proof** . . . Mice, rats, insect larvae, or termites will not attack it.
9. **Rot-proof** . . . Will not decompose nor give off odors. It is a 100% mineral material.
10. **Naturally Permanent** . . . The permanence of Zonolite is not dependent upon synthetic treatments. Its inherent permanence means efficient insulation for your home forever.

Permanent as the Earth Itself

EXHIBIT 31 Emergency Notice

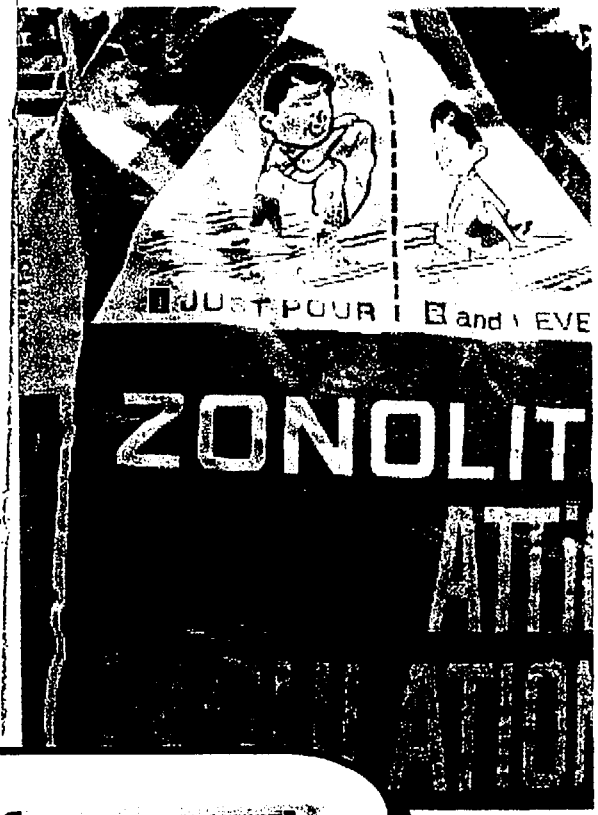
ZONOLITE

IF YOU ARE BUILDING A HOME, don't take chances with just "insulation." Be sure of permanent, efficient performance. Select Zonolite, the material that fulfills all the requirements for good insulation.

If your present home is not insulated, don't shiver through another winter nor swelter through another summer. Let your present wasted fuel dollars pay for a complete Zonolite installation . . . now!

Why not talk to your lumber dealer today? He'll be glad to tell you all about it.

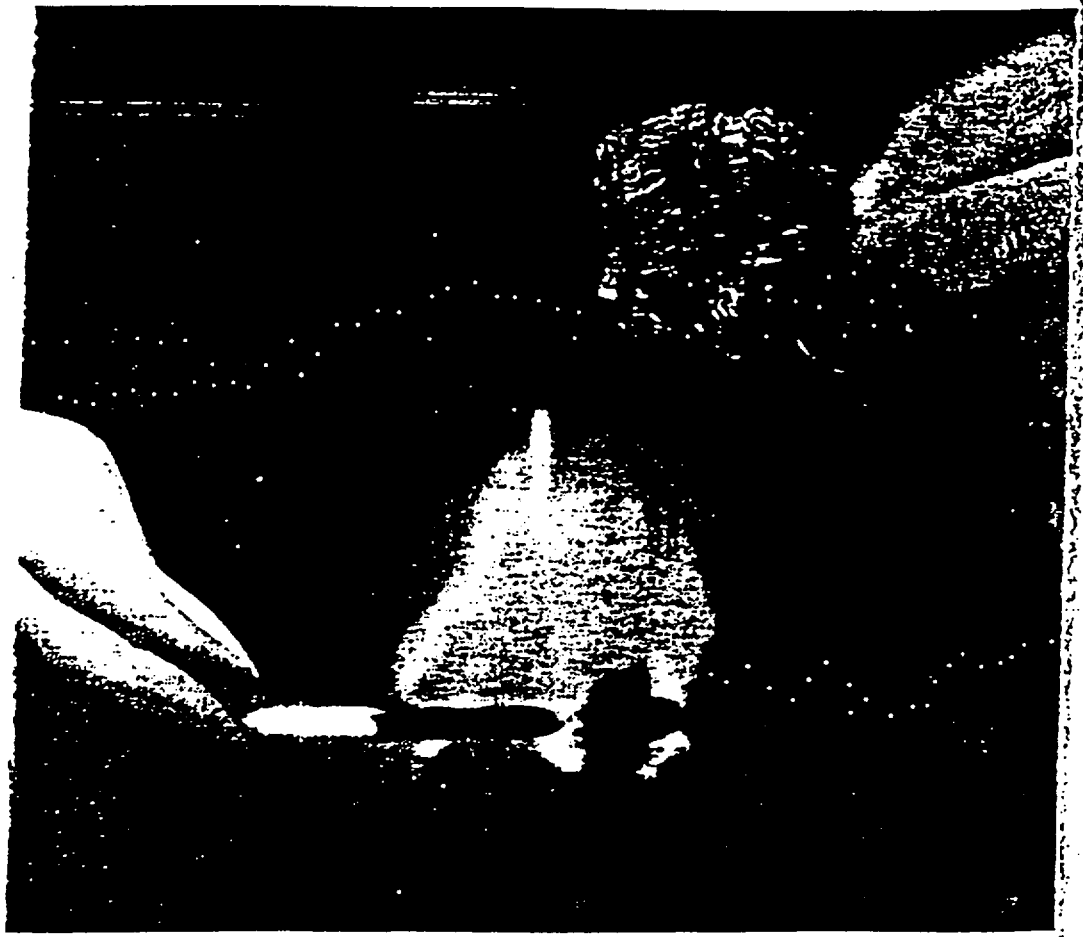
Permanent as the Earth Itself



"No need for mask ...It pours...cleanly. . . . Contains no harmful chemicals."

ZONOLITE

THE MODERN MIRACLE OF INSULATION



Permanent as the Earth Itself

[redacted]

EXHIBIT

10c

EXHIBIT

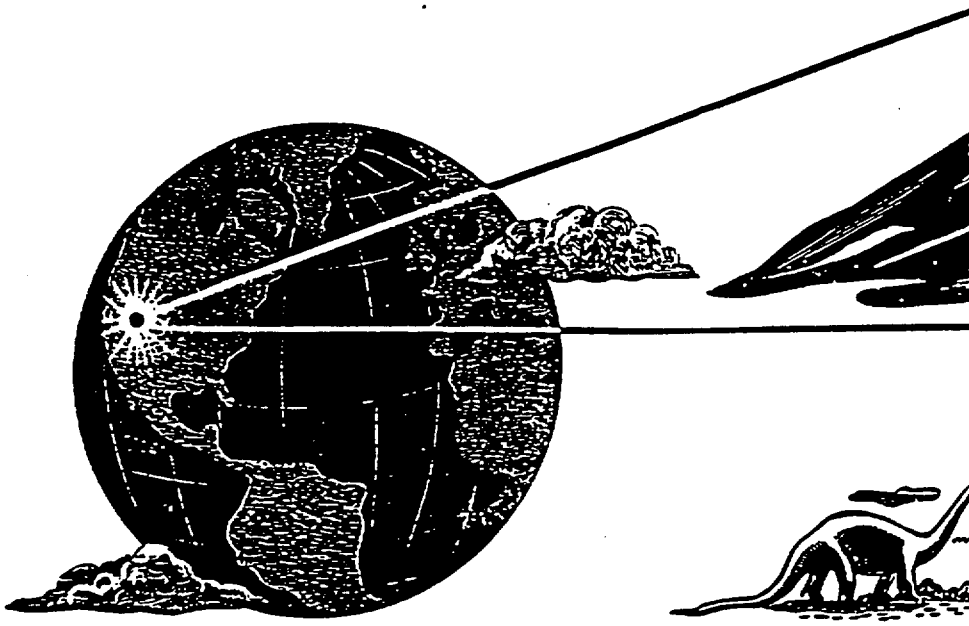
10c

ZONOLITE

REMEMBER THE STORY of how roast pork was discovered? Back in Ancient China, according to the legend, some fellow's pig pen burned to the ground, and all his pigs with it. After the fire he accidentally stuck his finger into one of the simmering animals. Jamming the smarting finger into his mouth, he was delighted with the taste he found there. That gave him an idea. He spread the word, and soon his neighbors for miles around were burning down their pig pens.

And so roast pork was discovered!

Just a few years ago a discovery equally important was made in much the same way. A group of engineers were seeking mineral deposits in the mountains near Libby, Montana. One day one of the men



Permanent as

ZONOLITE

accidentally heated what looked like ordinary mica. To his amazement the ore expanded to several times its original size and changed its color as he watched.

Although these engineers didn't know it, on that day they discovered Zonolite—a material which now is used in a thousand ways the world over. Today Zonolite is known as "The Modern Miracle of Insulation."

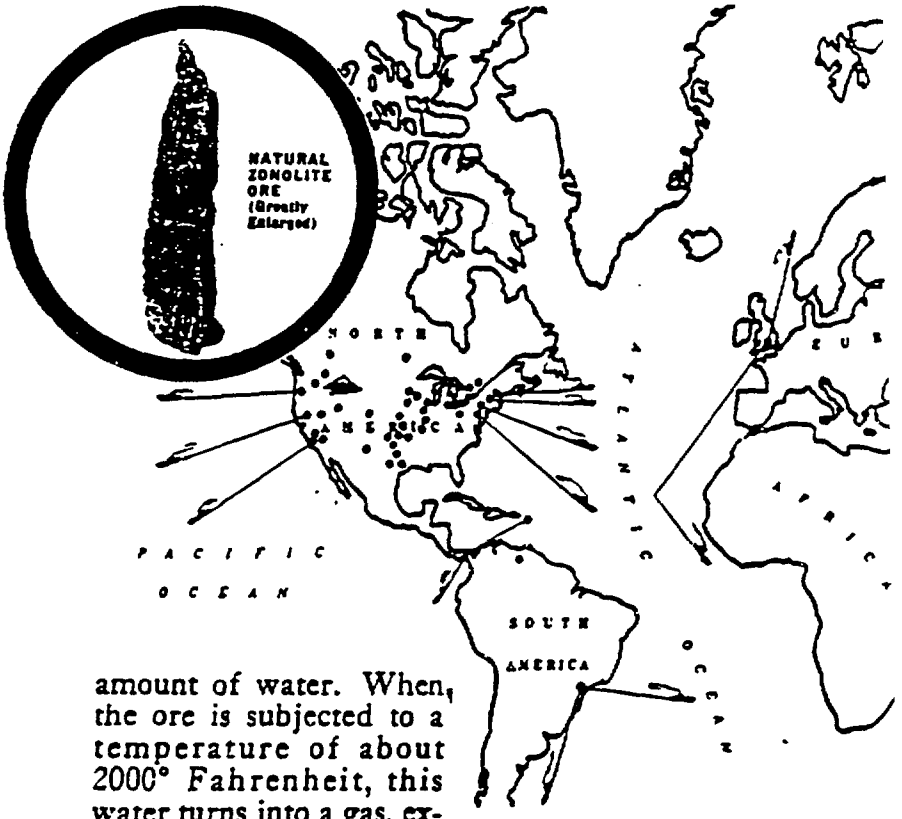
For six hundred million years the mica-like ore from which Zonolite is made has lain on Mount Zonolite completely unprotected, perfect prey for the destructive forces of time and weather. Rain has drenched it; winter cold has chilled it; forest fires have raged around it; summer sun has blazed down upon it; yet it has stood all these tests without deterioration.

Who knows what prehistoric monsters wandered over Mount Zonolite, how many battles were fought or how many generations of trees grew and died in that spot before a curious engineer accidentally discovered the secret of Zonolite?

In the romantic story of Zonolite there is a clear cut, unimpeachable record of natural permanence that no other insulation has been able to equal.

Earth Itself

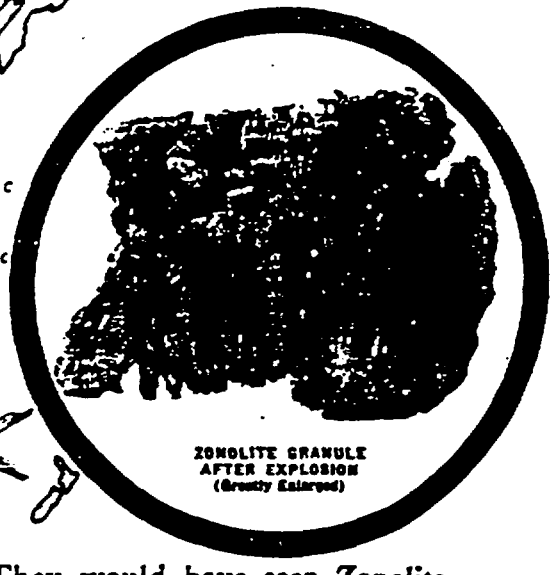
THE METHOD OF CONVERTING the micaceous ore tha is dug from the earth at Mount Zonolite into the lightweight, air-filled granular substance that is Zonolite Insulation has changed very little from the first. It is a process of heating, nothing more. Each flake of ore consists of about one million laminations per inch. Trapped between each layer there is a minute



amount of water. When the ore is subjected to a temperature of about 2000° Fahrenheit, this water turns into a gas, explodes the ore and expands it twelve to fifteen times its original size, producing countless tiny dead air spaces in each granule. In the exploding process the color of the ore changes to a glittering golden brown giving the expanded granules of insulation bright, shiny surfaces which have high heat reflectivity. This reflective quality plus the dead air cell entrapment makes Zonolite the only material having a dual insulating value. It insulates efficiently from sub-zero to 2000° F.

Permanent as

If the engineers who discovered Zonolite could have looked just twenty years into the future they would have seen ore from Mount Zonolite travelling by land and water to Burma, India, Australia, Malaya, England, Canada and South America. They would have seen a vast network of more than fifty Zonolite manufacturing plants, thirteen of them in foreign countries. They would have seen thousands of homes, office buildings, and factories made comfortable—warmer in winter, cooler in summer—by Zonolite Granu-


ZONOLITE GRANULE
AFTER EXPLOSION
(Greatly Enlarged)

lar Fill Insulation. They would have seen Zonolite Insulating Bricks protecting the walls of gigantic furnaces, Zonolite in the walls of great cold storage plants, Zonolite All-Purpose Plaster providing better walls for countless buildings, Zonolite Lightweight Concrete on the roofs of some of the largest buildings in the world. They would have thrilled to see how rapidly new uses are being found for that simple ore that waited six hundred million years to reveal its great secret.

Earth Itself

ZONOLITE

INSULATION IS NOW ACCEPTED as an essential part of every building. Home owners, as well as architects and builders, know that it is false economy to try to get along without it. In a recent nationwide survey the respondents were asked to rank in the order of importance to them the reasons why they might insulate their homes. More people gave "because insulation makes homes warmer in winter," than any other reason. Close behind were "because it lowers fuel bills," and "because it makes homes cooler in the summer." Insulation will do all these things. An efficient insulation will pay for itself in actual fuel savings within one to three years.

There are several materials on the market today which, if properly installed, will do an efficient job of insulating for a time. In choosing an insulation it is extremely important to investigate two things:

1. *"Does this insulation automatically assume the correct insulating density when it is installed?"*
2. *"Will it stay forever at maximum efficiency without settlement, rot or disintegration?"*

The efficiency of Zonolite is not dependent upon the chance that it may be installed at the correct density. It cannot be stretched too thin nor compressed too tight. You know what you are getting with Zonolite. The long life of Zonolite is not dependent upon fancy treatments. It is 100% mineral and naturally permanent. You get lasting, uniform insulation with Zonolite.

Don't make the mistake of buying just "insulation." Insulation is a sound investment in comfort, health, money; but poor insulation is a bad investment com-

Permanent as

ZONOLITE

pounded. When insulation decomposes, absorbs moisture, becomes infested with vermin, or loses its insulating efficiency after it is installed, it may have to be removed and replaced. That means cleaning out all the old insulation, putting in new insulation, and repairing the walls or ceilings. It means a lot of trouble and expense.

The only way to be sure that this will not happen to you is to select an insulation of proved permanence. Select Zonolite Insulation. Through rigorous testing and extensive usage over many years, Zonolite has proved that it fulfills completely all of the following requirements for good insulation. No other known material can equal such a record.

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7. **Fire-proof** . . . Not merely fire "resistant." It melts at about 2400° Fahrenheit.
8. **Vermin-proof** . . . Mice, rats, insect larvae, or termites will not attack it.
9. **Rot-proof** . . . Will not decompose nor give off odors. It is a 100% mineral material.
10. **Naturally Permanent** . . . The permanence of Zonolite is not dependent upon synthetic treatments. Its inherent permanence means efficient insulation for your home forever.

earth itself

ZONOLITE

IF YOU ARE BUILDING A HOME, don't take chances with just "insulation." Be sure of permanent, efficient performance. Select Zonolite, the material that fulfills all the requirements for good insulation.

If your present home is not insulated, don't shiver through another winter nor swelter through another summer. Let your present wasted fuel dollars pay for a complete Zonolite installation . . . now!

Why not talk to your lumber dealer today? He'll be glad to tell you all about it.

Permanent as the Earth Itself

ZONOLITE®

NOW...

Save on fuel, add comfort

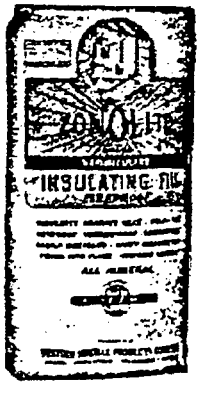
ZONOLITE
Vermiculite Insulating Fill
Easiest of all to install. Just pour it, level it, leave it!

$1.45
per bag covers 17 sq. ft. 3" thick

Just pour it, level it, leave it!

V-8, Fo

ZONOLITE INSULATING FILL



Zonolite Insulating Fill is used to insulate and sound-deaden side-walls and ceilings of all types of buildings. Zonolite Fill has one of the best insulation factors of any insulation on the market ("K" factor .28 B.t.u.).

Zonolite Insulating Fill comes in 4 cu. ft. bags which weigh about 23 lbs. No special installation equipment is needed. Zonolite Fill is poured from the bag, like popcorn. It flows readily around pipes, wiring, etc., to make a complete, uniform fill without tamping, cutting, or nailing.

Zonolite Insulating Fill is a non-conductor of electricity and can be safely installed over or around electrical wiring. It is rot-proof and does not permit tunneling or nesting by rodents. It does not attract vermin or termites. It is safe to handle because it is non-irritating to the skin and lungs.

It is safe to handle because it is non-irritating to the skin and lungs.

EXHIBIT
32
Emergency Notice

VS

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Save on fuel, add comfort

ZONOLITE
Vermiculite Insulating Fill
Easiest of all to install. Just pour it, level it, leave it!
$1.45
per bag covers 17 sq. ft. 3" thick

ZONOLITE
Glass Fiber Home Insulation
Super-efficient...3 thicknesses for every insulating need.
per M

ZONOLITE
Masonry Fill Insulation
Doubles insulating value of block and cavity walls. Shade [illegible]!
$1.70
per bag

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Western News November, 1960

HOW TO DO IT

Installing All Forms of Zonolite* Insulations

INSULATION

ZONOLITE

HANDBOOK

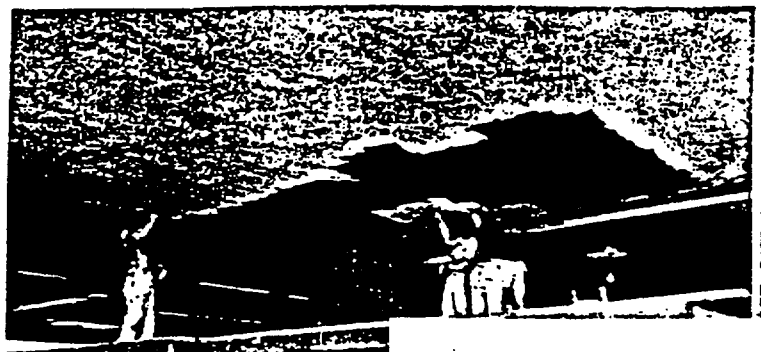
*Zonolite is the registered trademark of the Zonolite Co

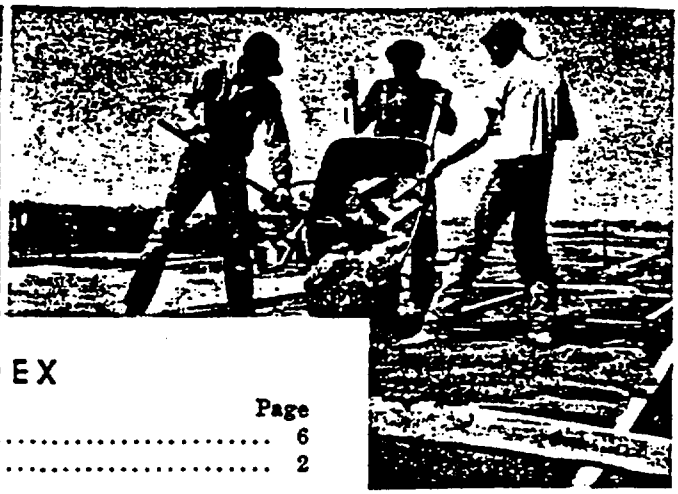
EXHIBIT

11

THIS booklet is designed to supply "How To Do It" information for installing all forms of Zonolite brand vermiculite. For more technical information or help with special problems, write our Engineering Department.

Zonolite brand of expanded vermiculite is one of the mica minerals. It is fireproof, rot-proof, permanent, and a good insulator against heat and cold. Zonolite Insulations are marketed through lumber and building material dealers.





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PREFACE

The design data, methods, and specifications for the use of the products outlined in this manual are the result of laboratory research and field tests made under actual service conditions. No attempt is made in this manual to cover each and every specific use to which the Zonolite products described in the manual may be adapted. This is due to the many factors which enter into the field of building construction and engineering, such as weather conditions, design, equipment, standards of labor, steel, cement, and other materials used in combination with, or as accessory to, Zonolite products. Because of such factors, Zonolite Company does not warrant expressly or impliedly the use of the materials described in this manual, or the results that may be obtained from the use of specifications, design data, and methods herein outlined. Due to the variable conditions which may be encountered on any particular job, and the different results that may be obtained from the use of other materials used in combination with, or accessory to, the Zonolite products listed herein, it is our intent in the publication of the specifications, methods, and design data contained herein to furnish a guide only for architects, engineers, contractors, plasterers, and fabricators in adapting Zonolite products to their particular requirements.

ZONOLITE Brand Vermiculite

Sold by Lumber and Building Material Dealers Everywhere

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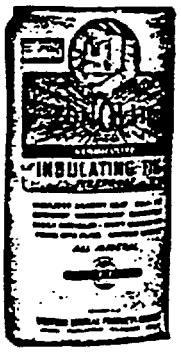
Form AD-2 3-54 10M

ZONOLITE INSULATING FILL



Zonolite Insulating Fill is used to insulate and sound-deaden side-walls and ceilings of all types of buildings. Zonolite Fill has one of the best insulation factors of any insulation on the market ("K" factor .28 B.t.u.).

Zonolite Insulating Fill comes in 4 cu. ft. bags which weigh about 23 lbs. No special installation equipment is needed. Zonolite Fill is poured from the bag, like popcorn. It flows readily around pipes, wiring, etc., to make a complete, uniform fill without tamping, cutting, or nailing.

Zonolite Insulating Fill is a non-conductor of electricity and can be safely installed over or around electrical wiring. It is rot-proof and does not permit tunneling or nesting by rodents. It does not attract vermin or termites. It is safe to handle because it is non-irritating to the skin and lungs.

Zonolite Insulating Fill is a natural mineral that will not draw moisture from the atmosphere. In the event of a roof leak, water will be readily picked up by the Zonolite, and held until conditions are right for it to dry.

The approximate coverage of Zonolite Insulating Fill is as follows:

Thickness in Inches	2"	3"	3⅝"	4"	5⅝"
Coverage per bag in sq. ft. based upon joists spaced 16" on center	26	17	14	13	9

A thickness of 3⅝", with a minimum of 3", is recommended. Insulation is installed for two reasons: to keep out summer heat, and to keep heat within the building in winter. Both purposes are served better with thick insulation. The low cost of Zonolite makes possible this greater thickness for essentially the same cost as the 1" or 2" recommended by manufacturers of higher-priced materials.

INSTALLING ZONOLITE INSULATING FILL

Approximate Number of Bags of Zonolite to Cover Flat Ceilings to Full Depth of 2" x 4" Joists 16" O.C.

Ft.	18'	20'	22'	24'	26'	28'	30'	32'	34'	36'	38'	40'	42'	44'	46'	48'	50'
18'	23	25	28	30	32	35	37	40	42	45	47	50	52	55	57	60	62
20'	25	28	31	33	36	38	41	44	47	50	53	55	58	61	64	66	69
22'	28	31	33	37	39	43	46	49	52	55	58	61	64	67	70	73	76
24'	30	33	37	40	43	47	50	53	57	60	64	67	70	73	76	80	83
26'	32	36	39	43	47	50	54	57	61	64	68	72	76	79	83	86	90
28'	35	38	43	47	50	54	58	62	66	70	74	78	82	85	89	93	97
30'	37	41	46	50	54	58	62	66	70	75	79	83	87	91	95	99	102
32'	40	44	49	53	57	62	66	70	75	80	84	88	93	97	102	106	110
34'	42	47	52	57	61	66	70	75	80	84	89	94	99	104	108	113	117
36'	45	50	55	60	64	70	75	80	84	89	95	100	105	110	115	120	125
38'	47	53	58	64	68	74	79	84	89	95	100	105	110	116	121	126	131
40'	50	55	61	67	72	78	83	88	94	100	105	110	116	121	127	133	138

To find number of bags for other than 3⅝" thickness, multiply number of bags shown in table by following factors:

For 3" Multiply by .83
For 4" Multiply by 1.1
For 5⅝" Multiply by 1.55

Side-walls: Check attic to see if Zonolite can be poured into side-walls directly from attic. If walls are open (balloon construction), drop a weight on a line into each stud space, to determine where fire-stops or headers would prevent the Zonolite from going clear to the foundation. After these are located, pour Zonolite into side-walls.

If construction is such that a plate at the ceiling line blocks off the side-wall, it may be possible to bore a 1½" hole through this plate between each studding space. Check wall for fire-stops and headers with a weight on a line. Pour Zonolite Insulating Fill over the holes which have been bored, allowing it to run into side-walls until walls are completely filled. This eliminates the necessity of removing siding from the outside, except below windows and where fire-stops occur, particularly important in stucco or brick-veneer construction.

If Zonolite cannot be installed from attic, entry can be effected from outside. Remove a row of siding and sheathing at ceiling line all around the building. Drop a weight on a line into each exposed studding space to determine location of fire-stops and headers. Pour Zonolite directly from bag into walls. A simple, home-made trough facilitates pouring Zonolite and eliminates spilling. To insure a complete fill below plaster clinches and other obstructions, vibrate wall slightly with a rubber mallet or short 2 by 4 as Zonolite is poured in.

Zonolite Insulating Fill (Continued)

Installing Zonolite Fill below window

It is important that walls be completely filled to top. In some cases, this can be done by tacking building paper to the exposed portion of the studs, allowing top edge of paper to flare. Pour Zonolite behind this paper, and press paper and insulation into place. Replace sheathing and siding. If this method is not possible, due to an over-hanging eave, top portion of walls can be filled by hand-packing fibre insulation.

It is important to insulate below windows and fire-stops located as outlined previously. Procedure for insulating these locations is exactly the same as for insulating walls from the outside.

BALLOON CONSTRUCTION: In new construction, the installation of Zonolite is made very simple by constructing the wall open from attic or loft, by putting the 2 by 4 plate on top of ceiling joists, rather than below. This allows Zonolite to be poured from attic down into walls after the studs have been sheathed and lathed. Contractors using this method say that Zonolite can be installed faster than any other type of insulation: no cutting, no fitting, no tacking; just let it run down into the open wall space.

Another advantage of using balloon type construction is that Zonolite can be poured down wall after plaster has had a chance to dry thoroughly. Drying is accelerated by circulation of air on both sides of the lath and plaster. This saves time for the contractor and allows casing to be done sooner with safety because the plaster has dried faster.

Zonolite Fill should be poured under window openings as the lath or other lining is installed.

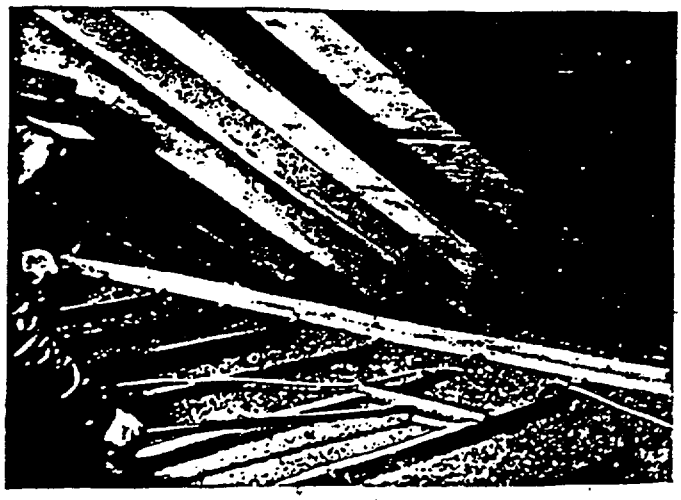
Vapor Barriers: A vapor barrier will help maintain desirable humidity within the rooms and is good construction practice. It should be installed on the inside (warm side) of the wall. The vapor barrier should consist of a glossy-surfaced, asphalt-impregnated building paper nailed to the studs before the lath is applied. Use Treated Sisalkraft, Bird's Neponset, Ruberoid's Giant Sheathing, or equal. Foil-backed rock-lath provides good vapor resistance. Due to the joints between the lath, it is not so effective as a good vapor-proof paper, but it has the advantage of being easier to apply.

Unfloored Attics: Pour Zonolite Insulating Fill into each joist channel, and level off to proper depth with a wooden screed. Minimum thickness should be 3".

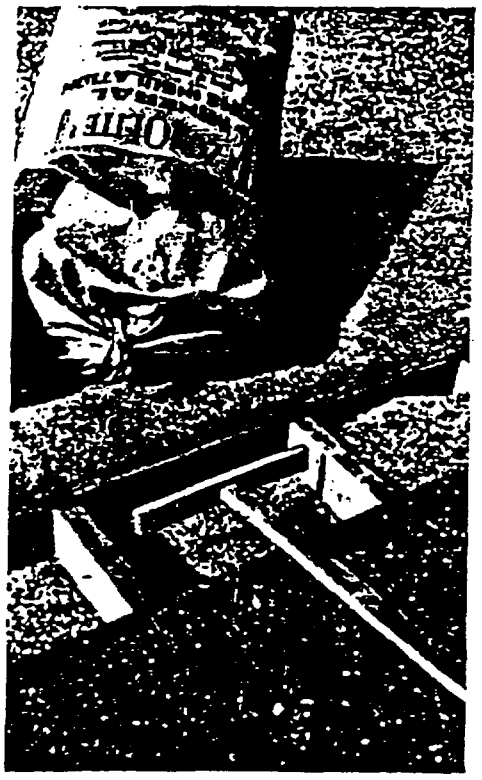
Floored Attics: Remove two or three floor boards at convenient intervals, push Zonolite under floor with rake, and level.

To reach inaccessible attic areas or pockets, make small openings in the roof.

Attic Ventilation: Installation of louvers is good construction practice. The number of louvers is governed by the size of the structure. The ideal condition is to provide 1 sq. ft. of ventilator to each 200 sq. ft. of attic area.



Leveling Zonolite Fill in attic



Opening in flat roof for Zonolite installation

Flat Roofs: If the clearance under lowest portion of roof does not allow sufficient working space, make an opening through roof. Opening should be 2 ft. wide, beginning at lowest point in roof at the center, and extending as far as necessary toward high end. Pour Zonolite between joists, and rake or push laterally to either side-wall to desired level and depth. If building is too wide to cover from one opening, additional openings should be made in same manner. Carefully reseal roof opening.

Sound-Deadening: When sound-deadening partition walls, studs should be staggered so they are not continuous through the wall. One set of studs is placed to support one side of the partition, and a separate set of studs is placed for the opposite side of the wall, so that solid wood does not extend through partition. Wall is then filled with Zonolite. The sound-deadened wall can be maintained at normal thickness by using 2" by 3" studs. A wall of this thickness will provide satisfactory results except in extreme cases. Good sound-deadening results between floors can be obtained by providing a set of joists to support the ceiling, separate from joists supporting the floor above, and placing approximately 4" of Zonolite Fill over the ceiling.

Animal Shelters: Existing animal shelters which are cold or in which excessive condensation occurs can be made warm and dry by the addition of Zonolite Insulating Fill in side-walls and ceiling, a Zonolite Insulating Concrete floor (See page 9), and an efficient ventilating system.

In buildings of wood construction, nail vapor barrier, described previously, to inside of studding and ceiling joists. Over this apply the lining (asbestos board, treated gypsum board, or lumber). Pour Zonolite Fill into cavity as lining is installed.

In existing buildings of masonry construction, fur out side-walls with 2" by 3" furring strips well anchored to the wall. Tack vapor barrier to furring strips. Pour Zonolite 3" thick into cavity as lining is applied over vapor barrier. Apply vapor barrier and lining on ceiling joists, and insulate between the joists with 3" or more of Zonolite.

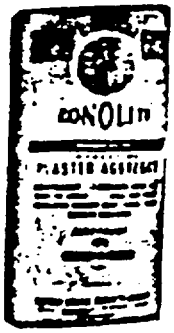
It is a mistake to think that only double boarding outside the studs will sufficiently insulate the side walls. This "double boarding" method is questioned by many. Cora Cooke, University of Minnesota Agriculture Extension Service, says:

"It is known from experience that double-boarding outside the studding is far from adequate. The improvement in insulating value made when the layers of boards are nailed to the inside and outside of the studding is slight, and the room is still subject to rapid changes in temperature. The air space thus provided is far less effective as an insulator than is commonly supposed. Fill materials offer a very practical solution." (POULTRY HOUSING, by Cora Cooke.)

Warm, dry Zonolite Concrete floors reduce farrowing loss.

ZONOLITE PLASTER

(Covered More Completely in Folder PA-2)



Zonolite Plaster Aggregate is a specially-sized vermiculite aggregate to be used in place of sand. When mixed with gypsum, it produces a plaster that is light in weight, has good insulation value, and provides remarkable fire protection.

Zonolite Plaster was the first material on the market to obtain official 4-hour fire ratings for protecting steel floors, roofs, beams, trusses, and girders with a 1" application. (Vermiculite Institute fireproofing booklet available on request.)

Zonolite Plaster on the wall weighs less than one-third as much as sand plaster. Five bags of Zonolite Aggregate (180 lbs.) replace 2,000 lbs. of sand.

Zonolite Plaster has more than three times the insulating value of sand plaster. It has a "K" factor of .95, compared with 3.3 for sand plaster.

Zonolite is the most uniform aggregate available for plaster. It meets A.S.T.M. Standard Specifications, and carries the Underwriters' Laboratories seal. This means that the material is examined at regular periods for screen analysis, density, and absence of impurities.

Zonolite Plaster Aggregate bags contain 4 cu. ft. and weigh about 32 lbs.

THICKNESS (RECOMMENDED MINIMUM)

Base	
Gypsum Lath	½"
Metal Lath	¾"
Masonry	⅝"

For estimating purposes, ½" Zonolite Plaster over gypsum lath, figure 6 bags Zonolite, 9 bags gypsum plaster per 100 square yards.

Materials required over masonry and metal lath bases will depend on the evenness of the wall and the depth of the key.

Zonolite Plaster is applied exactly as sand plaster. One-coat browning is satisfactory over gypsum lath. When other types of lath are used, apply scratch and brown coats. Allow scratch coat to set before applying brown coat.

MIXING AND APPLICATION

The following mixes, on a bag basis, assure accurate proportioning. They are in complete agreement with American Standards Association specifications.

Only sufficient water to make a workable mix shall be added. Water shall be fresh and of potable quality.

Over Gypsum Lath
(One Coat Browning)

1 bag	Zonolite Plaster Aggregate
1½ to 2 (100 lb.) bags	Gypsum Neat Plaster

Over All Other Lath

Scratch Coat:	
1 bag	Zonolite Plaster Aggregate
2 (100 lb.) bags	Gypsum Neat Plaster
Brown Coat:	
1 bag	Zonolite Plaster Aggregate
1½ to 1½ (100 lb.) bags	Gypsum Neat Plaster

Insulation Lath: Care should be taken that first coat of plaster applied to insulation lath sets within 1 to 2 hours. Fiber insulation lath should not be wet down prior to receiving plaster. Thickness of plaster should not be less than ½". Plasterer should guard against grounds that are too thin.

Over Masonry
(Scratch and Brown Coat)

1 bag	Zonolite Plaster Aggregate
1½ to 1½ (100 lb.) bags	Gypsum Neat Plaster

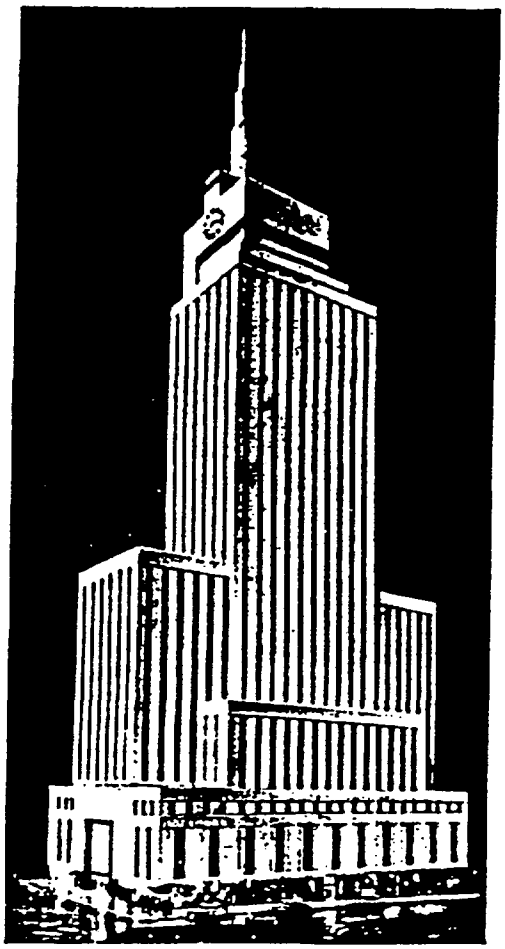
In plastering over masonry bases that exhibit high suction, it may be necessary to increase aggregate content. Under no circumstances should more than 1 bag of Zonolite Aggregate be mixed with 100 lbs. of gypsum plaster.

When Zonolite Plaster is applied directly to monolithic concrete surfaces, concrete should first be coated with a specially-prepared bond plaster for use on concrete. Aggregate shall not be added.

Avoid bituminous plaster bond.

Fireproofing steel beams with 1" of Zonolite Plaster

Zonolite Plaster (Continued)



Mercantile Bank Bldg., Dallas, Tex., fireproofed with Zonolite Plaster

SETTING TIME

Gypsum manufacturers adjust the set of gypsum to fit local sand conditions by adding varying quantities of retarder. If a strongly retarded gypsum is used with Zonolite, a slow set may be encountered. Plaster should set in 3 to 6 hours. Delay of set may cause excessive shrinkage, resulting in cracked plaster. To avoid slow set, add a small quantity of commercial accelerator to mix, amount easily determined on job. On large jobs, the gypsum company should be advised that vermiculite aggregate is to be used.

FINISH COATS

Any of the conventional plaster finishes, such as lime putty or sand float, may be applied over a brown coat of Zonolite Plaster. (See Zonolite Plaster Finish and Acoustical Plastic.) Zonolite Plaster develops suction faster than sand plaster. Finish coat should be applied to a Zonolite base coat that is semi-green. If brown coat is dry, it shall be evenly wetted but not saturated. Too much water in brown coat may cause blistering.

TEMPERATURE AND VENTILATION

Plaster shall not be applied to surfaces that contain frost. A minimum temperature of 40° F. shall be maintained prior to and during application of plaster, and until it is completely dry. Protect fresh plaster from excessive heat, and provide adequate ventilation. Drying should commence immediately after plaster has set, and be continuous until thoroughly dry. Temperatures as uniform as possible shall be maintained during drying period. Prevent dry-outs prior to set by screening openings in hot weather.

For additional information, see American Standards Association, "Standard Specifications for Gypsum Plastering," 70 E. 45th St., New York 17, N. Y.

ZONOLITE PLASTER FINISH

(Covered More Completely in AD-3)

Zonolite Plaster Finish Aggregate is a fine-sized vermiculite for trowel finish only. It shall be mixed with unfibred gypsum plaster.

Zonolite Plaster Finish provides a hard finish coat with a pleasing tan cast. Gypsum-to-gypsum application assures the strongest possible bond to the base coat.

Plasterers favor Zonolite Plaster Finish for a number of reasons; primarily, because it eliminates the time-consuming hand operation of mixing lime and gypsum gauging plaster. All mixing is done by the tender.

Zonolite Plaster Finish Aggregate is packed in 2 cu. ft. bags that weigh about 22 lbs.

STANDARD PROPORTIONS	
1 bag (2 cu. ft.)	Zonolite Finish Aggregate
2 bags (100 lbs. each)	Unfibred Gypsum Plaster
16 gals. (Approx.)	Water

This batch will cover approximately 40 yds.

MIXING AND APPLICATION

Place approximate amount of water in mixing box.

Spread gypsum plaster over water, and allow to soak.

After all dry plaster has been taken up by the water, add Zonolite Finish Aggregate, and mix thoroughly. Add more water as necessary to obtain workable consistency.

Zonolite Plaster Finish shall be applied over a base coat in a semi-green condition. If brown coat is dry, it should be evenly wetted, but not saturated. Too much water in brown coat may cause blistering. The thickness of Zonolite Plaster Finish shall be from 1/16 to 1/8 inch. Additional thickness is permissible to level uneven base coat.

Zonolite Plaster Finish is applied the same as a putty coat. A tight scratch is first applied and allowed to draw. This is followed by a fill-in coat, troweled with water to a smooth finish, free from cat faces and other blemishes.

Provide adequate heat and ventilation, and observe usual precautions to prevent dry-outs.

PAINTING

Oil-base paints should not be applied to any plaster until it is dry. If immediate decoration is desired, use water-base paint.

Zonolite Plaster Finish produces more suction than other smooth finishes, and adequate sizing is recommended.

ZONOLITE ACOUSTICAL PLASTIC

(Covered More Completely in Folder PA-5)

Zonolite Acoustical Plastic is a ready-mixed acoustical plaster that requires only the addition of water. It can be troweled over any clean, firm, water-resistant surface, such as brown coat plaster, masonry walls, oil-painted surfaces, etc. It is easily applied to irregular surfaces.

Zonolite Acoustical Plastic has a noise reduction coefficient of .65 for a ½ inch thickness. In effect this means that 65% of noise is absorbed. Few other acoustical materials of equivalent thickness provide as much sound absorption.

Zonolite Acoustical Plastic is FIREPROOF. Combustible ceilings in public buildings are hazardous. Protect this critical area from flash fires with Zonolite Acoustical Plastic.

One bag of Zonolite Acoustical Plastic will cover approximately 4 sq. yds. ½" thick. Mix with approximately 10 gals. of water for good consistency.

MIXING

Pour water into a clean mixing box or mechanical mixer. Add dry Zonolite Acoustical Plastic, and mix thoroughly. Allow to soak 30 minutes, and re-mix prior to application. No set takes place with Zonolite Acoustical Plastic; therefore, large quantities can be mixed ahead and may stand in the mixing box over night.

WATERPROOFING

When installation is made above swimming pools, directly to cold surfaces where condensation may develop, or other places where damp conditions exist, specify plain Acoustical Plastic (to which no pigment has been added). Add Zonolite Waterproofing Admix in the proportion of 1 qt. of Admix to each bag of Zonolite Acoustical Plastic. The order of mixing is then: Water, Admix, and Zonolite Acoustical Plastic. Admix and water must be stirred together before Acoustical Plastic is added.

The Admix will darken the color of the finished plastic

APPLICATION

Apply in two coats, each about ¼" thick, to a finished thickness of ½". Allow first coat to dry before applying second coat. A dry first coat assures a finer texture in finish coat.

Surface may be left under an aluminum or smooth wooden darby. If a finer texture is desired, trowel lightly day after finish is applied. Darby or trowel finish coat in one direction only. Varied textures may be obtained by floating or stippling while wet. Any material left loose by stippling should be pressed back into place by troweling lightly.

To avoid joinings, use sufficient plasterers to complete entire area in one operation. If dry joinings are unavoidable, thoroughly wet back 3 ft. of previous application, and join as though application were continuous.

PAINTING

The new Zonolite Acoustical Plastic is a pleasing off-white and may be satisfactory without further decoration. Where colors are desired, or to obtain a whiter appearance, spray paint with non-bridging, water-thinned resin emulsion or casein paint, such as Kemtone, Texolite, or Spred. Thin each gallon of paint with about 1 gal. of water. Paint may be brushed on, but spray painting is preferable.

Initial decoration and redecoration will not reduce the sound-absorption coefficient provided properly thinned water-base paint is used.

Zonolite Acoustical Plastic Ceiling, school room

ZONOLITE INSULATING CONCRETE

(Covered More Completely in Concrete Manual CA-1)

Zonolite Insulating Concrete, the lightest of all mineral concretes, is a mixture of Portland cement, Zonolite Concrete Aggregate, and water. Its principal uses are:

Floors:
- Grade level floor insulation
- Lightweight floor fills
- Insulation below radiant heat pipes and ducts
- Cold storage
- Farm buildings

Tanks:
- Milk cooling

Roof Construction:
- Lightweight decks
- Insulating fills
- Slope to drains; cants, saddles, crickets

Masonry Wall Insulation:
- Double (Cavity)
- Single unit

Properties of Zonolite Concrete Mixes and Materials Required for 1 cu. yd. of Placed Concrete:

Mix by Volume			Density in Lbs. Per Cubic Foot	Strength in Pounds Per Square Inch		Thermal Conductivity ("K") in B.t.u. Per Inch Thickness Per Sq. Ft. Per Hour Per Degree F.	*Approximate Quantities Required for One Cu. Yd. of Placed Zonolite Concrete		
Bags Portland Cement	Cu. Ft. Zonolite Concrete Aggregate	†Gallons Water		Compressive Strength 1" Disc on 6"x12" Cylinders	Indentation Strength 1" Disc on 3"x12"x12" Slab		Bags Portland Cement	Bags Zonolite Concrete Aggregate	Gallons Water
1	4	12	35	325	350	0.97	7½	7½	85 to 95
1	6	18	25	125	160	0.76	5	7½	85 to 95
1	8	24	22	70	121	0.60	3¾	7½	85 to 95
1	16	48	16	11	28	0.46	1⅞	7½	85 to 95

(Each bag of Zonolite Concrete Aggregate contains approximately 4 cu. ft.)

†A wet mix is recommended, a 6" to 9" slump as measured by a standard slump cone.

*These figures are recommended for estimating purposes. Allowance must be made for sag in forms and loss in mixing and placing.

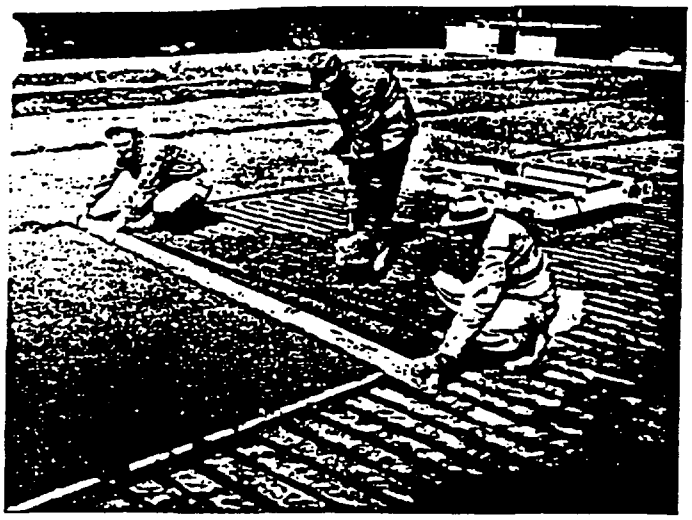
MIXING AND PLACING ZONOLITE CONCRETE

Job Mixed: Zonolite Concrete shall be mixed in a mechanical mixer, preferably of the paddle type which has a stationary drum with rotating paddles. Any sequence of charging the mixer is satisfactory which results in all water and all aggregate coming together at one time. The yield of concrete will be reduced if either water or aggregate is added slowly while mixing continues. Mix to uniform and pourable consistency (approximately 3 minutes). Place the mixed concrete promptly to avoid any change in slump or consistency.

Transit Mixed:

1. Place all water, cement, and aggregate (in this order if possible) for required batch in the mixer.
2. Turn drum at plant only enough to obtain uniform mix.
3. Do not turn drum while driving from plant to job.
4. At job, remix approximately 1 minute. Add water if necessary to obtain 6" to 9" slump.

Over-mixing or delay in placing will result in low yield.



Typical finished surface after screeding

FINISHING

Zonolite Concrete shall be placed in panels of a width capable of being screeded and finished. Screeding usually provides the desired finish. A smoother finish may be obtained by floating. Troweling is unnecessary and is not recommended.

CURING ZONOLITE CONCRETE

The curing of any concrete is particularly important. Cement becomes a strong binder only because of its chemical reaction with water. To allow the cement and water to complete the chemical reaction and to prevent the water in the mix from escaping, surface curing is necessary.

The following methods of curing sand-and-gravel concrete apply also to Zonolite Concrete:

Warm and Hot Weather Construction:

1. Keep the surface constantly wet with water for three days. A covering of wet burlap or wet canvas may be used. The covering is placed as soon as it can be done without marring the surface, care being taken to keep covering continuously wet by sprinkling. When a cover is not used, sprinkling is begun as soon as the concrete has set.

2. Ponding is a good method of curing for flat surfaces, such as floors and roofs. With this method, the surface to be cured is surrounded by small earth dikes, and kept flooded with water for about three days.

3. Another method suitable for curing concrete is the use of asphalt curing compounds which prevent rapid evaporation of the mixing water needed for proper hydration of the cement. These coatings are sprayed on immediately after the free water has disappeared from the concrete's surface. Follow manufacturer's recommendations for coverage. The surface must be well coated with asphalt.

Cold Weather Construction:

It is not advisable to place Zonolite Concrete if temperatures below 30° F. are expected within two or three days. If job conditions are such that it is necessary to place Zonolite Concrete in temperatures below 30° F., the following precautions should be observed:

1. Use high early strength cement.

2. The concrete must be placed in the forms at a temperature of not less than 60° F. nor more than 80° F. This is accomplished by heating the mixing water, taking care that water is not heated to more than 175° F.

3. After the concrete is placed, it must be kept from freezing for at least five days. Cover with heavy paper, and then with hay or straw. Provide heat with steam, if available, or with some form of salamander. Do not place salamanders too near the fresh concrete to cause rapid drying.

The strength gain of any concrete is slow at low temperatures. For this reason, the temperature of the concrete should be maintained above 50° if possible. The effect of temperature is given by the following data from the American Concrete Institute:

Average 24 Hr. Temperature	Days to Reach Equal Strength
70° F.	7 days
60° F.	15 days
50° F.	23 days
40° F.	31 days

The fresh concrete must be protected against damage from other construction activity. The length of time such protection will be required depends entirely upon the temperatures and moisture present during the early stages of curing.

Radiant heat pipes on Zonolite Insulating Concrete

ZONOLITE CONCRETE FLOORS

Zonolite Insulating Concrete floors provide efficient thermal insulation in heated buildings, in refrigerated buildings, and in animal shelters. Zonolite Concrete floors are fireproof, rot-proof, permanent, and easily installed.

Drainage: Provide adequate drainage in all types of floor construction.

Animal Shelters: Properly installed, Zonolite Concrete floors will remain dry, even in animal shelters where relative humidity is unusually high. They can be quickly installed in old or new structures.

New Floors: Fill area with gravel to within 3" of top of concrete footings. Place 3" thick slab of Zonolite Insulating Concrete, 1-to-6 mix, level with top of footing or sill. Allow to stand over night to set. Place 2" of sand concrete topping for permanent wearing surface.

1-to-6 Mix	1½	bags	Zonolite Concrete Aggregate
	1	bag	Portland cement
	18	gals.	Water (Approx.)

This mix will cover approximately 22 sq. ft. 3" thick.

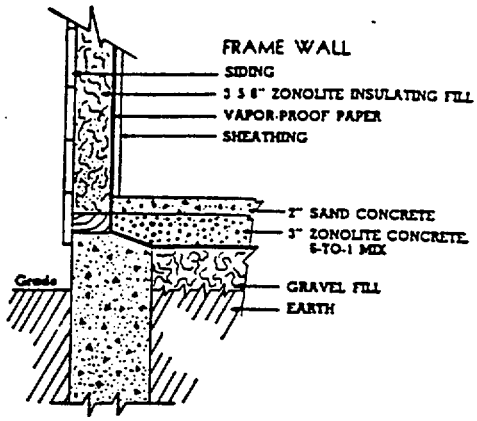
Existing Floors: Lay heavy, asphalt-impregnated roofing paper over old floor of ordinary concrete or tile. Place 3" thick slab of Zonolite Insulating Concrete, 1-to-6 mix. Allow to stand over night to set. Place 2" of sand concrete topping for permanent wearing surface.

Grade Level and Radiant Heat Floors: (Covered More Completely in Folder CA-4.) Fill floor area with gravel to within 4" of top of concrete footing. Lay the vapor barrier over gravel fill. Vapor barrier should consist of two layers of glossy - surfaced, asphalt-impregnated paper with edges lapped 4" and sealed (Treated Sisalkraft, Bird's Neponset, Ruberoid's Giant Sheathing Paper, or equal), or two layers of tarred felt in three moppings of hot pitch. Place Zonolite Insulating Concrete, 1-to-6 mix, level with top of footing.

1-to-6 Mix	1½	bags	Zonolite Concrete Aggregate
	1	bag	Portland cement
	18	gals.	Water (Approx.)

This mix will cover approximately 16 sq. ft. 4" thick.

Radiant heating pipes or ducts, where used, are laid on the Zonolite Concrete slab, and covered with a sand concrete slab to a thickness of 1" above the pipes. A light wire mesh embedded in the sand concrete topping minimizes cracking.



Detail, Farm Building Floor

Design the topping to carry the anticipated load. Minimum thickness, 2".

Cold Storage Floors: (Covered More Completely in Cold Storage Manual CS-1.)

For best results, the floor should be constructed above ground with air circulation below. Floors directly on the ground are satisfactory for room temperatures above 20° F. Make sure of good drainage away from the under side of floor (see Zonolite fill floors, page 12, for temperatures below 20°). If in doubt, consult our Engineering Department.

First provide structural floor capable of carrying floor loads. Over this place a good VAPOR BARRIER—2 layers of tarred felt mopped in hot pitch. Next, place required thickness of Zonolite Concrete, 1-to-8 mix, as per table below:

Temperature	Recommended Thickness On Ground	Recommended Thickness Above Ground
Above 50°	4"	4"
50 - 35	6"	6"
35 - 20	8"	8"
20 - 10	—	10"
10 - 0	—	12"
0 - — 10	—	14"
Below — 10	—	16"

1-to-8 Mix	2	bags	Zonolite Concrete Aggregate
	1	bag	Portland cement
	24	gals.	Water (Approx.)

This mix makes approximately 7 cu. ft. of concrete.

After the Zonolite Concrete has set and become dry, broom the surface clean and apply sand concrete topping capable of supporting anticipated loads. Minimum thickness, 2". Do not mix topping too rich. 1 part cement, 3 parts sand, 2 parts pea gravel is recommended. A reinforcing mesh in the topping is recommended to minimize shrinkage cracks.

Moisture present in the concrete at time refrigeration is turned on will gradually be drawn to the refrigerating coils.

ZONOLITE CONCRETE ROOF DECKS AND INSULATION

Zonolite Insulating Concrete has gained wide recognition in recent years as efficient roof insulation. It does not rot, disintegrate, or burn. There are no joints to open up. The insulation, including cants, saddles, and crickets, may be placed monolithically all at one time. Roof leaks will not deteriorate Zonolite Concrete because it is not affected by moisture. The customary built-up roof of asphalt or pitch-and-gravel is applied over the Zonolite Concrete slab after it has set and dried out.

ROOF DECKS

(Covered More Completely in Folder CA-5)

Support: Zonolite Concrete can be used effectively as the roof deck where joists or other support is provided at close spacing—up to 32". Where joists or purlins are widely spaced, a sub-purlin (usually a light "T" section) may be incorporated to provide proper spacing for support.

Insulation Value: A 3" Zonolite Concrete deck will provide a U factor for the roof of .24. Greater insulation values can be provided by increasing the thickness.

Strength: The strength of Zonolite Concrete decks depends upon the joist spacing, type of form and reinforcing used, and thickness of slab. The construction recommended will provide for 50 lbs. live load with an excellent safety factor.

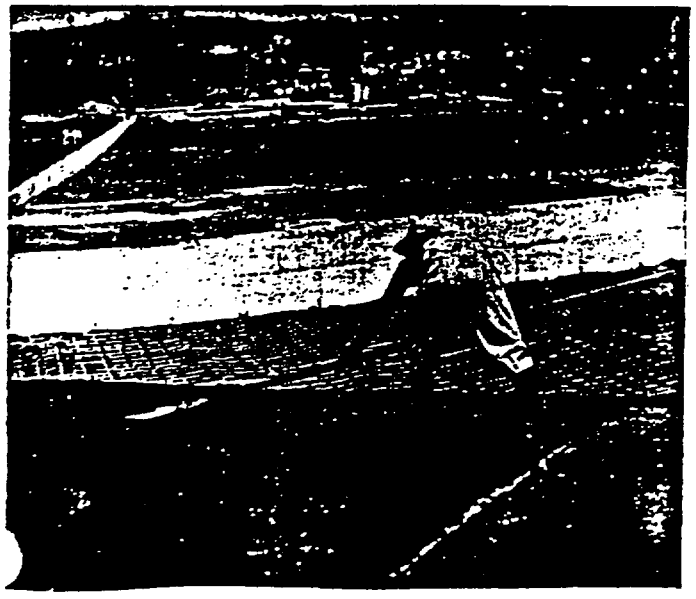
Joist Spacing	Min. Slab Thickness
Up to 16"	2"
16" to 24"	2½"
24" to 32"	3"

The 1-to-4 mix is recommended.

1-to-4 Mix	1 bag	Zonolite Concrete Aggregate
	1 bag	Portland cement
	12 gals.	Water (Approx.)

This mix will cover approximately 14 sq. ft. 3" thick.

Forms: Permanent form material is recommended. The form shall be stiff enough to support the fresh concrete until it has set. Paper-backed wire mesh (Steeltex), high rib metal lath, corrugated sheet steel, asbestos board, and some types of insulation boards provide satisfactory forming.



Structural deck. Zonolite Concrete over Steeltex

Reinforcing: High rib metal lath and Steeltex provide necessary reinforcing for the deck. When other types of form material are used, a reinforcing mesh must be embedded in the lower half of the slab. Use a 6"x6"x10 gauge welded wire mesh or equal.

ROOF INSULATION

(Covered More Completely in Folder CA-2)

Zonolite Concrete roof insulation is placed over a structural roof deck, such as concrete, steel, tile, wood, etc. If applied over a wood deck, cover the wood with a layer of waterproof paper before placing the concrete. The structural deck may be designed dead level. The lightweight Zonolite Concrete may be placed sloping to the drains. Thickness of the Zonolite Concrete shall be designed to provide the insulation value and/or drainage desired—minimum thickness, 2".

The 1-to-6 mix is recommended.

1-to-6 Mix	1½ bags	Zonolite Concrete Aggregate
	1 bag	Portland cement
	18 gals.	Water (Approx.)

This mix will cover approximately 16 sq. ft. 4" thick.

ROOFING

APPLICATION OF BUILT-UP ROOFING: A Zonolite Concrete roof deck is ready for built-up roofing when it has developed the following characteristics:

1. **Surface Hardness:** Hardness of the surface shall be considered adequate when it will withstand foot traffic and other light operations of roofing, without damage; but it must be protected from gouging or excessive loads.

2. **Surface Finish:** Surface shall be firmly bound and free from loose material. The screeded surface finish shall be free from any extreme roughness capable of interfering with proper bonding of the felt.

3. **Surface Dryness:** The exposed surface shall look and feel substantially dry, and have a uniform gray-cement color. When in this state, the hot mopped bond coat will go on smoothly without frothing, and will adhere well to the surface.

MASONRY WALL INSULATION

Double (Cavity) Walls: Masonry walls can be very satisfactorily insulated by constructing a two-unit ("Cavity") wall, using two separate walls of tile or concrete block spaced 2½" or more apart. The cavity thus formed is filled with a very lean mix of Zonolite Concrete.

Lay up 3 or 4 courses of inside wall. Apply an asphalt paint as a vapor barrier to cavity side of this wall. The paint can be applied with a brush or sprayed on. Lay up outside wall to same level, and place necessary wall ties. Place Zonolite Concrete in cavity as soon as mortar used in laying up blocks has become thoroughly set. Zonolite Concrete should be rodded into cavity as each 3 or 4 courses of masonry are laid up.

Single Unit Walls: Concrete block walls can be insulated by filling the cores of the blocks with Zonolite Insulating Concrete. Due to the conductance through the solid portion of the block, this wall does not provide as much insulation as the double cavity wall described above, but provides approximately twice as much insulation value as the wall with the cores left open.

The 1-to-16 mix is recommended for masonry walls:

1-to-16 Mix	4 bags	Zonolite Concrete Aggregate
	1 bag	Portland cement
	48 gals.	Water (Approx.)

This mix will cover approximately 76 sq. ft. 2½" thick.

Mixing: For such installations, the Zonolite Concrete is more conveniently mixed in a mortar box, inasmuch as smaller quantities of concrete are needed at one time. A garden rake works well for mixing. To keep crew working continuously, tenders for the masons can mix up batches of Zonolite Concrete, and place it in the walls, following the masons.

Insulating cavity wall with Zonolite Concrete

ZONOLITE CONCRETE MILK COOLING TANKS

Zonolite Insulating Concrete makes an efficient, economical, insulated milk tank. The 1-to-3 mix is recommended:

1-to-3 Mix	¾ bag	Zonolite Concrete Aggregate
	1 bag	Portland cement
	4½ qts.	Zonolite Waterproofing Admix
	9 gals.	Water (Approx.)

This batch will make approximately 3 cu. ft. of concrete.

Zonolite Waterproofing Admix is specified in order to make a more waterproof concrete, particularly important in a milk-cooling tank.

Mixing Directions: When Zonolite Waterproofing Admix is used, place correct amount of water in mixer, then the Admix, followed by the Portland cement. Mix slightly. Add Zonolite Concrete Aggregate, and mix to uniform and pourable consistency. Place promptly.

Walls of milk tank should be 8" thick, and reinforced with wire netting, as well as steel rods spaced 12" on center. Interior of tank should be painted with a good waterproof coating.

ZONOLITE INSULATING PLASTIC

(Covered More Completely in Folder G-23)

Zonolite Insulating Plastic is used principally by householders for insulating hot water tanks, furnaces, boilers, hot water and steam pipes, chimney flue openings, and stoves. It comes ready-mixed and needs only the addition of water.

Zonolite Insulating Plastic will stick to any clean surface without wrapping or reinforcing. It is fireproof and permanent, and can be easily applied with a trowel or the hands.

The formula is:

2 parts Zonolite Insulating Plastic
1 part Water, by volume
Warm water accelerates plasticizing.

One bag of Zonolite Insulating Plastic will cover approximately 12 sq. ft. ½" thick.

ZONOLITE REFRIGERATION INSULATION

(Covered More Completely in Cold Storage Manual CS-1)

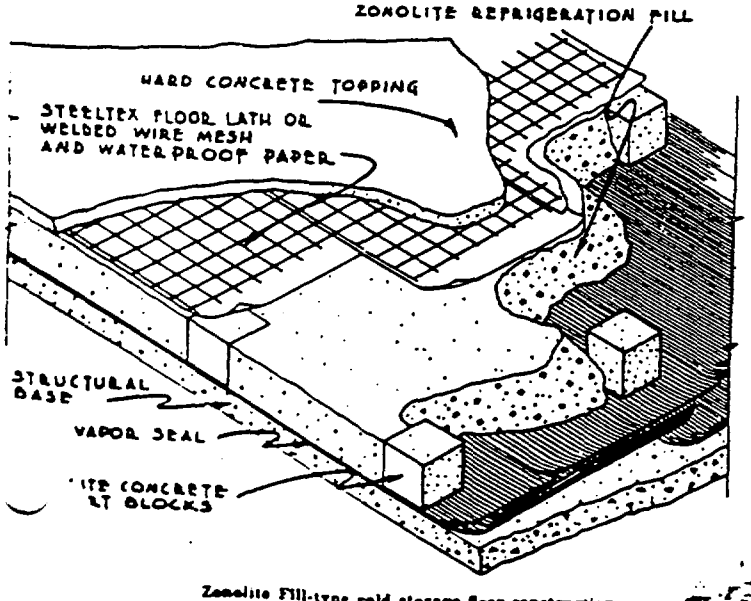
Due to many special problems encountered in cold storage work, it is desirable that a competent refrigeration engineer be consulted for such installations. Our Engineering Department will be glad to advise regarding the use of Zonolite products.

The following table shows minimum and recommended thicknesses of Zonolite Refrigeration-size Fill for temperatures to be maintained. The thickness of insulation affects the size and cost of refrigeration equipment. Cost of operation of a cold storage plant is also proportional to the thickness of insulation. The greater the thickness of insulation, the less will be the original cost of equipment, and the lower will be the operating cost. The refrigeration engineer who designs the installation can determine what insulation thickness will give the most practical and economical result. Zonolite is so inexpensive and easy to install that greater thicknesses can be economically used.

Temperature	Walls, Ceilings, Floors Above Ground		Floors on Ground	
	Minimum	Recommended	Minimum	Recommended
Above 50°	2"	4"	2"	3"
50 - 35	3"	5"	3"	4"
35 - 20	4"	6"	4"	5"
20 - 10	5"	8"	4"	6"
10 - 0	6"	10"	5"	8"
0 - —10	7"	12"	5"	8"
—10 - —20	8"	13"	6"	8"
Below —20	9"	14"	6"	8"

Zonolite Fill Cold Storage Floors with Pre-cast Zonolite Concrete Blocks: Zonolite Refrigeration-size Fill may be combined with pre-cast Zonolite Insulating Concrete blocks for insulating cold storage floors.

If the floor is to be built on the ground, place a 3" structural slab over a well-drained gravel fill. Best results can be obtained by constructing the structural floor above the ground, providing air circulation below the floor. Over the structural floor, apply the vapor barrier. Place pre-cast Zonolite Concrete blocks, at least 6" by 8" in cross section, spaced 2 ft. on center both ways. Blocks should be as high as needed to provide thickness of insulation required. After blocks are set in place, pour Zonolite Refrigeration-size Fill level with top of blocks. Roll waterproof paper over Zonolite to keep insulation dry while placing concrete. Place a structural concrete slab 3" thick. The structural slab should be reinforced with a 6" by 6" by 10 gauge reinforcing mesh. Two sizes of Zonolite Concrete blocks, 6" by 8" by 10" or 8" by 10" by 12" are suitable for Zonolite Cold Storage floor installations.



Zonolite Fill-type cold storage floor construction

For Zonolite Concrete cold storage floors, see p. 9.

Installing Zonolite Refrigeration-size Fill in Sidewalls and Ceilings: When Zonolite Refrigeration-size Fill is poured into walls or sloping ceilings, these areas must be vibrated or rodded during installation.

All types of wall construction must be built to eliminate any movement or bulging which would permit settling of the insulation. In hollow masonry construction, all interior joints should be carefully filled with mortar to prevent sifting of the Zonolite Fill into the cores.

Side-wall insulation should connect directly with ceiling and floor insulation, so that no breaks or joints occur. The use of balloon-type construction having no plates or fire-stops at the ceiling and floor line makes it possible to install Zonolite Refrigeration-size Fill so that wall, ceiling, and floor insulation is continuous.

Cavity tile wall showing vapor barrier

Cold Storage Vapor-Proofing: The vapor-proofing of any construction used for cold storage insulation is exceedingly important. Due to the wide difference in temperature between the inside and outside of the cold storage room, vapor pressure becomes great on the warm side of the walls, ceiling, and floor. Too much passage of moisture-vapor will result in condensation within the insulation. Moisture within the insulation reduces efficiency and increases operating costs.

There are two acceptable types of vapor barrier. Select the type most adaptable to the type of construction used.

(1) Two layers of glossy-surfaced, asphalt-impregnated paper with edges lapped 4" and sealed. (Treated Sisalkraft, Bird's Neponset, Ruberoid's Giant Sheathing Paper, or equal.)

(2) Two layers of tarred felt in three moppings of hot pitch.

The vapor barrier is placed only on the warm side of the insulation. Any cracks or openings in the vapor barrier, even though only the size of a nail hole, should be sealed. The heads of the nails which secure the vapor barrier to the studding should also be sealed.

ZONOLITE

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REALLY STOPS HEAT

THE MODERN MIRACLE OF INSULATION

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ZONOLITE

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EPA

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1985 EDITION

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Office of Toxic Substances
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Joseph Breen, Exposure Evaluation Division

Elizabeth Dutrow, Exposure Evaluation Division

Dave Mayer, Asbestos Action Program

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Carol Bass, Office of Toxic Substances/Exposure Evaluation Division

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SUMMARY OF GUIDANCE

INTRODUCTION

Airborne asbestos contamination in buildings is a significant environmental problem. Various diseases have been linked with industrial exposure to airborne asbestos, and the extensive use of asbestos products in buildings has raised concerns about exposure to asbestos in nonindustrial settings. Surveys conducted by the Environmental Protection Agency (EPA) estimate that asbestos containing materials can be found in approximately 31,000 schools and 733,000 other public and commercial buildings in this country.

The presence of asbestos in a building does not mean that the health of building occupants is necessarily endangered. As long as asbestos-containing material (ACM) remains in good condition and is not disturbed, exposure is unlikely. When building maintenance, repair, renovation or other activities disturb ACM, or if it is damaged, asbestos fibers are released creating a potential hazard to building occupants. Although not required to do so by federal law, the prudent building owner will take steps to limit building occupants' exposure to airborne asbestos. In 1983 EPA prepared and distributed "Guidance for Controlling Friable Asbestos-Containing Materials in Buildings" (USEPA 1983a). Since this guidance was published, EPA has gathered additional information and has gained valuable experience through its continuing Asbestos-in-Buildings Program. The guidance document has been substantially revised to incorporate this new information and to reflect the comments and suggestions of building owners and other readers. EPA offers building owners guidance to understand the technical issues, determine if asbestos is present in a building, plan a control program, and choose the course of further action if necessary.

This summary is divided into two parts. The first is an introduction to the problem of asbestos in buildings and summarizes the material that is presented in Chapter 1. The second part of the summary provides a concise outline of the remainder of the report. It lists the major steps needed to determine whether asbestos is present in a building (Chapter 2), establish a special operations and maintenance (O&M) program (Chapter 3), assess the need for further action (Chapters 4 and 5), and carry out an abatement project (Chapter 6). It is intended as a checklist for the building owner.

ACM IN BUILDINGS

ACM in buildings is found in three forms: (1) sprayed or troweled on ceilings and walls (surfacing material); (2) in insulation around hot or cold pipes, ducts, boilers, and tanks (pipe and boiler insulation); and (3) in a variety of other products such as ceiling and floor tiles and wall boards (miscellaneous materials). In general, ACM in the first two categories is of greatest concern, especially if it is friable. (Friable material can be crumbled, pulverized, or reduced to powder by hand pressure.)

Testing for ACM is required in primary and secondary schools only. (Regulations are specified in "The Friable Asbestos-Containing Materials in Schools; Identification and Notification Rule.") At present, no parallel rule applies to other public or commercial buildings. Further, no Federal regulations require abatement actions (repair or removal, enclosure, encapsulation).

The OSHA (Occupational Safety and Health Administration) regulations specifying work practices and the EPA rules governing the handling and disposal of asbestos apply to abatement actions. State regulations on these issues vary and may be more stringent than federal requirements.

ASBESTOS CONTROL ACTIVITIES

The following pages outline the steps that a building owner should take to control asbestos. Each step is described in more detail in the body of the report.

Survey to See If Asbestos Is Present

- Appoint an asbestos program manager and assemble a survey team.
- Check building records for evidence of asbestos- containing surfacing materials, pipe and boiler insulation, or miscellaneous ACM.
- Locate and document all ACM identified in building records.
- Inspect the building for friable materials on walls or ceilings. Inspection means touching walls and ceilings.
- Inspect the building for insulation on pipes and boilers. Inspection means looking at pipes and boilers.
- Be persistent. Friable materials may be hidden behind dropped ceilings or partitions.
- Collect samples of friable ceiling and wall materials following EPA procedures.
- Collect samples of pipe and boiler wrap if the insulation is exposed. Otherwise, assume the insulation contains asbestos.
- Send samples to a qualified laboratory for analysis by polarized light microscopy (PLM). If the samples show more than one percent asbestos, the building contains ACM.
- Document all findings.

Establish a Special Operations and Maintenance (O&M) Program

- Obtain cooperation of building maintenance and custodial managers.
- Educate building occupants and employees about ACM.
- Train custodial and maintenance workers in special cleaning techniques and maintenance precautions.
- Clean the building thoroughly using wet cleaning and HEPA-vacuum techniques.
- Repeat the cleaning monthly (near surfacing materials) or semi-annually (near wrapped insulation).
- Take special precautions before starting maintenance and construction work.
- Inspect ACM at least twice a year for evidence of damage or deterioration.
- Continue the O&M program until all ACM is removed.

Assess the ACM to Determine the Need for Further Action

- Assess the likelihood of fiber release from the ACM by evaluating its current condition and the potential for future disturbance, damage or erosion.
- Determine:

- The need for further action.
- When it should be done.
- What abatement method should be used.

Conduct Abatement Actions If Needed

- Hire an abatement contractor or, if in-house capabilities are available, use building staff.
- To select a contractor:
  - Write precise contract specifications.
  - Check references.
  - Conduct interviews.
  - Review insurance coverage.
  - Select the "best" contractor, not necessarily the lowest bidder.
- To Manage the work:
  - Inspect the work site at least four times a day to insure compliance with all prescribed work practices and worker protection measures. These include:
    - Construction of a containment barrier around the entire work area, or the use of containment bags for wrapped insulation.
    - Use of coveralls and respirators by the workers.
    - Provision of worker change and decontamination facilities.
  - Stop abatement work immediately if any condition of the worksite appears to be hazardous.
  - Release the contractor only after:
    - The work site has been thoroughly cleaned at least twice.
    - The work site passes a visual test for abatement completion and cleanliness.
    - The work site passes a test for airborne asbestos.

CHAPTER 1. BACKGROUND ON EXPOSURE TO ASBESTOS INSIDE BUILDINGS

Construction materials containing asbestos have been used extensively in schools and other buildings. The concern about exposure to asbestos in these buildings is based on evidence linking various respiratory diseases with occupational exposure in the shipbuilding, mining, milling, and fabricating industries. The presence of asbestos in a building does not mean that the health of building occupants is endangered. If asbestos-containing material (ACM) remains in good condition and is unlikely to be disturbed, exposure will be negligible. However, when ACM is damaged or disturbed — for example, by maintenance or repairs conducted without proper controls — asbestos fibers are released. These fibers can create a potential hazard for building occupants.

This chapter describes ACM found in buildings and the potential health risks to occupants of buildings where ACM is present. Also, federal regulations addressing asbestos in buildings are briefly summarized.

SUMMARY

ACM in Buildings: Three forms of asbestos are typically found in buildings: (1) sprayed- or troweled-on surfacing materials; (2) insulation on pipes, boilers, and ducts; and (3) miscellaneous forms, such as wallboard, ceiling tiles, and floor tiles. EPA surveys estimate that 31,000 schools and 733,000 public and commercial buildings contain friable (easily crumbled) ACM. Friable ACM and ACM disturbed during maintenance, repair or renovation are of greatest concern from an exposure perspective.

Levels of Airborne Asbestos in Buildings and Other Settings: Prevalent levels of airborne asbestos inside buildings with ACM may be 10 to 100 times higher than outdoor levels. However, these indoor levels are typically 10,000 to 100,000 times lower than levels in asbestos industry workplaces where asbestos-related diseases have been well-documented.

Asbestos-Related Disease: Most people with asbestos-related diseases (asbestosis, lung cancer, and mesothelioma) were exposed to high levels of asbestos while working in asbestos industries prior to 1972. Extrapolation of the relationship between exposure level and disease indicates that only a small proportion of people exposed to low levels of asbestos will develop asbestos-related diseases. Smokers, children, and young adults are at somewhat greater risk.

Federal Regulations Regarding Asbestos in Buildings: Current regulations (1) restrict the use of most asbestos products in new buildings, (2) specify work practices for removal of ACM from buildings, and (3) require the identification of asbestos in schools. There are no exposure standards for nonindustrial settings, and no regulations requiring corrective actions in buildings with ACM.

1.1 Asbestos-Containing Materials in Buildings

Asbestos may be found in cement products, acoustical plaster, fireproofing textiles, wallboard, ceiling tiles, vinyl floor tiles, thermal insulation, and other materials.[1] EPA surveys estimate that 31,000 schools and 733,000 federal and commercial buildings have ACM in one form or another (USEPA 1984a, 1984b). ACM has been grouped into three categories: (1) sprayed- or troweled-on materials on ceilings, walls, and other surfaces; (2) insulation on pipes, boilers, tanks, ducts, and other equipment; and (3) other miscellaneous products. (Examples of ACM are shown in Figure 1.) Material in the first two categories can be friable, that is, it can be crumbled, pulverized, or reduced to powder by hand pressure. Most ACM in the third category is nonfriable.

[1] Descriptions of these and other types of products containing asbestos appear in Appendix A.

Friable materials are more likely than nonfriable materials to release fibers when disturbed or damaged. Although nonfriable ACM is of less immediate concern, it should not be ignored. Fibers will be released if nonfriable material is cut, drilled, sanded, or broken during building repairs or renovation.

1.2 Levels of Airborne Asbestos in Buildings and Other Settings

Levels of airborne asbestos in the asbestos industry workplace are substantially higher than levels found outdoors or in buildings with ACM. Figure 2 shows levels measured in the three settings: asbestos insulation plants before the 1972 Occupational Safety and Health Administration (OSHA) exposure standards, schools with ACM, and outdoor urban areas.[2] The range of values in each category reflects differences in location, source of asbestos, and variability in asbestos measurements. Concentrations may exceed the upper limits of these ranges for short periods if, for example, manufacturing equipment malfunctions, insulating material is pierced with a sharp object, or asbestos-coated surfaces are disturbed by the impact of a ball or similar object.

Figure 2 shows that prevalent concentrations of airborne asbestos in a sample of school buildings were approximately 10 to 100 times higher than outdoors. At the same time, asbestos levels in the schools were 10,000 to 100,000 times lower than pre-1972 levels in asbestos insulation workplaces.[3]

1.3 Diseases Associated with Exposure to Asbestos

Much of what is known about asbestos-related diseases comes from studying workers in the various asbestos industries. Exposure to levels of airborne asbestos typical of the asbestos workplace prior to 1972 has been linked with a debilitating lung disease called asbestosis; a rare cancer of the chest and abdominal lining called mesothelioma; and cancers of the lung, esophagus, stomach, colon, and other organs. In 1972 federal exposure standards were imposed.

The relationship between exposure level and health risk is complex. The potential for disease appears to be related to the physical and chemical characteristics of asbestos fibers as well as to the concentration of fibers in the air. Data on asbestos workers indicate that the risks of asbestosis, lung cancer, and mesothelioma decrease in direct proportion to a decrease in total asbestos dose. Because there is no direct information on health risks from exposure to asbestos in buildings with ACM, the risks are estimated by extrapolation from studies of asbestos industry workers (Nicholson 1984, NRC 1984, The Royal Commission of Ontario 1984). The estimates indicate that only a small proportion of people exposed to low levels of asbestos will develop asbestos-related diseases. However, combining smoking with occupational exposure to asbestos increases the lung cancer rate above the rate due to either smoking or asbestos exposure alone. Also, asbestos exposure in children is of special concern: since they have a greater remaining lifespan than adults, their lifetime risk of developing mesothelioma is greater. Avoiding unnecessary exposure to asbestos is prudent.

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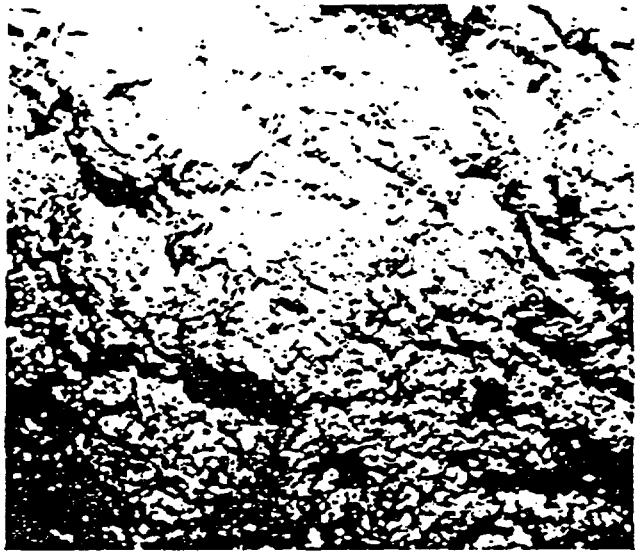
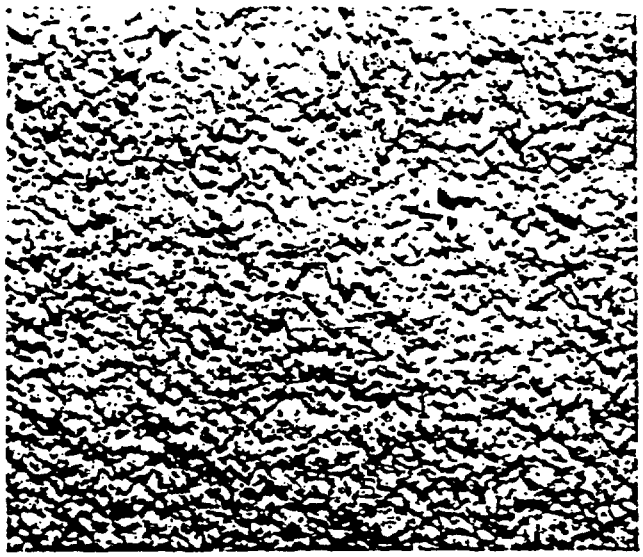
[2] For comparison, all data are expressed in nanograms per cubic meter (ng/m^3) units. Concentrations of asbestos fibers in the air are measured in terms of either the number of fibers per unit volume (typically, fibers per cubic centimeter) or the mass per unit volume (typically, ng/m^3). A nanogram is one-billionth of a gram. See Appendix B for a simple explanation of measurement units used for airborne asbestos concentrations.

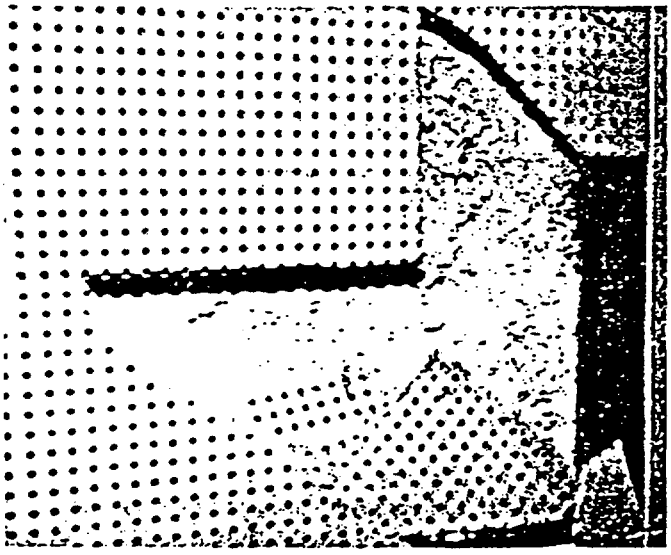
[3] The data in Figure 2 should be interpreted with caution. Estimated concentrations in asbestos workplaces are based on measurements of airborne fibers using the method specified by OSHA (phase contrast microscopy), while the levels in schools and outdoors were measured by a different method (transmission electron microscopy). Comparisons of measurements obtained by the two methods are based on certain assumptions (see footnote to Figure 2). Measurement of airborne asbestos fibers is a complex subject and is discussed in more detail in Section 4.1.2.



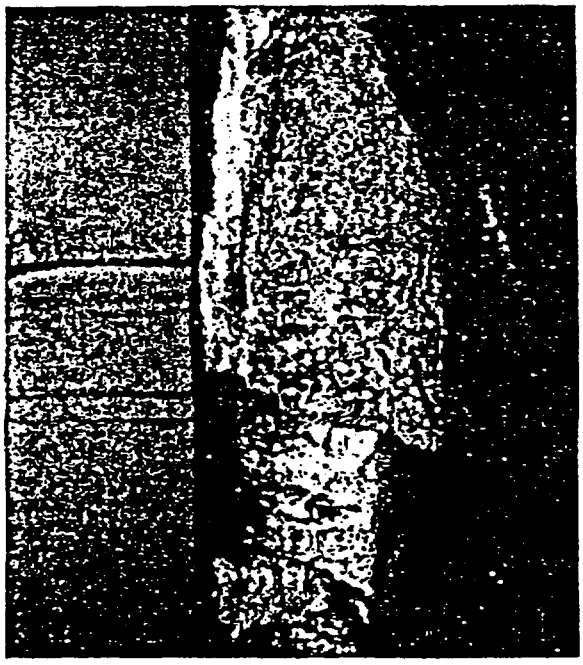
Friable, fluffy sprayed-on material



Friable, cementitious sprayed-on or troweled material (acoustical plaster)



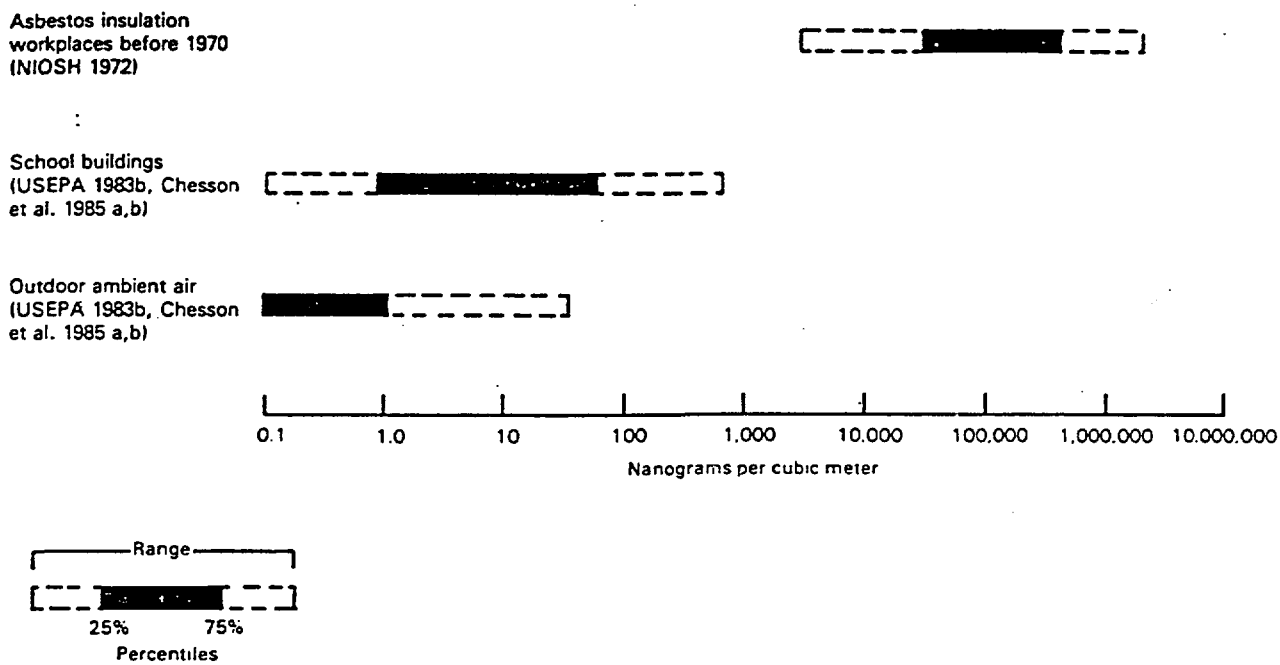
Nonfriable wallboard with friable sprayed-on material behind



Pipe lagging

Figure 1. Examples of asbestos-containing materials found in buildings.

Figure 2. Comparison of measured airborne asbestos concentrations in three settings.*



*Levels in asbestos workplaces were derived from measurements using phase contrast microscopy (PCM) while levels in school buildings and outdoors were measured using electron microscopy (EM). PCM and EM measurements are not directly comparable. PCM measures all fibers whereas EM can distinguish between asbestos and nonasbestos fibers. In addition, EM has a better capability than PCM for detecting small fibers. In order to translate the workplace PCM measurements (expressed as fiber counts) into values of asbestos mass (nanograms) that are approximately comparable to EM measurements, 30 fibers were assumed to equal one nanogram. This value is an average obtained from many comparisons of PCM and EM measurements taken at the same location (industrial settings) and time. Values for individual samples range from about 10 fibers per nanogram of asbestos to well over 100 fibers per nanogram, depending on the average size of fibers and the relative number of asbestos and nonasbestos fibers in the air (Versar 1980 and William Nicholson, personal communication, 1982).

1.4 Federal Regulations Regarding Asbestos in Buildings

Both EPA and OSHA have published regulations to reduce asbestos exposure. EPA regulations focus on: (1) application and removal of ACM in new or remodeled buildings, and (2) identification of friable asbestos in schools. EPA also regulates the industrial emission of asbestos fibers and the disposal of asbestos waste. OSHA addresses worker protection in the workplace.

The first EPA regulations were issued in 1973 under the National Emission Standards for Hazardous Air Pollutants (NESHAPS), as authorized by the Clean Air Act. The first regulations were directed largely at the asbestos industries, but also partially banned spray-applied ACM in new buildings, and established procedures for handling ACM during demolition. The regulations were revised in 1975 and 1978 to cover building renovations, the use of all types of insulating ACM in new buildings, and asbestos emissions from ACM waste disposal.[4]

Of particular interest to owners of buildings with ACM are the following regulations:

- When a building is demolished — or more than 260 linear ft. of asbestos pipe insulation or 160 sq. ft. of asbestos surfacing material are removed during renovation — advance notice must be filed with the EPA regional office and/or the state, giving:

  — name and address of the building owner or manager;
  — description and location of the building;
  — scheduled starting and completion dates of ACM removal;
  — description of the planned removal methods; and
  — name, address, and location of disposal site.

- ACM can be removed only with wet removal techniques (see Section 5.1). Dry removal is allowed only under special conditions and only with written EPA approval.

- No visible emissions of dust are allowed during removal, transportation, and disposal of ACM. (The wet removal techniques described in Section 5.1 are designed to satisfy this requirement.)

The entire text of the NESHAPS regulations appears in Appendix C. Before beginning any ACM removal or building demolition, the building owner should review the NESHAPS requirements in detail. More information can be obtained from the regional NESHAPS contact. Addresses and telephone numbers of the contacts are found in Appendix D.

The second set of EPA regulations is in the "Friable Asbestos-Containing Materials in Schools; Identification and Notification Rule," (40 CFR Part 763)[5] promulgated under the Toxic Substances Control Act. Known as the Asbestos-in-Schools rule, it requires all primary and secondary schools, both public and private, to:

- inspect, sample, and analyze friable materials for asbestos;

- document all findings; and

- inform all school employees and the school's parent-teacher organization (or parents, ~~if there is no~~ organized group) of the location of friable ACM, and provide each custodial worker with a copy of the EPA publication, "A Guide for Reducing Asbestos Exposure," as published in the FEDERAL REGISTER (40 CFR Part 763).

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[4] The complete set of regulations was repromulgated on April 5, 1984.

[5] The deadline for compliance with the Rule was June 28, 1983. A copy of the Rule is available from EPA. See Appendix E.

The OSHA regulations were first issued in 1972 and modified in 1976. They specify airborne exposure standards for asbestos workers, engineering and administrative controls, workplace practices, and medical surveillance and worker protection requirements. In 1982, OSHA announced its intention to tighten the exposure standards. (See the "Calendar of Federal Regulations," published in the FEDERAL REGISTER [47 FR 1807].)[6] The OSHA regulations apply to all workplace activities involving asbestos, including removal of ACM from buildings. Future OSHA regulations may include separate exposure standards for ACM removal operations. The complete text of the OSHA regulations appears in Appendix F.

OSHA's worker exposure standards are inappropriate for nonindustrial settings. First, the standards were set to protect workers only against asbestosis, which does not occur at the lower exposure levels typical of buildings with ACM. Second, the measurement technique that determines OSHA compliance does not distinguish between asbestos and nonasbestos fibers and does not measure the small asbestos fibers typically found in buildings with ACM.

The measurement problem is not a major shortcoming in industrial settings where most airborne fibers are expected to be asbestos. However, only a few fibers in building air are asbestos, and the OSHA measurements may be misleading. (Other limitations of the OSHA technique further confound the measurement of airborne asbestos in buildings. See Section 4.1.2 for a more detailed discussion of measuring airborne asbestos.)

[6] As of July 1, 1976, the OSHA standards were set at 2 fibers per cubic centimeter averaged over 8 hours and a ceiling level not to exceed 10 fibers per cubic centimeter "at any time." OSHA is now evaluating the effect of lowering the 8-hour standard to either 0.5 or 0.2 fibers per cubic centimeter in order to protect workers against cancer, as published in the FEDERAL REGISTER (47 FR 1807).

CHAPTER 2. DETERMINING IF ASBESTOS-CONTAINING MATERIAL (ACM) IS PRESENT IN BUILDINGS

To determine if ACM is present in a building, examine construction records and conduct a thorough inspection of building materials. If asbestos is not present, no further action is required. If asbestos is found, however, a control program should be initiated. In either case, workers and other building occupants will be concerned. The building owner must be prepared to explain the purpose of the survey, its results, and plans for controlling ACM if it is present.

SUMMARY

Planning the Survey: A plan for conducting the ACM survey should include assembling the survey team and gaining cooperation of building management. The plan should also include a public information program.

Conducting the Survey: The survey consists of checking building records and inspecting the building for evidence of ACM. Specific procedures differ for the three types of ACM, and may include sampling and analysis of suspect materials.

2.1 Planning the Survey

The survey has four components:

- Reviewing building records for references to asbestos used in construction or repairs;
- Inspecting materials throughout the building to identify those that may contain asbestos;
- Sampling suspect materials for laboratory confirmation that asbestos is present; and
- Mapping the locations of all confirmed or suspected ACM.

Thorough planning is essential because:

- The survey must provide accurate and reliable information;
- Questions from building occupants or the public about the survey and about asbestos in general must be answered quickly and responsively;
- Complete, accurate, unambiguous documentation of the survey and all test results is critical; and
- If ACM is found, the building owner must be prepared to initiate special operations and maintenance (O&M) practices immediately, and to develop other controls to minimize health risks (see Chapter 3).

The importance of a well-planned public communications program cannot be over- emphasized. Asbestos is an exceptionally emotional issue. A building owner must clearly understand the purpose of the survey in order to anticipate and address the concerns of building occupants and the public.

2.1.1 Assembling the Survey Team

Owners are ultimately responsible for asbestos-related problems in their buildings. The owner should appoint an asbestos program manager to direct all asbestos-related activities. The asbestos program manager

must be able to identify and assess the expertise of the diverse personnel required for an effective team. The asbestos program manager should communicate directly with the building owner. In addition, if ACM is present, the asbestos program manager will oversee the development of the asbestos control program, and provide information to the public. The manager needs to become familiar with the use of ACM in buildings, the potential for building contamination by airborne asbestos, the health risks to building occupants, and options for controlling ACM. The manager needs a general understanding of all the issues in order to review technical tasks and judge whether they are being performed properly. If the building owner has no experienced person on his staff, he should consider hiring a qualified consultant.

The program manager's responsibilities include:

- Implementing a training program for the ACM survey if the survey is to be conducted in-house;
- Selecting a technical advisor to conduct the ACM survey if an outside consultant is needed;
- Selecting a laboratory to analyze samples of material from the building;
- Designing a system to document all information about asbestos in the building; and
- Developing a communications package for discussions with building occupants and others.

If ACM is found, the asbestos program manager should also be prepared to initiate special operations and maintenance (O&M) practices (see Chapter 3), assess the need for other control measures (see Chapters 4 and 5), and oversee abatement projects if additional corrective action is necessary (see Chapter 6). The duties and responsibilities of the manager continue until all ACM is removed from the building.

An asbestos survey team should be assembled under the direction of the asbestos program manager. Figure 3 illustrates the organization of the team. The building architect, the facilities (or physical plant) manager, and the head of building maintenance are obvious choices due to their knowledge of building records and facilities. Maintenance and engineering staffs may also be team members since they likely will conduct the survey. If an outside technical advisor is hired to conduct the survey, he or she would be a member of the team. Other team members acting primarily as special advisors would include an attorney and a risk manager (i.e., a person responsible for insurance).

As indicated by Figure 3, the asbestos program manager should seek advice from the EPA Regional Asbestos Coordinator (RAC). (Addresses and telephone numbers for the 10 RACs are listed in Appendix D.) The RAC has information on ACM surveys, technical advisors, consultants, laboratories for analyzing samples of building materials, training programs, and abatement contractors.

The asbestos program manager should attend one of the asbestos control training courses offered by universities and private organizations. Currently, EPA-sponsored programs are offered in conjunction with Georgia Institute of Technology, Kansas University and Tufts University. The RAC is the best source of further information regarding these programs and others which may be available in each Region.

If a technical advisor will be hired to conduct the survey, the asbestos program manager should require evidence of experience and/or training. Examine references, especially those provided by other building owners. Be sure the advisor has a reputation for being thorough. Most survey errors involve overlooking building areas where there could be ACM. Asbestos control advisors include specially trained engineers, architects, and industrial hygienists.

If ACM is found, the technical advisor may assist with the continuation of the control program. In that case, the advisor should also have experience in developing a special O&M program, assessing the need for additional corrective action, and monitoring abatement projects. Additional information on selecting technical advisors is provided in Chapters 3 and 4.

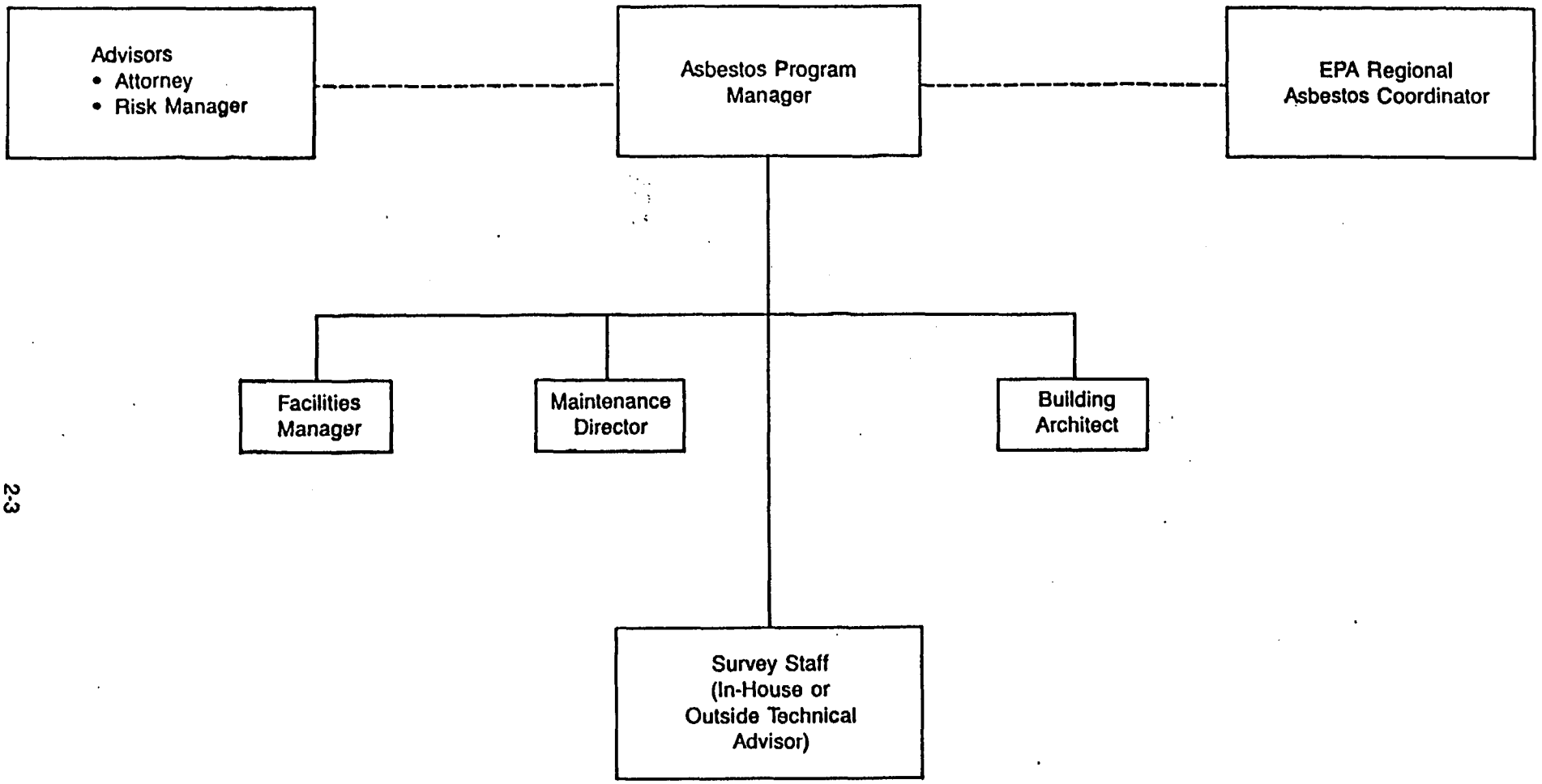

Figure 3. Composition of the ACM survey team.

2.1.2 Obtaining Cooperation

An ACM survey will be successful only if everyone in building management cooperates. Most importantly, the building owner must be convinced that exposure to asbestos is potentially a serious problem, and that a careful survey for ACM is needed. The asbestos program manager and the building owner must have a close working relationship.

Beyond this, cooperation must be obtained from building maintenance, operations, and planning personnel. A survey for ACM can disrupt normal building activities. Occupants will be concerned and curious. The survey team must be prepared to discuss the purpose of the survey in a way that is realistic, yet does not cause undue anxiety. Questions requiring a lengthy response should be referred to the program manager.

2.2 Conducting the Survey

The survey involves a review of building records and an inspection of the building for friable materials. The inspection is the more important component of the survey since building records are often incomplete and unreliable. Whenever the presence of asbestos is in doubt, prudence is recommended: treat the material as if it contains asbestos.

2.2.1 General Survey Elements

Figure 4 illustrates the survey steps. Begin by reviewing building records to see if ACM was specified at any stage. Although building records are often unreliable, they are a useful starting point. Check the original plans, shop drawings, remodeling records, and work change orders. Appendix A is a list of the most common uses and types of ACM in buildings since 1960. If any of these items appears in the records, assume that asbestos is in the building. Identify ACM mentioned in building records by type: (1) troweled- or sprayed-on surfacing material, (2) pipe and boiler insulation, or (3) other miscellaneous ACM.

Next, inspect the building for ACM identified in the building records. Determine if the materials are friable and record the findings. They may be sampled and analyzed to confirm the presence of asbestos. Thoroughly inspect all areas of the building for friable materials and sample them. The specific procedures for inspection and sampling vary depending on which of the three types of material are involved. The sampler of building materials should wear a respirator to prevent inhalation of fibers. (See Section 5.1 for information on respirators.)

2.2.2 Procedures for Sprayed- or Troweled-on Surfacing Materials

Surfacing materials can be friable or nonfriable. Friable forms are either very fibrous and fluffy (sometimes like cotton candy) or granular and cementitious (review Figure 1). Since friable materials are more likely than nonfriable materials to release fibers when disturbed, the first priority is to identify those friable surfacing materials that contain asbestos. As shown in Figure 5, the first step is to locate ACM specified in building records and determine its friability. Then, identify all friable surfacing materials in the building and take samples to be analyzed for asbestos.

2.2.2.1 Surfacing Materials Identified as ACM in Building Records

Begin by locating any acoustical plaster or other surfacing materials that, according to building records, contain asbestos. Rub these materials to see if they crumble or produce a light powder. If so, consider them friable. (When disturbing material that may contain asbestos, the inspector should wear protective equipment.) Either assume that these materials contain asbestos, or sample and analyze them, as discussed below. Record the location and degree of friability.

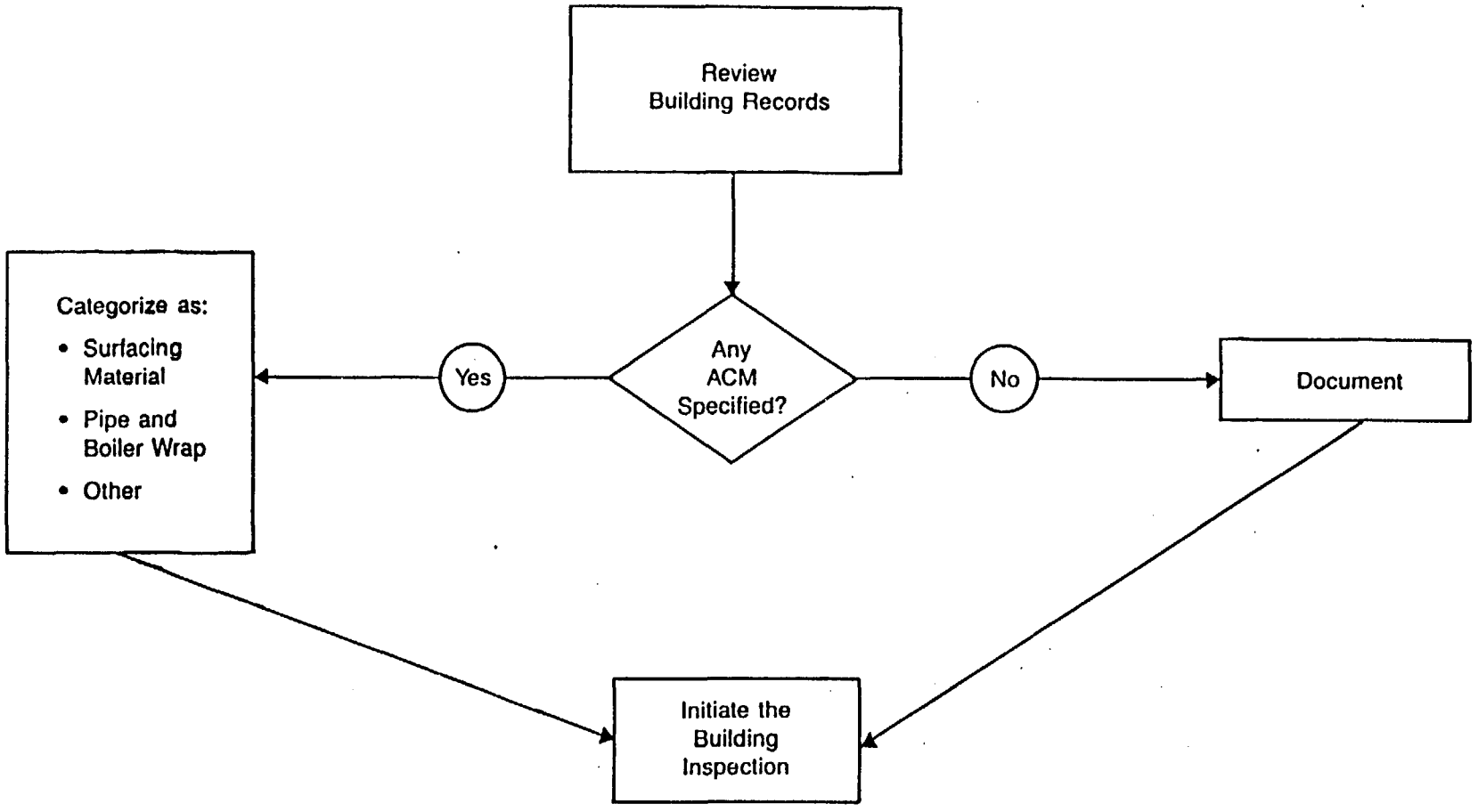

Figure 4. Initial Steps in an ACM Survey.

2.2.2.2 Other Surfacing Materials That May Contain Asbestos

Conduct a thorough building inspection for friable materials on walls, ceilings, beams, ducts, and any other surface. Rub the material to see if it is friable. Following Figure 5, group any friable material into "homogeneous" areas for further study.[1] A homogeneous area contains friable material that seems by texture and color to be uniform. If materials appearing uniform were installed at different times, designate the two materials as distinct homogeneous areas.

Once homogeneous areas of friable materials have been delineated and recorded on floor plans, collect samples of the materials and send them to a qualified laboratory. Sampling and analysis should be conducted according to the following guidelines:[2]

- Appoint a coordinator to oversee the entire sampling and analysis operation and quality assurance program. The asbestos program manager or technical expert may assume this role.
- Choose a qualified laboratory to analyze the samples (see Appendix G.2). The approved method of bulk sample analysis for asbestos is polarized light microscopy. In certain cases, X-ray diffraction may be required to confirm the presence of asbestos.
- Collect at least three core samples of material in each homogeneous sampling area. Select sampling locations that are representative of the homogeneous area. (Either select locations evenly distributed throughout the area or choose the locations by a random selection method such as the one described in USEPA 1980a. It is important that three samples not be collected in the same location.) Remember that everyone taking samples should wear a respirator.
- Collect at least 1 quality control (QC) sample per building or 1 QC sample per 20 samples, whichever is larger. A QC sample is taken from the area abutting a regular sample. (The two samples are referred to as "side-by-side samples.") The QC sample should be analyzed at a second laboratory to confirm the results of the primary laboratory.
- Label all samples with an identifying code and keep a code log. To avoid bias, the laboratory analyst should not know the origin of the samples.
- Asbestos is present if the material analyzed is more than one percent asbestos by weight.

Record the results of the sampling and analysis program and save the records indefinitely. If no asbestos is found in these materials, no further action is necessary for this category of ACM. If asbestos is present, then an asbestos control program should be developed as described in Chapters 3 and 4.

2.2.3 Procedures for Pipe and Boiler Insulation

Asbestos-containing insulation is found on equipment containing hot air or liquid — pipes, boilers, tanks, and sometimes ducts. These insulation materials may be a chalky mixture of magnesia and asbestos, preformed fibrous asbestos wrapping, asbestos fiber felt, corrugated paper, or insulating cement. In most cases, the insulating material is covered with a protective jacket of cloth, tape, paper, metal, or cement.[3]

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[1] The Asbestos-in-Schools rule allows schools to skip the sampling and analysis steps by assuming that any friable materials found in the building contain asbestos. The location of all friable materials must be documented and all affected parties must be notified whether asbestos is assumed to be present or confirmed by laboratory analysis. Nonfriable materials are not addressed by the Asbestos-in-Schools rule.

[2] Specific procedures for sampling and analyzing friable materials in schools were presented in the Asbestos-in-Schools rule. These procedures are consistent with the guidelines presented here.

[3] ACM sprayed on ducts should be considered surfacing material.

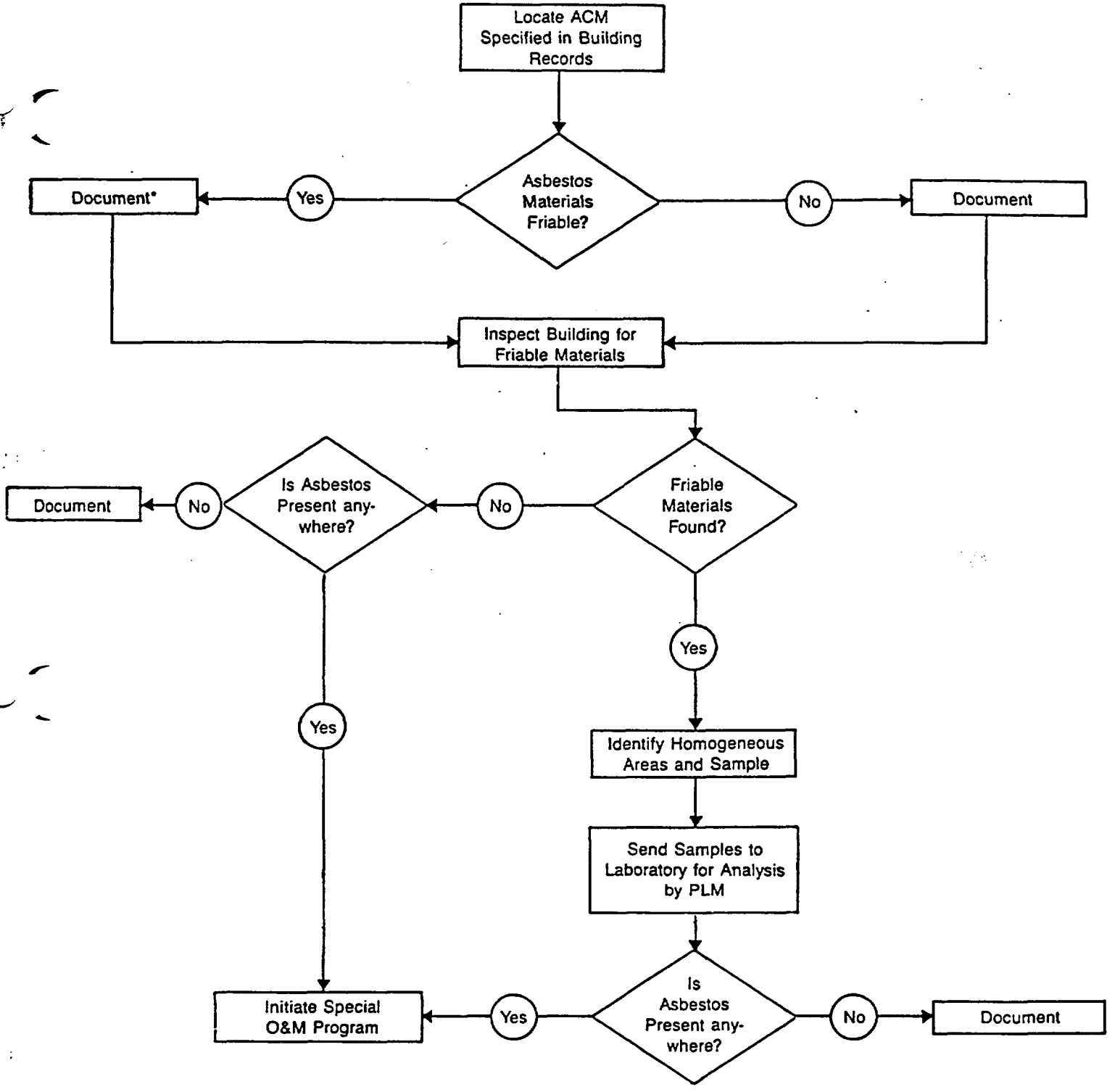


Figure 5. Survey procedures for sprayed- or troweled-on surfacing material.

*These materials can be sampled and analyzed to confirm that they do contain asbestos, and that a special O&M program is needed.

Boiler insulation may consist of thermal bricks (refractory) or asbestos insulating blankets, and is usually covered with finishing cement. Occasionally, asbestos millboard is used as a stiff outside covering on removable boiler insulation.

Figure 6 outlines how to inspect pipe and boiler insulation. Start in the boiler room and follow air and water distribution systems throughout the building. Building plans should indicate the location of pipes and ducts.

If the insulation is in good condition, leave it undisturbed. Sampling is not recommended in this case: instead, assume that the insulation contains asbestos. An EPA nationwide survey of federal, residential, and commercial buildings revealed that approximately 16 percent (20 percent of those constructed before 1970) contained asbestos pipe or boiler insulation. An exception to this rule is yellow or pink wrapped insulation. The color is usually a clear indication of fibrous glass rather than asbestos material. Even here, however, pipe elbows and joints will likely contain asbestos.

Sample the insulation materials from the damaged or exposed ends or other parts. Procedures for sampling and analyzing insulation materials are similar to those for surfacing materials:

- Identify homogeneous areas (i.e., sections of insulation that appear uniform in color and texture).
- Take samples for each homogeneous area where the insulation is damaged or exposed. Remember, all persons taking samples should wear a respirator.
- Submit samples to a qualified laboratory for analysis (see Appendix G).

As indicated in Figure 6, the presence (assumed or confirmed) or absence (confirmed) of asbestos should be documented in permanent records. If asbestos is present, an asbestos control program should be implemented as described in Chapters 3 and 4. If the presence of asbestos has been assumed, sampling and analysis may be useful for confirmation before any additional corrective action is taken.

2.2.4 Procedures for Other ACM

Most ACM in this category (e.g., wallboard, ceiling tile, floor tile) is hard and nonfriable, and sampling would damage it and release fibers needlessly. Information on asbestos in these materials comes mainly from building records or building personnel. Document the presence and location of these materials in permanent records, and proceed with an asbestos control program as described in Chapter 3.

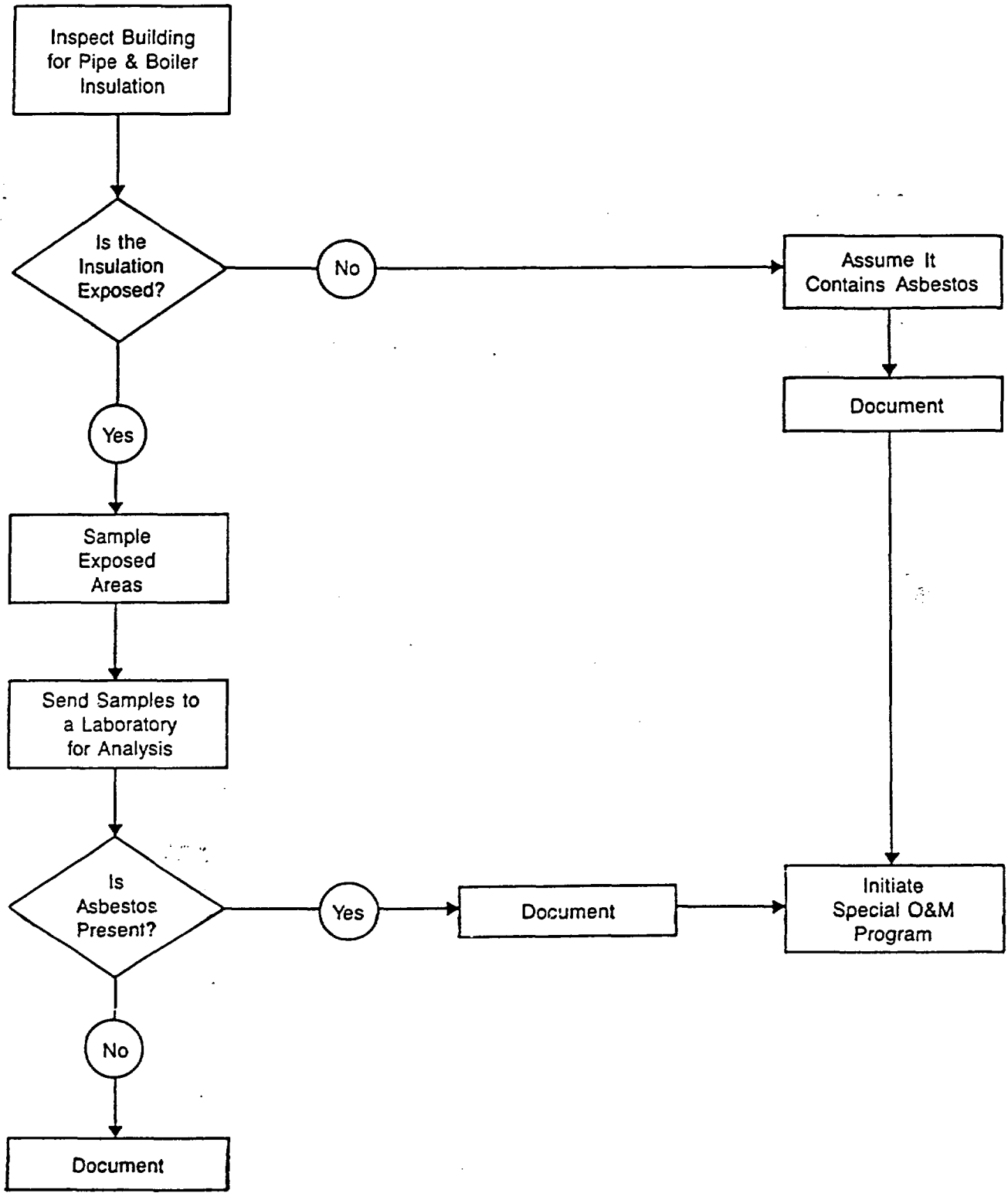


Figure 6. Survey procedures for pipe and boiler insulation.

CHAPTER 3. ESTABLISHING A SPECIAL OPERATIONS AND MAINTENANCE (O&M) PROGRAM

If ACM is found in a building, a special O&M program should be implemented as soon as possible. An O&M program is recommended for each type of ACM: surfacing material, pipe and boiler insulation, and miscellaneous materials. Although many of the procedures are the same, certain steps vary according to the type of ACM.

SUMMARY

Purpose of a Special O&M Program: The program is designed to (1) clean up asbestos fibers previously released, (2) prevent future release by minimizing ACM disturbance or damage, and (3) monitor the condition of ACM. The program should continue until all ACM is removed or the building is demolished.

Who Should Participate: The asbestos program manager, the manager of building maintenance, and the supervisor of the custodial staff are key participants in the O&M program.

Program Elements: The program should alert workers and building occupants to the location of ACM, train custodial and maintenance personnel in proper cleaning and maintenance, implement initial and periodic cleaning using special methods (for surfacing materials and pipe and boiler insulation only), establish a process that assures ACM is not disturbed during building repairs and renovations, and periodically re-inspect areas with ACM.

3.1 The Purpose of a Special O&M Program

The discovery of ACM in buildings raises two concerns: (1) how to clean up asbestos fibers previously released, and (2) how to avoid ACM disturbance or damage. The special O&M program addresses both of these issues, with procedures tailored to each of the three types of ACM.

3.2 Who Should Participate

The asbestos program manager develops and implements the special O&M program. He or she may serve as coordinator or delegate that responsibility to the facilities manager or other appropriate employee.

The manager of building maintenance and the custodial staff supervisor are the other key participants. Both must support the program and must generate the same sense of commitment in their staff. A special O&M program will increase cleaning and maintenance work; staff dedication is necessary for an effective program.

Trained building inspectors also participate in all special O&M programs. These inspectors may be the ones who made the initial inspection for ACM. They may or may not be members of the in-house custodial or maintenance staff. In the O&M program, they will be inspecting the condition and other characteristics of the ACM as described in Section 4.1.

3.3 Program Elements

Several aspects of a special O&M program are the same for all three types of ACM. For clarity and completeness, these steps are repeated in the description of each program.

3.3.1 Special Practices for Sprayed- and Troweled-on Surfacing Materials

ACM that is sprayed or troweled on ceilings and walls is often the main source of airborne asbestos fibers in the building. Areas covered by ACM tend to be large. If the material is friable, fibers are slowly released as the material ages.

To reduce the level of released fibers and to guard against disturbing or damaging the ACM, the following measures should be taken:

Documentation, Education, and Training

The O&M program coordinator should:

- Record the exact location of ACM on building documents (plans, specifications, and drawings).
- Inform all building occupants and maintenance and custodial workers about the location of ACM and caution them against disturbing or damaging the ACM (e.g., by hanging plants or mobiles from the ceiling, or pushing furniture against walls). Be sure to give this information to new occupants and employees.
- Require all maintenance and custodial personnel to wear a half-face respirator with disposable cartridge filters or a more substantial respirator (see Section 5.1) during the initial cleaning and whenever they come in contact with ACM.
- Train custodial workers to clean properly and maintenance workers to handle ACM safely. (As noted in Chapter 2, EPA is sponsoring three pilot training programs. Contact the RAC for information on these and other training programs.)

Initial Cleaning

Custodial staff should:

- Steam-clean all carpets throughout the building or vacuum them with a High Efficiency Particulate Air (HEPA)-filtered vacuum cleaner, but never with a conventional vacuum cleaner. Spray vacuum cleaner bags with water before removal and discard in sealed plastic bags according to EPA regulations for removal and disposal of asbestos (see Section 5.1 and USEPA 1985a). Discard vacuum filters in a similar manner.
- HEPA-vacuum all curtains and books. Discard vacuum bags and filters in sealed plastic bags according to EPA regulations for disposal of asbestos waste.
- Mop all noncarpeted floors with wet mops. Wipe all shelves and other horizontal surfaces with damp cloths. Use a mist spray bottle to keep cloths damp. Discard cloths and mopheads in sealed plastic bags according to EPA regulations for disposal of asbestos waste.

Monthly Cleaning

Custodial staff should:

- Spray with water any debris found near surfacing ACM and place the debris in plastic bags using a dust pan. Rinse the pan with water in a utility sink. Report presence of debris immediately to the O&M program coordinator.

- HEPA-vacuum all carpets.
- Wet-mop all other floors and wipe all other horizontal surfaces with damp cloths.
- Dispose of all debris, filters, mopheads, and cloths in plastic bags according to EPA regulations for disposal of asbestos waste.

Building Maintenance

The special O&M program coordinator should:

- Ensure that recommended procedures and safety precautions will be followed before authorizing construction and maintenance work involving surfacing ACM (see Section 5.1). Specifically, containment barriers should be erected around the work area and workers should wear coveralls as well as respirators.

Maintenance staff should:

- Clear all construction, renovation, maintenance, or equipment repair work with the O&M program coordinator in advance.
- Avoid patching or repairing any damaged surfacing ACM until the ACM has been assessed by the asbestos program manager.
- Mist filters in a central air ventilation system with water from a spray bottle as the filters are removed. Place the filters in plastic bags and dispose of them according to EPA regulations.

Periodic Inspection

Building inspectors should:

- Inspect all ACM materials for damage or deterioration at least twice a year and report findings to the O&M program coordinator. (See Chapter 4 for detailed information on assessing ACM.)
- Investigate the source of debris found by the custodial staff.

Custodial and maintenance staff should:

- Inform the O&M program coordinator when damage to ACM is observed or when debris is cleaned up.

An illustrated EPA pamphlet, "Asbestos in Buildings—Guidance for Service and Maintenance Personnel" (USEPA 1985a), may be especially useful in publicizing and initiating the special O&M program. Contact the RAC or call the EPA toll-free line for copies of the pamphlet (see Appendix E for telephone numbers).

The special O&M program should continue until all surfacing ACM is removed. Over time, the special O&M program may need to be altered if the ACM is enclosed or encapsulated (refer to Section 5.1).

3.3.2 Special Practices for Pipe and Boiler Insulation

Asbestos-containing pipe and boiler insulation typically is a less significant source of airborne asbestos fibers than surfacing ACM. Unless damaged, protective jackets around such insulation prevent fiber release.

Thus, the special O&M program for pipe and boiler insulation focuses on alerting workers to its location, inspecting the protective jacket (and pipe joints or elbows) for damage, and taking precautions prior to building construction activities. The program also includes repair and selected special cleaning practices.

Documentation, Education, and Training

The O&M program coordinator should:

- Record the exact location of asbestos-containing insulation on building documents (plans, specifications, and drawings).
- Inform maintenance and custodial workers about the location of asbestos-containing insulation, and caution them about disturbing it.
- Post signs reading, "Caution — Asbestos," on boilers, tanks, pipes, and ducts with asbestos-containing insulation.
- Require all maintenance and custodial personnel to wear at least a half-face respirator with disposable HEPA cartridge filters (see Section 5.1) during initial cleaning and whenever they come in contact with asbestos-containing insulation.
- Train custodial workers to clean properly and maintenance workers to handle ACM safely. (As noted in Chapter 2, EPA is sponsoring three pilot training programs. Contact the RAC for more information on these and other programs.)

Initial Cleaning

Custodial staff should:

- Clean carpets in rooms containing heating, cooling, air-handling, and similar equipment that has asbestos-containing insulation. Use a HEPA-filtered vacuum cleaner or steam cleaner. Discard filters in sealed plastic bags according to EPA regulations for removal and disposal of asbestos.
- Wet-mop all other floors in rooms with asbestos-containing insulation. Wipe all shelves and other horizontal surfaces with damp cloths. Use a mist spray bottle to keep cloths damp. Discard cloths and mopheads in sealed plastic bags according to EPA regulations for removal and disposal of asbestos.
- HEPA-vacuum all curtains in rooms with asbestos-containing insulation, and discard vacuum filters in sealed plastic bags according to EPA regulations for removal and disposal of asbestos.

Semiannual Cleaning

Custodial staff should:

- Spray with water any debris found near asbestos-containing insulation, and place the debris in a plastic bag using a dustpan. Clean the pan with water in a utility sink. Report presence of debris immediately to the O&M program coordinator.
- HEPA-vacuum all carpets in rooms with asbestos-containing insulation.

- Wet-mop all other floors and dust all other horizontal surfaces with damp cloths in rooms with asbestos-containing insulation.

- Seal all debris, vacuum bags, vacuum filters, cloths, and mopheads in plastic bags for disposal according to EPA regulations for asbestos waste.

Maintenance

The special O&M program coordinator should:

- Ensure that recommended procedures and safety precautions will be followed before authorizing construction and maintenance work involving pipe and boiler insulation (see Section 5.2). Specifically, containment barriers or bags should be positioned around the work area and workers should wear coveralls and respirators. Insulation damaged during construction and maintenance activities should be repaired with non-asbestos mastic, new protective jackets, and/or replacement insulation.

- Authorize repair of minor insulation damage with non-asbestos mastic, new protective jackets, and/or non-asbestos insulation following recommended repair techniques and precautions (see Section 5.2).

- Authorize large-scale abatement only after a complete assessment of the asbestos-containing insulation (see Section 5.2).

The maintenance staff should:

- Clear all construction, renovation, maintenance, or equipment repair work with the O&M program coordinator in advance.

- Avoid patching and repair work on insulation until the ACM has been assessed by the asbestos program manager.

Periodic Inspection

Building inspectors should:

- Inspect all insulation for damage or deterioration at least twice a year and report findings to the O&M program coordinator. (See Chapter 4 for detailed information on assessing ACM.)

- Investigate the source of debris found by the custodial staff.

Custodial and maintenance staff should:

- Inform the O&M program coordinator when damage to the insulation is observed or when debris is cleaned up.

The illustrated EPA pamphlet, "Asbestos in Buildings—Guidance for Service and Maintenance Personnel" (USEPA 1985a), may be useful for the special O&M program for pipe and boiler insulation. The O&M program should continue until all asbestos-containing insulation (including materials on pipe joints and elbows) is removed and replaced with another type of insulation.

3.3.3 Special Practices for Other ACM

Most ACM that is neither surfacing material nor pipe and boiler insulation is hard and nonfriable. This type of ACM releases fibers only when manipulated (e.g., cut, drilled, sawed) or damaged. The special O&M program is designed to alert workers to the location of ACM, and to avoid its disturbance or damage.

Documentation, Education, and Training

The O&M program coordinator should:

- Record the exact location of these types of ACM on building documents (plans, specifications, and drawings).
- Inform maintenance and custodial workers about the location of ACM and caution them about disturbance or damage.
- Train maintenance workers to handle ACM safely. (As noted in Chapter 2, EPA is sponsoring three pilot training programs. Contact the RAC for information on these and other programs.)

Maintenance

The O&M program coordinator should:

- Ensure that recommended procedures and safety precautions will be followed before authorizing construction or maintenance work involving ACM. Specifically, containment barriers should be erected around the construction and maintenance work area and workers should wear coveralls as well as respirators. All tools should be equipped with HEPA-filtered vacuum devices.

The maintenance staff should:

- Clear all construction, renovation, maintenance, or equipment repair work with the O&M program coordinator in advance.
- Avoid removing, sanding, or stripping floor tiles containing asbestos. If tiles are removed, do not sand asbestos backing material remaining on the floor.

Periodic Inspection

Building inspectors should:

- Inspect all ACM for damage or deterioration at least twice a year, and report findings to the O&M program coordinator.

Custodial and maintenance staff should:

- Report any ACM damage to the O&M program coordinator.

The special O&M program for miscellaneous ACM should continue until all ACM is removed.

CHAPTER 4. ASBESTOS CONTROL BEYOND SPECIAL OPERATIONS AND MAINTENANCE

If a building contains ACM, implementing a special O&M program will remove asbestos fibers and limit further fiber release. Once the program is operational, the need for additional asbestos control or abatement should be considered. Three questions need to be answered:

- Is abatement necessary?
- When should abatement be done?
- What abatement method should be used?

In some situations, assessing the need for abatement is a straightforward process. Badly damaged ACM in public areas should be removed immediately. ACM in good condition with virtually no chance of being disturbed except under controlled conditions (e.g., during scheduled repairs) requires no additional action, at least not immediately. (An example of the latter is tightly bound, undamaged ACM insulation wrapped around heating or water pipes.) Deciding how to control ACM is complicated; assessment requires simultaneous consideration of the type and condition of the material, timing and alternative abatement methods, as well as constraints that are specific to individual buildings.

This chapter contains an approach to assessing the need for abatement, determining its timing, and choosing an abatement method. Factors used in the decision-making process are introduced and discussed. The three types of ACM — surface material, pipe and boiler insulation and miscellaneous products — are treated separately. Constraints that affect individual owners or buildings are also discussed.

SUMMARY

Assessment Information:

- The likelihood of fiber release from ACM is based on evaluating its current condition and the potential for future disturbance, damage, or erosion.
- Air monitoring alone should not be used for assessment.

The Assessment Process:

The likelihood of fiber release from ACM determines the need for and timing of additional action. The nature and location of the material determines the abatement method.

- **Surfacing Materials**

Need: Surfacing material in good condition and with a low potential for future disturbance, damage, or erosion may need no further action.

Timing: ACM in poor condition should be dealt with first. If ACM is in good condition but has a high potential for future fiber release, abatement can be scheduled with building renovation or maintenance.

Method: Removing the ACM is the only permanent solution. Enclosure and encapsulation are temporary solutions to be implemented in special circumstances.

- **Pipe and Boiler Insulation**

  Need: If the insulation is intact, no further action is needed.

  Timing: Damaged insulation should be repaired or replaced as soon as possible.

  Method: Removal is appropriate where the insulation is extensively damaged or deteriorated. Repair is appropriate where the insulation has minor damage.

- **Other Types of ACM**

  A special O&M program is usually all that is needed.

Further Considerations In Selecting an Abatement Schedule:

- If an abatement project is not urgent, it will be less costly if combined with building repair, renovation, or expansion, or with scheduled maintenance to equipment and building systems.

- Other factors that may influence the timing of abatement include:

  — The pattern of normal building operations;
  — The building owner's legal liability;
  — Pressures from building occupants and the public; and
  — Expected useful life of the building.

4.1 Assessment Information

The need for asbestos control beyond a special O&M program depends on the likelihood of fiber release from ACM. The possibility of fiber release should be assessed by evaluating the material's condition, physical characteristics, and location. Another approach is to measure the current levels of asbestos in the air. As explained below, however, assessment by air monitoring alone is not recommended because it reflects conditions only at the time of sampling. In addition, air monitoring is technically difficult and expensive.

4.1.1 Potential Fiber Release

Factors for assessing fiber release potential are listed in Table 1. (Figures 7 and 8 illustrate some of these factors.) The first set of factors focuses on the current condition of ACM. If water or physical damage, deterioration, or delamination of the material is evident, then fiber release has occurred, is occurring, or is likely to occur. The appearance of the material and the presence of broken or crumbled material on horizontal surfaces indicate fiber release.

Factors under the second heading in Table 1 reflect potential fiber release due to disturbance or erosion. Visible, highly accessible materials in areas frequently used or needing periodic maintenance are most vulnerable to physical damage. Also in this category are materials subject to vibration from mechanical equipment, sound, or athletic activities — for example, materials near a gymnasium or band room, or in buildings near an airport or highway. ACM in an air plenum or near a forced airstream (e.g., air from a heating vent) is likely to suffer surface erosion. In addition, fibers released into an airstream may be transported to other parts of the building, possibly exposing more people. Any planned changes in building use should also be considered when assessing potential fiber release.

Table 1. Factors for Assessing Potential Fiber Release
(See Appendix H for more detail.)

Current Condition of ACM

- Evidence of deterioration or delamination from the underlying surface (substrate)
- Evidence of physical damage (e.g., presence of debris)
- Evidence of water damage

Potential for Future Disturbance, Damage, or Erosion of ACM

- Proximity to air plenum or direct airstream
- Visibility, accessibility (to building occupants and maintenance personnel), and degree of activity (air movement, vibration, movement of building occupants)
- Change in building use

The factors in Table 1 are fully described in Appendix H. The descriptions should assist the evaluator in assessing ACM at individual sites.

A simple "present" or "absent," "high" or "low" rating should be used for each factor. More elaborate rating schemes have been tried. For example, factors have been assigned numerical scores and, using mathematical formulas, the scores have been combined into indices to reflect potential exposure.[1] These "exposure indices" have met with mixed success. In tests, several indices showed wide variation from one rater to the next and often did not indicate current, elevated airborne asbestos levels (e.g., USEPA 1983b). Assigning numerical ratings to assessment factors and combining them into a single score cannot be recommended. However, the factors are useful when they are scored with a simple, nonnumerical rating scheme.

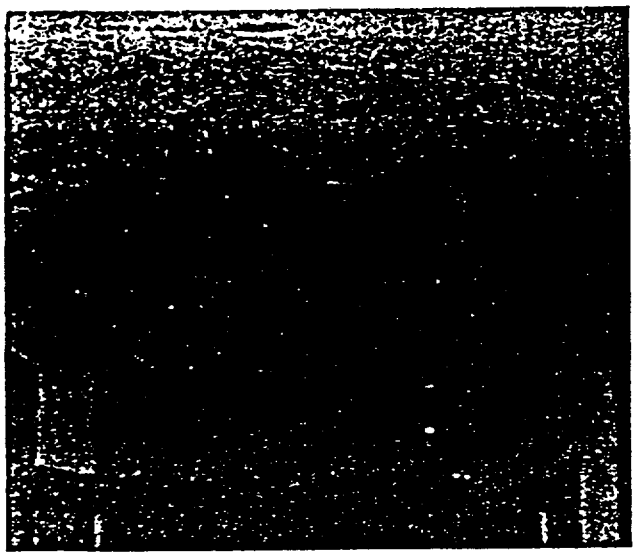
4.1.2 Air Monitoring

Another way to assess asbestos fiber release is to measure asbestos fibers in the air. This approach is appealing because it quantitatively measures airborne asbestos contamination. However, it measures only current conditions and provides no information about fiber release potential and future air levels. Moreover, implementing an effective monitoring program to measure current levels of airborne asbestos is difficult and can be expensive.

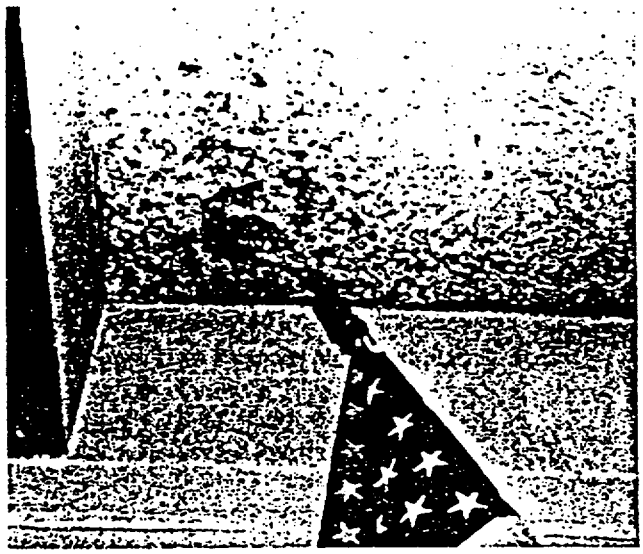
One proposed method for measuring airborne asbestos in buildings was developed by the National Institute for Occupational Safety and Health (NIOSH) in connection with the OSHA asbestos exposure standard for workplace settings. This method uses phase contrast microscopy (PCM), which may be effective for industrial measurements where most airborne fibers are asbestos, but is less useful in settings with much lower asbestos levels. PCM is not sensitive to fibers with diameters less than 0.2 micrometers.[2] In addition, the NIOSH method excludes fibers shorter than 5 micrometers and does not distinguish between

[1] See, for example, Lory 1980, Pinchin 1982, and USEPA 1979.

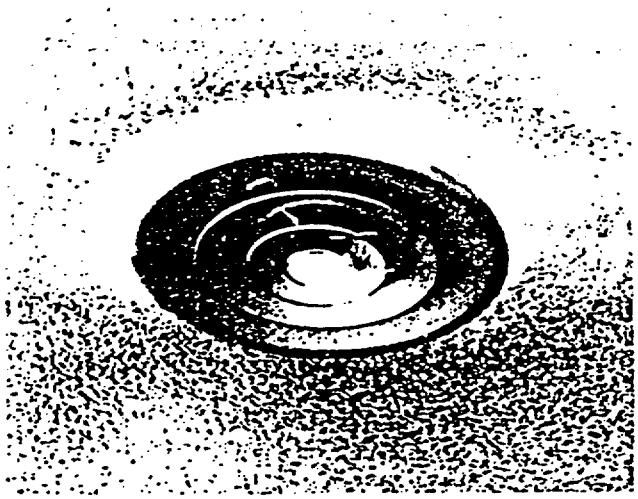
[2] A micrometer is one-millionth of a meter. See Appendix B for a simple discussion of measurement units used to describe and measure asbestos fibers.



Water damage



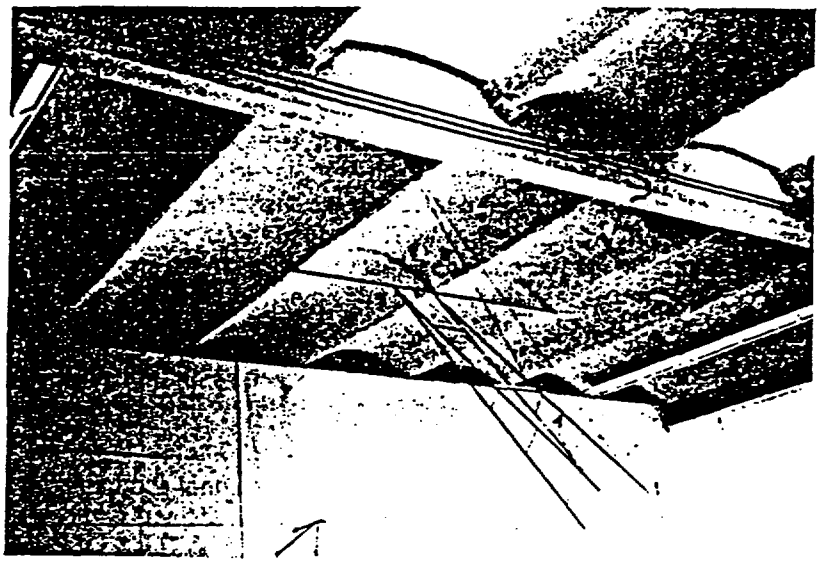
Physical damage to ceiling material from a flagpole



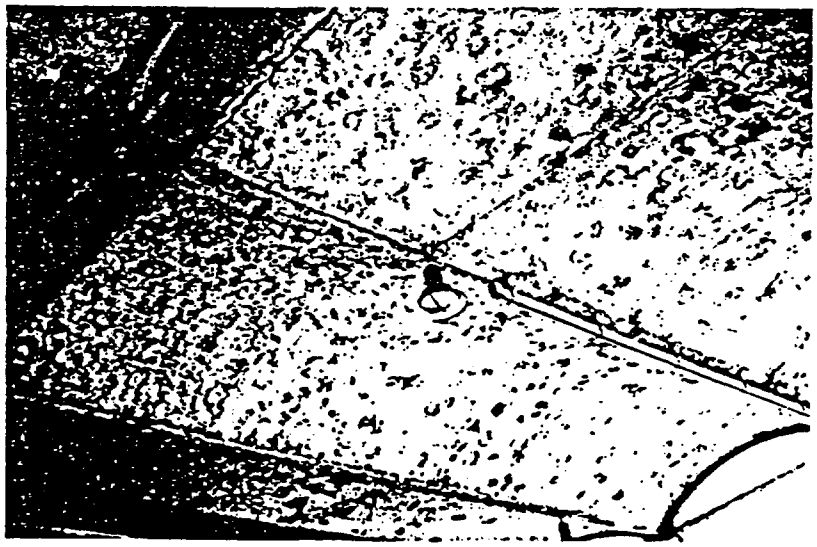
Airstream erosion from a heating vent

High activity level near friable asbestos

Figure 7. Example assessment characteristics of asbestos-containing materials.



Ceiling of a gymnasium in an elementary school
(no basketball marks)



Ceiling of a gymnasium in a high school showing evidence of damage from basketballs thrown by students

Figure 8. An example of the effect of a change in building use.

asbestos and non-asbestos fibers. Many airborne fibers in buildings with ACM are likely to be thinner and shorter than these limits (Chatfield 1983 and NRC 1984), and are likely to include fibers from carpets, clothing, hair, paper, books, and many other sources. As a result, PCM analyses of air inside these buildings could be seriously misleading.

Other methods measure both small and large fibers and distinguish asbestos from non-asbestos materials. Those methods count fibers by electron microscopy, and confirm that the fibers are asbestos with chemical and crystallographic analyses. The analytical transmission electron microscope (TEM) [3] is the most sensitive and asbestos-specific instrument. EPA has used TEM in experiments to establish baseline asbestos levels indoors and outdoors. However, obtaining enough samples to estimate prevalent airborne levels is difficult in occupied buildings. In addition, TEM analysis is expensive (ranging from $200 to $600 per sample) and few laboratories are qualified to perform it. These limitations, combined with the inability of air monitoring to provide information on future conditions, restrict its usefulness for assessment. EPA, therefore, does not recommend it as a primary assessment tool at this time. (Air monitoring does have a role, however, in determining when an abatement project is complete. See Section 6.4.)

4.2 The Assessment Process

The assessment factors discussed above are used to decide if additional asbestos control is needed and, if so, when and what method. Although the process is similar for each of the three types of ACM, the details are specific to each type and are discussed separately below.

4.2.1 Sprayed- and Troweled-on Surfacing Materials

4.2.1.1 Need

Use the factors described in 4.1.1 to determine the current condition of the ACM and the potential for future disturbance, damage, or erosion. Table 2 shows how these two considerations influence the decision regarding action beyond a special O&M program. Surfacing material in good condition may need no further action if potential for future disturbance, damage, or erosion is low. The material must be inspected regularly (see Section 3.3.1) to assure that it remains in good condition. Further action is needed if the material is damaged or in poor condition, or if there is high potential for future disturbance or erosion.

4.2.1.2 Timing

When further action is necessary, its timing must be carefully considered. A well-planned and executed abatement program is needed to ensure that the abatement activity itself does not create a hazard. If the ACM is currently in good condition, but the potential for future fiber release is high, scheduling of asbestos abatement can take advantage of other building plans. For example, renovation work, which requires precautions to control fiber release, provides an opportunity to remove, encapsulate, or enclose ACM. There are no set rules to determine the timing of asbestos abatement, since circumstances vary from building to building. Table 2 provides a guide.

As one moves through the table from left to right (from good to poor condition) and from top to bottom (from low to high potential for disturbance, damage, or erosion), the need for immediate action increases. Material in poor condition should be dealt with first. Materials that are in better condition or have a low potential for disturbance or erosion have a lower priority.

[3] A provisional method for TEM measurement of asbestos has been developed by EPA (USEPA 1977).

Table 2. Assessment Table for Surfacing Materials

Potential for Future Damage, Disturbance, or Erosion	Current Condition of ACM: Good*	Minor Damage or Deterioration	Poor
Low	No Further Action Now Beyond Special O&M Program	Selective or Complete Removal as Soon as Possible	Removal as Soon as Possible
High†	Removal, Enclosure, Encapsulation Integrated with Other Building Activities		

*Good condition means no water damage, physical damage, or deterioration.
†High potential means that ACM is exposed or accessible, in an air plenum or airstream, or subject to vibration.

Table 3. Comparison of Asbestos Abatement Methods for Surfacing Materials

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

Table 3. (continued)

Method	Advantages	Disadvantages	Appropriate applications	Inappropriate applications	General comments
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

4.2.1.3 Method

The choice of abatement method is determined mainly by the condition of the ACM. Surfacing materials can be removed, encapsulated with sealant, or enclosed within an airtight structure. The three methods are summarized in Table 3 and described in more detail in Section 5.1. Worker protection and the construction of sealed containment barriers around the work site are required for all three methods.

Removal has the widest applicability. It also is the only truly permanent solution, since no building containing asbestos can be demolished without first removing the ACM. If ACM has only minor, isolated damage, removal of selected areas may be sufficient.

Enclosure and encapsulation have limited application. Enclosure is restricted to situations where ACM can be isolated in small localized areas. Encapsulation can be used only for acoustical plaster in good condition. In addition, the special O&M program must be continued and the enclosed or encapsulated materials reinspected periodically (at least monthly) until the ACM is removed or the building is demolished. Encapsulation may make eventual removal more difficult and costly, since encapsulated ACM may have to be removed in dry form.

Initial cost of removal may be higher than for other abatement methods. However, removal may be less expensive over the long term, since the continued presence of ACM requires special O&M practices, periodic reinspection, and repairs. Enclosure and encapsulation are options only when the ACM is in good condition. These are primarily temporary measures to reduce the potential for future disturbance or erosion until the ACM is eventually removed.

4.2.2 Pipe and Boiler Insulation

4.2.2.1 Need

Pipe and boiler insulation typically presents a more localized fiber release problem than surfacing material. The insulated pipes, boilers, ducts, and other equipment are frequently confined to equipment rooms or placed within walls or behind ceilings. Even accessible insulation is localized to the piece of insulated equipment. Thus, the potential for disturbance, damage, or erosion is lower than for surfacing material; frequent inspection can spot any new disturbance and the damage can be repaired quickly. The condition of the ACM determines the need for further action (see Table 4). If the insulation is intact, no further action is needed.

4.2.2.2 Timing

Damaged insulation should be repaired or replaced as soon as possible. Major renovation, such as installation of a new boiler, is a good time to consider replacing pipe and boiler insulation with non-asbestos material. This will eliminate the need for a continuing special O&M program.

4.2.2.3 Method

Removal is appropriate where the insulation is extensively damaged or deteriorated. It involves cutting and stripping the insulation from pipes (or other equipment) and substituting non-asbestos material. Plaster around elbows, valves, and flanges should also be replaced with non-asbestos materials. Removal of pipe and boiler insulation requires many of the same precautions and worker protection measures for removal of surfacing materials.

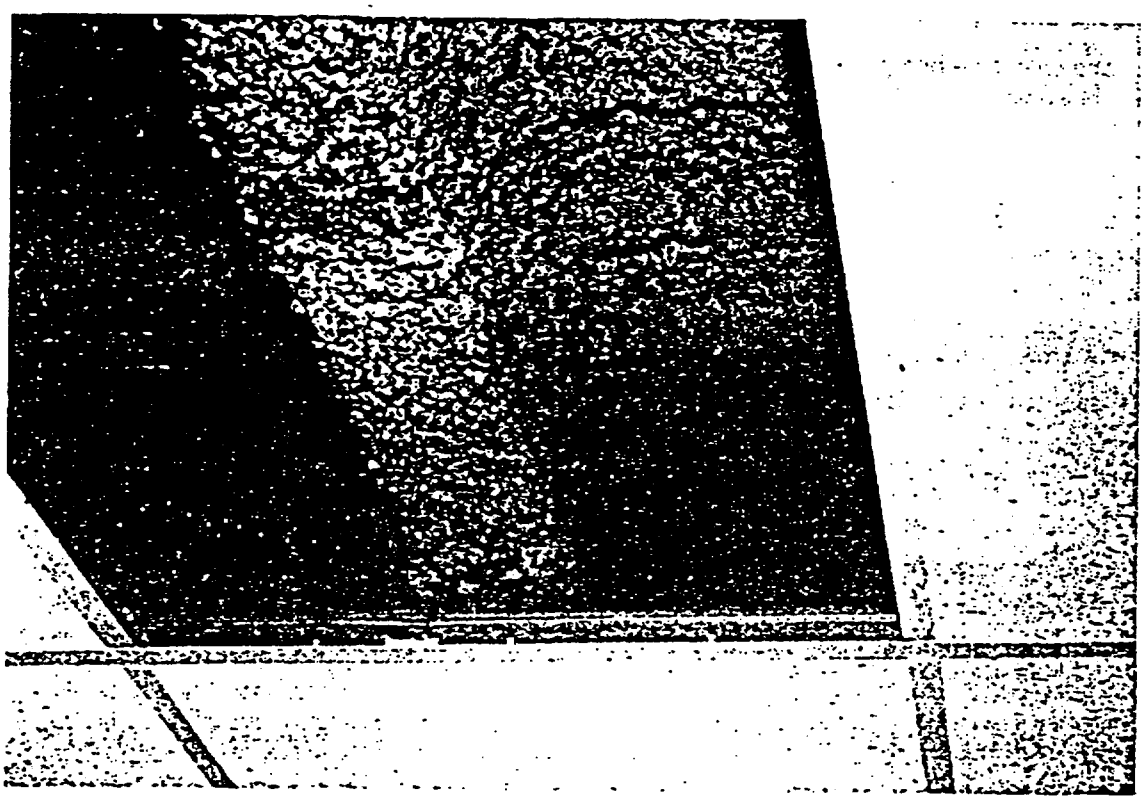


Figure 9. Asbestos-containing material located above a suspended ceiling.

are required for removal of ACM and are highly recommended for other abatement methods, since enclosure and encapsulation may also elevate fiber levels.

The third common feature is proper work area containment. Containment typically means construction of barriers with 6 mil polyethylene plastic sheets joined with folded seams, and with sealing tape at the seams and boundaries. Some contractors have had problems attaching plastic sheets to walls. Thinner sheets or a better attachment system (for example, stapling and taping sheets to furring strips fastened to walls) may be required. (Figure 10 shows the construction of a typical containment system. Note that respirators should be worn if the ACM will be disturbed during construction.) Air locks and worker decontamination facilities with showers are recommended, as well as negative air pressure systems, described in Section 5.1.1 below.[2] All return air vents should be sealed to prevent asbestos contamination of the air-handling system. Without such containment measures, increased exposure for building occupants is likely. Once abatement begins, everyone not participating in the project should be kept out of the area.

The fourth common feature is the need for a rigorous postabatement cleanup. This includes wet-mopping or HEPA-vacuuming all horizontal and vertical surfaces in the work area. (Wet mopheads and cloths should be discarded in sealed plastic bags and treated as asbestos-contaminated waste.) Cleaning of surfaces outside the work area is highly recommended. Two cleanings—the second after at least 24 hours when suspended fibers have settled—will provide better assurance of fiber reduction than a single cleaning. (Section 6.4 contains additional information on cleaning and inspecting the work site.)

5.1.1 Removal, Disposal, and Replacement

Figure 11 is a photograph of a typical removal project. When removing ACM, observe the following requirements:

- The material must first be treated with a solution of water and a wetting agent to reduce fiber release. Some types of amosite-containing materials will not absorb either water or water combined with the wetting agent suggested by EPA (50% polyoxyethylene ester and 50% polyoxyethylene ether). Other wetting agents should be tested on the material for absorption. If the material will not absorb the wetting agent, undertake a dry removal using Type C respiratory protection. EPA must approve all dry removal operations. Get in touch with the NESHAPS contact in your region (see Appendix D).

- Friable ACM must be disposed of in "leak-tight containers," typically 6 mil polyethylene bags. Bags can be placed in 55-gallon drums for additional protection. Bags or drums must be labeled, as specified by NESHAPS (see Appendix C) or OSHA (see Appendix F).

- OSHA procedures for worker protection and decontamination, as well as for measurement of airborne asbestos, must be strictly followed (see Appendix F). While not required by law, EPA procedures for work area containment should also be followed to assure safe removal.

Research on asbestos removal plus EPA's experience with removal activities in schools since 1979 have pointed up several other important issues:

- A tear in the containment barrier is a significant exposure hazard for building occupants and should be repaired immediately. The use of negative pressure systems together with HEPA filtration (that is, low speed exhaust fans with HEPA filters) to move air from within the work area

[2] OSHA decontamination requirements specify worker change rooms as a minimum provision for asbestos removal projects. If negative air systems are used, "air locks" should not be airtight. That is, make-up air should pass through the air lock. See Appendix J for additional information.

Figure 10. Construction of containment barriers.

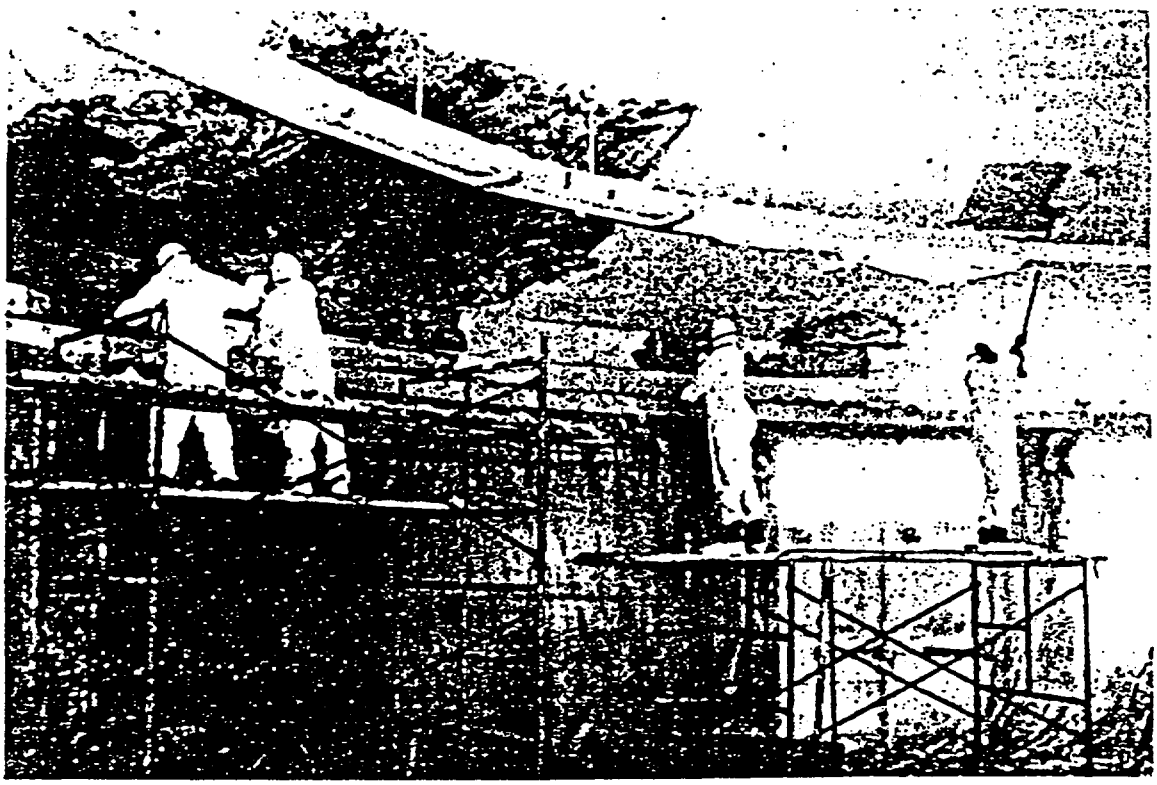


Figure 11. An asbestos removal project.

to outside the building will provide added protection in case of an accident. Appendix J summarizes specifications for negative air systems.

- When containment barriers are dismantled after ACM removal, the sealing tape used to attach the plastic sheets to walls and ceilings frequently removes paint. It is prudent to include the cost of repainting all walls (and ceilings, if appropriate) in estimates of asbestos removal costs.

- Asbestos waste is sometimes spilled both in and outside the work area. Containers full of wet material are very heavy and hard to transport. These containers must be sealed and handled carefully. Workers should continue to wear protective equipment during these operations. Also, disposal sites may be scarce. Some states require a disposal permit before removal begins.

- Amended water (water and wetting agents) from spray operations may leak through the polyethylene sheets and damage floors, especially tile and wood. Sealed double plastic sheets should protect the floors.

When removal and disposal operations are finished, evaluate the need for a sealant on the exposed surface. (The need to reinsulate or resoundproof with asbestos-free materials should be decided before removal begins.) Sealants generally are necessary where the underlying surfaces are porous (for example, concrete blocks or slabs), since a few fibers usually remain after removal.

Cost of asbestos removal varies widely by region and by job. Where the underlying surface must be sealed and the ACM replaced, those costs must be added to removal costs.

5.1.2 Enclosure

Enclosure involves construction of airtight walls and ceilings around the ACM. Figure 12 shows a typical enclosure. These recommendations for constructing enclosures should be followed:

- To reduce fiber release, drills used during installation should be equipped with HEPA-filtered vacuums.

- Underlying structures must be able to support new walls and ceilings.

- New construction material should be impact-resistant and assembled to be airtight.[3] Gypsum panels taped at the seams, tongue-and-groove boards, and boards with spline joints all qualify. Suspended ceilings with lay-in panels are not acceptable. Joints between walls and ceilings should be caulked.

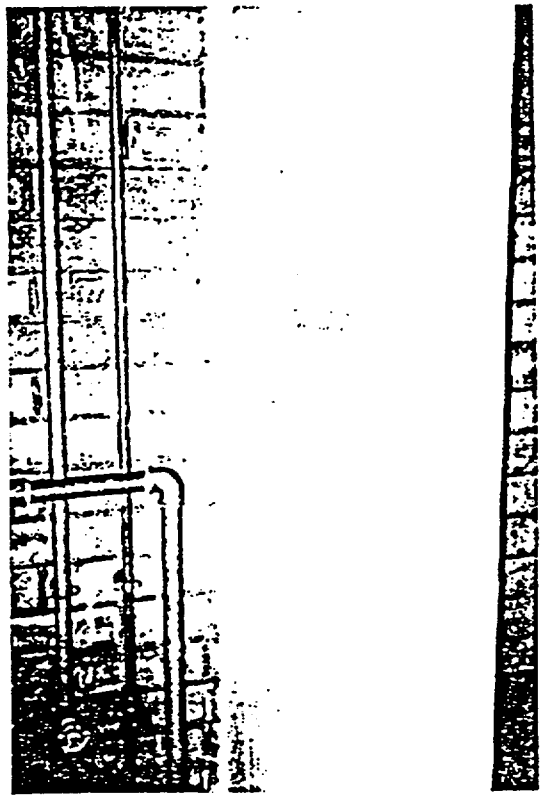
- If lights are recessed into ACM, they must be removed carefully to minimize fiber release. Lights should be reinstalled beneath the new ceiling.

- Relocation of plumbing lines and computer cables may be necessary.

- Building records must note the presence of asbestos behind the enclosure to prevent accidental fiber release during remodeling or building demolition. (The presence of ACM should have been documented as part of the special O&M program.) Signs should be posted, noting that ACM is behind the enclosure.

[3] No enclosure will be totally airtight. The practices recommended here are designed to greatly reduce air movement across the enclosure boundary.

Before enclosure



After enclosure

Figure 12. An asbestos enclosure project.

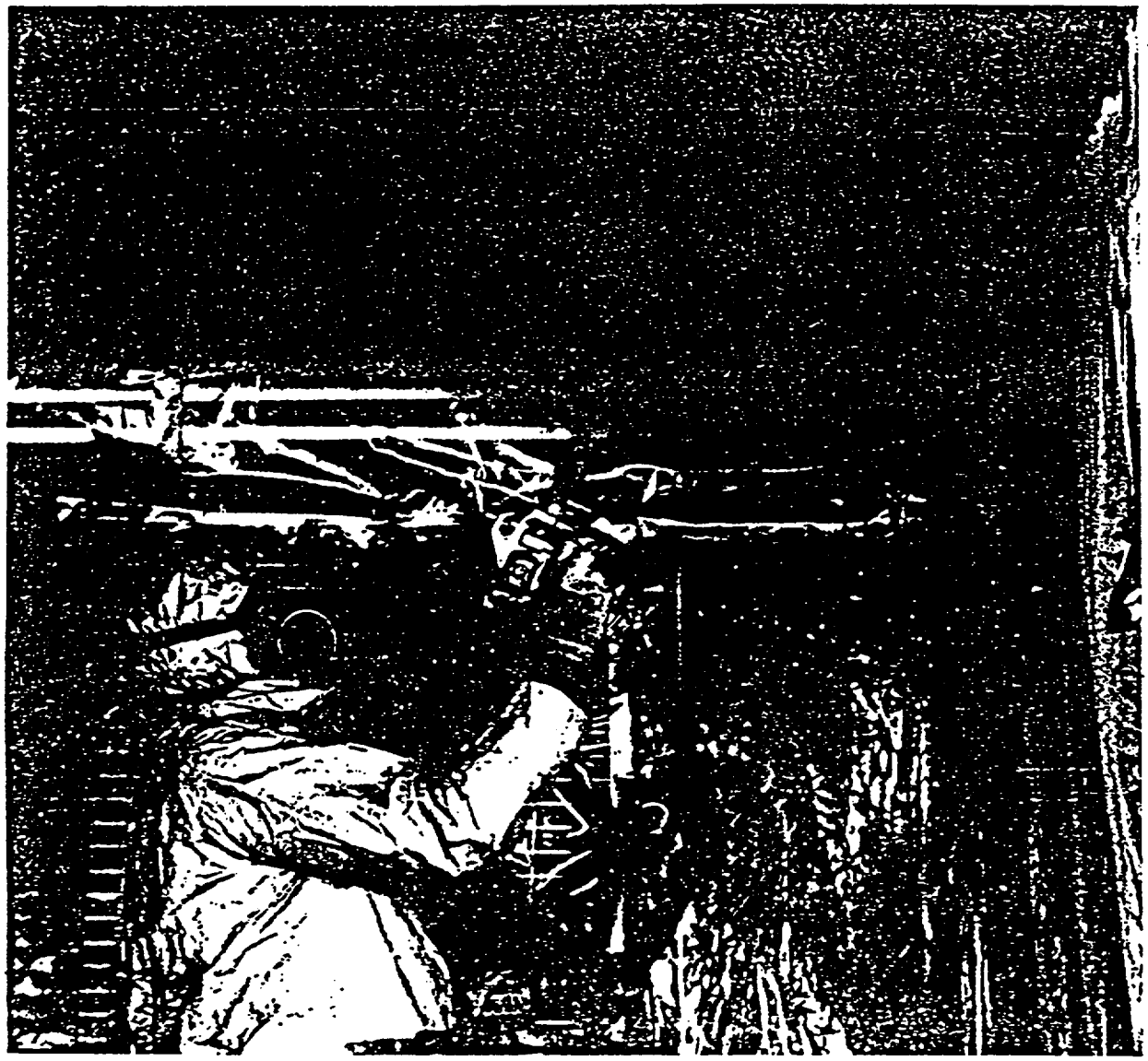


Figure 13. An asbestos encapsulation project.

Armholes and an inside pouch for tools let the worker remove insulation without exposure to asbestos fibers. A sealed side port also can be constructed to allow access for wetting the asbestos and evacuating the bag with a HEPA-filtered vacuum.[6] Workers who use containment bags should still wear respirators in case a bag leaks.

To remove individual pipe sections or an entire pipe network, a small section (about 6 inches wide) of insulation should be removed. The pipe then can be cut into manageable lengths with a saw or torch. Exposed ends of the insulating material should be sealed with plastic and tape. If the remaining insulation is not in good condition, the entire pipe should be wrapped in 6 mil plastic. Disposal of insulation material must follow EPA procedures discussed earlier for ACM disposal (Sections 1.4 and 5.1). More information on pipe and pipe insulation removal will be provided in a future technical bulletin.

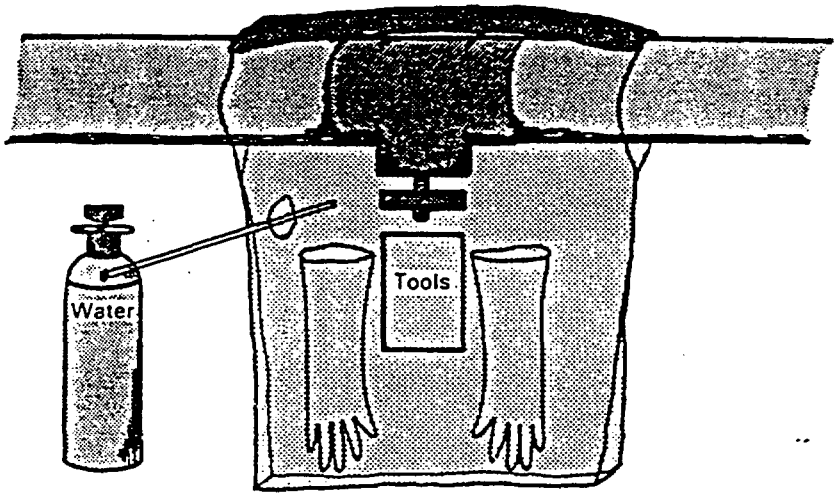


Figure 14. Custom containment bags for repairing or removing pipe insulation.

5.3. Abatement Methods for Other Types of ACM

Additional corrective action generally is not needed for other types of ACM. The special O&M program should continue until building renovation or maintenance requires ACM removal. The ACM should then be removed following the guidelines for surfacing materials (i.e., worker protection and work area containment). Removed ACM should be wrapped in 6 mil plastic sheets or placed in plastic bags, labeled as asbestos waste, and transported to a solid waste site. Unless these materials are friable, OSHA and NESHAPS regulations covering removal operations do not apply.

[6] Seals can be checked with a flashlight and smoke from a smoke tube.

CHAPTER 6. CONDUCTING ABATEMENT PROJECTS

Because efforts to treat ACM may be hazardous to abatement workers and building occupants, careful planning and diligent implementation of the project are essential. Removal, enclosure, or encapsulation of surfacing materials and removal or repair of pipe and boiler insulation may cause large-scale fiber release if proper procedures are not followed. As a result, asbestos levels in the building may increase rather than decrease.

For this reason, key elements of the abatement project include comprehensive and precise contract specifications, workers specially trained in asbestos abatement, rigorously applied worker protection and site containment measures, and the regular monitoring of the work site. When abatement activity is complete, the entire work site should be thoroughly cleaned. The contractor should be released only after the work site has passed visual inspection and a test for airborne asbestos.

SUMMARY

Who Should Do the Work:

Usually a contractor is hired to conduct abatement work that goes beyond special O&M. Occasionally, a large school district or an owner of many buildings will train and dedicate an in-house asbestos abatement team.

Selecting a Contractor:

Steps in selecting a contractor include checking references, conducting interviews, reviewing insurance coverage, and writing precise contract specifications. Note that the most cost-effective contractor is not necessarily the lowest bidder.

Managing the Work:

- Regular on-site inspections will assure conformance with work specifications and avoid costly and hazardous errors.
- Before the contractor is released, the work site should pass both a visual inspection and an air test for asbestos fibers to be sure the site has been adequately cleaned. From a technical point of view, the TEM method is preferred for the air test. Although the PCM method is not as specific for asbestos nor as sensitive to thin fibers as the TEM method, it is frequently more available and easier to implement.

6.1 Who Should Do the Abatement Work

Employees involved in the abatement work must be specially trained and committed to quality work. Training should:

- Familiarize workers with the general problems of airborne asbestos;
- Teach them to handle ACM safely and prevent unnecessary fiber release; and
- Explain how to interpret asbestos abatement work orders.

Either in-house staff or outside contractors can conduct asbestos abatement work. The decision depends primarily on training, equipment, and experience.

In most cases, the in-house maintenance staff will not have enough time to master asbestos abatement methods for surfacing materials—removal, enclosure, and encapsulation. However, some school districts with many buildings containing surfacing ACM have formed asbestos abatement teams whose sole responsibility is control of ACM. These in-house teams can thoroughly learn the requirements and methods of asbestos abatement. With this training and knowledge of the buildings, an in-house team may be the most effective. More typically, however, an outside contractor specializing in asbestos abatement is hired for specific abatement projects.

Building maintenance workers accustomed to repairing equipment with insulation are frequently trained to undertake abatement actions involving pipe and boiler insulation. However, outside contractors are typically hired to remove extensive amounts of insulation or to remove both pipe and insulation.

6.2 Selecting a Contractor

Selecting a competent contractor is the first step toward successful abatement. EPA's experience with asbestos abatement and comments from technical advisors suggest that many contractors cannot properly conduct abatement projects. Several contractors, awarded jobs based on responsive and reasonable cost bids, proved unable or unwilling to follow contract specifications. Suggestions to help building owners avoid these situations are as follows:

- Assign the technical advisor who will monitor the abatement work to assist in writing job specifications and selecting the contractor. The advisor should not be employed by an abatement contractor.
- Require evidence of prospective contractors' experience and/or training in asbestos abatement.
- Check references, including other building owners for whom contractors have worked. (See Appendix K for an example checklist of contractor qualifications.)
- Ask for detailed written descriptions of how bidders will satisfy the project specifications.
- Interview bidders regarding their work, worker protection, and site containment plans. A statement that the contractor will comply with all EPA, OSHA, and state regulations is not sufficient. Ask bidders for copies of their standard operating procedures and employee protection plans, specifically their OSHA medical monitoring and respirator training program. The interview is invaluable for evaluating each contractor's capabilities and understanding of the problem.
- Obtain documentation of each contractor's fiscal qualifications, including financial performance, assets, liabilities, legal judgments, and insurance.
- Be sure that the contractor selected has adequate liability insurance. Some forms of insurance may not provide enough long-term protection against inadequate abatement work. The building owner's attorney and insurance advisor should determine if coverage is adequate.
- Be specific about what constitutes successful job completion. A thorough visual inspection to insure adequate cleaning is an absolute necessity. Air monitoring is also recommended (see Section 6.4). The person carrying out the air monitoring should not be employed by the abatement contractor.
- Require evidence of worker certification or have the contractor conduct an on-site training program for workers.

- Encourage bidding competition, since prices can vary greatly. Multiple bids are desired, but too many can confuse the selection process. Remember that successful abatement, not cost minimization, is the goal.

- If possible, avoid contracting for abatement work during the summer. Many school projects are conducted during that season, taxing the limited number of competent contractors.

Appendix L contains a list of organizations that have prepared model contract specifications for asbestos removal. Together with the above suggestions, these models can serve as the basis for writing specifications tailored to individual projects. Remember that EPA's RAC can provide additional information and suggestions.

6.3 Managing the Work

As in all construction jobs, the program manager or the manager's representative (frequently the technical advisor) should visit the abatement work site often (no less than four times per day) to insure that all plans and procedures are properly implemented. The work site monitor should:

- Be sure the workers follow specifications;

- Confirm compliance with worker protection requirements; and

- Assure that the containment barriers around the work site are properly constructed and maintained.

By carefully monitoring the abatement work, the asbestos program manager can correct errors quickly. Work site inspections are most effective if the manager can refer to a detailed workplan containing specific work practices. Where work does not follow specifications, the project should be stopped immediately. The abatement contractor, the asbestos program manager, and the work site monitor (if different from the program manager) should then identify the problems and take steps to correct them.

The need for worker protection (protective clothing, respirators, and change facilities) was discussed in Section 5.1. Although contractors are responsible for their employees, a building owner's concern for the safety of everyone in the building extends to the abatement workers.

Work area containment is essential for all types of abatement and for both surfacing material and pipe and boiler insulation. Once abatement begins, all persons not directly involved in the work should be barred from the area. The work site monitor should make sure plastic barriers are in place (see Section 5.1) and that warning signs are posted at least 20 ft. in front of the work site entrance.

If abatement activity is limited to repair or minor removal of pipe and boiler insulation, containment bags will probably be used (see Section 5.2). The monitor should inspect the construction and use of the bags. Warning signs should be posted outside the work site.

The monitor should also check the air lock at the entrance to the work site. If a negative pressure system is not used, the air lock (and the entire containment system) should be airtight. If a negative pressure system is used (as recommended), the air lock must allow air from the building to enter the work site to replace the contaminated air that is filtered and exhausted outside. When inspecting the work in progress, the monitor's specific checklist will depend on the type of abatement. Abatement inspection for surfacing materials and pipe and boiler insulation should be based on guidelines and precautions described in Chapter 5 (Sections 5.1 and 5.2, respectively).

Work site inspections greatly increase an abatement project's likelihood of success. The importance of doing the job right the first time cannot be over-emphasized. Tests must be performed when the work is

finished to determine if the project has been conducted properly and the work site adequately cleaned (described in 6.4.) However, if the workers have not been diligent throughout the project, proper cleaning of the work site may not be possible.

6.4 Releasing the Contractor

An asbestos abatement project is successful when the source of fiber release has been controlled and airborne asbestos generated during abatement has been reduced to an acceptable level. As discussed earlier in this chapter, success can be built into the project with a sound work plan and constant monitoring of the work area to insure proper implementation. All workers must be trained and must follow stipulated work practices. Also, it is important to use negative air pressure ventilation to capture asbestos fibers generated during all types of abatement, and to continually remove debris from the site. When the abatement project is completed, the entire site should be cleaned at least twice.

Success is confirmed with a final evaluation at each work area. The evaluation consists of visual inspection and air testing. Visual inspection is used to determine if the work has been performed properly and to check for debris and other obvious signs of poor cleaning. Air testing helps confirm that the work site has been adequately cleaned. Only then is the contractor released.

6.4.1 Visual Inspection

The primary test for releasing the contractor is a thorough visual inspection of the work site. The inspection should be conducted before the containment barriers have been taken down but after the plastic sheets have been cleaned with damp mops and cloths or a HEPA vacuum cleaner. Since elevated levels of airborne asbestos may still be present, the inspector should wear a respirator (see Section 5.1).

First, the inspector should confirm job completeness. If ACM has been removed, substrate surfaces should be checked to be sure no ACM remains. Special attention should be given to pipes, beams, and irregular surfaces that may have corners and hard-to-reach areas. If the materials were enclosed, check the area for tight construction (e.g., no stray drill holes or openings at corners). Inspect encapsulated surfaces to insure that the right amount of sealant has been used: there should be no holes, voids, or cracks. Check surfaces behind obstructions (e.g., pipes or ducts) for these signs.

Next, the inspector should determine that the work site has been adequately cleaned. Any activity that disturbs ACM will release fibers. Therefore, work site cleanup after removal, repair, enclosure, or encapsulation is critical:

Examine all surfaces for dust and debris, especially overhead areas like tops of suspended light fixtures. Use a damp cloth to collect dust from these surfaces and then inspect the cloth for evidence of dust. This is a practical way to establish that the "no dust" requirement has been met.

A more sensitive test for dust is to darken the room and shine a flashlight so that the beam just glances any smooth horizontal surface. Run your finger across the illuminated area. If a line is left on the surface, or if airborne particles shine in the light, dust is still present.

If dust is found by either of the two tests, the entire work area should be recleaned and the tests repeated.

6.4.2 Air Testing

Conduct air monitoring only after the site has passed visual inspection. First, remove all plastic sheets covering floors, walls, and other surfaces. (The plastic barriers separating the site from the rest of the building

and the plastic sheets covering doors, vents, and windows should be left in place until the air test has been passed.) If a negative air pressure ventilation system was used during abatement, it should continue operating while air monitoring is in progress.

As discussed in Section 4.1, measuring airborne asbestos fibers accurately is technically complex and usually expensive. It involves two steps: air sampling to capture fibers on a filter, and laboratory analysis to determine the quantity of asbestos. There are several approaches to air sampling and analysis, varying in technical requirements, cost, and availability. Which approach is more appropriate is a controversial subject. The information presented in the remainder of this chapter is based in part on a 1984 workshop sponsored by EPA and the National Bureau of Standards. A companion EPA guidance document on air monitoring following an abatement action discusses the subject in more detail (USEPA 1985b).

6.4.2.1 Sampling

Sampling for asbestos consists of collecting fibers by drawing air through a filter at a known rate. Usually, sampling equipment is placed at a fixed location for a certain period of time. But this approach may fail to detect the presence of fibers. For example, if sampling is conducted for a short time during a quiet period (i.e., when air movement is limited), many fibers will settle out of the air onto the floor and other surfaces and may not be captured on the filter. Under these conditions, air measurements could show little or no asbestos.

Previously, EPA recommended sampling for at least eight hours to cover various air circulation conditions and thus increase the likelihood of capturing asbestos fibers if they are present. A quicker and more effective way to accomplish this, however, is to circulate the air artificially so that the fibers remain airborne during sampling.

This "aggressive sampling" is recommended for the post-abatement air test. Recommended methods for conducting aggressive sampling are presented in Appendix M. They use forced-air equipment such as a leaf blower to dislodge free fibers, then slow-speed fans to keep the fibers suspended during sampling.

Persons who conduct the sampling should wear a respirator. Even though the work site has been cleaned and has passed the visual test, levels of airborne asbestos still may be elevated.

6.4.2.2 Analysis of Samples

Three microscopic methods are currently being used to analyze asbestos: phase contrast microscopy (PCM), scanning electron microscopy (SEM), and transmission electron microscopy (TEM). The characteristics and relative merits of each method are summarized in Table 5 and are described in detail in the companion EPA guidance document (USEPA 1985b).

As indicated in Table 5, PCM is the method that is most familiar, available, and frequently used. It is also the least expensive and has a well-established analytical protocol. (As noted in Section 4.1.2, OSHA specifies PCM for monitoring worker exposure in asbestos industries.) However, the NIOSH protocol for PCM does not distinguish between asbestos and other types of fibers and counts only fibers longer than 5 micrometers. Nor is PCM sensitive enough to detect the extremely thin fibers typical of airborne asbestos in buildings. Thus, the interpretation of PCM results assumes that a low concentration of relatively large airborne fibers means that the concentration of asbestos fibers is also low.

The TEM method gives the most complete information on airborne asbestos: it can distinguish asbestos from other fibers and also is able to detect very thin fibers. However, it can be expensive and time-consuming. TEM is not widely available.

TABLE 5. COMPARISON OF METHODS FOR MEASURING AIRBORNE ASBESTOS

	PCM	SEM	TEM
Standard Methods	NIOSH P&CAM 239 Method.[1]	No standard method.	EPA provisional method & update.[2]
Quality Assurance	Proficiency Analytical Testing Program; no NBS[3] reference materials.	No lab testing, or NBS reference materials.	Limited lab testing; NBS reference materials available.
Cost	$25-50	$50-300	$200-600
Availability	Most available.	Less available.	Least available.
Time Requirements	1 hr. preparation & analysis, < 6 hrs. turnaround.	4 hrs. preparation & analysis, 6-24 hrs. turnaround.	4-24 hrs. preparation & analysis, 2-7 days turnaround.
Sensitivity (Thinnest Fiber Visible)	0.15 μm at best; 0.25 μm typical.	0.05 μm at best; 0.20 μm typical.	0.0002 μm at best; 0.0025 μm typical.
Specificity	Not specific for asbestos.	More specific than PCM but not definitive for asbestos.	Definitive for asbestos. when used to its fullest capabilities.

[1] NIOSH 1979. The new NIOSH 7400 method is an alternative.
[2] USEPA 1977, Yamate 1984.
[3] National Bureau of Standards.

Source: Taken with modification from USEPA 1985b.

The SEM method can be somewhat more specific for asbestos and more sensitive to thin fibers than PCM, but less so than TEM. It is also less expensive and time-consuming than TEM. At present, however, no standard measurement protocol is available for SEM. As a result, it has not been systematically evaluated nor has the reliability of SEM measurements been established.

EPA acknowledges that all three methods are used in air testing for the purpose of releasing abatement contractors. However, only PCM and TEM have standard methods and testing programs. A standard method has not yet been developed for SEM. While TEM is technically the method of choice, PCM is the only option in many localities.

6.4.2.3 Recommended Test Specifications

Regardless of the microscopic method for measuring asbestos, identifying homogeneous work sites is the first important step in the process. A site within the abatement work area is homogeneous if it contains one type of ACM and only one type of abatement was used. For sampling purposes, the air in each

homogeneous site is assumed to be relatively uniform. Guidelines for locating the samplers are included in Appendix M. Several other aspects of the air test are identical, regardless of microscopic method:

- Choose sampling locations within the homogeneous work site to assure representative samples. (See Appendix M).
- Begin sampling when the work site is dry (24 hours after cleaning).
- Conduct aggressive air sampling in all cases.
- Follow sampling and analysis specifications, including procedures for quality control.

The asbestos program manager should be sure the technical advisor in charge of the air test knows the specifications listed below. The advisor should insist that recommended procedures be followed for both air sampling and laboratory analysis.

Testing with the TEM Method

Sampling:

- Draw at least 3000 liters of air through each filter at a rate of 2 to 12 liters per minute.
- Collect at least five samples in each homogeneous work site.
- At the same time, collect at least five samples just outside the work site but within the building. These samples will be compared with those collected inside the work site to ensure that the work site is at least as clean as the incoming air (see Appendix M for details).[1]

Analysis:

- Measure the asbestos on each filter with TEM using the EPA provisional procedures and updates (USEPA 1977 and Yamate 1984).
- Use a direct transfer method of sample preparation if possible (see Appendix M).
- Express the results as f/cc, or as ng/m^3 if an indirect sample preparation is used.
- Include at least one field blank [2] and one laboratory blank per abatement job for quality control purposes (see Section 6.4.3). Also, split one work site sample and conduct duplicate analyses.

Release Criterion:

- Release the contractor if the average fiber concentration of the work site samples is not statistically larger than the average of the outside samples. Each homogeneous site must pass the test before the contractor is released. (Appendix M contains information to determine statistical differences.)
- If the average of the work site samples is statistically larger than the average of the outside samples, clean the entire work site again and repeat the test (collect new work site samples and follow the procedures described above).

[1] If a negative pressure system has not been used, collect the "outside" samples outdoors.

[2] A blank is a filter that is not used for sampling but is otherwise treated in the same way as other filters.

Testing with the PCM Method

Sampling:

- Draw at least 3000 liters of air through each filter at a rate of 2 to 12 liters per minute.
- Collect at least five samples per homogeneous work site, or one per room, whichever is greater.

Analysis:

- Measure the asbestos on each filter with PCM using the NIOSH P&CAM 239 procedures. (The newer NIOSH 7400 procedures can also be used. See Appendix M.)
- Include at least one field blank and one laboratory blank per abatement project, for quality control purposes. Also, split one work site sample for duplicate analysis.

Release Criterion:

- Release the contractor if every sample value is below the limit of reliable quantification (approximately 0.01 f/cc when 3000 liters of air are sampled; see Appendix M).
- If any of the sample values is above the prescribed level, clean the entire work site again, collect new samples, and evaluate the samples as described above.

For each method, the recommended number of samples and the prescribed use of the data defining the release criteria are based on a compromise involving practical considerations of cost, time required for the tests, performance characteristics of the methods, and statistical criteria. Details of the sampling and analysis specifications are provided in Appendix M.

6.4.3 Quality Assurance

Notwithstanding the advantages of one microscopic method over another, no method will produce reliable results unless both the field sampling and laborabory analysis are properly conducted. To obtain reliable results, a quality assurance (QA) program for the collection and analysis of data is essential.

The objective is to produce measurements with sufficient and documented quality for their intended purpose. In this case, the purpose is to determine satisfactory completion of an abatement project. The components of a QA program range from clerical activities such as labeling samples and documenting results, to performing technically complex tasks in the laboratory. When establishing the quality of data, however, all activities are equally important.

Preparing and implementing a QA program requires the assistance of a technical advisor on asbestos measurement. EPA and OSHA have published guidelines on quality assurance for TEM and PCM (Yamate 1984, and NIOSH 1979). The QA Program Checklist below can be used by the asbestos program manager in reviewing a proposed QA program.

QA Program Checklist

- **Training and Experience:** Be sure that all persons producing the measurement understand their roles and are trained. Select a laboratory with demonstrated proficiency in asbestos analysis. Request details of the laboratory's quality control program, and get documentation of the lowest level of fibers routinely reported.

- **Quality Control Checks:** Use field and laboratory blanks to check for fiber contamination, coded sample labels to avoid analyst bias, duplicate analyses to confirm precision, and a second laboratory to spot-check the accuracy of results.

- **Chain-of-Custody:** Assign responsibility for security of the samples to specific persons at each stage of the analysis. Document each step in the passage of the sample from the field to the laboratory.

- **Documentation:** Check and document laboratory results as well as their labeling. The building owner should retain all test results and records documenting the testing process.

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USEPA. 1980b. U.S. Environmental Protection Agency. Asbestos-containing materials in schools, economic impact analysis of identification and notification proposed rule, Sec. 6, TSCA. Washington, DC: Office of Toxic Substances, USEPA. EPA-560/12-80-004.

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USEPA. 1984a. U.S. Environmental Protection Agency. Evaluation of the EPA asbestos-in-schools identification and notification rule. Washington, DC: Office of Toxic Substances, USEPA. EPA 560/5-84-005.

USEPA. 1984b. U.S. Environmental Protection Agency. Asbestos in buildings: national survey of asbestos-containing friable materials. Washington, DC: Office of Toxic Substances, USEPA. EPA 560/5-84-006.

USEPA. 1985a. U.S. Environmental Protection Agency. Asbestos in buildings: guidance for service and maintenance personnel. Washington, DC: Office of Toxic Substances, USEPA. EPA 560/5-85-018.

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Appendix A. Asbestos-Containing Materials Found in Buildings*

Subdivision	Generic name	Asbestos (%)	Dates of use	Binder/sizing
Surfacing material	sprayed- or troweled-on	1-95	1935-1970	sodium silicate, portland cement, organic binders.
Preformed thermal insulating products	batts, blocks, and pipe covering			
	85% magnesia	15	1926-1949	magnesium carbonate
	calcium silicate	6-8	1949-1971	calcium silicate
Textiles	cloth[a]			
	blankets (fire)[a]	100	1910-present	none
	felts:	90-95	1920-present	cotton/wool
	blue stripe	80	1920-present	cotton
	red stripe	90	1920-present	cotton
	green stripe	95	1920-present	cotton
	sheets	50-95	1920-present	cotton/wool
	cord/rope/yarn[a]	80-100	1920-present	cotton/wool
	tubing	80-85	1920-present	cotton/wool
	tape/strip	90	1920-present	cotton/wool
	curtains[a] (theatre, welding)	60-65	1945-present	cotton
Cementitious concrete-like products	extrusion panels:	8	1965-1977	portland cement
	corrugated	20-45	1930-present	portland cement
	flat	40-50	1930-present	portland cement
	flexible	30-50	1930-present	portland cement
	flexible perforated	30-50	1930-present	portland cement
	laminated (outer surface)	35-50	1930-present	portland cement
	roof tiles	20-30	1930-present	portland cement
	clapboard and shingles:			
	clapboard	12-15	1944-1945	portland cement
	siding shingles	12-14	unknown-present	portland cement
	roofing shingles	20-32	unknown-present	portland cement
	pipe	20-15	1935-present	portland cement
Paper products	corrugated:			
	high temperature	90	1935-present	sodium silicate
	moderate temperature	35-70	1910-present	starch
	indented	98	1935-present	cotton and organic binder
	millboard	80-85	1925-present	starch, lime, clay
Roofing felts	smooth surface	10-15	1910-present	asphalt
	mineral surface	10-15	1910-present	asphalt
	shingles	1	1971-1974	asphalt
	pipeline	10	1920-present	asphalt

* The information in this Appendix is taken, with modification, from: Lory EE, Coin DC. February 1981. *Management Procedure for Assessment of Friable Asbestos Insulating Material.* Port Hueneme, CA: Civil Engineering Laboratory Naval Construction Battalion Center. The U.S. Navy prohibits the use of asbestos-containing materials when acceptable nonasbestos substitutes have been identified.

Laboratory aprons, gloves, cord, rope, fire blankets, and curtains may be common in schools.

Appendix A. (continued)

Subdivision	Generic name	Asbestos (%)	Dates of use	Binder/sizing
Asbestos-containing compounds	caulking putties	30	1930-present	linseed oil
	adhesive (cold applied)	5-25	1945-present	asphalt
	joint compound		1945-1975	asphalt
	roofing asphalt	5	unknown-present	asphalt
	mastics	5-25	1920-present	asphalt
	asphalt tile cement	13-25	1959-present	asphalt
	roof putty	10-25	unknown-present	asphalt
	plaster/stucco	2-10	unknown-present	portland cement
	spackles	3-5	1930-1975	starch, casein, synthetic resins
	sealants fire/water	50-55	1935-present	caster oil or polyisobutylene
	cement, insulation	20-100	1900-1973	clay
	cement, finishing	55	1920-1973	clay
	cement, magnesia	15	1926-1950	magnesium carbonate
Asbestos ebony products		50	1930-present	portland cement
Flooring tile and Sheet Goods	vinyl/asbestos tile	21	1950-present	poly(vinyl)chloride
	asphalt/asbestos tile	26-33	1920-present	asphalt
	sheet goods/resilient	30	1950-present	dry oils
Wallcovering	vinyl wallpaper	6-8	unknown-present	—
Paints and coatings	roof coating	4-7	1900-present	asphalt
	air tight	15	1940-present	asphalt

asbestos measured in air samples indicate that, on an average, about 30 fibers counted by the NIOSH procedures equal one nanogram of asbestos. This relationship applies to samples collected during the spray application of asbestos insulation. For these samples, each fiber counted weighs an average of 0.033 ng, or about 37 times more than those in the example, and 2,000,000 of them would weigh about 67,000 ng.

asbestos on a dry weight basis on equipment and machinery, except as provided in paragraph (c) of this section:

(1) Notify the Administrator at least 20 days before beginning the spraying operation. Include the following information in the notice:

(i) Name and address of owner or operator.

(ii) Location of spraying operation.

(iii) Procedures to be followed to meet the requirements of this paragraph.

(2) Discharge no visible emissions to the outside air from the spray-on application of the asbestos-containing material or use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(c) The requirements of paragraphs (a) and (b) of this section do not apply to the spray-on application of materials where the asbestos fibers in the materials are encapsulated with a bituminous or resinous binder during spraying and the materials are not friable after drying.

(d) Owners and operators of sources subject to this section are exempt from the requirements of §§ 61.05(a), 61.07, and 61.09.

(Approved by the Office of Management and Budget under control number 2000-0264.)

§ 61.149 Standard for fabricating.

(a) *Applicability.* This section applies to the following fabricating operations using commercial asbestos:

(1) The fabrication of cement building products.

(2) The fabrication of friction products, except those operations that primarily install asbestos friction materials on motor vehicles.

(3) The fabrication of cement or silicate board for ventilation hoods; ovens; electrical panels; laboratory furniture, bulkheads, partitions, and ceilings for marine construction; and flow control devices for the molten metal industry.

(b) *Standard.* Each owner or operator of any of the fabricating operations to which this section applies shall either:

(1) Discharge no visible emissions to the outside air from any of the operations or from any building or structure in which they are conducted; or

(2) Use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

§ 61.150 Standard for insulating materials.

After the effective date of this regulation, no owner or operator of a facility may install or reinstall on a facility component any insulating materials that contain commercial asbestos if the materials are either molded and friable or wet-applied and friable after drying. The provisions of this paragraph do not apply to spray-applied insulating materials regulated under § 61.148.

§ 61.151 Standard for waste disposal for asbestos mills.

Each owner or operator of any source covered under the provisions of § 61.142 shall:

(a) Deposit all asbestos-containing waste material at waste disposal sites operated in accordance with the provisions of § 61.156; and

(b) Discharge no visible emissions to the outside air from the transfer of asbestos waste from control devices to the tailings conveyor, or use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air. Dispose of the asbestos waste from control devices in accordance with § 61.152(b) or paragraph (c) of this section; and

(c) Discharge no visible emissions to the outside air during the collection, processing, packaging, transporting, or deposition of any asbestos-containing waste material, or use one of the disposal methods specified in paragraphs (c) (1) or (2) of this section, as follows:

(1) Use a wetting agent as follows:

(i) Adequately mix all asbestos-containing waste material with a wetting agent recommended by the manufacturer of the agent to effectively wet dust and tailings, before depositing the material at a waste disposal site. Use the agent as recommended for the

the area adequate to prevent exposure of the asbestos-containing waste material; or

(3) Cover the asbestos-containing waste material with at least 60 centimeters (2 feet) of compacted nonasbestos-containing material, and maintain it to prevent exposure of the asbestos-containing waste; or

(4) For inactive waste disposal sites for asbestos tailings, apply a resinous or petroleum-based dust suppression agent that effectively binds dust and controls wind erosion. Use the agent as recommended for the particular asbestos tailings by the manufacturer of the dust suppression agent. Obtain prior approval of the Administrator to use other equally effective dust suppression agents. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

(b) Unless a natural barrier adequately deters access by the general public, install and maintain warning signs and fencing as follows, or comply with paragraph (a)(2) or (a)(3) of this section.

(1) Display warning signs at all entrances and at intervals of 100 m (330 feet) or less along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material was deposited. The warning signs must:

(i) Be posted in such a manner and location that a person can easily read the legend; and

(ii) Conform to the requirements for 51 cm×36 cm (20"×14") upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph; and

(iii) Display the following legend in the lower panel with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend	Notation
Asbestos Waste Disposal Site	2.5 cm (1 inch) Sans Serif, Gothic or Block
Do Not Create Dust	1.9 cm (¾ inch) Sans Serif, Gothic or Block
Breathing Asbestos is Hazardous to Your Health.	14 Point Gothic.

Spacing between any two lines must be at least equal to the height of the upper of the two lines.

(2) Fence the perimeter of the site in a manner adequate to deter access by the general public.

(3) Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access by the general public.

(c) The owner or operator may use an alternative control method that has received prior approval of the Administrator rather than comply with the requirements of paragraph (a) or (b) of this section.

§ 61.154 Air-cleaning.

(a) The owner or operator who elects to use air-cleaning, as permitted by §§ 61.142, 61.144, 61.147(c)(2), 61.147(d)(2), 61.148(b)(2), 61.149(b), 61.151(b), 61.151(c)(1)(ii), 61.152(b)(1)(ii), and 61.152(b)(2) shall:

(1) Use fabric filter collection devices, except as noted in paragraph (b) of this section, doing all of the following:

(i) Operating the fabric filter collection devices at a pressure drop of no more than .995 kilopascal (4 inches water gage), as measured across the filter fabric; and

(ii) Ensuring that the airflow permeability, as determined by ASTM Method D737-75, does not exceed 9 $m^3/min/m^2$ (30 $ft^3/min/ft^2$) for woven fabrics or $11^3/min/m^2$(35 $ft^3/min/ft^2$) for felted fabrics, except that 12 $m^3/min/m^2$ (40 ft^3min/ft^2) for woven and 14 $m^3/min/m^2$ (45 ft $^3min/ft^2$) for felted fabrics is allowed for filtering air from asbestos ore dryers; and

(iii) Ensuring that felted fabric weighs at least 475 grams per square meter (14 ounces per square yard) and is at least 1.6 millimeters (one-sixteenth inch) thick throughout; and

(iv) Avoiding the use of synthetic fabrics that contain fill yarn other than that which is spun.

(2) Properly install, use, operate, and maintain all air-cleaning equipment authorized by this section. Bypass devices may be used only during upset or emergency conditions and then only for so long as it takes to shut down the operation generating the particulate asbestos material.

(b) There are the following exceptions to paragraph (a)(1):

(1) If the use of fabric creates a fire or explosion hazard, the Administrator may authorize as a substitute the use of wet collectors designed to operate with a unit contacting energy of at least 9.95 kilopascals (40 inches water gage pressure).

(2) The Administrator may authorize the use of filtering equipment other than that described in paragraphs (a)(1) and (b)(1) of this section if the owner or operator demonstrates to the Administrator's satisfaction that it is equivalent to the described equipment in filtering particulate asbestos material.

[49 FR 13661, Apr. 5, 1984; 49 FR 25453, June 21, 1984]

§ 61.155 Reporting.

(a) Within 90 days after the effective date of this subpart, each owner or operator of any existing source to which this subpart applies shall provide the following information to the Administrator, except that any owner or operator who provided this information prior to April 5, 1984 in order to comply with § 61.24 (which this section replaces) is not required to resubmit it.

(1) A description of the emission control equipment used for each process; and

(2) If a fabric filter device is used to control emissions, the pressure drop across the fabric filter in inches water gage; and

(i) If the fabric device uses a woven fabric, the airflow permeability in $m^3/min/m^2$ and; if the fabric is synthetic, whether the fill yarn is spun or not spun; and

(ii) If the fabric filter device uses a felted fabric, the density in g/m^2, the minimum thickness in inches, and the airflow permeability in $m^3/min/m^2$.

(3) For sources subject to §§ 61.151 and 61.152:

(i) A brief description of each process that generates asbestos-containing waste material; and

(ii) The average weight of asbestos-containing waste material disposed of, measured in kg/day; and

(iii) The emission control methods used in all stages of water disposal; and

(iv) The type of disposal site or incineration site used for ultimate disposal, the name of the site operator, and the name and location of the disposal site.

(4) For sources subject to § 61.153:

(i) A brief description of the site; and

(ii) The method or methods used to comply with the standard, or alternative procedures to be used.

(b) The information required by paragraph (a) of this section must accompany the information required by § 61.10. The information described in this section must be reported using the format of Appendix A of this part.

(Approved by this Office of Management and Budget under control number 2000-0264)

(Sec. 114, Clean Air Act as amended (42 U.S.C. 7414))

§ 61.156 Active waste disposal sites.

To be an acceptable site for disposal of asbestos-containing waste material under §§ 61.151 and 61.152, an active waste disposal site must meet the requirements of this section.

(a) Either there must be no visible emissions to the outside air from any active waste disposal site where asbestos-containing waste material has been deposited, or the requirements of paragraph (c) or (d) of this section must be met.

(b) Unless a natural barrier adequately deters access by the general public, either warning signs and fencing must be installed and maintained as follows, or the requirements of paragraph (c)(1) of this section must be met.

(1) Warning signs must be displayed at all entrances and at intervals of 100 m (330 ft) or less along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material is deposited. The warning signs must:

(i) Be posted in such a manner and location that a person can easily read the legend; and

(ii) Conform to the requirements of 51 cm × 36 cm (20" × 14") upright

format signs specified in 29 CFR 1910.145(d)(4) and this paragraph; and

(iii) Display the following legend in the lower panel with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend	Notation
Asbestos Waste Disposal Site.	2.5 cm (1 inch) Sans Serif, Gothic or Block.
Do Not Create Dust	1.9 cm (¾ inch) Sans Serif, Gothic or Block.
Breathing Asbestos is Hazardous to Your Health.	14 Point Gothic.

Spacing between any two lines must be at least equal to the height of the upper of the two lines.

(2) The perimeter of the disposal site must be fenced in a manner adequate to deter access by the general public.

(3) Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access by the general public.

(c) Rather than meet the no visible emission requirement of paragraph (a) of this section, an active waste disposal site would be an acceptable site if at the end of each operating day, or at least once every 24-hour period while the site is in continuous operation, the asbestos-containing waste material which was deposited at the site during the operating day or previous 24-hour period is covered with either.

(1) At least 15 centimeters (6 inches) of compacted nonasbestos-containing material, or

(2) A resinous or petroleum-based dust suppression agent that effectively binds dust and controls wind erosion. This agent must be used as recommended for the particular dust by the manufacturer of the dust suppression agent. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

(d) Rather than meet the no visible emission requirement of paragraph (a) of this section, an active waste disposal site would be an acceptable site if an alternative control method for emissions that has received prior approval by the Administrator is used.

(Secs. 112 and 301(a) of the Clean Air Act as amended (42 U.S.C. 7412, 7601(a))

Appendix D. Addresses of EPA NESHAPS Contacts and Regional Asbestos Coordinators

NESHAPs Contacts

(For information on NESHAPs rule compliance and disposal)

Region 1
Asbestos NESHAPs Contact
Air Management Division
USEPA
JFK Federal Building
Boston, MA 02203
(617) 223-4872

Region 2
Asbestos NESHAPs Contact
Air & Waste Management Division
USEPA
26 Federal Plaza
New York, NY 10007
(212) 264-4479

Region 3
Asbestos NESHAPs Contact
Air Management Division
USEPA
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-6552

Region 4
Asbestos NESHAPs Contact
Air, Pesticide & Toxic Management
USEPA
345 Courtland Street N.E.
Atlanta, GA 30365
(404) 881-4901

Region 5
Asbestos NESHAPs Contact
Air Management Division
USEPA
230 S. Dearborn Street
Chicago, IL 60604
(312) 353-2088

Region 6
Asbestos NESHAPs Contact
Air & Waste Management Division
USEPA
1201 Elm Street
Dallas, TX 75270
(214) 767-9835

Region 7
Asbestos NESHAPs Contact
Air & Waste Management Division
USEPA
726 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2576

Region 8
Asbestos NESHAPs Contact
Air & Waste Management Division
USEPA
1860 Lincoln Street
Denver, CO 80295
(303) 293-1767

Region 9
Asbestos NESHAPs Contact
Air Management Division
USEPA
215 Fremont Street
San Francisco, CA 94105
(415) 974-7648

Region 10
Asbestos NESHAPs Contact
Air & Toxics Management Division
USEPA
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-2724

Regional Asbestos Coordinators

(For information on asbestos identification, health effects, abatement options, analytic techniques, asbestos in schools, and contract documents)

Region 1
Regional Asbestos Coordinator
USEPA
JFK Federal Building
Boston, MA 02203
(617) 223-0585

Region 2
Regional Asbestos Coordinator
USEPA
Woodbridge Avenue
Edison, NJ 08837
(201) 321-6668

Region 3
Regional Asbestos Coordinator
USEPA
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-9859

Region 4
Regional Asbestos Coordinator
USEPA
345 Courtland Street N.E.
Atlanta, GA 30365
(404) 881-3864

Region 5
Regional Asbestos Coordinator
USEPA
230 S. Dearborn Street
Chicago, IL 60604
(312) 886-6879

Region 6
Regional Asbestos Coordinator
USEPA
First International Building
1201 Elm Street
Dallas, TX 75270
(214) 767-5314

Region 7
Regional Asbestos Coordinator
USEPA
726 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2838

Region 8
Regional Asbestos Coordinator
USEPA
999 18th Street
Denver, CO 80202
(303) 293-1730

Region 9
Regional Asbestos Coordinator
USEPA
215 Fremont Street
San Francisco, CA 94105
(415) 974-8588

Region 10
Regional Asbestos Coordinator
USEPA
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-2632

Appendix E. Phone Numbers for Obtaining Information and EPA Publications

Information **800/334-8571**

- Sampling and analysis of ACM (bulk materials)
- EPA Sealant Study

Publications **800/424-9065 (554-1404 — In Washington, DC)**

- Friable Asbestos-Containing Materials in Schools: Identification and Notification Rule (40 CFR Part 763).
- Evaluation of the EPA Asbestos-in-Schools Identification and Notification Rule. EPA 560/5-84-005.
- Asbestos in Buildings: National Survey of Asbestos-Containing Friable Materials. EPA 560/5-84-006.
- Asbestos in Buildings: Guidance for Service and Maintenance Personnel. EPA 560/5-85-018.
- Asbestos Waste Management Guidance. EPA 530-SW-85-007.
- Asbestos Fact Book. EPA Office of Public Affairs.

Appendix F. Occupational Health and Safety (OSHA) Asbestos Regulations (29 CFR 1910.1001)

§ 1910.1001 Asbestos.

(a) *Definitions.* For the purpose of this section, (1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

(2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.

(b) *Permissible exposure to airborne concentrations of asbestos fibers*—(1) *Standard effective July 7, 1972.* The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(2) *Standard effective July 1, 1976.* The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) *Ceiling concentration.* No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(c) *Methods of compliance*—(1) *Engineering methods.* (i) *Engineering controls.* Engineering controls, such as, but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) *Local exhaust ventilation.* (a) Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971, which is incorporated by reference herein.

(b) See § 1910.6 concerning the availability of ANSI Z9.2-1971, and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(iii) *Particular tools.* All hand-operated and power-operated tools which may produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, such as, but not limited to, saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems in accordance with subdivision (ii) of this subparagraph.

(2) *Work practices*—(i) *Wet methods.* Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section, unless the usefulness of the product would be diminished thereby.

(ii) *Particular products and operations.* No asbestos cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated so as to prevent effectively the release of airborne asbestos fibers in excess of the limits prescribed in paragraph (b) of this section.

(iii) *Spraying, demolition, or removal.* Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d)(2)(iii) of this section and with special clothing in accordance with paragraph (d)(3) of this section.

(d) *Personal protective equipment*—(1) Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (c) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by paragraphs (d)(1) (i), (ii), or (iii) of this section, and both are practicable, personnel rotation shall be preferred and used.

(2) Where a respirator is permitted by paragraph (d)(1) of this section, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health, Department of

Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 FR 6244, Mar. 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii), and (iv) of this subparagraph.

(i) *Air purifying respirators.* A reusable or single use air purifying respirator, or a respirator described in paragraph (d)(2) (ii) or (iii) of this section, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) *Powered air purifying respirators.* A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in paragraph (d)(2)(iii) of this section, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) *Type "C" supplied-air respirators, continuous flow or pressure-demand class.* A type "C" continuous flow or pressure-demand, supplied-air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) *Establishment of a respirator program.* (*a*) The employer shall establish a respirator program in accordance with the requirements of the American National Standards Practices for Respiratory Protection, ANSI Z88.2-1969, which is incorporated by reference herein.

(*b*) See § 1910.6 concerning the availability of ANSI Z88.2-1969 and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of a respirator. Such employee shall be rotated to another job or given the opportunity to transfer to a different position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) Special clothing: The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) Change rooms: (i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, the employer shall provide change rooms for employees working regularly at the place.

(ii) Clothes lockers: The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) Laundering: (*a*) Laundering of asbestos contaminated clothing shall be done so as to prevent the release of air-borne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(*b*) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in paragraph (d)(4)(iii)(*a*) of this section to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(c) Contaminated clothing shall be transported in sealed impermeable bags, or other closed, impermeable containers, and labeled in accordance with paragraph (g) of this section.

(e) *Method of measurement.* All determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400-450 × (magnification) (4 millimeter objective) with phase contrast illumination.

(f) *Monitoring*—(1) *Initial determinations.* Within 6 months of the publication of this section, every employer shall cause every place of employment where asbestos fibers are released to be monitored in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately undertake a compliance program in accordance with paragraph (c) of this section.

(2) *Personal monitoring*—(i) Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by paragraph (f)(1) of this section, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall the sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

(3) *Environmental monitoring.* (i) Samples shall be collected from areas of a work environment which are representative of the airborne concentrations of asbestos fibers which may reach the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) *Sampling frequency and patterns.* After the initial determinations required by paragraph (f)(1) of this section, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposures to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) *Employee observation of monitoring.* Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) *Caution signs and labels*—(1) *Caution signs*—(i) *Posting.* Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) *Sign specifications.* The warning signs required by paragraph (g)(1)(i) of this section shall conform to the requirements of 20" × 14" vertical format signs specified in § 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

Legend	Notation
Asbestos	1" Sans Serif, Gothic or Block.
Dust Hazard	¾" Sans Serif, Gothic or Block.
Avoid Breathing Dust	¼" Gothic.
Wear Assigned Protective Equipment.	¼" Gothic.

Legend	Notation
Do Not Remain In Area Unless Your Work Requires It.	¼" Gothic.
Breathing Asbestos Dust May Be Hazardous To Your Health.	14 point Gothic.

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) *Caution labels*—(i) *Labeling.* Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other material so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.

(ii) *Label specifications.* The caution labels required by paragraph (g)(2)(i) of this section shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION

Contains Asbestos Fibers

Avoid Creating Dust

Breathing Asbestos Dust May Cause Serious Bodily Harm

(h) *Housekeeping*—(1) *Cleaning.* All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

(2) *Waste disposal.* Asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing, consigned for disposal, which may produce in any reasonably foreseeable use, handling, storage, processing, disposal, or transportation airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall be collected and disposed of in sealed impermeable bags, or other closed, impermeable containers.

(i) *Recordkeeping*—(1) *Exposure records.* Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least 20 years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and to authorized representatives of either.

(2) *Access.* Employee exposure records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)–(e) and (g)–(i).

(3) *Employee notification.* Any employee found to have been exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) *Medical examinations*—(1) *General.* The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) *Preplacement.* The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 × 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(3) *Annual examinations.* On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examination shall include, as a minimum, a chest roentgenogram (posteri-

or-anterior 14 × 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(4) *Termination of employment.* The employer shall provide, or make available, within 30 calendar days before or after the termination of employment of any employee engaged in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 × 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(5) *Recent examinations.* No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with this paragraph within the past 1-year period.

(6) *Medical records*—(i) *Maintenance.* Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be retained by employers for at least 20 years.

(ii) *Access.* Records of the medical examinations required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (g)-(i). These records shall also be provided upon the request to the Director of NIOSH. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

Appendix G. Specifications for Sampling Materials and Selecting a Qualified Laboratory to Analyze for Asbestos

G.1 Collecting Samples

Taking a sample of ACM can damage the material and cause significant release of fibers. The following guidelines are designed to minimize both damage and fiber release.[1]

- Wear at least a half-face respirator with disposable filters (see Section 5.1).
- Wet the surface of the material to be sampled with water from a spray bottle or place a plastic bag around the sampler.
- Sample with a reusable sampler such as a cork borer or a single-use sampler such as a glass vial. (Figure G-1 shows a single-use sampler constructed from an acrylic tube.)
- With a twisting motion, slowly push the sampler into the material. Be careful not to penetrate beyond the surface layer.
- For reusable samplers, extract and eject the sample into a container. Wet-wipe the tube and plunger. For single-use samplers, extract, wet-wipe the exterior, and cap it.
- Label the container.
- Clean debris using wet towels and discard them in a plastic bag.
- For surfacing material, use latex paint or a sealant to cover the sample area. For pipe and boiler insulation, use a nonasbestos mastic.

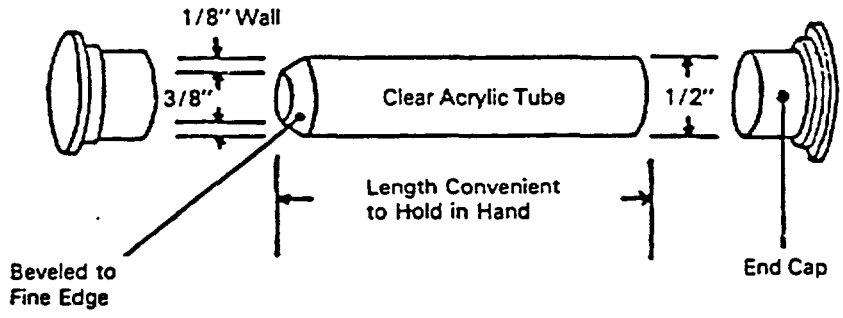

Figure G-1 - Sampler/container

G.2 Selecting a Qualified Laboratory

The U.S. Environmental Protection Agency (EPA) runs a bulk asbestos sample quality assurance program. Updated lists of participating laboratories, their performance scores, and further information on the program are available from the Asbestos Technical Information Service at (800) 334-8571 (Extension 6741).

[1] The guidelines are based on information in John T. Jankovic, "Asbestos Bulk Sampling Procedure," American Industrial Hygiene Association, 46, B-8 to B-10, 1985.

Appendix H. Definition and Description of Factors for Assessing the Need for Corrective Action*

H.1 Condition of the Asbestos-Containing Material

H.1.1 Factors 1 and 2: Deterioration or Delamination and Physical Damage

An assessment of the condition should evaluate: the quality of the installation, the adhesion of the friable material to the underlying substrate, deterioration, and damage from vandalism or any other cause. Evidence of debris on horizontal surfaces, hanging material, dislodged chunks, scrapings, indentations, or cracking are indicators of poor material condition.

Accidental or deliberate physical contact with the friable material can result in damage. Inspectors should look for any evidence that the asbestos-containing material has been disturbed: finger marks in the material, graffiti, pieces dislodged or missing, scrape marks from movable equipment or furniture, or accumulation of the friable material on floors, shelves, or other horizontal surfaces.

Asbestos-containing material may deteriorate as a result of either the quality of the installation or environmental factors which affect the cohesive strength of the asbestos-containing material or the strength of the adhesion to the substrate. Deterioration can result in the accumulation of dust on the surface of the asbestos-containing material, delamination of the material (i.e., separating into layers), or an adhesive failure of the material where it pulls away from the substrate and either hangs loosely or falls to the floor and exposes the substrate. Inspectors should touch the asbestos-containing material and determine if dust is released when the material is lightly brushed or rubbed.

If the coated surface "gives" when slight hand pressure is applied or the material moves up and down with light pushing, the asbestos-containing material is no longer tightly bonded to its substrate.

H.1.2 Factor 3: Water Damage

Water damage is usually caused by roof leaks, particularly in buildings with flat roofs or a concrete slab and steel beam construction. Skylights can also be significant sources of leaks. Water damage can also result from plumbing leaks and water or high humidity in the vicinity of pools, locker rooms, and lavatories.

Water can dislodge, delaminate, or disturb friable asbestos-containing materials that are otherwise in good condition and can increase the potential for fiber release by dissolving and washing out the binders in the material. Materials which were not considered friable may become friable after water has dissolved and leached out the binders. Water can also act as a slurry to carry fibers to other areas where evaporation will leave a collection of fibers that can become suspended in the air.

Inspect the area for visible signs of water damage, such as discoloration of or stains on the asbestos-containing material; stains on adjacent walls or floors; buckling of the walls or

*The information in this Appendix is taken, with modification, from: Brandner, W. October 1982. *Asbestos Exposure Assessment in Buildings Inspection Manual.* Kansas City, MO: U.S. Environmental Protection Agency, Region VII.

floors; or areas where pieces of the asbestos-containing material have separated into layers or fallen down, thereby exposing the substrate.

Close inspection is required. In many areas, staining may occur only in a limited area while water damage causing delamination may have occurred in a much larger area. In addition, the water damage may have occurred since the original inspection for friable material, causing new areas to become friable and require a reinspection.

Delamination is particularly a problem in areas where the substrate is a very smooth concrete slab. Check to see if the material "gives" when pressure is applied from underneath.

H.2 Potential for Disturbance or Erosion

H.2.1 Factor 4: Air Plenum or Direct Airstream

An air plenum exists when the return (or, in rare cases, conditioned) air leaves a room or hall through vents in a suspended ceiling and travels at low speed and pressure through the space between the actual ceiling and the suspended ceiling or ducts. The moving air may erode any asbestos-containing material in the plenum. In evaluating whether an air plenum or direct airstream is present, the inspector must look for evidence of ducts or cavities used to convey air to and from heating or cooling equipment or the presence of air vents or outlets which blow air directly onto friable material.

A typical construction technique is to use the space between a suspended ceiling and the actual ceiling as a return air plenum. In many cases, the tiles in the suspended ceiling must be lifted to check if this is the case. Inspection of the air handling or HVAC equipment rooms may also provide evidence (such as accumulated fibers) of the presence of this material in the plenums.

Special attention should be paid to whether frequent activities (such as maintenance) disturb the material in the plenum. It is also important to check for evidence that the material is being released or eroded (i.e., has it deteriorated or been damaged so that the material is free to circulate in the airstream?).

H.2.2 Factor 5: Exposure, Accessibility, and Activity

These three considerations are highly interrelated and have been combined into a single factor. In general, for a site to show a high potential for disturbance, it must be exposed (visible) and accessible, and be located near movement corridors or subject to vibration.

The amount of asbestos-containing material exposed to the area occupied by people will contribute to the likelihood that the material may be disturbed and determines whether the fibers can freely move through the area. An asbestos-containing material is considered exposed if it can be seen. For a material not to be exposed, a physical barrier must be complete, undamaged, and unlikely to be removed or dislodged. An asbestos-containing material should be considered exposed if it is visible, regardless of the height of the material.

If the asbestos-containing material is located behind a suspended ceiling with movable tiles, a close inspection must be made of the condition of the suspended ceiling; the likelihood and frequency of access into the suspended ceiling, and whether the suspended ceiling forms a complete barrier or is only partially concealing the material.

Asbestos-containing material above a suspended ceiling is considered exposed if the space above the suspended ceiling is an air plenum. Suspended ceilings with numerous louvers, grids, or other open spaces should be considered exposed.

If friable asbestos-containing material can be reached by building users or maintenance people, either directly or by impact from objects used in the area, it is accessible and subject to accidental or intentional contact and damage. Material which is accessible is likely to be disturbed in the future.

Height above the floor is one measure of accessibility. However, objects have been observed embedded in ceilings 25 feet or more high. Nearness of the friable asbestos-containing material to heating, ventilation, lighting and plumbing systems requiring maintenance or repair may increase the material's accessibility.

In addition, the activities and behavior of persons using the building should be included in the assessment of whether the material is accessible. For example, persons involved in athletic activities may accidentally damage the material on the walls and ceilings of gymnasiums with balls or athletic equipment. To become fully aware of occupants' use of the building, the inspector should consult with building staff or personnel.

When assessing activity levels, consider not only the movement caused by the activities of people but also movement from other sources such as high vibration from mechanical equipment, highways, and airplanes. Another source of vibration is sound, such as music and noise, which sets airwaves in motion at certain frequencies. As these sound waves impact on asbestos-containing material, they may vibrate the material and contribute to fiber release. Therefore, more fibers may be released in a music practice room or auditorium than in the rest of the building.

The amount of activity of the occupants can best be described by identifying the purpose of the area as well as estimating the number of persons who enter the area on a typical day.

H.2.3 Factor 6: Change in Building Use

A planned change in the use of the building from, for example, a junior to a senior high school may imply significant changes in the potential for erosion or disturbance. Of particular note is the increased potential for damage from balls to previously inaccessible ceilings in gymnasiums. The addition of machinery (such as dust collectors in wood or metal shops) to a school or office building may introduce vibrations which, again, may be a future cause of concern. The inspector should exercise judgement and draw on experience in evaluating the likely effect of such changes.

Appendix I. Example Building Inspection Form

Room:_____ Sample Number(s):_____

Building:_____ Address:_____

Evaluator:_____ Phone No.:_____

Coated Area: Ceiling Wall(s) Structural Members Above Suspended Ceiling

Pipe Lagging Boiler Insul. Other:_____

Type of Ceiling: Concrete 3 Coat Plaster System Suspended Metal Lath

Concrete Joists and Beams Tile Suspended Lay-In Panels

Metal Deck Corrugated Steel Steel Beam or Bar Joists

Ceiling Height:_____ft.

Ceiling Shape: Flat Dome Other (draw):

Folded Plate Barrel

Type of Wall (If Coated): Smooth Concrete Rough Concrete Masonry

Plasterboard Other:_____

Amount of Friable Material in Area being Evaluated:_____sq. ft.

Description of Coating: Fibrous (highly friable) Granular/Cementitious (soft) Concrete Like (hard)

Thickness:_____inch(s) Is thickness uniform: Yes No

Coating debris on Floor/Furniture/Work Surfaces: Yes No

Curtains, expandable partitions, etc. being pulled across coating: Yes No

Type of Lighting: Surface Mounted Suspended Recessed

No. of Lights:_____ Type of Heating/Cooling Systems:_____

Type of Floor: Concrete Tile Wood Carpet Other:_____

What is above the room being evaluated?_____

_____

Comments:_____

_____

_____

I.1 Notes to Appendix I

The need for collecting most of the information on this form is discussed in Chapter 5 (Section 5.1). The form requires one additional piece of information: the presence of curtains or expandable partitions which are pulled across asbestos-containing material. Where this situation is found, the curtains or partitions should be removed or repositioned to eliminate contact with the material. Any damage to the asbestos-containing material then can be repaired.

This form was provided by Wolfgang Brandner, the Regional Asbestos Coordinator in Region VII.

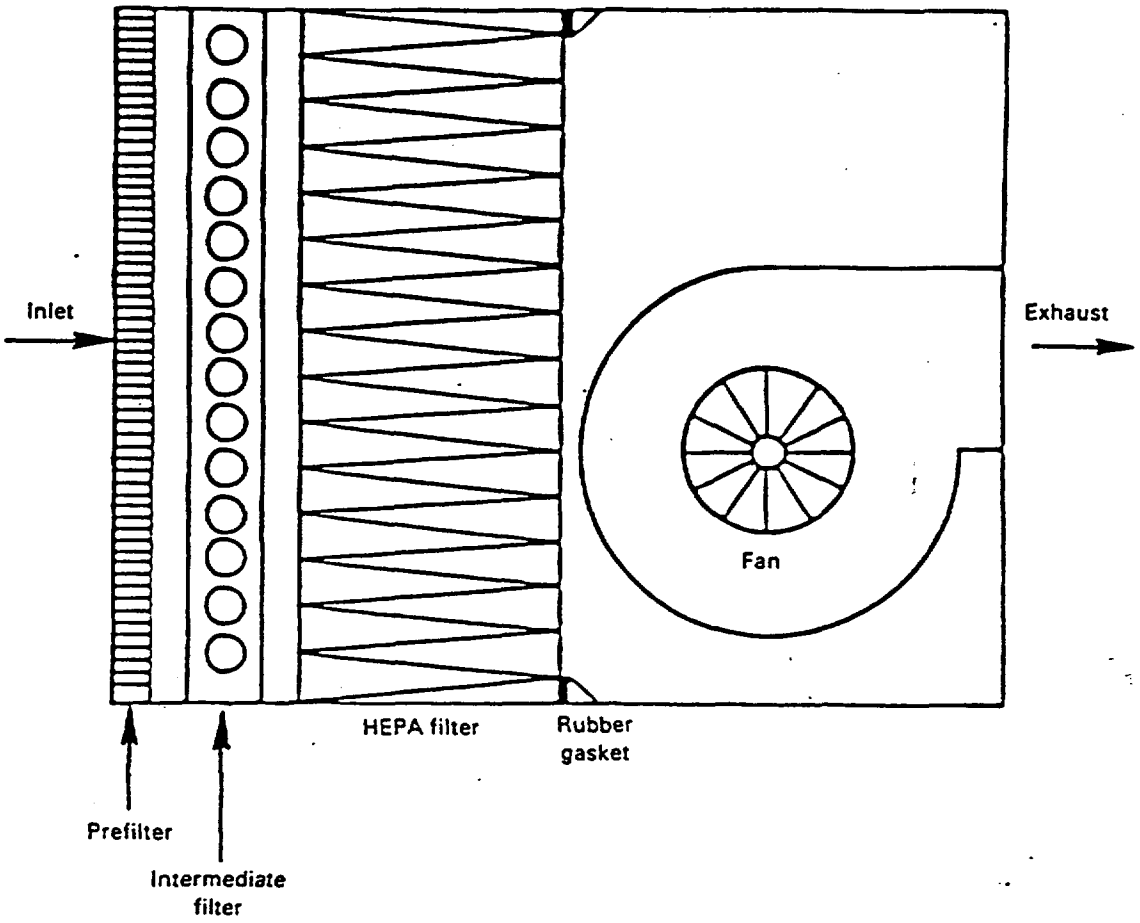

Figure J-1. An example of a HEPA-filtered exhaust unit. This scheme is one of several possible designs.

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.

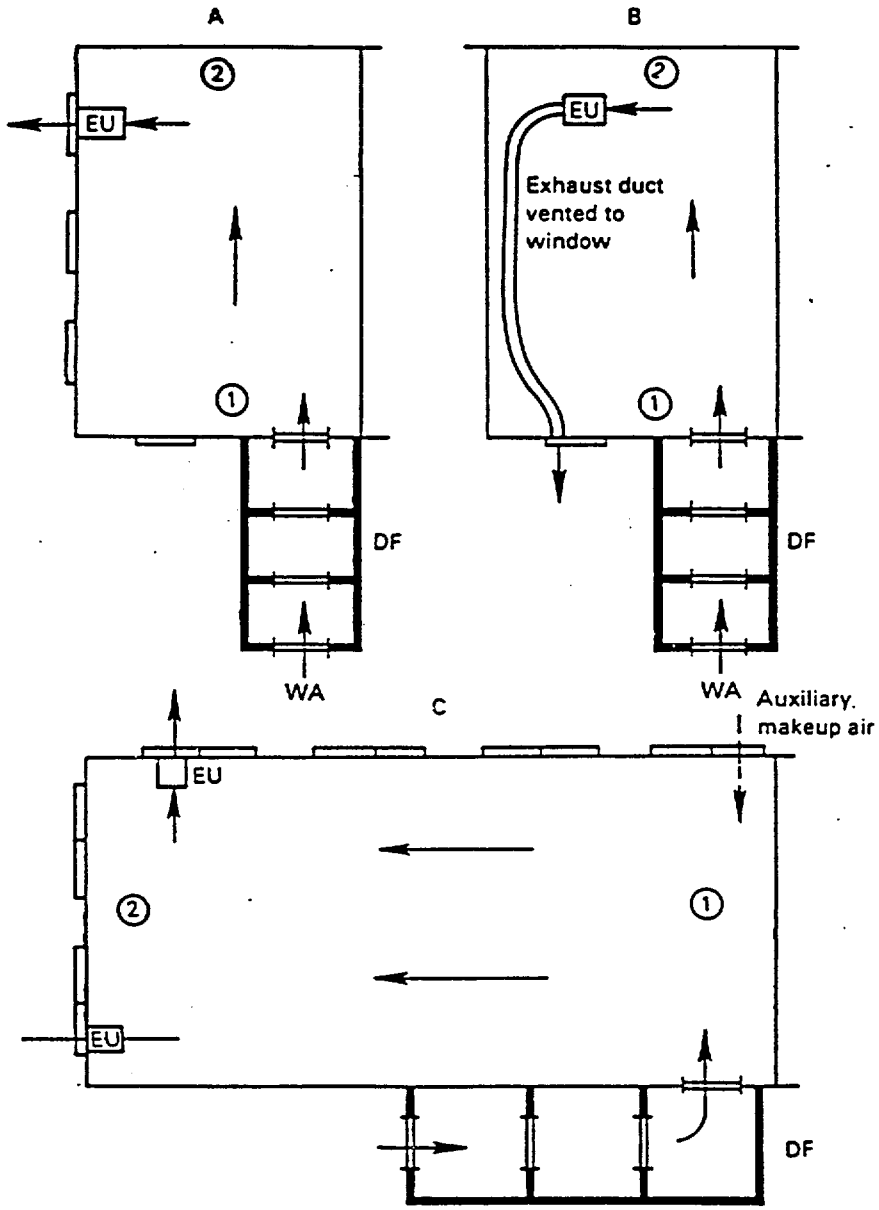

Figure J-2. Examples of negative pressure systems. DF, Decontamination Facility; EU, Exhaust Unit; WA, Worker Access; A, Single-room work area with multiple windows; B, Single-room work area with single window near entrance; C, Large single-room work area with windows and auxiliary makeup air source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

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.

Appendix K. Checklist for Determining Contractor Qualifications

a. Contractors shall demonstrate reliability in performance of general contracting activities through the submission of a list of references of persons who can attest to the quality of work performed by the contractor.

b. Contractors must demonstrate ability to perform asbestos abatement activities by submitting evidence of the successful completion of training courses covering asbestos abatement. At a minimum, the contractor shall furnish proof that employees have had instruction on the dangers of asbestos exposure, on respirator use, decontamination, and OSHA regulations.

c. Contractors must be able to demonstrate prior experience in performing previous abatement projects through the submission of a list of prior contracts, including: the names, addresses, and telephone numbers of building owners for whom the projects were performed. In rare circumstances inexperienced contractors may be qualified if they can demonstrate exceptional qualifications in the other contractor standards.

d. Additional evidence of successful completion of prior abatement projects should be demonstrated by contractors through the submission of air monitoring data, if any, taken during and after completion of previous projects in accordance with 29 CFR 1910.1001 (e).

e. Contractors must possess written standard operating procedures and employee protection plans which include specific reference to OSHA medical monitoring and respirator training programs. In addition, the contractor must be prepared to make available for viewing at the job site a copy of OSHA regulations at 29 CFR 1910.1001 governing asbestos controls, and Environmental Protection Agency regulations at 40 CFR Part 61, Subpart M. (NESHAPS) governing asbestos stripping work practices, and disposal of asbestos waste.

f. In those States which have contractor certification programs, contractors must possess State certifications for the performance of asbestos abatement projects.

g. Contractors must be able to provide a description of any asbestos abatement projects which have been prematurely terminated, including the circumstances surrounding the termination.

h. Contractors must provide a list of any contractual penalties which the contractor has paid for breach or noncompliance with contract specifications, such as overruns of completion time or liquidated damages.

i. Any citations levied against the contractor by any Federal, State, or local government agencies for violations related to asbestos abatement, shall be identified by contractors, including the name or location of the project, the date(s), and how the allegations were resolved.

j. Contractors must submit a description detailing all legal proceedings, lawsuits or claims which have been filed or levied against the contractor or any of his past or present employees for asbestos-related activities.

k. Contractors must supply a list of equipment that they have available for asbestos work. This should include negative air machines, type "C" supplied air systems, scaffolding, decontamination facilities, disposable clothing, etc.

Appendix L. Guide Specifications for Abatement Projects

The following organizations have developed contract specifications that can be used as a guide for abatement projects:

Association of the Wall/Ceiling Industries—International, Inc.
Guide Specifications for the Abatement of Asbestos Release from Spray- or Trowel-Applied Materials in Buildings and Other Structures. December 1981. The Foundation of the Wall and Ceiling Industry, 25 K Street, N.E., Washington, DC 20002 USA.

Maryland State Department of Health and Mental Hygiene
Recommended Contract Specifications for Asbestos Abatement Projects.

Federal Construction Guide Specifications (FCGS): 02085. Asbestos Abatement Procedures.

GSA Guide Specifications PBS (PCD): 02085. Asbestos Abatement Procedures.

Appendix M. Detailed Specifications for Sampling and Analyzing Airborne Asbestos

The following specifications are summarized from "Measuring Airborne Asbestos Following an Abatement Action" (USEPA 1985).

M.1 Sampling

M.1.1 Sampling Equipment

Standard sampling equipment consists of a pump (operated at a 2 to 12 liter per minute flow rate), a filter in a cassette and associated tubing and supports. Three types of filters can be used:

PCM — cellulose ester with 0.8 to 1.2 μm pore size;

TEM — polycarbonate with 0.4 μm pore size (preferred); or cellulose ester with 0.8 μm pore size.

M.1.2 Number of Samples

M.1.2.1 TEM

A minimum of five samples inside and five outside the work site is recommended. When a negative air pressure ventilation system has been used during the abatement operation the "outside" samples should be collected outside the work site, but inside the building. This provides a comparison between the work site and the incoming air. If a negative air pressure ventilation system has not been used, the "outside" samples should be collected outdoors. These sample sizes are based on calculations of statistical reliability and on the following characteristics:

- The coefficient of variation for TEM measurements is between 100% and 150% based on data from EPA research studies.
- A false positive rate of .10 (i.e., based on the statistical test comparing inside and outside measurements, 10% of the "clean" work sites will fail and have to be recleaned).
- A false negative rate of at most .10 (i.e., the statistical test comparing inside and outside measurements will identify at least 90% of the sites that must be recleaned).

M.1.2.2 PCM

A minimum of five samples is recommended. A sample size of five controls the false negative error rate. At least 90% of the sites where the actual fiber concentration exceeds 0.01 f/cc will fail the test. If the actual concentration is 0.02 f/cc the probability of failure is 99%.

M.1.3 Location of Samplers

M.1.3.1 Indoors

Indoor samplers should be placed so they are not influenced by unusual air circulation patterns. Avoid corners of rooms and obstructions (like furniture). Within the above constraints, samplers should be placed at random around the work site. For example, if the site is a single room of 1000 or more sq. ft., the five samplers should be distributed in an approximately uniform manner. If the site includes more than five rooms, the rooms to be sampled may be selected randomly. The companion EPA document (USEPA 1985) describes this procedure in more detail.

When TEM is used for the air test and a negative air pressure ventilation system has been employed during the abatement operation, the five "outside" samplers should be placed outside the work site but inside the building, and the negative air system left running during sampling. These outside samplers should be located to avoid any air that might escape through the containment barriers. Minimum recommendations are at least 50 ft. from the entry portal to the work site, or 25 ft. from the plastic containment barriers.

M.1.3.2 Outdoors

If TEM is to be used for the air test and a negative air pressure ventilation system has not been used during abatement, then five samplers should be placed outdoors. These should be placed at ground level (about 2 meters high), if possible, and away from obstructions that may influence wind patterns. If access to electricity and concerns about security dictate a roof-top site, do not place samplers near vents or other structures on the roof.

M.1.4 Sampling Volumes

M.1.4.1 TEM

The required sampling volume for the TEM air test is calculated from the theoretical detection limit of the TEM analysis procedures, and from typical levels of asbestos against which measurements in the work site will be compared:

$$\text{Volume} = \frac{(1\ \text{f/10 grid squares})}{(0.005\ \text{f/cc})} \times \frac{(855\ \text{mm}^2)}{(0.0056\ \text{mm}^2)} \times \frac{(1\ \text{liter})}{(1000\ \text{cc})} = 3054\ \text{liters}$$

Where:

- 1 f/10 grid squares (the maximum recommended filter counting area) is the smallest number of fibers needed to make a non-zero measurement. (This is below the limit of reliable quantification.)
- 0.005 f/cc is a typical outdoor asbestos level in urban areas, as measured by TEM (Chatfield 1983).
- 855 mm^2 is the collection area of a 37 mm diameter filter.
- 0.0056 mm^2 is the area of each grid square (75 μm per side) in a 200 mesh electron microscope grid. This value will vary from 0.0056 to 0.0081 mm^2 for different grids. Larger grid squares will improve measurement accuracy for the same sampling volume.

This equation is appropriate for TEM analysis using a direct sample transfer technique (see Section M.2.1). If an indirect technique is used, the required sampling volume is increased in proportion to the dilution used. For example, if the sample is diluted by a factor of 10, the required volume is 10 times larger.

M.1.4.2 PCM

The equivalent PCM limit of reliable quantification for a sampling volume of 3000 liters is:

$$\text{Quantification Limit} = \frac{(10\ \text{f/100 fields})}{(3000\ \text{liters})} \times \frac{(855\ \text{mm}^2)}{(0.003\ \text{mm}^2)} \times \frac{(1\ \text{liter})}{(1000\ \text{cc})} = 0.01\ \text{f/cc}$$

Where:
- 10 f/100 fields is the limit of reliable quantification for the P&CAM 239 method.
- 855 mm^2 is the collection area of a 37 mm diameter filter.
- 0.003 mm^2 is the size of a typical field of view for a PCM microscope. This value will vary from 0.003 to 0.006 mm^2 for different microscopes. Larger fields of view will improve (decrease) the limit of reliable quantification.

By increasing the sampling volume, the PCM test criterion can be made proportionally more stringent:

Volume	Quantification Limit
3000 liters	0.01 f/cc
5000	0.006
7500	0.004

If the sampling scheme associated with the new NIOSH 7400 PCM method is used, the limit of reliable quantification will be lower for the same sampling volume.

M.1.5 Aggressive Sampling

Procedures for sampling aggressively are:

- Before starting the sampling pumps, direct the exhaust from forced air equipment (such as a 1 horsepower leaf blower) against all walls, ceilings, floors, ledges and other surfaces in the room. This should take at least 5 minutes per 1000 sq. ft. of floor.
- Place a 20-inch fan in the center of the room. (Use one fan per 10,000 cubic feet of room space.) Place the fan on slow speed and point it toward the ceiling.
- Start the sampling pumps and sample for the required time.
- Turn off the pump and then the fan(s) when sampling is complete.

M.2 Analysis

M.2.1 TEM

Use the update to the EPA provisional method (Yamate 1984). The sample should be transferred directly from the polycarbonate filter to the electron microscope grid. If high levels of organic materials are suspected or found, cellulose ester filters and indirect transfer (involving ashing, sonicating, and refiltering the fibers) is recommended. However, levels of airborne organic particles should be low in a cleaned work site.

M.2.2 PCM

Use the NIOSH P&CAM 239 method (NIOSH 1979). The newer NIOSH 7400 methods can also be used, although OSHA has yet to replace P&CAM 239 with 7400 for workplace compliance monitoring. NIOSH reports that 7400 is at least as accurate as P&CAM 239.

M.3 Interpretation of Results

M.3.1 TEM

Use student's "t" test to compare inside and outside levels.

- Compute the natural logarithm of fiber concentration for each sample.
- Compute means of the log transformed data for inside samples and outside samples.
- Form the ratio

$$T = \frac{\overline{y}_1 - \overline{y}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where:

$\overline{y}_1$ = average of log concentrations inside the work site

$\overline{y}_2$ = average of log concentrations outside the work site

$S = [(\Sigma(y_{1i}-\overline{y}_1)^2 + \Sigma(y_{2i}-\overline{y}_2)^2)/(n_1+n_2-2)]^{*}$

n_1 = number of samples collected inside the work site

n_2 = number of samples collected outside the work site

Then compare T to the 95 percentile point of a "t" distribution with $n_1 + n_2 - 2$ degrees of freedom. (When 5 samples are collected inside and outside the 95 percentile point is 1.86.) If T exceeds the 95 percentile point, reclean. Otherwise, release the contractor.

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Appendix N. Glossary

Abatement	Asbestos control beyond a special operations and maintenance program.
Asbestos	A group of naturally occurring minerals that separate into fibers. There are six asbestos minerals used commercially: Chrysotile, Amosite, Crocidolite, Anthophyllite, Tremolite, and Actinolite.
Cementitious	Friable materials that are densely packed and nonfibrous.
Containment	Isolation of the work area from the rest of the building to prevent escape of asbestos fibers.
Delaminate	To separate into layers. As used here, to separate from the substrate.
(Human) Exposure	The presence of people in an area where levels of an airborne contaminant are elevated. A more technical definition sometimes found in scientific literature is: The total amount of airborne contaminant inhaled by a person, typically approximated by the product of concentration and duration.
(Material) Exposure	The amount or fraction of material visible.
Fibrous	Spongy, fluffy, composed of long strands of fibers.
Friable	Capable of being crumbled, pulverized, or reduced to powder by hand pressure.
Homogenous (Material)	Similar in appearance and texture.
Homogenous (Work Site)	Contains only one type of asbestos-containing material and only one type of abatement method was used.
Peak levels	Levels of airborne contaminant which are much higher than average and occur for short periods of time in response to sudden release of the contaminant.
Prevalent levels	Levels of airborne contaminant occurring under normal conditions.
Resolve	To distinguish different objects with a microscope.
Risk	The likelihood of developing a disease as a result of exposure to a contaminant.

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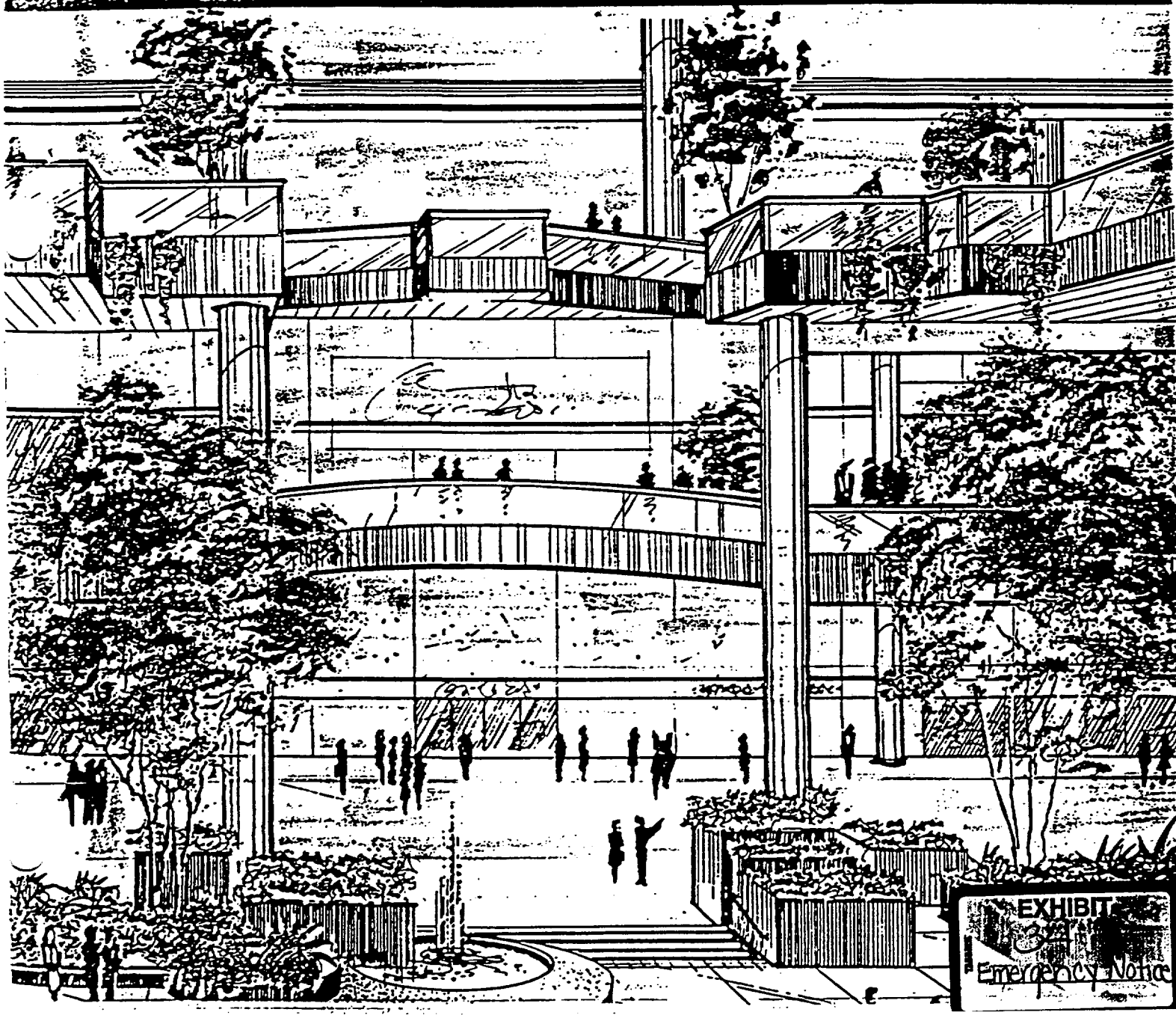
Managing Asbestos In Place

A Building Owner's Guide to Operations and Maintenance Programs for Asbestos-Containing Materials



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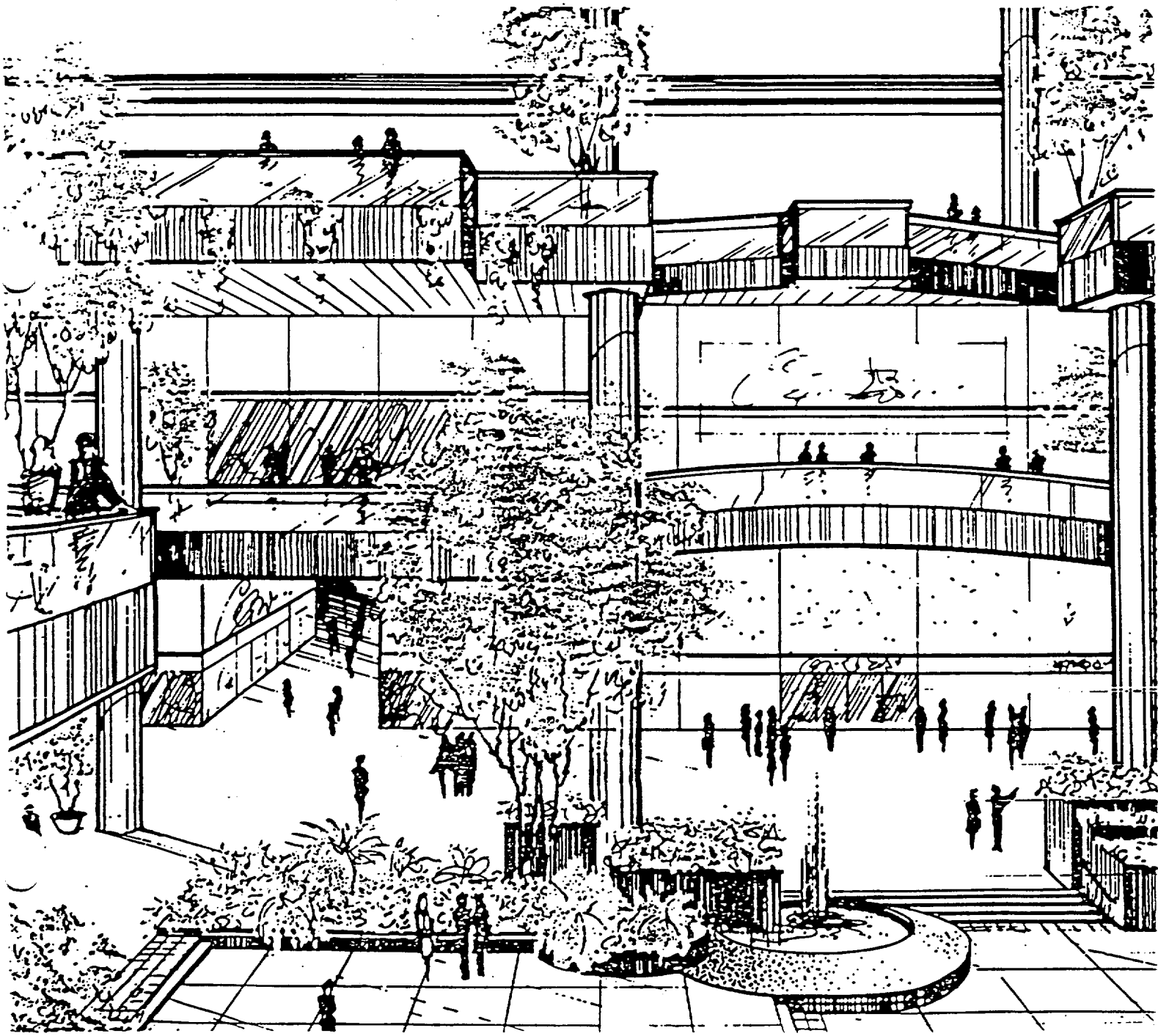
Managing Asbestos in Place

A Building Owner's Guide to Operations and Maintenance Programs for Asbestos-Containing Materials



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Foreword

In February 1988, the Administrator of the Environmental Protection Agency (EPA) recommended to Congress that the Agency work during the next three years to enhance the nation's technical capability in asbestos by helping building owners better select and apply appropriate asbestos control and abatement actions in their buildings. The publication of this guidance document is EPA's most extensive effort to date to carry out that recommendation. In fact, *Managing Asbestos In Place* is the most comprehensive asbestos guide published by EPA since the Agency expanded and updated *Guidance for Controlling Asbestos-Containing Materials in Buildings* (also known as the Purple Book) in June 1985. Based on the insights and recommendations of nationally recognized asbestos experts, this new guide, along with a new operations and maintenance work practices manual expected to be available in 1991, provides "state-of-the-art" instruction to building owners to help them successfully manage asbestos-containing materials in place.

Managing Asbestos in Place does not supplant the 1985 Purple Book as EPA's principal asbestos guidance document. Rather, based on our experience since 1985, it expands and refines the Purple Book's guidance for a special operations and maintenance (O&M) program. In particular, the guide more strongly emphasizes the importance of in-place management. The guide's purpose is two-fold. First, it offers building owners the more detailed and up-to-date instruction they need to carry out a successful O&M program. Second, it informs building owners, lenders, and insurers that a properly conducted O&M program can in many cases be as appropriate an asbestos control strategy as removal. Furthermore, in some cases, an O&M program is *more* appropriate than other asbestos control strategies, including removal.

Emphasizing the importance and effectiveness of a good O&M program is a critical element of EPA's broader effort to put the potential hazard and risk of asbestos exposure in proper perspective. That effort centers around communicating the following *five facts*, which EPA hopes will help calm the unwarranted fears that a number of people seem to have about the mere presence of asbestos in their buildings and discourage the spontaneous decisions by some building owners to remove all asbestos-containing material regardless of its condition.

FACT ONE: Although asbestos *is* hazardous, the risk of asbestos-related disease depends upon exposure to airborne asbestos fibers.

In other words, an individual must breathe asbestos fibers in order to incur any chance of developing an asbestos-related disease. How many fibers a person must breathe to develop disease is uncertain. However, at very low exposure levels, the risk may be negligible or zero.

FACT TWO: Based upon available data, the average airborne asbestos levels in buildings seem to be very low. Accordingly, the health risk to most building occupants also appears to be very low.

A 1987 EPA study found asbestos air levels in a small segment of Federal buildings to be essentially the same as levels outside these buildings. Based on that limited data, most building occupants (i.e., those unlikely to disturb asbestos-containing building materials) appear to face only a very slight risk, if any, of developing an asbestos-related disease.

FACT THREE: Removal is often *not* a building owner's best course of action to reduce asbestos exposure. In fact, an improper removal can create a dangerous situation where none previously existed.

By their nature, asbestos removals tend to elevate the airborne level of asbestos fibers. Unless all safeguards are properly applied, a removal operation can actually increase rather than decrease the risk of asbestos-related disease.

FACT FOUR: EPA *only* requires asbestos removal in order to prevent significant public exposure to airborne asbestos fibers during building demolition or renovation activities.

Asbestos removal before the wrecking ball swings into action is appropriate to protect public health. At other times, EPA believes that asbestos removal projects, unless well-designed and properly performed, can actually increase health risk.

FACT FIVE: EPA *does* recommend a proactive, in-place management program whenever asbestos-containing material is discovered.

As this guide will explain in some detail, in-place management does *not* mean "do nothing." It means having a program to ensure that the day-to-day management of the building is carried out in a manner that minimizes release of asbestos fibers into the air, and ensures that when asbestos fibers are released, either accidentally or intentionally, proper control and cleanup procedures are implemented. As such, it may be all that is necessary to control the release of asbestos fibers until the asbestos-containing material in a building is scheduled to be disturbed by renovation or demolition activities.

MANAGING ASBESTOS IN PLACE

1

Why Is Asbestos a Problem?

Introduction: Asbestos in Buildings

This U.S. Environmental Protection Agency (EPA) guide is primarily directed to owners and managers of office buildings, shopping centers, apartment buildings, hospitals, and similar facilities which may contain asbestos materials. Managers of industrial plants and other types of structures may need to supplement this information with additional specialized guidance. This document gives building owners, managers, workers, and other key building staff basic information on how to develop and carry out high-quality operations and maintenance programs for managing asbestos in place to safeguard the health of all building occupants. An operations and maintenance (O&M) program can be defined as a formulated plan of training, cleaning, work practices, and surveillance to maintain asbestos-containing materials (ACM) in good condition.

In this document you will find the following information:

- The objectives of an O&M program, and an indication of the scope of O&M activities (Chapter 2);
- Basic steps to take before starting an O&M program, including an initial survey and evaluation of ACM (Chapter 3);
- How to implement and manage the program, including some basic cost considerations (Chapter 3);
- O&M work practices that protect both workers and the general building environment (Chapter 4);
- Recordkeeping suggestions and requirements (a section of Chapter 4);
- Training recommendations and requirements for workers performing O&M activities (Chapter 5); and
- An overview of federal regulations, including those affecting O&M programs (Chapter 6).

In addition, the Appendices provide other useful information, including a glossary of useful terms, and contacts for additional assistance.

How O&M Fits In

There are steps which a building owner can take to prevent asbestos fiber releases or resuspension of already-released fibers, or control fiber releases quickly and safely if they occur. O&M programs are designed to achieve both these goals. This guide's purpose, therefore, is to inform building owners about how to develop, implement and manage effective O&M programs, and to encourage their use.

EPA recommends a pro-active, in-place management program whenever asbestos is discovered. In many buildings, a well-run O&M program may be all that is necessary to control the release of asbestos fibers until the ACM in the building is abated through renovation or demolition activities. Also, an emergency repair to equipment or building services, or an unexpected incident such as ACM falling from a surface could necessitate a different control strategy. However, barring such events, if ACM is properly managed, release of asbestos fibers into the air is minimized. The exposure to asbestos fibers, and therefore the risk of asbestos-related disease, can be reduced to a negligible level for all building occupants.

An O&M program may also provide an effective, less costly alternative to wholesale removal operations. Some additional cost-related considerations are discussed in Chapter 3.

The EPA National Emission Standards for Hazardous

An O&M program can be defined as a formulated plan of training, cleaning, work practices, and surveillance to maintain asbestos-containing materials in good condition.

Air Pollutants (NESHAP) regulations on asbestos may require ACM removal prior to renovation and/or demolition projects, to prevent significant asbestos releases into the air (see Chapter 6). Additionally, removal of some ACM in a building will be necessary if the material has been damaged beyond repair. *However*, at other times, removal is often *not* a building owner's best course of action to reduce asbestos exposure. (Extraneous factors—for example, difficulty in obtaining insurance, or obtaining financing relative to a real estate transaction—may actually represent the driving forces in a decision to remove all ACM, rather than a health-based need for removal.) In fact, unless all safeguards are properly applied by trained, experienced individuals, removing ACM can actually increase building occupants' risk of asbestos-related disease.

Background

The Asbestos Issue

Asbestos fibers can cause serious health problems. If inhaled, they can cause diseases which disrupt the normal functioning of the lungs. Three specific diseases—asbestosis (a fibrous scarring of the lungs), lung cancer, and mesothelioma (a cancer of the lining of the chest or abdominal cavity)—have been linked to asbestos exposure. These diseases do not develop immediately after inhalation of asbestos fibers; it may be 20 years or more before symptoms appear.

In general, as with cigarette smoking and the inhalation of tobacco smoke, the more asbestos fibers a person inhales, the greater the risk of developing an asbestos-related disease. Most of the cases of severe health problems resulting from asbestos exposure have been experienced by workers who held jobs in industries such as shipbuilding, mining, milling, and fabricating, where they were exposed to very high levels of asbestos in the air, without benefit of the worker protections now afforded by law. Many of these same workers were also smokers. These employees worked directly with asbestos materials on a regular basis and, generally, for long periods of time as part of their jobs. Additionally, there is an increasing concern for the health and safety of construction, renovation, and building maintenance personnel, because of possible periodic exposure to elevated levels of asbestos fibers while performing their jobs.

Whenever we discuss the risk posed by asbestos, we must keep in mind that asbestos fibers can be found nearly everywhere in our environment (usually at very low levels). There is, at this time, insufficient information concerning health effects resulting from low-level asbestos exposure, either from exposures in buildings or from our environment. This makes it difficult to accurately assess the magnitude of cancer risk for building occupants, tenants, and building maintenance and custodial workers. Although in general the risk is likely to be negligible for occupants, health concerns remain, particularly for the building's custodial and maintenance workers. Their jobs are likely to bring them into close proximity to ACM, and may sometimes require them to disturb the ACM in the performance of maintenance activities. For these workers in particular, a complete and effective O&M program can greatly reduce asbestos exposure. This kind of O&M program can also minimize asbestos exposures for other building occupants as well.

What is Asbestos?

The term "asbestos" describes six naturally occurring fibrous minerals found in certain types of rock formations. Of that general group, the minerals chrysotile, amosite, and crocidolite have been most commonly used in building products. When mined and processed, asbestos is typically separated into very thin fibers. When these fibers are present in the air, they are normally invisible to the naked eye. Asbestos fibers are commonly mixed during processing with a material which binds them together so that they can be used in many different products. Because these fibers are so small and light, they may remain in the air for many hours if they are released from ACM in a building. When fibers are released into the air they may be inhaled by people in the building.

Asbestos became a popular commercial product because it is strong, won't burn, resists corrosion, and insulates well. In the United States, its commercial use began in the early 1900's and peaked in the period from World War II into the 1970's. Under the Clean Air Act of 1970 the EPA has been regulating many asbestos-containing materials which, by EPA definition, are materials with more than 1 percent asbestos. The Occupational Safety and Health Administration's (OSHA) asbestos construction standard in section K, "Communication of hazards to employees," specifies labeling many materials containing 0.1% or more asbestos. In the mid-1970's several major kinds of asbestos materials, such as spray-applied insulation, fireproofing, and acoustical surfacing material, were banned by EPA because of growing concern about health effects, particularly cancer, associated with exposures to such materials.

In July 1989, EPA promulgated the Asbestos Ban and Phasedown Rule. The rule applies to new product manufacture, importation, and processing, and essentially bans almost all asbestos-containing products in the United States by 1997. This rule does *not* require removal of ACM currently in place in buildings.

Where is Asbestos Likely to be Found in Buildings?

In February 1988, the EPA released a report titled *EPA Study of Asbestos-Containing Materials in Public Buildings: A Report to Congress*. EPA found that "friable" (easily crumbled) ACM can be

found in an estimated 700,000 public and commercial buildings. About 500,000 of those buildings are believed to contain at least some damaged asbestos, and some areas of significantly damaged ACM can be found in over half of them.

According to the EPA study, significantly damaged ACM is found primarily in building areas not generally accessible to the public, such as boiler and machinery rooms, where asbestos exposures generally would be limited to service and maintenance workers. Friable ACM, if present in air plenums, can lead to distribution of the material throughout the building, thereby possibly exposing building occupants. ACM can also be found in other building locations.

Asbestos in buildings has been commonly used for thermal insulation, fireproofing, and in various building materials, such as floor coverings and ceiling tile, cement pipe and sheeting, granular and corrugated paper pipe wrap, and acoustical and decorative treatment for ceilings and walls. Typically, it is found in pipe and boiler insulation and in spray-applied uses such as fireproofing or sound-deadening applications.

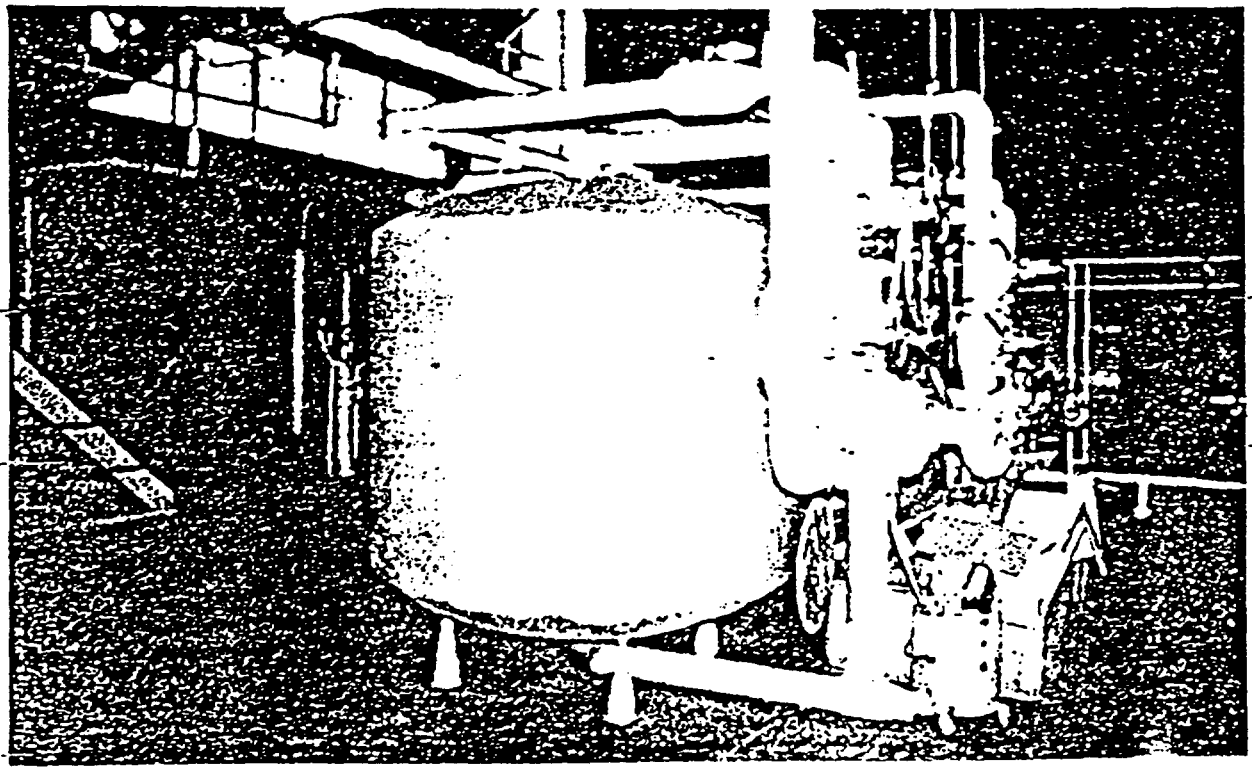
The amount of asbestos in these products varies widely (from approximately 1 percent to nearly 100 percent). The precise amount of asbestos in a product cannot always be accurately determined from labels or by asking the manufacturer. Nor can positive identification of asbestos be ascertained merely by visual examination. Instead, a qualified laboratory must analyze representative samples of the suspect material. Appendix G contains a sample list of some suspect materials.

When is Asbestos a Problem?

Intact and undisturbed asbestos materials do not pose a health risk. The mere presence of asbestos in a building does not mean that the health of building occupants is endangered. ACM which is in good condition, and is not somehow damaged or disturbed, is not likely to release asbestos fibers into the air. When ACM is properly managed, release of asbestos fibers into the air is prevented or minimized, and the risk of asbestos-related disease can be reduced to a negligible level.

ACM which is in pc physical condition Under a proper op ations and mainte nance program, cc rective action wou normally prevent deterioration of th insulation.

However, asbestos materials can become hazardous when, due to damage, disturbance, or deterioration over time, they release fibers into building air. Under these conditions, when ACM *is* damaged or disturbed — for example, by maintenance repairs conducted without proper controls — elevated airborne asbestos concentrations can create a potential hazard for workers and other building occupants.



ACM with sound structural integrity on the exterior of a domestic hot water tank. Note that the insulation jacketing is intact and there is no evidence of disturbance.

Chapter Summary

This document, directed to owners and managers of office buildings and similar facilities, should help lay the groundwork for developing and implementing effective operations and maintenance programs. Major highlights in this section have focused on background information concerning asbestos and have touched on the current asbestos-in-buildings situation. Important points to remember are the following:

- Inhalation of asbestos fibers has been shown to cause asbestosis, lung cancer and mesothelioma. Much of our knowledge of these health effects has come primarily from studies of workers exposed routinely to very high levels of asbestos in their jobs.
- Information on health effects of low-level asbestos exposure is less certain; custodial/maintenance workers who sometimes disturb asbestos as part of their job would benefit from properly executed O&M programs.
- Three of the six naturally occurring asbestos minerals, chrysotile, amosite, and crocidolite, have been most commonly used in building products.
- Asbestos became a popular commercial product because of its strength, heat resistance, corrosion resistance, and thermal insulation properties.
- Asbestos-containing materials (ACM) are regulated by EPA, OSHA, and the Consumer Product Safety Commission (CPSC), and individual state and local agencies.
- Friable ACM can be found in about 700,000 public and commercial buildings. Many areas where asbestos is found are not accessible to the general public.
- Some common uses of asbestos have included pipe/boiler insulation, spray-applied fireproofing, floor and ceiling tile, cement pipe/sheeting and paper pipe wrap.
- Positive identification of asbestos requires laboratory analysis; information on labels or visual examination only is not sufficient.
- Intact, undisturbed materials generally do not pose a health risk; they may become hazardous when damaged, disturbed, or deteriorated over time and release fibers into building air.

MANAGING ASBESTOS IN PLACE

2

What Is an O&M Program?

Purpose and Scope of an Operations and Maintenance Program

Purpose of O&M

The principal objective of an O&M program is to minimize exposure of all building occupants to asbestos fibers. To accomplish this objective, an O&M program includes work practices to (1) maintain ACM in good condition, (2) ensure proper cleanup of asbestos fibers previously released, (3) prevent further release of asbestos fibers, and (4) monitor the condition of ACM.

Scope of an O&M Program

An effective O&M program should address all types of ACM present in a building. ACM that may be managed as part of an O&M program in buildings can be classified in one of the following categories:

1. **Surfacing Material:** Examples include ACM sprayed or troweled onto surfaces, such as decorative plaster on ceilings or acoustical ACM on the underside of concrete slabs or decking, or fireproofing materials on structural members.

2. **Thermal System Insulation (TSI):** Examples include ACM applied to pipes, boilers, tanks, and ducts to prevent heat loss or gain, or condensation.

3. **Miscellaneous ACM:** Examples include asbestos-containing ceiling or floor tiles, textiles, and other components such as asbestos-cement panels, asbestos siding and roofing materials.

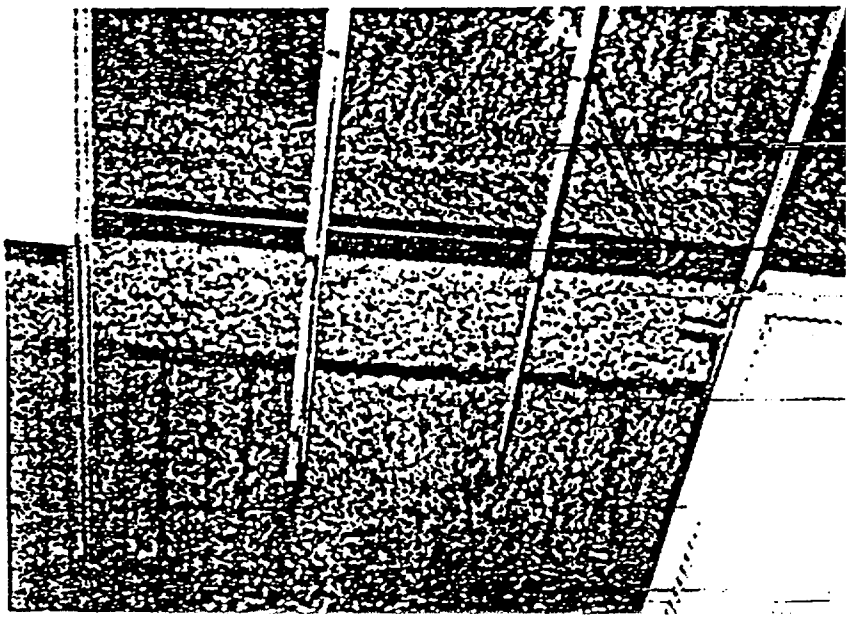
The O&M program, when developed and implemented in a particular facility, should include specific direction on how to deal with each of these general categories of ACM. Specified O&M work practices and procedures should be employed by trained personnel during building cleaning, maintenance, renovation, and general operational activities that may involve surfacing, thermal, or miscellaneous ACM. Some elaboration of O&M work practices and procedures is found in Chapter 4.

The O&M program can be divided into three types of projects:

- those which are unlikely to involve any direct contact with ACM;
- those which may cause accidental disturbance of ACM;
- those which involve relatively small disturbances of ACM.

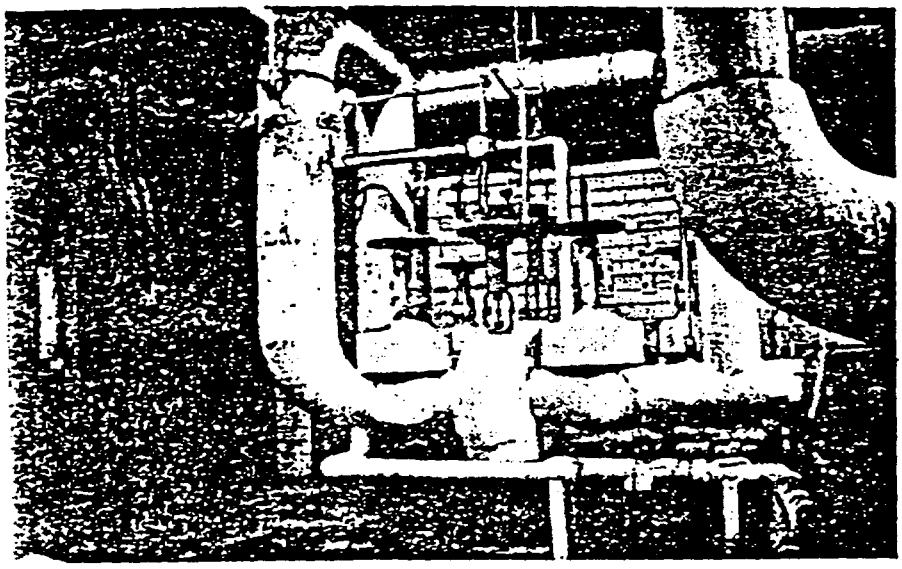
The first type may involve routine cleaning of shelves and counter tops or other surfaces in a building (provided ACM debris is not present). Generally, such

An example of spray applied surfacing ACM on a metal dec above a suspended ceiling.



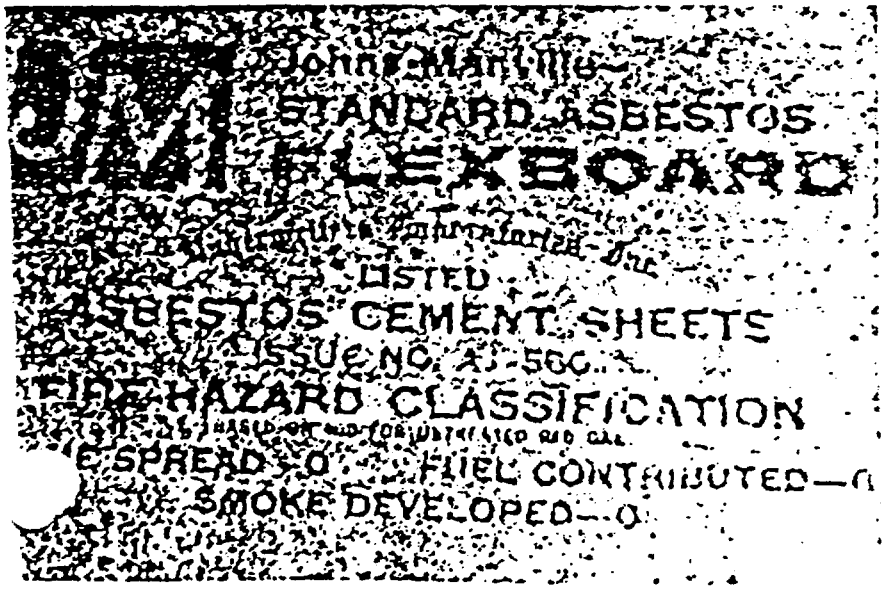
activities would not be expected to disturb ACM. The second type of project could include maintenance work above a suspended ceiling in an area that may have surfacing ACM overhead. The third type of project — small-scale, short-duration maintenance, repair, or installation projects involving minor disturbances of ACM — includes activities such as installation of new light fixtures on or in an ACM ceiling. A single glovebag operation to remove a small amount of ACM to repair a pipe in a boiler room is another example of intentional small-scale, short-duration disturbance.

An example of asbestos-containing thermal system insulation on pipes in a building's mechanical room.



Larger projects involving more complex procedures for the intentional removal of ACM are considered asbestos abatement projects. These require asbestos control and abatement procedures that are outside the scope of an O&M program. Before taking action, building owners should consult qualified professionals for advice and alternative solutions. Guidance for building owners on the management of abatement projects is included in EPA's "Guidance for Controlling Asbestos-Containing Materials in Buildings," June 1985, also known as the "Purple Book."

An example of an asbestos-containing cement sheet product (miscellaneous ACM).



Chapter Summary

The purpose of an Operations and Maintenance Program is to minimize exposure of all building occupants to asbestos fibers. Through supervised work practices, ACM can be managed in place. Important points to remember are:

ACM can be classified into three categories:

- Surfacing Material
- Thermal System Insulation (TSI)
- Miscellaneous Material

O&M Programs can be divided into three types of projects:

- Unlikely to involve direct contact with ACM.
- Accidental disturbance of ACM.
- Small-scale, short-duration maintenance or repair activity, which may involve intentional disturbance of ACM.

MANAGING ASBESTOS IN PLACE

3

How Does the Program Start?

Laying the Foundation for an Effective O&M Program

A comprehensive asbestos control program for a building should include these basic steps:

- Appoint an Asbestos Program Manager and develop an organizational policy.
- Conduct a physical and visual inspection of the building and take bulk samples of suspect materials to determine if ACM is present, establish an ACM inventory, and assess the ACM's condition and potential for disturbance.
- If ACM is located, develop an O&M program, based on the inspection and assessment data.
- Implement and manage the O&M program conscientiously.
- Select and implement abatement actions other than O&M when necessary.

This chapter provides information about each of these basic steps. In addition, see Appendix F for a chart of references outlining existing EPA guidance for each of these steps.

The Asbestos Program Manager

The position of Asbestos Program Manager (APM) is frequently held by the building engineer, superintendent, facilities manager, or safety and health director. In a small organization, the building owner may have this role. Regardless of who holds this position, EPA stresses the need for the Asbestos Program Manager to be properly qualified, through training and experience, and to be *actively involved* in all asbestos-control activities. EPA accreditation under the Asbestos Hazard Emergency Response Act (AHERA) or state certification as a Building Inspector/Management Planner would be typical of the requisite training.

If the person selected is not adequately prepared, he or she should receive the training necessary to develop and manage an asbestos control program prior to beginning the job. If for some reason this is not possible, the building owner should strongly consider hiring a properly trained, experienced, and credentialed outside consultant or firm to provide direction to the owner or the Asbestos Program Manager.

In general, the Asbestos Program Manager should have the authority to oversee all asbestos-related activities in the building, including inspections, O&M activities, and other abatement actions. The Asbestos Program Manager will either train building workers in O&M techniques or ensure that such worker training takes place. In addition, he or she should oversee the custodial and maintenance staffs, contractors, and outside service vendors with regard to all asbestos-related activities.

Building Inspection and Assessment

To determine whether an asbestos control and management program should be implemented, the owner should have an initial building inspection performed to locate and assess the condition of all ACM in the building. A trained, experienced and qualified inspector, who is able to perform the sampling of suspect ACM for laboratory analysis, should conduct the inspection. If an inspection is not performed, then certain suspect materials should be assumed to contain asbestos, and treated accordingly. (Refer to Appendix G for a sample list of suspect ACM.)

EPA guidance on how to take "bulk" samples of suspect ACM is contained in several publications (see Appendix H) and from EPA Regional Asbestos Coordinators (listed in Appendix D).

The building inspection by a qualified professional serves as the basis for establishing an effective overall plan for dealing with the asbestos in the building. The inspector should advise the owner and the Asbestos

To determine whether an asbestos control and management program should be implemented, the owner should have an initial building inspection performed to locate and assess the condition of all ACM in the building.

A properly trained and protected building inspector collecting a bulk sample of suspected asbestos-containing thermal system insulation.

Program Manager of inspection findings. Of course, the inspection may show that ACM is *not* present and that an asbestos-control program is not required.

If ACM *is* found, the material's characteristics, condition, quantity, and location within the building, as well as building use, will affect how the building owner should deal with the ACM. For example, operations and maintenance procedures may be appropriate and sufficient in a particular building for ACM in good condition. But O&M procedures alone are not sufficient for ACM that the inspector determines is significantly damaged, and may not be sufficient for some types of ACM situated in highly accessible areas; in these instances, some form of full scale abatement — repair, encapsulation, enclosure, encasement, or removal — will be necessary. Removal of the ACM may also be appropriate when performed in conjunction with major building renovations, or as part of long-term building management policies (such as staged removal in conjunction with renovation over the life of the building, as covered by the EPA NESHAP requirements for removal before demolition or renovation).

Developing an O&M Program

If ACM is found, the building owner should have an O&M program developed as soon as possible. Either the Asbestos Program Manager or a qualified consultant should develop the O&M program. The written O&M program should state clearly the O&M policies and procedures for that building, identify and describe the administrative line of authority for that building, and should clearly define the responsibilities of key participants, such as the Asbestos Program Manager and custodial and maintenance supervisors and staff. The written O&M program should be available and understood by all participants involved in the management and operations of the building.

In general, the O&M program developed for a particular building should include the O&M program elements discussed in the next chapter. However, the building owner should make sure that the O&M program developed is site-specific and tailored for the building. The O&M program should take into account use, function, and design characteristics of a particular building.

Implementing and Managing an O&M Program

A well-developed O&M program is ineffective unless the building owner is committed to implementing it properly. The building owner should convey this commitment to key personnel involved in a building's management and operations — particularly the Asbestos Program Manager and custodial and maintenance supervisors and staff. The O&M program's success is contingent upon key personnel understanding the O&M program and committing themselves to implementing it effectively.

To the greatest extent possible, the building owner should incorporate the O&M program into the existing system for managing a building's operations. Each building owner, therefore, will determine the appropriate organizational structure on a case-by-case basis. Two possible arrangements are suggested in Figures 1 and 2 in Appendix C.

When managing an O&M program, the Asbestos Program Manager should oversee all asbestos-related activities. In instances where a building owner hires a contractor to perform custodial and maintenance work, the Asbestos Program Manager should ensure that the contractor is qualified to conduct work that may involve ACM. Before hiring a contractor, the Asbestos Program Manager should investigate to determine whether the contractor's staff is qualified, trained and equipped to deal with O&M asbestos activities. Thoroughly checking the references of a contractor is a good recommended practice.

The Asbestos Program Manager should also monitor the work performed in the building by other contractors, such as electricians and plumbers, who might inadvertently disturb ACM. Instituting a work permit system, as discussed in the next chapter, may prevent accidental disturbances of ACM. Under this system, a

contractor must receive a work permit from the Asbestos Program Manager before commencing work. At that time, the Asbestos Program Manager will inform the contractor whether the project could disturb ACM and provide any special instructions to make sure the work is done properly. *Communication between the Asbestos Program Manager and tenants occupying the building is essential to prevent activities that might compromise the O&M program.*

In addition, the Asbestos Program Manager should routinely and frequently check the work being performed in the building by contractors and custodial and maintenance staff to see if their work is disturbing ACM. By maintaining close surveillance over these activities, the Asbestos Program Manager can help ensure that work which may disturb ACM is being done safely. Tenants should be required (by legal agreement or understanding) to notify the building owner or the Asbestos Program Manager before conducting even small planned renovations. This would help prevent building tenants from unknowingly disturbing ACM. For both the work permit system and the renovation notification requirement, clear and effective communications to workers and tenants are crucial to the success of the O&M management program.

The Asbestos Program Manager should periodically review the written O&M plan to determine whether it should be updated. For example, if all ACM were removed from some areas of the building during a recent renovation, or if some ACM was damaged, the O&M program should be revised accordingly. The O&M program should remain in effect as long as there is ACM present in the building.

Cost Considerations

The costs associated with implementing and managing an O&M program may vary significantly depending on the types of ACM, building-specific factors, actual O&M procedures adopted, types of equipment used, and the useful life of the building. Owners may find it more cost-effective to continue a well-supervised and managed O&M program than to incur the costs of immediate, large-scale removal. In addition to the direct costs of removal, other costs related to ACM removal include moving building occupants, arranging alternative space for building occupants during the removal work, and restoring the building after the removal is completed.

Clearly, many factors enter into the decision. Only by conducting a cost-effectiveness analysis of the long-term options (e.g., comparing (a) immediate removal with (b) phased removal plus O&M with (c) removal just before demolition plus lifetime O&M) will owners be truly able to determine which option is most cost-effective for their buildings. The prudent owner may need to consult one or more qualified consultants or firms for advice, if such expertise does not exist within the owner's organization.

Selecting and Implementing Alternative Abatement Actions

In some instances, due to the condition of ACM or upcoming building renovations, a building owner may decide to take other abatement actions to deal with ACM in the building. These response actions could include encapsulation (covering the ACM with a sealant to prevent fiber release), enclosure (placing an air-tight barrier around the ACM), encasement (covering the ACM with a hard-setting sealing material), repair, or removal of the ACM. Qualified, trained, and experienced contractors should be used for any of these actions. EPA's Purple Book discusses most of these alternatives in some detail. In general, repair, encapsulation, enclosure, and encasement, are intended to help prevent the release of asbestos fibers. As aspects of O&M, these techniques manage ACM in place. See Appendix F of this document for additional federal reference sources on asbestos response actions.

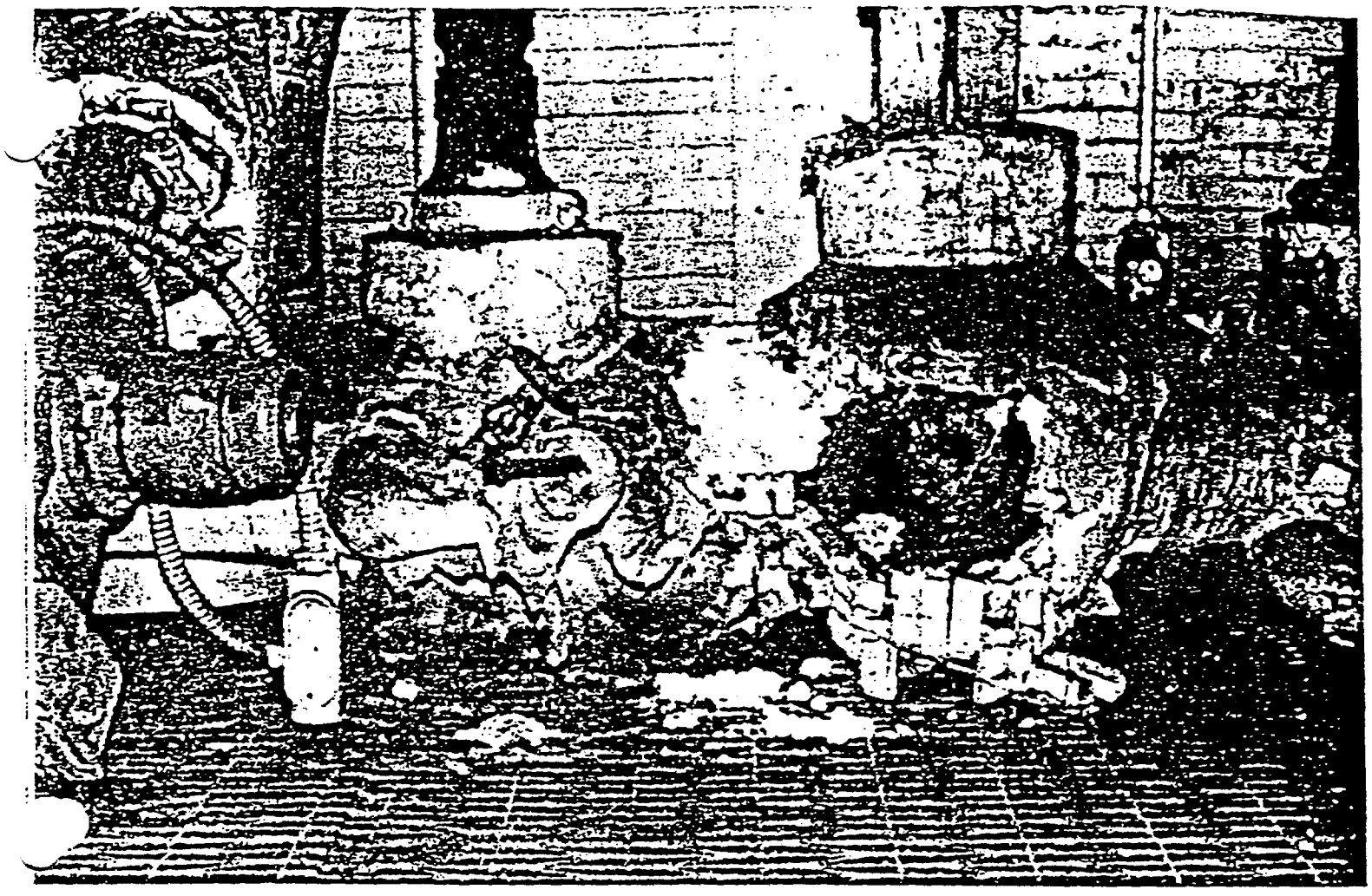
When determining which response alternative to select, the building owner and Asbestos Program Manager may consider seeking advice from qualified, independent consultants with specific training and experience in asbestos management.

Asbestos consultants should have a background in engineering, architecture, industrial hygiene, safety, or a similar field. Experts who are Registered and/or with Board Certified backgrounds are recommended. *To help ensure that no "conflict of interest" exists, consultants should not be affiliated with the abatement contractors who may be used on a recommended ACM control project, nor with analytical laboratories which perform sample analyses.* As with other similar business decisions, building owners should interview several consultants and check references.

Renovations (including remodeling or redecorating) of buildings or replacement of utility systems increase the potential for disturbing ACM.

Renovations (including remodeling or redecorating) of buildings or replacement of utility systems increases the potential for disturbing ACM. Before conducting any renovation or remodeling work, the building owner should have the Asbestos Program Manager review asbestos inspection and assessment records to determine where ACM may be located, visually reinspect the area, and evaluate the likelihood that ACM will be disturbed. Any suspect or assumed ACM that could be disturbed during the renovation work should either be sampled and analyzed to determine whether it contains asbestos, or the work should be carried out as if the materials did contain asbestos. The Asbestos Program Manager should also ensure that no new ACM is introduced into the building as part of the renovation work.

Removal of the ACM before renovation begins may be necessary in some instances. Removal is required by the Asbestos NESHAP regulations for projects which would break up more than a specified minimum amount of ACM; specifically, at least 160 square feet of surfacing



Asbestos-containing thermal system insulation which has sustained significant damage in a mechanical/boiler room of a building.

or miscellaneous material or at least 260 linear feet of thermal system insulation (40 CFR 61.145–147). Building owners and managers are encouraged to contact their state or local health or environmental department for further clarification of these requirements (also, see Chapter 6 of this document). It is important to ensure that new materials placed in the building do not contain asbestos in order to comply with the recent EPA Asbestos Ban and Phase Out rule (see Chapter 6).

In general, building owners should thoroughly consider any decision to remove ACM. *O&M, encapsulation, encasement, enclosure, or repair may be viable alternatives to removal.* Building owners should assess these in-place management techniques carefully before deciding to remove undamaged ACM.

Under certain circumstances, however, such as when some ACM must be removed during building renovations, when the ACM has sustained a great deal of damage, or ACM disturbance will be difficult to manage properly, the building owner may decide to remove ACM in parts of the building.

When removal must occur, only qualified, trained and experienced project designers and contractors should be permitted to design and perform the work. Building owners might consider contacting local, state, and federal asbestos regulatory agencies to see if prospective contractors have received citations for violating asbestos regulations in the past. In addition, if the building owner and Asbestos Program Manager are not properly qualified themselves, they should retain a qualified and independent project designer and a project monitor with training and experience in asbestos abatement to oversee and ensure that the asbestos abatement work is done safely. When these precautions are taken, asbestos removal is more likely to proceed safely and effectively.

Proper completion of the ACM removal is best evaluated by means of the analytical procedures using transmission electron microscopy (TEM). (These are described in 40 CFR Part 763, Appendix A to Subpart E.) Clearance protocols for statistically comparing asbestos fiber levels inside the work area with outside levels are available. If the measured levels inside are not statistically higher than the average airborne asbestos concentration measured outside the abatement area, the cleanup is considered successful, and the space is judged ready for reoccupancy. (For reference, see Appendix H, U.S. EPA "Guidelines for Conducting the AHERA TEM Clearance Test . . . .")

Chapter Summary

Laying the foundation for a comprehensive asbestos control program for a building includes some basic steps. Important points contained in this discussion are the following:

- An Asbestos Program Manager needs to be properly qualified through training and experience, and be actively involved in all asbestos control and disturbance activities.
- An Asbestos Program Manager should have authority to oversee and to direct custodial/maintenance staff and contractors with regard to all asbestos-related activities.
- An initial building inspection should be performed by a trained, qualified, experienced inspector to locate and assess the condition of all ACM in the building.
- The inspection results serve as the basis for establishing an O&M program. O&M procedures may not be sufficient for certain ACM that is significantly damaged or in highly accessible areas.
- An Asbestos Program Manager or qualified consultant should develop the written O&M program that is site-specific and tailored for individual buildings. The O&M program should take into account use, function and design characteristics of a building.
- The success of any O&M program lies in the commitment by the building owner to implement it properly.
- When outside contractors are used for asbestos-related activities, their references and training should be thoroughly checked and their subsequent work monitored.
- Periodically review written O&M programs.
- Alternatives or control options that may be implemented under an O&M program include:
  - repair
  - encapsulation
  - enclosure
  - encasement
  - removal (minor)
- Removal of ACM before renovations may be necessary in some instances. (See NESHAP and State/Local regulations discussion in Chapter 6.)

The success of any O&M program depends on the building owner's commitment to implement it properly.

MANAGING ASBESTOS IN PLACE

4

What Does an O&M Program Include?

O&M Program Elements

To achieve its objectives, an O&M program should include seven elements. Although these should appear in any O&M program, the extent of each will vary from program to program depending on the building type, the type of ACM present, and the ACM's location and physical condition. For example, if only nonfriable ACM is present, minimal notification might be needed, and custodial or maintenance staff would most likely have fewer work practices to be followed. If friable ACM is present, a more detailed O&M program should be prepared and followed. Each of the first six elements listed below is described in this chapter to provide an illustration of a basic O&M program. The seventh program element, training of the Asbestos Program Manager and custodial and maintenance staff, is very important. If staff are not adequately trained, the O&M program will not be effective. Chapter 5 is devoted exclusively to O&M training topics.

A successful O&M program should include the following elements:

- **Notification:** A program to tell workers, tenants, and building occupants where ACM is located, and how and why to avoid disturbing the ACM. All persons affected should be properly informed.
- **Surveillance:** Regular ACM surveillance to note, assess, and document any changes in the ACM's condition.
- **Controls:** Work control/permit system to control activities which might disturb ACM.
- **Work Practices:** O&M work practices to avoid or minimize fiber release during activities affecting ACM.
- **Recordkeeping:** To document O&M activities.
- **Worker Protection:** Medical and respiratory protection programs, as applicable.
- **Training:** Asbestos Program Manager, and custodial and maintenance staff training.

If staff are not adequately trained, the O&M program will not be effective.

Informing Building Workers, Tenants, and Other Occupants

Building owners should inform building workers, occupants, and tenants about the location and physical condition of the ACM that they might disturb, and stress the need to avoid disturbing the material. Occupants should be notified for two reasons: (1) building occupants should be informed of any potential hazard in their vicinity; and (2) informed persons are less likely to unknowingly disturb the material and cause fibers to be released into the air.

Building owners can inform occupants about the presence of ACM by distributing written notices, posting signs or labels in a central location where affected occupants can see them, and holding awareness or information sessions. The methods used may depend on the type and location of the ACM, and on the number of people affected. Some states and localities have "right-to-know" laws which may require that all occupants, workers, and visitors in buildings with ACM be informed that asbestos is present.

In service and maintenance areas (such as boiler rooms), signs such as "Caution — Asbestos — Do Not Disturb" placed directly adjacent to thermal system insulation ACM will alert and remind maintenance

workers not to inadvertently disturb the ACM. In most cases, all boilers, pipes, and other equipment with ACM in service areas where damage may occur should have prominent warning signs placed next to the ACM. As an alternative, color coding can be used to identify the ACM in certain situations provided that all potentially involved parties understand the coding system.

Information sessions reinforce and clarify written notices and signs, and provide an opportunity to answer questions. All employees and tenants or tenant representatives likely to disturb ACM should be included in the notification program on a continuing basis. Building owners should inform new employees about the presence of ACM before they begin work. Owners should provide additional signs and information sessions in languages other than English where a significant number of workers, occupants, or visitors do not speak English. It may be necessary to make special provisions for illiterate workers, such as providing clear verbal information or signs, about potential hazards of disturbing ACM and showing them where ACM is located.

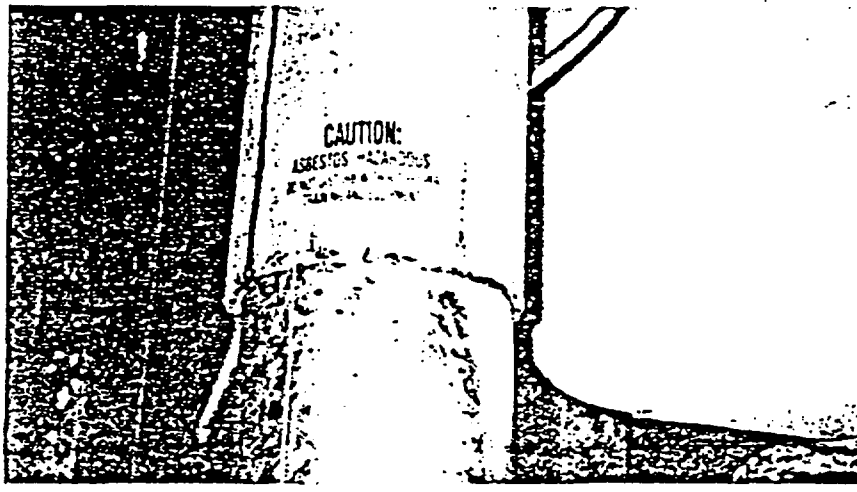
The specific information given to types of building occupants will vary. For example, since service workers carry out certain tasks that office workers or tenants do not perform, they should receive additional information. Most important, O&M workers should receive the training necessary for them to perform their tasks safely.

Whatever its form, the information given to building occupants and workers should contain the following points to the extent they reflect building conditions:

- ACM has been found in the building and is located in areas where the material could be disturbed.
- The condition of the ACM, and the response which is appropriate for that condition.
- Asbestos only presents a health hazard when fibers become airborne and are inhaled. The mere presence of ACM does not represent a health hazard.
- The ACM is found in the following locations (e.g., ceilings in Rooms 101 and G-323, walls in the lobby, above suspended ceilings in the first floor corridor, on columns in the main entry, on pipes in the boiler room).
- Do not disturb the ACM (e.g., do not push furniture against the ACM, do not damage TSI).
- Report any evidence of disturbance or damage of ACM to (name, location, and phone number of Asbestos Program Manager).

Routine maintenance activities can cause disturbance of ACM if workers are not properly trained in operations and maintenance procedures. Here, a worker carelessly contacts ACM, possibly damaging it.

- Report any dust or debris that might come from the ACM or suspect ACM, any change in the condition of the ACM, or any improper action (relative to ACM) of building personnel to (name, location, and phone number of Asbestos Program Manager).
- Cleaning and maintenance personnel are taking special precautions during their work to properly clean up any asbestos debris and to guard against disturbing ACM.
- All ACM is inspected periodically and additional measures will be taken if needed to protect the health of building occupants.



An example of an asbestos caution sign placed directly on a section of asbestos-containing duct insulation. Signs such as this help to ensure that workers will not inadvertently disturb ACM.

It is important to undertake an honest and open approach to the ACM notification procedure. Owners should strive to establish clear lines of communication with all building occupants regarding asbestos issues. People who are informed of the presence, location and condition of ACM in a building where they work or live, who understand that the mere presence of ACM is not necessarily hazardous to them, and who accept that ACM can often be managed effectively in place, can be

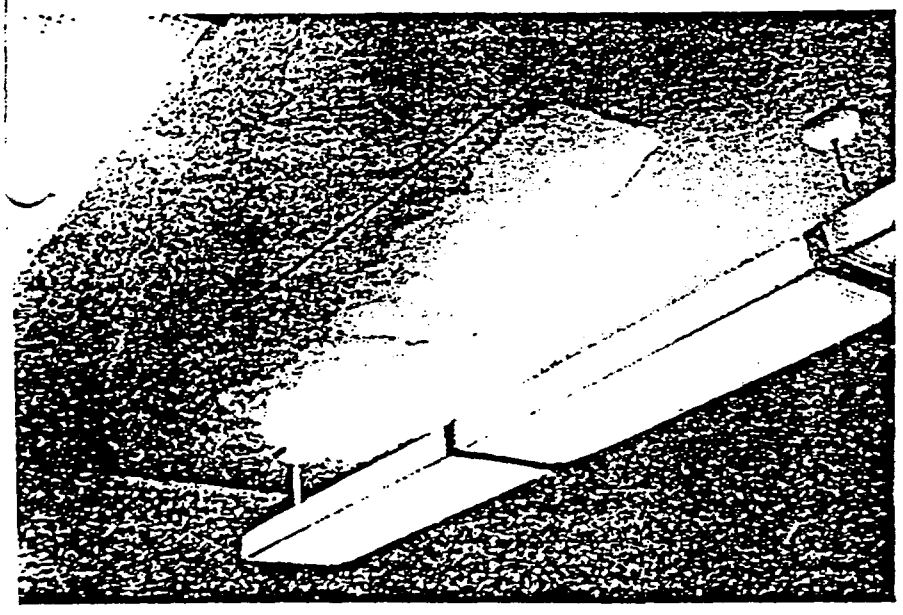
very helpful to the owner in eliminating or reducing hysteria on the part of other less informed building occupants. On the other hand, if occupants suspect the building owner is not being honest about asbestos activities in the building, that owner's credibility may be questioned and the situation can become far more difficult to manage. *If and when asbestos incidents occur, it is especially important for the building owner to deal with occupants and contractors openly and honestly, for that is the best way to maintain occupant/tenant confidence in both the owner and the building's asbestos program.*

ACM Surveillance

Visual reinspections of asbestos materials at regular intervals can detect changes in material condition. Here, surfacing ACM has delaminated from a ceiling in a building; O&M routines can keep small problems from becoming big problems.

Reinspection and Periodic Surveillance

A visual reinspection of all ACM should be conducted at regular intervals as part of the O&M program. Combined with ongoing reports of changes in the condition of the ACM made by service workers, the reinspections should help ensure that any ACM damage or deterioration will be detected and corrective action taken.



According to recent EPA regulations covering schools (the Asbestos Hazard Emergency Response Act, "AHERA"), an accredited inspector must reinspect school buildings at least once every three years to reassess the condition of ACM. The AHERA regulations for schools also require a routine surveillance check of ACM every six months to monitor the ACM's condition. The AHERA Rule permits this surveillance to be conducted by a trained school custodian or maintenance worker. While these intervals are mentioned here as a guide, they may also be appropriate for other buildings. The Asbestos Program Manager should establish appropriate intervals, based on consultation with the building owner and any other qualified professionals involved in the O&M program.

EPA recommends a visual and physical evaluation of ACM during the reinspections to note the ACM's current condition and physical characteristics. Through this reinspection, it is possible to determine both the relative degree of damage and assess the likelihood of future fiber release. Maintenance of a set of visual records (photos or video tape) of the ACM over time can be of great value during reinspections.

Some asbestos consultants recommend examining settled dust for accumulations of asbestos fibers as another surveillance tool in an O&M program. While no universally accepted standardized protocols currently exist for sampling and analysis of settled dust, positive results (i.e., ACM is present in the dust) may indicate the need for special cleaning of the affected area, or other action. Because the results of this testing are difficult to interpret and evaluate at this time, building owners should carefully consider the appropriateness of this testing to their situation.

Supplement to Visual/Physical Evaluation

As part of an O&M program, a carefully designed air monitoring program to detect airborne asbestos fibers in the building may provide useful supplemental information when conducted along with a comprehensive visual and physical ACM inspection and reinspection program. If the ACM is currently in good condition, increases in airborne asbestos fiber levels at some later time may provide an early warning of deterioration or disturbance of the material. In that way, supplemental air monitoring can be a useful management tool. If an owner chooses to use air monitoring in an "early warning" context, a knowledgeable and experienced individual should be consulted to design a proper sampling strategy. Appendix H contains a reference to a useful guide to monitoring airborne asbestos, which can be consulted for further discussion of this subject.

If supplemental air monitoring is done, a baseline airborne asbestos fiber level should be established soon after the O&M program is initiated. Representative, multiple air samples should be collected throughout the building during periods of normal building operation. This should be done over a long enough period of time to be representative of existing conditions, in order to adequately characterize prevailing fiber levels in the building. *This air monitoring should supplement, not replace, physical and visual inspection.* Visual inspection can recognize situations and anticipate future exposure (e.g., worsening water damage), whereas air monitoring can only detect a problem after it has occurred, and fibers have been released.

Note that the collection of air samples for supplementary evaluation *should not* use aggressive air sampling methods. Aggressive sampling methods, in which air is deliberately disturbed or agitated by use of a leaf blower or fans, should be used at the completion of an asbestos removal project when the building or area is unoc-

cupied, not for routine monitoring.

The most accurate and preferred method of analysis of air samples collected under an O&M program would require the use of transmission electron microscopy (TEM). Phase contrast microscopy (PCM), which is commonly used for personal air sample analysis and as a screening tool for area air monitoring, cannot distinguish between asbestos fibers and other kinds of fibers which may be present in the air. PCM analysis also cannot detect thin asbestos fibers, and does not count short fibers. TEM analysis is approximately ten times more expensive than PCM analysis. However, the more accurate information on actual levels of airborne asbestos fibers should be more beneficial to the building owner who elects to use supplemental air monitoring in the asbestos management program. TEM analysis is most reliably performed by laboratories accredited by the National Institute for Standards and Technology (NIST; see Appendix D for telephone number), and who follow EPA's quality assurance guidelines. (Appendix H, U.S. EPA, Dec. 1989, "Transmission Electron Microscopy Asbestos Laboratories: Quality Assurance Guidelines.")

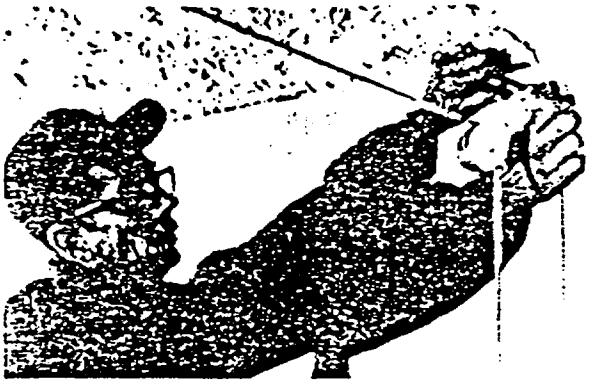
Selection of a reliable and experienced air monitoring firm and analytical laboratory is important, if the building owner elects to conduct supplemental air monitoring under the O&M program. A consultant knowledgeable in air sampling and analysis protocols can be contacted for recommendations if the building owner or Asbestos Program Manager has limited knowledge in this area.

Periodic air monitoring, conducted simultaneously with the visual reinspections or surveillance, would then be used to see if asbestos levels have changed relative to the baseline. Some building owners may wish to present current air monitoring results to building occupants in addition to information regarding the physical reinspections. Although this supplemental use of air monitoring as part of an O&M program may provide useful information, it is likely to be very expensive, particularly if the more accurate and recommended TEM analysis is used. Use of only a small number of measurements or measurements taken only at one time may be misleading (i.e., overestimate or underestimate of fiber levels), and can lead to inappropriate decisions.

It should be noted that some of the exposures of persons to airborne asbestos fibers in buildings may result from episodic events, such as repair work or the accidental disturbance of the ACM or of ACM debris by maintenance activities inside the building. Air monitoring may not be done frequently enough to include such episodic events; this can lead to a misleading interpretation of air sampling results. In particular, air sampling may underestimate the exposure of O&M workers and building occupants. A good reference sourcebook for additional information on air sampling and analysis for asbestos fibers is "A Guide to Monitoring Airborne Asbestos in Buildings" (see Appendix H).

Work Control/Permit System

The O&M program should include a system to control all work that could disturb ACM. Some building owners have had success using a "work permit" program, which requires the person requesting the work to submit a Job Request Form to the Asbestos Program Manager (Appendix B, Form 2) before any maintenance work is begun. The form gives the time and location of the requested work, the type of maintenance needed, and available information about any ACM in the vicinity of the requested work. The contractor or other person authorized to perform the work should be identified on the work request.



An example of a maintenance worker conducting activities near a friable asbestos-containing ceiling. Under a proper permitting system, the building Asbestos Program Manager would evaluate and authorize projects such as this prior to beginning work.

Upon receiving a pre-work Job Request Form, the Asbestos Program Manager should take the following steps:

1. Refer to written records, building plans and specifications, and any building ACM inspection reports to determine whether ACM is present in the area where work will occur. If ACM is present, but it is not anticipated that the material will be disturbed, the Asbestos Program Manager should note the presence of the ACM on the permit form and provide additional instruction on the importance of not disturbing the ACM.

2. If ACM is both present and likely to be disturbed, the Asbestos Program Manager or a designated supervisor qualified by training or experience, should visit the site and determine what work practices should be instituted to minimize the release of asbestos fibers during the maintenance activity.

3. This determination should be recorded on the Maintenance Work Authorization Form (see example in Appendix B, Form 3), which is then sent to the in-house maintenance supervisor or to the maintenance contractor to authorize the work.

4. The Asbestos Program Manager should make sure that a copy of both the request and the authorization forms (if granted) are placed in the permanent file.

5 Where the task is not covered by previously approved standard work practices, the Asbestos Program Manager should make sure that the appropriate work practices and protective measures are used for the job.

6 For all jobs where contact with ACM is likely, the Asbestos Program Manager or a designated supervisor qualified by training or experience should visit the work site when the work begins to see that the job is being performed properly. For lengthy jobs where disturbance of ACM is intended or likely, periodic inspections should be made for the duration of the project.

7 The Asbestos Program Manager's observations should be provided on an *Evaluation of Work Form* (see Appendix B, Form 4). Any deviation from standard and approved work practices should be recorded immediately on this form and the practices should be immediately corrected *and reported to the Asbestos Program Manager.*

8 Upon completion of the work, a copy of the evaluation form should be placed in the permanent asbestos file for the building.

Building owners should consider using asbestos O&M work control forms similar to those which already may be in use for non-ACM work in their facilities, or expanding the existing forms to include the content of the request, approval, and evaluation forms illustrated in Appendix B.

It is important to undertake an honest and open approach in ACM notification.

The O&M management system should also address work conducted by outside contractors. Many building owners contract for at least some custodial and maintenance services. A building's asbestos work control/permit system, as described above, should also cover contract work.

At a minimum, contracts with service trades or abatement companies should include the following provisions to ensure that the service or abatement workers can and will follow appropriate work practices:

- Proof that the contractor's workers have been properly notified about ACM in the owner's building and that they are properly trained and accredited (if necessary) to work with ACM.
- Copies of respiratory protection, medical surveillance, and worker training documentation as required by OSHA, EPA and/or state regulatory agencies.
- Notification to building tenants and visitors that abatement activity is underway (performed by owner).
- Written work practices must be submitted by the vendor or contractor for approval or modification by the Asbestos Program Manager. The vendor or contractor should then agree to abide by the work practices as finally accepted by the Asbestos Program Manager.
- Assurance that the contractor will use proper work area isolation techniques, proper equipment, and sound waste disposal practices.
- Historical air monitoring data for representative examples of the contractor's previous projects, with emphasis on projects similar to those likely to be encountered in the building.
- Provisions for inspections of the area by the owner's representative to ensure that the area is acceptable for re-entry of occupants/tenants.
- A resume for each abatement contractor/supervisor or maintenance crew chief, known as the "competent person" in the OSHA standard and EPA Worker Protection Rule.
- Criteria to be used for determining successful completion of the work (i.e., visual inspections and air monitoring).
- Any other information deemed necessary by the owner's legal counsel.
- Notification to EPA (and other appropriate agencies) if the abatement project is large enough (see Chapter 6).

O&M Work Practices

- The O&M program focuses on a special set of work practices for the custodial, maintenance, and construction staff. The nature and extent of any special work practices should be tailored to the likelihood that the ACM will be disturbed and that fibers will be released. In general, four broad categories of O&M work practices are recognized:

1 **Worker Protection Programs** — These work practices help ensure custodial and maintenance staff are adequately protected from asbestos exposure.

2 **Basic O&M Procedures** — Basic procedures are used to perform routine custodial and maintenance tasks that may involve ACM.

3 **Special O&M Cleaning Techniques** — Special techniques to clean up asbestos fibers on a routine basis.

Procedures for Asbestos Fiber Release Episodes — If moderate to relatively large amounts of ACM are disturbed, the building owner should use these procedures to address the hazard.

A brief synopsis of worker protection and O&M work practices follows. *(Note: A more detailed, technically oriented O&M "work practices" manual specifically addressing topics such as work practices, worker protection, and specific information on how to carry out O&M plans, is being developed, with publication expected in 1991.)*

Worker Protection Programs

A worker protection program includes engineering controls, personal exposure monitoring, medical surveillance, and personal protection. While engineering controls are the preferred method of worker protection, there are few engineering control options available for O&M work. This section discusses two key aspects of personal protection: use of respiratory protection and protective clothing for workers in an asbestos O&M program. According to OSHA regulations (see Chapter 6), a written respiratory protection program is necessary whenever an O&M program specifies that service workers wear respirators, or where respirators are made available to employees. OSHA regulations also require a respirator program whenever workers are exposed, or are likely to be exposed, to fiber levels above OSHA's "permissible exposure limits" such as the 8-hour time weighted average (TWA) limit or the 30-minute "excursion limit" (EL). The 8-hour TWA limit and the EL are described in more detail in Chapter 6. In addition, OSHA requires workers to wear special protective clothing under the same circumstances.

Respiratory Protection/Worker Protection Programs The selection of approved respirators, suitable for the hazards to which the worker is exposed, is only one aspect of a complete respiratory protection program. Other elements include written operating procedures for respirator use; outlining personnel responsibilities for respirator cleaning, storage, and repair; medical examination of workers for respirator use; training in proper respirator use and limitations; respirator fit testing; respirator cleaning and care; and work-site supervision. All of these are described in detail in the OSHA respirator standard, 29 CFR 1910.134. The O&M respirator program can be administered by the facility safety and health manager or the Asbestos Program Manager, if properly qualified.

Proper respiratory protection is an integral part of all custodial and maintenance activities involving potential exposure to asbestos. When in doubt about exposure during a certain work operation, building owners should provide respiratory protection to custodial and maintenance workers. OSHA specifies general types of respirators for protection against airborne asbestos during "construction" activities, which include abatement, renovation, maintenance, repair, and remodeling.

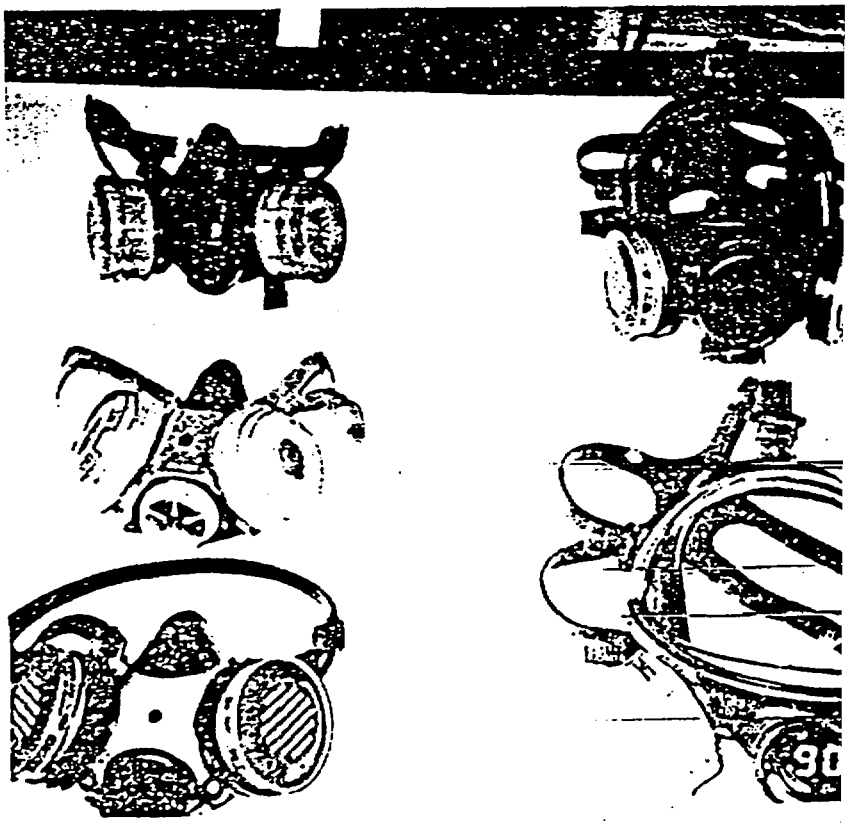
Personal air sampling is not the same as area air monitoring. Personal air sampling (required by OSHA) is designed to measure an individual worker's exposure to fibers while the worker is conducting tasks that may disturb ACM. The sampling device is worn by the worker and positioned so that it samples air in the worker's breathing zone. In contrast, area (or ambient) air sampling is conducted to get an estimate of the numbers of airborne asbestos fibers present in a building. It is used as an assessment tool in evaluating the potential hazard posed by asbestos to all building occupants. (See the previous discussion of area air monitoring on page 14.)

When adequate care is taken to prevent or minimize and control fiber release, routine, small-scale/short-duration maintenance or custodial tasks are not likely to generate high levels of airborne asbestos compared to large asbestos removal projects; and respirators which filter breathing air may be used. OSHA, EPA, and NIOSH are on record as *not* recommending single use, disposable paper dust masks for use against asbestos; in fact, OSHA has *disallowed their use* against airborne asbestos fibers.

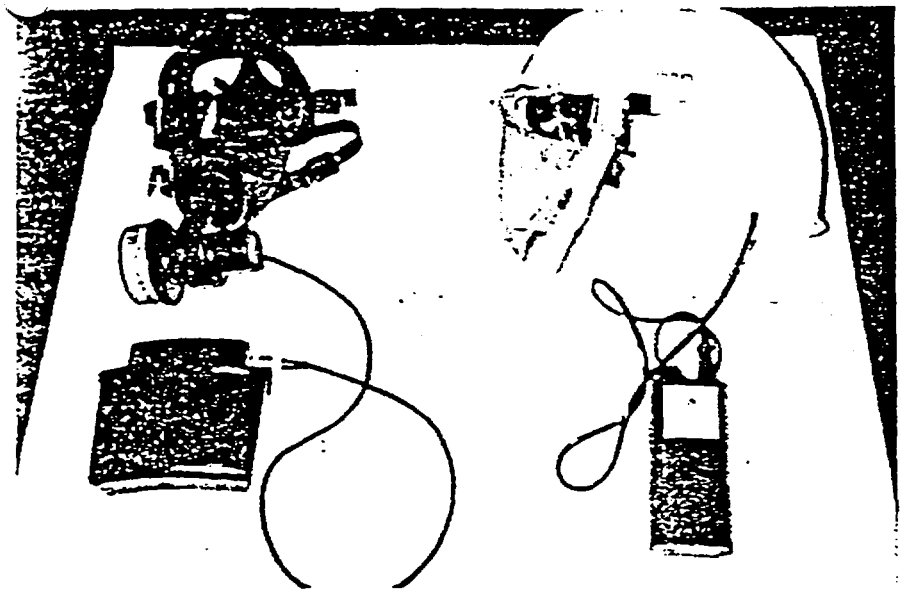
The options that may be used include:

- A half-face or full facepiece, negative pressure, air-purifying respirator with replaceable high-efficiency filters.

Pictured below are different examples of air-purifying, negative pressure respirators equipped with high-efficiency cartridges which can be used to protect workers against asbestos exposure. On the left are examples of half mask facepieces equipped with high-efficiency cartridges and on the right are examples of full facepiece, high-efficiency masks.



- A half or full facepiece powered air-purifying respirator (PAPR) with replaceable high-efficiency filters. This has a battery powered pump which assists breathing and provides positive pressure in the facepiece.



Pictured above are two different types of powered air-purifying respirators (PAPR's) equipped with high-efficiency filters. On the left is an example of a tight fitting, full facepiece PAPR, and on the right is an example of a loose-fitting helmet style PAPR.

Under the OSHA standards for asbestos, any employee required to wear a negative pressure respirator can request a powered air-purifying respirator, and the employer is required to provide a fully functional and approved unit, provided it will afford the worker at least equal protection.

Currently, only respirators approved by NIOSH and the Mine Safety and Health Administration (MSHA) are permitted for use. If they are air-purifying respirators, the filtration device(s) must be rated as "high-efficiency."

Selecting the most appropriate respirator for each O&M task requires knowledge of the levels of airborne asbestos fibers and other possible air contaminants generated by the task or likely to be present where the task is performed. This knowledge is best gained through personal air monitoring conducted during worker performance of the actual task. (Obviously, the workers must have respiratory protection while this initial personal air sampling is carried out.) In fact, OSHA and EPA require air monitoring under certain circumstances (see Chapter 6). To learn more about the different types of respirators available and the degree of protection they provide, see Appendix E. Owners may also wish to contact the nearest OSHA office, a local trained and qualified industrial hygienist (preferably Certified), or an occupational health professional for more information on respirators. The expertise of these specialists should be used to ensure proper selection, fit testing, and training of workers in respirator use.

Building owners and other facility managers may not be familiar with some of the terms used in discussions of respirators, airborne fiber levels, and related topics. Appendix E contains more information on these topics, and gives the *minimum* EPA-recommended levels of respiratory protection to be provided during typical O&M tasks.

For additional information on respirator programs, respirator types, and respirator use, the building owner or Asbestos Program Manager may want to use the following references:

- "Respiratory Protection: An Employer's Manual," NIOSH, October 1978;
- "A Guide to Respiratory Protection for the Asbestos Abatement Industry," EPA/NIOSH, 1986;
- OSHA respirator standard (29 CFR 1910.134);
- OSHA asbestos regulations (29 CFR 1910.1001 and 1926.58);
- "Occupational Exposure Sampling Strategy Manual," NIOSH #77-173, January 1977.
- "Respirator Decision Logic," NIOSH, May 1987; and
- "NIOSH Guide to Industrial Respiratory Protection," September 1, 1987.

Protective Clothing/Worker Protection Programs In addition to the use of respirators, some O&M procedures may require workers to wear protective clothing. Most often, protective clothing is disposable and consists of coveralls, a head cover, and foot covers made of a synthetic fabric which does not allow asbestos fibers to pass through. This type of clothing prevents workers' regular clothing from becoming contaminated with asbestos fibers. Contaminated clothing could be taken home, creating a possible risk to the worker's family members.

OSHA and EPA regulations require workers to wear protective clothing whenever they are exposed, or likely to be exposed, to fiber levels above OSHA's permissible levels (see Chapter 6). It is important that workers be properly trained in the use, removal and disposal of protective clothing after use. All O&M activities may not require the use of protective clothing. It is important for the Asbestos Program Manager to assess this need on a case-by-case basis.

Basic O&M Procedures Basic O&M procedures to minimize and/or contain asbestos fibers may include wet methods, use of mini-enclosures, use of portable power-tools equipped with special local ventilation attachments, and avoidance of certain activities, such as sawing, sanding,

and drilling ACM. Maintenance activities can be divided into three categories with regard to their potential for disturbing ACM:

1. Those which are unlikely to involve any direct disturbance of ACM; for example, cleaning shelves or counter tops with a damp cloth.

2. Those which may cause accidental disturbance of ACM; for example, working on a fixture near a ceiling with surfacing ACM.

3. Those which involve intentional small-scale manipulation or disturbance of ACM; for example, removing a small segment of TSI ACM to repair a pipe leak.

The O&M program should include work practices for each type of ACM that is present in the building (surfacing, TSI, and miscellaneous) as well as for each type and category of maintenance activity performed (e.g., general cleaning, electrical work, plumbing).

Special work practices such as wet wiping, area isolation, and HEPA vacuuming, and the use of personal protective equipment such as respirators and protective clothing, may be needed where disturbance of ACM is likely. The need for these practices varies with the situation. For example, removing light fixtures located near surfacing ACM may disturb the material and might involve the use of special cleaning, possibly area isolation, and respiratory protection. Periodic emptying of a trash can near heavily encapsulated asbestos-containing plaster may not disturb the material at all, so no special work practices would generally be necessary. These work practices and procedures are intended to ensure that disturbance of any ACM during O&M activities should be minimized, or carried out under controlled conditions when the disturbance is required by the nature of a specific O&M task.

In addition, ACM may readily release asbestos fibers into the air when certain mechanical operations are performed directly on it. For example, fiber releases can occur when workers are drilling, cutting, sanding, breaking, or sawing vinyl asbestos floor tile.

The *action* of drilling, cutting, abrading, sanding, chipping, breaking, or sawing is the critical factor here, since it is likely to cause a release of fibers. Maintenance or repair operations involving those actions should be eliminated or carefully controlled with basic O&M procedures in order to prevent or minimize asbestos fiber release.

Certain activities that occur in the vicinity of ACM can also cause damage which may result in asbestos fiber release. For example, maintenance and custodial staff may damage ACM accidentally with broom handles, ladders, and fork lifts while performing other tasks. Activities performed in the vicinity of ACM should always be performed cautiously to prevent fiber release.

To summarize, if in doubt about the possibility of disturbing ACM during maintenance activities, adequate precautions should be taken to minimize fiber release; these will protect workers as well as the building environment. Basic O&M procedures, including use of wet methods and specially equipped tools, should be used to protect building occupants.

O&M Cleaning Practices

Special cleaning practices are appropriate for a building with exposed surfacing or thermal system insulation ACM, especially if the ACM is friable. If gradual deterioration or damage of ACM has occurred or is occurring, asbestos-containing dust or debris could be present. If the building inspection has determined that asbestos-containing dust or debris is present in some areas, then the O&M program should include special cleaning practices to collect residual asbestos dust. Routinely cleaning floors using wet methods is an example of one such practice. Custodial and maintenance workers in the course of normal work can also identify and report areas which are in need of special cleaning or repair. *Special cleaning techniques should supplement, not replace, repair or abatement actions for damaged, friable ACM.* The cleaning program should include an initial cleaning followed, as needed, by subsequent periodic or episodic cleanings.

If in doubt about the possibility of disturbing ACM during maintenance activities, adequate precautions should be taken to minimize fiber release.

Building owners and custodial and maintenance staff should ensure that special O&M cleaning is done correctly. Proper cleaning is important for two reasons:

- The use of improper techniques to clean up asbestos debris caused by previous deterioration or damage may result in widespread contamination, and potentially increase airborne asbestos fiber levels in the building.

- Improper cleaning may cause damage to the ACM, thus releasing more airborne asbestos fibers.

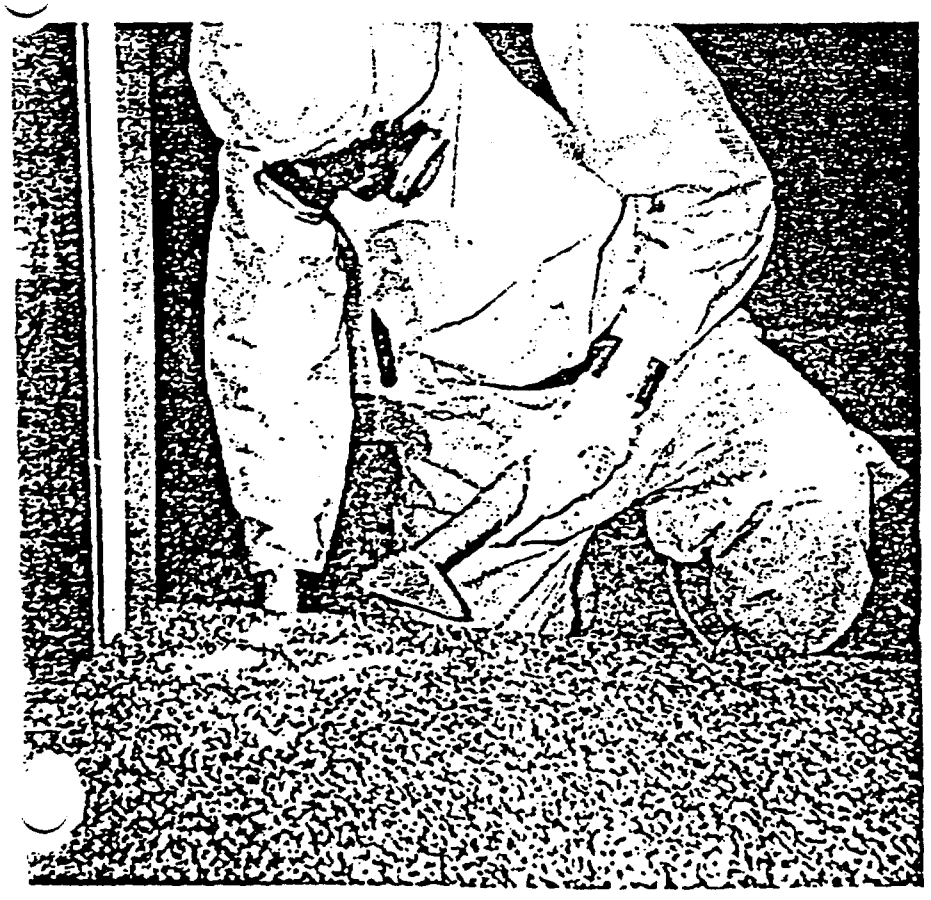
Proper O&M cleaning will involve the use of wet cleaning or wet-wiping practices to pick up asbestos fibers. Dry sweeping or dusting can result in asbestos fibers being re-suspended into the building's air and therefore should not be used. Once wet cloths, rags, or mops have been used to pick up asbestos fibers, they should be properly discarded as asbestos waste while still wet. They should not be allowed to dry out, since the collected fibers might be released at some later time when disturbed. The use of special vacuum cleaners, commonly referred to as HEPA vacuums, may be preferable to wet cleaning in certain situations. These vacuums are equipped with filters designed to remove very small particles or fibers — such as asbestos — by filtering those particles from the air passing through the vacuum. Since the exhaust air from an ordinary vacuum cleaner is not filtered sufficiently, it is possible for tiny asbestos fibers to pass through the filter and back into the building air.

Special procedures are generally needed to minimize the spread of fibers in the building after asbestos fiber release occurs.

It is important for O&M workers to use caution when emptying HEPA vacuums and changing the filters. Exposures could result from such activities. Workers should move the HEPA vacuum to a physically isolated area of the facility and put on proper personal protective equipment before emptying the dust and debris into properly labeled, sealed, and leak-tight containers for disposal as asbestos-containing waste. When custodial workers do not work with ACM, trained maintenance workers can be used to empty the HEPA vacuums and change their filters. Decisions regarding special cleaning practices should be based on the building inspection and ACM assessment data, including the potential for ACM disturbance. In general, the building would not need special O&M cleaning when the building contains only nonfriable (not easily crumbled) ACM; ACM which has been encapsulated, encased, or enclosed behind airtight barriers; or ACM known to be undamaged/undisturbed since the last special cleaning. Furthermore, where ACM is confined to a single room or area, special cleaning of just that area rather than other parts of the building may be sufficient.

If ACM has been released onto a carpeted area of a building, it may not always be possible to adequately clean the carpeted area. "Steam" cleaning and HEPA vacuuming methods are sometimes employed for this purpose. A preliminary study carried out by EPA in 1989 showed that hot water vacuums were more effective in carpet cleaning than HEPA vacuums, under the test conditions. Further field studies are planned to confirm these findings.

Here, a worker uses a HEPA vacuum (backpack type) to clean ACM debris from one of several carpeted areas in a room where surfacing material had fallen.



For carpets, successful cleaning will likely depend factors such as the amount of ACM released onto t carpet, how long the situation has existed, traffic ov the area, as well as the structure and composition of t carpet itself. It is prudent to evaluate individu situations on a case-by-case basis. The Asbest Program Manager should consider the need for worke engaged in cleaning asbestos fiber-contaminated c pets to wear proper respiratory protection. It may al be prudent to arrange for this type of cleaning to i done after normal working hours or when the facility less occupied. Additionally, it may be more cost effecti to properly dispose of contaminated carpets and oth fabrics as asbestos-containing waste if a permane asbestos control option is being undertaken in th building.

Where the ACM is damaged and located in an "a plenum" — where fibers can be transported by th heating, ventilation, or air conditioning (HVAC) syste throughout the building — special cleaning practice may be extended to the entire building, including th HVAC system itself.

Procedures for Asbestos Fiber Release Episodes

Special procedures ar generally needed to min imize the spread of fiber throughout the buildin after asbestos fiber releases occur, such as the partia collapse of an ACM ceiling or wall. These procedure are needed whether the ACM disturbance is intentiona or unintentional. To provide building owners with som guidance, under EPA regulations for schools a "majo fiber release" is defined as one involving more tha three square or linear feet of ACM. The procedures t be followed will vary according to the site of the majo release episode, the amount of ACM affected, the extent of fiber release from the ACM, the relationship o the release area to the air handling systems, and whether the release site is accessible to building occupants. Depending on the severity of the episode, asbestos abatement consultants and contractors may be needed to develop a strategy for conducting the cleanup operations.

In general, for major fiber releases, the area should be isolated by closing doors and/or erecting temporary barriers to restrict airflow as well as access to the site. Signs should be posted as necessary immediately outside the fiber release site to prevent persons not involved in the cleanup operation from inadvertently entering the area. If asbestos fibers could enter the HVAC system, the system should be modified to prevent fiber entry, or should be shut down and sealed off. The final step should be to employ thorough cleanup procedures to properly control the ACM, a careful visual inspection, and final clearance air monitoring to verify satisfactory cleanup.

Similar procedures can be used for much smaller fiber release events; where the amount of ACM is on the

order of three square or linear feet or less. The HEPA vacuuming, wet wiping, and worker protection procedures outlined in this guidance document, as well as wetting ACM wastes and properly placing them in an appropriate leak-tight container (such as a properly labeled, 6-mil-thick plastic bag), are examples of some of the procedures which could be used for both major and minor fiber releases.

It is important to recognize that different levels of training are needed for workers involved with fiber release episodes. A major release will generally require "asbestos abatement worker training," rather than the degree of training considered adequate for O&M workers.

EPA suggests that building owners and Asbestos Program Managers consult with state and local regulatory officials before establishing formal training procedures for each type of situation.

The following table should be useful in determining when to apply certain O&M work practices in buildings. The table illustrates the O&M work practices that should be used by custodial and maintenance staff, depending on the likelihood of ACM disturbance.

Summary of When to Apply Key O&M Work Practices

	Likelihood of ACM Disturbance		
	Contact Unlikely	Accidental Disturbance Possible	Disturbance Intended or Likely
Management Responsibilities			
Need Pre-Work Approval from Asbestos Program Manager	Review by Program Manager	Yes	Yes
Special Scheduling or Access Control	No	Yes	Yes
Supervision Needed	No	Initial, At Least	Yes
HVAC System Modification	None	As Needed[1]	Shut Down[1]
Area Containment	None	Drop Cloths, Mini-enclosures	Yes[2]
Personal Protection			
Respiratory Protection	Available For Use	Yes	Yes
Protective Clothing	None	Review by Asbestos Program Manager	Yes
Work Practices			
Use of Wet Methods	No	As Needed	Yes
Use of HEPA Vacuum	Available For Use	Available For Use	As Needed

1) In the area where work takes place
2) Type of containment may vary. For example, small-scale, short-duration tasks may not require full containment.

Recordkeeping

All the building asbestos management documents discussed in this Guide (inspection and assessment reports, O&M program plan, work practices and procedures, respirator use procedures, fiber release reports, application for maintenance work and work approval forms, evaluations of work affecting ACM, and reinspections/surveillance of ACM) should be stored in permanent files. In addition, for employees engaged in asbestos-related work, federal regulations (see Chapter 6) require that employers retain:

- personal air sampling records, for at least 30 years. Personal air samples are those collected in the worker's breathing zone during performance of work involving asbestos exposures.
- objective data used to qualify for exemptions from OSHA's initial monitoring requirements for the duration of the exemption.
- medical records for each employee subject to the medical surveillance program for the duration of their employment plus 30 years.
- all employee training records for one beyond the last date of each worker's em ment.

In addition, OSHA requires that employers provi each employee their record of exposure and me surveillance under the Records Access Standard CFR 1910.20) and the Hazard Communication Stan (29 CFR 1910.1200). See the OSHA Construction (29 CFR 1926.58) or the EPA Worker Protection (40 CFR 763 Subpart G) for more details of recordk ing requirements.

EPA recommends that building owners make avail all written elements of the O&M program to building's O&M staff as well as to tenants and ot building occupants, if applicable. Building owners also encouraged to consult with their legal cour concerning appropriate recordkeeping strategies a standard part of their O&M programs. Additiona state and local regulations may also require additio recordkeeping procedures.

EPA recommends that building owners make available all written elements of the O&M program to the building's O&M staff as well as to tenants and other building occupants.

Chapter Summary

Although the elements discussed in this chapter should appear in any O&M program, the extent to which each applies will vary depending on the building type, the type of ACM present, and the ACM's location and physical condition. To achieve its objectives an O&M program should include the following:

- A notification program to inform building occupants, workers, and tenants about the location of ACM and how to avoid disturbing ACM.
- Periodic surveillance and reinspection of ACM at regular intervals by trained workers or properly trained inspectors. Air monitoring to detect airborne asbestos fibers in the building may provide useful supplemental information when conducted along with a comprehensive visual and physical ACM inspection/ reinspection program. Air samples are most accurately analyzed using transmission electron microscopy (TEM).
- A "work control/permit" system, which some building owners have used successfully to control work that could disturb ACM. This system requires the person requesting work to submit a Job Request Form to the Asbestos Program Manager before any work is begun.
- O&M work practices to avoid or minimize fiber release during activities affecting ACM.
- Recordkeeping. OSHA and EPA have specific requirements for workers exposed to asbestos.

MANAGING ASBESTOS IN PLACE

5

What O&M Training Is Necessary?

Types of Training

Training of custodial and maintenance workers is one of the keys to a successful O&M program. If building owners do not emphasize the importance of well-trained custodial and maintenance personnel, asbestos O&M tasks may not be performed properly. This could result in higher levels of asbestos fibers in the building air and an increased risk faced by both building workers and occupants.

OSHA and EPA require a worker training program for all employees exposed to fiber levels (either measured or anticipated) at or above the action level (0.1 f/cc, 8-hour *time-weighted average*—the TWA) and/or the excursion limit (1.0 f/cc, 30-minute TWA—see Chapter 6). According to the EPA regulations governing schools, all school staff custodial and maintenance workers who conduct any activities that will result in the disturbance of ACM must receive 16 hours of O&M training. Some states and municipalities may also have specific training requirements for workers who may be exposed to asbestos, or who work in a building with ACM present.

With proper training, custodial and maintenance staff can successfully deal with ACM in place, and greatly reduce the release of asbestos fibers. Training sessions should provide basic information on how to deal with all types of maintenance activities involving ACM. However, building owners should also recognize that O&M workers in the field often encounter unusual, "non-textbook" situations. As a result, training should provide key concepts of asbestos hazard control. If these concepts are clearly understood by workers and their supervisors, workers can develop techniques to address a specific problem in the field. Building owners who need to provide O&M training to their custodial and maintenance staff should contact an EPA environmental assistance center (see Appendix D) or equally qualified training organization for more information.

At least three levels of maintenance worker training can be identified:

LEVEL 1: AWARENESS TRAINING. For custodians involved in cleaning and simple maintenance tasks where ACM may be accidentally disturbed.

For example, fixing a light fixture in a ceiling covered with surfacing ACM. Such training may range from two to eight hours, and may include such topics as:

- Background information on asbestos.
- Health effects of asbestos.
- Worker protection programs.
- Locations of ACM in the building.
- Recognition of ACM damage and deterioration.
- The O&M program for that building.
- Proper response to fiber release episodes.

Training of custodial and maintenance workers is one of the keys to a successful O&M program.

A properly protected and trained worker conducts a glovebag removal job on a section of thermal system insulation. Under a proper operations and maintenance program, any worker involved in such activities would have Level 1 and 2 training.

LEVEL 2: SPECIAL O&M TRAINING. For maintenance workers involved in general maintenance and asbestos material repair tasks.

For example, a repair or removal of a small section of damaged TSI, or the installation of electrical conduit in an air plenum containing ACM or ACM debris. Such training generally involves at least 16 hours. This level of training usually involves more detailed discussions of the topics included in Level 1 training as well as:

- Federal, state, and local asbestos regulations.
- Proper asbestos-related work practices.
- Descriptions of the proper methods of handling ACM, including waste handling and disposal.
- Respirator use, care, and fit-testing.
- Protective clothing donning, use, and handling.
- Hands-on exercises for techniques such as glovebag work and HEPA vacuum use and maintenance.
- Appropriate and proper worker decontamination procedures.

This is an example of a large-scale asbestos removal project (note missing scaffold safety rails). Such projects are well beyond the scope of an O&M program. The EPA NESHAP regulations require that asbestos materials be removed from buildings prior to demolition or renovation when the asbestos will be disturbed.

LEVEL 3: ABATEMENT WORKER TRAINI For workers who may conduct asbes abatement.

For example, conducting a removal job, constructing enclosure, or encapsulating a surface containing AC This work involves direct, intentional contact w ACM. The recognized "abatement worker" train courses approved by EPA or states, under the E AHERA model accreditation plan for schools, wh involve 24 to 32 hours of training, would fulfill this le of training.

If this level of training is provided to in-house staff. may save time and money in the long run to use the individuals to perform such activities. This level training is much more involved than Levels 1 and although it should include some of the same elemer (e.g., health effects of asbestos). It will typically inclu a variety of specialized topics, such as:

- Pre-asbestos abatement work activities.
- Work area preparation.
- Establishing decontamination units.
- Personal protection, including respirator sele tion, use, fit-testing, and protective clothin
- Worker decontamination procedures.
- Safety considerations in the abatement wor area.
- A series of practical hands-on exercises.
- Proper handling and disposal of ACM wastes

The Asbestos Program Manager should consider con ducting the training program for Levels 1 and 2 if he o she has sufficient specific asbestos knowledge an training. If the Asbestos Program Manager does no conduct the training, the building owner should hire ar outside consultant or send workers to an appropriate O&M training course. A trained (preferably Certified) industrial hygienist or equally qualified safety and health professional should conduct the training on respirator use and fit-testing. A health professional should conduct the training on health effects.

OSHA or EPA Regional Offices, as well as state and local agencies and professional associations, may be able to suggest courses or direct you to listings of training providers for each of the three levels. Appendix D provides the addresses and/or phone numbers for OSHA, EPA, and EPA-sponsored training providers.

Where custodial and maintenance services are performed by a service company under contract, or where some installation or repairs are performed by employees of trade or craft contractors and subcontractors, those workers may need to have training at level 1, 2, or 3 as appropriate for their work. The Asbestos Program Manager or building owner should verify that these employees receive appropriate training before they begin any work.

In summary, good training is crucial to the success of an O&M program. Strong support for O&M training by the building owner should convince custodial and maintenance workers that following the appropriate work procedures is critical to protecting their own health as well as the health of other building occupants.

Chapter Summary

Properly trained custodial and maintenance workers are critical to a successful O&M program. The following items are highlighted training requirements:

- OSHA and EPA require worker training program for all employees exposed to fiber levels at or above the action level (0.1 f/cc, 8-hr. TWA) and/or the excursion limit (1.0 f/cc, 30-minute TWA — see Chapter 6).
- Some states and municipalities may have specific worker training requirements.
- At least three levels of maintenance worker training can be identified:

  Level 1 Awareness training for workers involved in activities where ACM may be accidentally disturbed. May range from 2-8 hours.

  Level 2 Special O&M training for maintenance workers involved in general maintenance and incidental ACM repair tasks. At least 16 hours.

  Level 3 Abatement worker training for workers who may conduct asbestos abatement. This work involves direct, intentional contact with ACM. "Abatement worker" training courses that involve 24 to 32 hours of training fulfill this level of training.

Strong support by the building owner can convince workers that following appropriate procedures is critical to protecting their own health as well as the health of other building occupants.

What Regulations Affect Asbestos Management Programs in Buildings, Especially O&M Programs?

Federal, State, and Local Regulations Affecting O&M Programs

Building owners are governed by a variety of federal, state, and local regulations which influence the way they must deal with ACM in their facilities. Some of these regulations, particularly at the state and local level, may change frequently. Building owners should contact their state and local government agencies, in addition to organizations such as the National Conference of State Legislatures (NCSL), the National Institute of Building Sciences (NIBS), or EPA environmental assistance centers, for updated information on these requirements. (Appendix D lists phone numbers for these organizations.)

Building owners are governed by a variety of federal, state, and local regulations which influence the way they must deal with ACM in their facilities.

OSHA Regulations and the U.S. EPA Worker Protection Rule

There are several important Occupational Safety and Health Administration (OSHA) and EPA regulations that are designed to protect workers. They are summarized here, as guidance. OSHA has specific requirements concerning worker protection and procedures used to control ACM. These include the OSHA construction industry standard for asbestos (29 CFR 1926.58), which applies to O&M work, and the general industry asbestos standard (29 CFR 1910.1001). State-delegated OSHA plans, as well as local jurisdictions, may impose additional requirements.

For most operations and maintenance activities in building areas where only non-friable ACM is present or where friable ACM is in good condition, applicable OSHA permissible exposure limits are not likely to be exceeded. However, it is possible that some O&M activities will disturb ACM to such an extent that the OSHA limits are exceeded, unless good work practices are followed.

The OSHA standards generally cover private sector workers, and public sector employees in states which have an OSHA state plan. Public sector employees, such as city or county government employees, or certain school employees, who are not already subject to a state OSHA plan are covered by the EPA "Worker Protection Rule" (Federal Register: February 25, 1987; 40 CFR 763 Subpart G, Asbestos Abatement Projects; Worker Protection, Final Rule). *Note: As this document goes to press, OSHA is considering a substantial number of changes to its regulations.*

The OSHA standards and the EPA Worker Protection Rule require employers to address a number of items which are triggered by exposure of employees to asbestos fibers. Exposure is discussed in terms of fibers per cubic centimeter (cc) of air. A cc is a volume approximately equivalent to that of a sugar cube.

Two main provisions of the regulations fall into the general category of "Permissible Exposure Limits (PELs)" to airborne asbestos fibers. They are:

1 **8-Hour Time-weighted average limit (TWA)** — 0.2 fiber per cubic centimeter (f/cc) of air based on an 8-hour time-weighted average (TWA) sampling period. This is the maximum level of airborne asbestos, on average, that any employee may be exposed to over an 8-hour period (normal work shift).

2 **Excursion limit (EL)** — 1.0 f/cc as averaged over a sampling period of 30 minutes.

These levels trigger mandatory requirements, which include the use of respirators and protective clothing, the establishment of "regulated areas," the posting of danger signs as well as the use of engineering controls and specific work practices.

OSHA regulations also establish an *"Action Level"*: 0.1 f/cc for an 8-hour TWA. Employee training is required once the action level of 0.1 f/cc and/or the "Excursion Limit" is reached. This training must include topics specified by the OSHA rules. If an employee is exposed at or above the action level for a period of 30 days or more in a calendar year, medical surveillance is required according to the OSHA construction industry asbestos standard.

OSHA also requires medical examinations under its "General Industry Standard" for any employee exposed to fiber levels in the air at or above the OSHA "action level" (0.1 f/cc) and/or the "excursion limit" (1.0 f/cc). In both cases — the action level and excursion limit — the OSHA medical examination requirement applies if the exposure occurs for at least one day per year.

The OSHA "Construction Industry Standard" (29 CFR 1926.58) for asbestos, is generally applicable for the workers who carry out the kinds of work discussed in this O&M guidance document. The OSHA construction industry asbestos standard applies to demolition and asbestos removal or encapsulation projects, as well as to repair, maintenance, alteration, or renovation if ACM is involved. ACM spills or emergency clean-up actions are also covered by this regulation.

According to those regulations, participation in a medical surveillance program is required for any employee who is required to wear a negative pressure, air-purifying respirator. Preplacement, annual, and termination physical exams are also required for these employees. However, a termination exam is only necessary under the construction industry standard (which applies to custodial and maintenance employees) if a physician recommends it. While not mandatory, EPA and NIOSH recommend physical examinations, including cardiac and pulmonary tests, for any employee required to wear a respirator by the building owner. These tests determine whether workers will be unduly stressed or uncomfortable when using a respirator.

Additional requirements of the OSHA asbestos standards, such as the use of air filtration systems and hygiene facilities, involve procedures which are most applicable to large-scale asbestos abatement projects. However, these rules also include a number of recommendations for procedures which might be appropriate for a variety of O&M programs for buildings.

Small-scale, Short-duration Projects

"Appendix G" which is specified as a non-mandatory section to the OSHA regulation 29 CFR 1926.58, may become mandatory under certain circumstances where "small-scale, short-duration" asbestos projects are conducted. These projects are not precisely defined in terms of either size or duration, although their nature and scope are illustrated by examples presented in the text of the regulation. Properly trained maintenance workers may conduct these projects. Examples may include removing small sections of pipe insulation or covering for pipe repair, replacing valves, installing electrical conduits, or patching or removing small sections of drywall. OSHA issued a clarification of the definition of a "small-scale, short-duration" (SS/SD) project in a September 1987 asbestos directive. The directive focuses on intent, stating that in SS/SD projects, the removal of ACM is not the primary goal of the job. If the purpose of a small-scale, short-duration project is maintenance, repair, or renovation of the equipment or surface behind the ACM — not abatement of ACM — then the appendix provisions may apply. If the intent of the work is abatement of the ACM, then the full-scale abatement control requirements apply.

In any event, this appendix section of the OSHA construction standard outlines requirements for the use of certain engineering and work practice controls such as glovebags, mini-enclosures, and special vacuuming techniques. Similar information on these procedures may be found in the EPA's AHERA regulations for schools. (See final AHERA rule, Appendix B, for SS/SD projects.)

In general, applicable OSHA permissible exposure limits are not likely to be exceeded for most O&M activities in building areas where only non-friable ACM is present or where friable ACM is in good condition.

U.S. EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61 Subpart M)

EPA's rules concerning the application, removal, and disposal of ACM, as well as manufacturing, spraying and fabricating of ACM, were issued under the asbestos NESHAP. The asbestos NESHAP regulation governs asbestos demolition and renovation projects in all facilities. The NESHAP rule usually requires owners or operators to have all friable ACM removed before a building is demolished, and may require its removal before a renovation. For renovation projects where friable ACM will be disturbed, the NESHAP rule may require appropriate work practices or procedures for the control of emissions. It is prudent to note that any ACM which may become friable poses a potential hazard that should be addressed. The building owner should consider that in many instances, the removal of friable ACM prior to demolition could be less expensive than removals while the building is still occupied and being used. *Some revisions to the current NESHAP rule are anticipated by the end of 1990.*

Notification

EPA or the state (if the state has been delegated authority under NESHAP) must be notified before a building is demolished or renovated. The following information is required on the NESHAP notice:

1. Name and address of the building owner or manager;
2. Description and location of the building;
3. Estimate of the approximate amount of friable ACM present in the facility;
4. Scheduled starting and completion dates of ACM removal;
5. Nature of planned demolition or renovation and method(s) to be used;
6. Procedures to be used to comply with the requirements of the regulation; and
7. Name, address, and location of the disposal site where the friable asbestos waste material will be deposited.

Depending on project size, EPA or the state must be notified before a building is demolished or renovated.

The notification requirements do not apply if a building owner plans renovation projects which will disturb less than the NESHAP limits of 160 square feet of friable ACM on facility components or 260 linear feet of friable ACM on pipes (quantities involved over a one-year period). For renovation operations in which the amount of ACM equals or exceeds the NESHAP limits, notification is required as soon as possible.

Emissions Control and Waste Disposal

The NESHAP asbestos rule prohibits visible emissions to the outside air by requiring emission control procedures and appropriate work practices during collection, packaging, transportation or disposal of friable ACM waste. All ACM must be kept wet until sealed in a leak-tight container that includes the appropriate label. The following table provides a simplified reference for building owners regarding the key existing NESHAP requirements.

Resource Conservation and Recovery Act Regulations (RCRA); and Comprehensive Environmental Response, Compensation, and Liability Act Regulations (CERCLA, or "Superfund")

Under expanded authority of RCRA, a few states have classified asbestos-containing waste as a hazardous waste, and require stringent handling, manifesting, and disposal procedures. In those cases, the state hazardous waste agency should be contacted before disposing of asbestos for approved disposal methods and record keeping requirements, and for a list of approved disposal sites.

Friable asbestos is also included as a hazardous substance under EPA's CERCLA regulations. The owner or manager of a facility (e.g., building, installation, vessel, landfill) may have some reporting requirements. Check with your EPA Regional Office for further information. (See Appendix D for telephone numbers.)

The Asbestos Hazard Emergency Response Act Regulations (AHERA)

In October 1987 EPA issued final regulations to carry out the Asbestos Hazard Emergency Response Act of 1986 (AHERA). The AHERA regulatory requirements deal *only with public and private elementary and secondary school buildings.* The regulations require schools to conduct inspections, develop comprehensive asbestos management plans, and select asbestos response actions to deal with asbestos hazards. The AHERA rules *do not* require schools to remove ACM.

A key element of the AHERA regulations requires schools to develop an O&M program if friable ACM is present. The AHERA O&M requirements also cover non-friable ACM which is about to become friable. For example, drilling through an ACM wall will likely result in friable ACM. Under the AHERA O&M provisions, schools must carry out specific O&M procedures which provide for the clean-up of any ACM releases and help ensure the general safety of school maintenance and custodial workers, as well as all other school building occupants. The AHERA regulation's O&M requirements mandate that schools employ specific work practices including wet wiping, HEPA vacuuming, proper waste disposal procedures, and specific training for custodial and maintenance employees who work in buildings with ACM.

U.S. EPA Asbestos Ban and Phaseout Rule

Bans on some uses and applications of asbestos under the Clean Air Act were briefly described in Chapter 1. In July 1989, under the Toxic Substances Control Act (TSCA), EPA promulgated an Asbestos Ban and Phaseout Rule. The complete rule was published in the *Federal Register* on July 12, 1989.

Beginning in 1990 and taking effect in three stages, the rule prohibits the importation, manufacture, and processing of 94 percent of all remaining asbestos products in the United States over a period of seven years.

Existing NESHAP Requirements Summary*

	Demolition		Renovation	
AMOUNT* (in 1 yr.)	≥260 ln.ft. or ≥ 160 sq. ft.	<260 ln.ft. or <160 sq.ft.	≥260 ln ft. or ≥ 160 sq. ft	<260 ln. ft. <160 sq. ft.
NOTIFICATION	YES	YES	YES	NOT REQUIRED
HOW FAR IN ADVANCE*	10 DAYS	20 DAYS	AS SOON AS POSSIBLE	NOT REQUIRED
EMISSION CONTROLS (Work Practices)	YES	NOT REQUIRED	YES	NOT REQUIRED
DISPOSAL STANDARD	YES	NOT REQUIRED	YES	NOT REQUIRED

*May be changed on promulgation of Revised NESHAP Rule in 1990

Chapter Summary

A variety of federal, state, and local regulations govern the way building owners must deal with ACM in their facilities. State and local regulations may be more stringent than federal standards and often change rapidly. Building owners should periodically check with the appropriate Federal, State, and local authorities to determine whether any new asbestos regulations have been developed or whether current regulations have been amended. Specific federal regulations that may affect asbestos-related tasks and/or workers are highlighted here:

- ○ OSHA Construction Industry Standard for Asbestos (29 CFR 1926.58).
- ○ OSHA General Industry Standard for Asbestos (29 CFR 1910.1001).
- ○ OSHA Respiratory Protection Standard (29 CFR 1910.134).
- ○ EPA Worker Protection Rule (40 CFR 763 Subpart G).
- ○ EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61 Subpart M).
- ○ EPA Asbestos Hazard Emergency Response Act (AHERA) Regulations (40 CFR 763 Subpart E).
- ○ EPA Asbestos Ban and Phaseout Rule (40 CFR 763 Subpart I).

Appendix A.

Glossary of Terms

ACM	Asbestos-Containing Material. Any material containing more than one percent asbe
Asbestos Program Manager	A building owner or designated representative who supervises all aspects of the fac asbestos management and control program.
Air Plenum	Any space used to convey air in a building or structure. The space above a suspended cei is often used as an air plenum.
Asbestos Abatement	Procedures to control fiber release from asbestos-containing materials in a building o remove it entirely. These may involve removal, encapsulation, repair, enclos encasement, and operations and maintenance programs.
Delamination	Separation of one layer from another.
EPA	U.S. Environmental Protection Agency
Friable Asbestos	Any materials that contain greater than one percent asbestos, and which can be crumbl pulverized, or reduced to powder by hand pressure. This may also include previously n friable material which becomes broken or damaged by mechanical force.
Glovebag	A polyethylene or polyvinyl chloride bag-like enclosure affixed around an asbest containing source (most often, TSI) so that the material may be removed while minimizi release of airborne fibers to the surrounding atmosphere.
HEPA Filter	High-Efficiency Particulate Air Filter. Such filters are rated to trap at least 99.97% of particles 0.3 microns in diameter or larger.
Industrial Hygienist	A professional qualified by education, training, and experience to anticipate, recogniz evaluate and develop controls for occupational health hazards.
Medical Surveillance	A periodic comprehensive review of a worker's health status. The required elements of a acceptable medical surveillance program are listed in the Occupational Safety and Healt Administration standards for asbestos.
Miscellaneous ACM	Interior asbestos-containing building material on structural components, structur members or fixtures, such as floor and ceiling tiles; does not include surfacing material c thermal system insulation.
NESHAP	National Emission Standard for Hazardous Air Pollutants—EPA Rules under the Clean Ai Act.
NIOSH	The National Institute for Occupational Safety and Health, which was established by th Occupational Safety and Health Act of 1970. Primary functions of NIOSH are to conduc research, issue technical information, and test and certify respirators.
Personal Air Samples	An air sample taken with a sampling pump directly attached to the worker with th collecting filter and cassette placed in the worker's breathing zone. These samples ar required by the OSHA asbestos stand. ds and the EPA Worker Protection Rule.
Prevalent Level Samples	Air samples taken under normal conditions (also known as ambient background samples).
Surfacing ACM	Asbestos-containing material that is sprayed-on, troweled-on or otherwise applied to surfaces, such as acoustical plaster on ceilings and fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, or other purposes.
TSI	Thermal system insulation — asbestos-containing material applied to pipes, fittings, boilers, breeching, tanks, ducts or other interior structural components to prevent heat loss or gain or water condensation.
TWA	Time-weighted Average. In air sampling, this refers to the average air concentration of contaminants during a particular sampling period.

Appendix B.

Sample Recordkeeping Forms

Form 1. A sample form for recording information during ACM reassessment.

Reinspection of Asbestos-Containing Materials

Location of asbestos-containing material (address, building, room, or general description):

_____

_____

_____

_____

Type of asbestos-containing material(s):
1. Sprayed- or troweled-on ceilings or walls
2. Sprayed- or troweled-on structural members
3. Insulation on pipes, tanks, or boiler
4. Other (describe):

_____

_____

Abatement Status:

1. The material has been encapsulated _____, enclosed _____, neither _____, removed _____.

Assessment:

1. Evidence of physical damage: _____

_____

2. Evidence of water damage: _____

_____

3. Evidence of delamination or other damage: _____

_____

4. Degree of accessibility of the material: _____

_____

5. Degree of activity near the material: _____

_____

6. Location in an air plenum, air shaft, or airstream: _____

_____

7. Other observations (including the condition of the encapsulant or enclosure, if any): _____

_____

•Recommended Action: _____

_____

Signed: _____ Date: _____
(evaluator)

Form 2. A sample application form for maintenance work approval.

Job Request Form for Maintenance Work

Name:_____ Date:_____

Telephone No._____ Job Request No. _____

Requested starting date:_____ Anticipated finish date:_____

Address, building, and room number(s) (or description of area) where work is to be performed:

_____

_____

_____

_____

Description of work:

_____

_____

_____

_____

_____

Description of any asbestos-containing material that might be affected, if known (include location and type):

_____

_____

_____

_____

_____

Name and telephone number of requestor:

_____

Name and telephone number of supervisor:

_____

Submit this application to:

_____

(The Asbestos Program Manager)

NOTE: An application must be submitted for all maintenance work whether or not asbestos-containing material might be affected. An authorization must then be received before any work can proceed.

_____ Granted (Job Request No._____)
_____ With conditions*
_____ Denied

*Conditions: _____

_____

Form 3. A sample maintenance work authorization form.

Maintenance Work Authorization Form

No._____

AUTHORIZATION

Authorization is given to proceed with the following maintenance work:

_____

_____

_____

_____

_____

_____

_____

_____

PRESENCE OF ASBESTOS-CONTAINING MATERIALS

_____ Asbestos-containing materials are not present in the vicinity of the maintenance work.

_____ ACM is present, but its disturbance is not anticipated; however, if conditions change, the Asbestos Program Manager will re-evaluate the work request prior to proceeding.

_____ ACM is present, and may be disturbed.

Work Practices if Asbestos-Containing Materials Are Present

The following work practices shall be employed to avoid or minimize disturbing asbestos:*

_____

_____

_____

_____

_____

Personal Protection if Asbestos-Containing Materials Are Present**

The following equipment/clothes shall be used/worn during the work to protect workers:

_____

_____

_____

_____

(manuals on personal protection can be referenced)

Special Practices and/or Equipment Required:

_____

_____

Signed: _____ Date: _____
(Asbestos Program Manager)

Form 4. A sample work evaluation form

Evaluation of Work Affecting Asbestos-Containing Materials

This evaluation covers the following maintenance work:

Location of workd (address, building, room number(s), or general description):

_____

_____

_____

_____

Date(s) of work: _____

Description of work: _____

Work approval form number: _____

Evaluation of work practices employed to minimize disturbance of asbestos:

_____

_____

_____

_____

_____

Evaluation of work practices employed to contain released fibers and to clean up the work area:

_____

_____

_____

_____

_____

Evaluation of equipment and procedures used to protect workers:

_____

_____

_____

_____

_____

Personal air monitoring results: (in-house worker or contract?)

Worker name _____ Results: _____

Worker name _____ Results: _____

Handling or storage of ACM waste: _____

Signed: _____ Date: _____
(Asbestos Program Manager)

Appendix C.

Illustrative Organization Charts

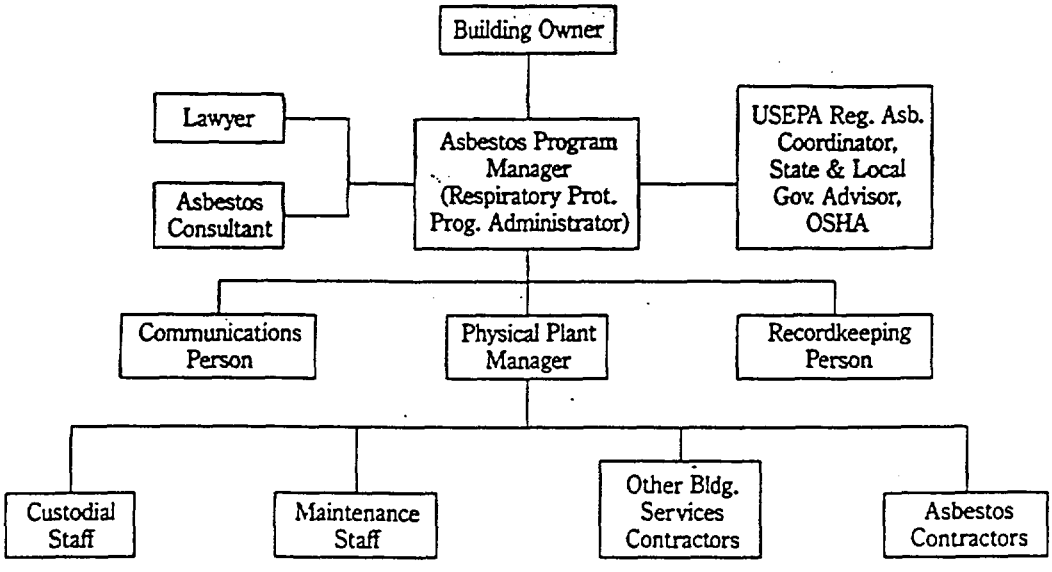


Figure 1. A *sample* organization for a building owner with a large in-house management staff. Shaded boxes indicate outside assistance.

Owners and Managers Who Employ an Extensive In-house Management Staff

IN-HOUSE STAFF (FIGURE 1)

Asbestos Program Manager: Has authority and overall responsibility for the asbestos control program. May develop the O&M program. Coordinates all activities. May also administer the respiratory protection program.

Physical Plant Manager: (may also be the Asbestos Program Manager) Participates in establishing work practices for cleaning and maintenance activities, and in training custodial and maintenance staff to use them. Assists in implementing the O&M program and in conducting periodic reinspections of the ACM. Ensures that outside contractors follow O&M procedures.

Communications Person: (Public Affairs Officer, Nurse, Physician, Industrial Hygienist) Assists in preparation and distribution of information about ACM in the building. Person should be a good speaker and communicator.

Recordkeeping Person: (Executive Assistant, Secretary) Responsible for maintaining records.

OUTSIDE ASSISTANCE

EPA Regional Asbestos Coordinator, NESHAP Coordinator and State/Local Government Advisors: Provide general guidance and answer specific questions.

OSHA Regional Office: May be helpful in answering questions about existing regulations, and providing guidance for worker protection.

Asbestos Consultant(s)*: (Industrial Hygienists, Health Professionals, Architects, Engineers, and others) May assist in various aspects of the asbestos O&M program, including its development and implementation. May also conduct material inspections and provide work practice recommendations.

Lawyer: Provides advice on legal requirements (such as laws and statutes) and liability aspects of the program.

Asbestos Contractor*: May provide services for ACM abatement and for building decontamination following a fiber release episode.

*It is important for owners and Asbestos Program Manager's to consider potential "conflict of interest" issues pertaining to those persons or firms used to sample, inspect, assess, analyze, recommend response actions, design response actions, and conduct asbestos response actions.

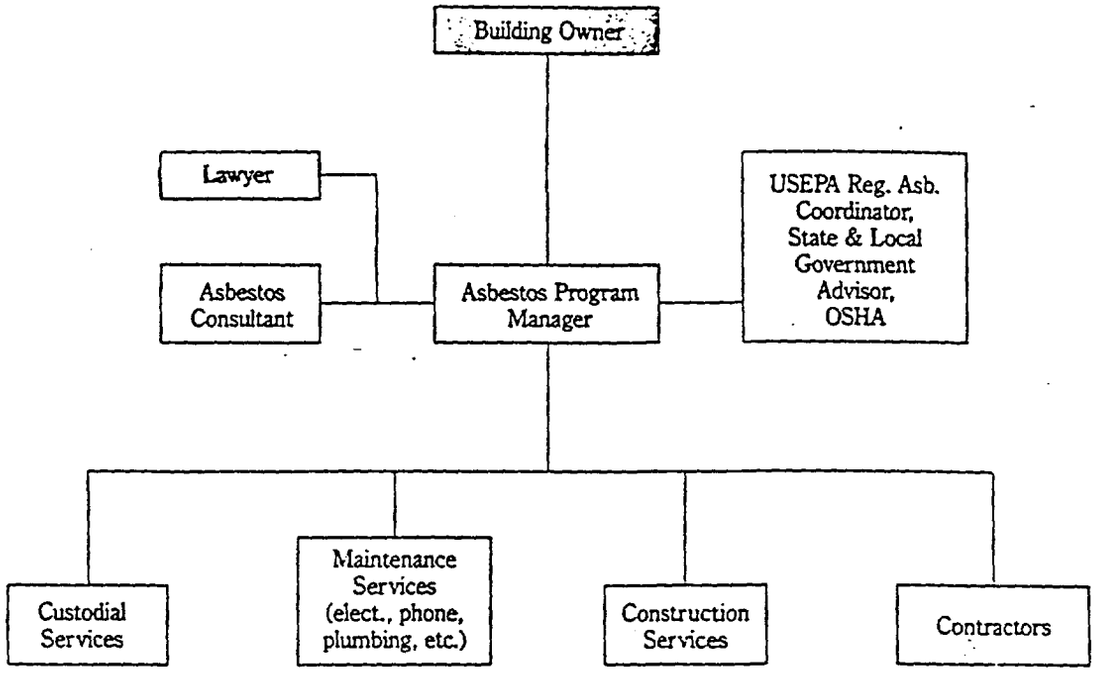


Figure 2. A *sample* organization for owners of buildings where services are provided by contract. Shaded boxes indicate outside assistance.

Owners and Managers Who Contract For Services

IN-HOUSE STAFF (FIGURE 2)

Asbestos Program Manager: Has overall responsibility for the asbestos control program. May develop and implement the O&M program. Establishes training and experience requirements for contractor's workers. Supervises and enforces work practices with assistance of work crew supervisors. Conducts periodic reinspections and responsible for recordkeeping. This person should be properly trained in O&M program development and implementation (see Chapter 5).

OUTSIDE ASSISTANCE

EPA Regional Asbestos Coordinator and State/Local Government Advisors: *Provide* general guidance and answer specific questions.

OSHA Regional Office: May be helpful in answering questions about existing regulations and providing guidance for worker protection.

Asbestos Consultant(s)*: (Industrial Hygienists, Health Professionals, Architects, Engineers, and others) May assist Asbestos Program Manager in various aspects of the asbestos O&M program, including development and implementation. May also conduct the inspection and provide work practices recommendations.

Lawyer: Provides advice on legal requirements (laws and statutes) and liability aspects of the program.

Asbestos Contractor*: May provide services for ACM abatement and building decontamination following a fiber release episode.

*It is important for owners and Asbestos Program Manager's to consider potential "conflict of interest" issues pertaining to those persons or firms used to sample, inspect, assess, analyze, recommend response actions, design response actions, and conduct asbestos response actions.

APPENDIX D.

Additional Assistance and Training

EPA REGIONAL CONTACTS

Additional assistance can be obtained from your U.S. EPA Regional Asbestos Coordinators, NESHAP Regional Coordinators, and OSHA Regional Offices. Their telephone numbers are listed below:

EPA Region I: (CT,ME,MA,NH,RI,VT)
Asbestos Coordinator (617) 565-3835
NESHAP Coordinator (617) 565-3265

EPA Region II: (NJ,NY,PR,VI)
Asbestos Coordinator (201) 321-6671
NESHAP Coordinator (212) 264-6770

EPA Region III: (DE,DC,MD,PA,VA,WV)
Asbestos Coordinator (215) 597-3160
NESHAP Coordinator (215) 597-6550

EPA Region IV: (AL,FL,GA,KY,MS,NC,SC,TN)
Asbestos Coordinator (404) 347-5014
NESHAP Coordinator (404) 347-2904

EPA Region V: (IL,IN,MI,MN,OH,WI)
Asbestos Coordinator (312) 886-6003
NESHAP Coordinator (312) 353-2088

EPA Region VI: (AR,LA,NM,OK,TX)
Asbestos Coordinator (214) 655-7244
NESHAP Coordinator (214) 655-7229

EPA Region VII: (IA,KS,MO,NE)
Asbestos Coordinator (913) 551-7020
NESHAP Coordinator (913) 551-7020

EPA Region VIII: (CO,MT,ND,SD,UT,WY)
Asbestos Coordinator (303) 293-1442
NESHAP Coordinator (303) 294-7685

EPA Region IX: (AZ,CA,HI,NV,AS,GU)
Asbestos Coordinator (415) 556-5406
NESHAP Coordinator (415) 556-5526

EPA Region X: (AK,ID,OR,WA)
Asbestos Coordinator (206) 442-4762
NESHAP Coordinator (206) 442-1757

OSHA REGIONAL OFFICES

Region I — Boston, MA: (617) 223-6710
Region II — New York, NY: (212) 944-3432
Region III — Philadelphia, PA: (215) 596-1201
Region IV — Atlanta, GA: (404) 347-3573
Region V — Chicago, IL: (312) 353-2220
Region VI — Dallas, TX: (214) 767 4731
Region VII — Kansas City, MO: (816) 374-5861
Region VIII — Denver, CO: (303) 844-3061
Region IX — San Francisco, CA: (415) 995-5672
Region X — Seattle, WA: (206) 442-5930

Toxic Substances Control Act (TSCA) Assistance Hotline

Copies of the EPA Guidance Documents, Technical Bulletins, and other publications cited here can be obtained by calling the TSCA Assistance Hotline, in Washington, D.C., at: (202) 554-1404.

Approved Training Centers

Certain training centers and satellite centers were initially funded by EPA to develop asbestos training courses. They, and other training providers approved by EPA or states, offer courses for professionals such as asbestos inspectors and management planners involved with ACM detection and control, for asbestos abatement project designers, project supervisors and abatement workers, and others. In general, qualified professionals trained as inspectors and asbestos management planners would be good choices to design an O&M plan. Original training centers are located at the following sites:

Georgia Institute of Technology
GTRI/EDL/ESTD
29 O'Keefe Building
Atlanta, GA 30332
(404) 894-3806

University of Kansas
Asbestos Training Center
6600 College Blvd. Suite 315
Overland Park, KS 66211
(913) 491-0181

Pacific Asbestos
Information Center
University CA/Extension
2223 Fulton St.
Berkeley, CA 94720
(415) 643-7143

Tufts University
Curtis Hall
Asbestos Information Center
474 Boston Avenue
Medford, MA 02155
(617) 381-3531

University of Illinois at Chicago
Midwest Asbestos Information Center
Box 6998
Chicago, IL 60680
(312) 996-6904

Additional training providers are listed in the *Federal Register* on a regular basis. Call (202) 554-1404 for information. In addition, information on how to receive a copy of an O&M Course produced by an EPA contractor may be obtained at the same number.

OTHER ORGANIZATIONS

National Conference of State Legislatures (NCSL)
Denver, CO — (303) 623-7800
National Institute of Building Sciences (NIBS),
Washington, D.C. — (202) 289-7800
American Board of Industrial Hygiene (ABIH),
Lansing, MI — (517) 321-2638
National Institute for Standards and Technology (NIST),
Gaithersburg, MD — (contact for lab accreditation) — (301) 975-4016

APPENDIX E:

Respiratory Protection Recommendations

EPA recommends that the following guidelines be followed for respiratory protection during various custodial and maintenance tasks. These guidelines are issued to cover tasks that do not always create routine fiber levels high enough to trigger OSHA respiratory protection requirements. Therefore, building owners should note they go *beyond* OSHA requirements.

- **Routine maintenance where contact with ACM is unlikely.** No respiratory protection required. (Air-purifying respirator with high-efficiency filters should be available if needed; half-face or full facepiece).

- **Routine maintenance where there is reasonable likelihood of ACM disturbance.** Air-purifying respirator with high-efficiency filters (half-face or full facepiece).

- **Maintenance or repair involving intentional small-scale disturbance of ACM.** Powered air-purifying respirator with high-efficiency filters, or air-purifying respirator with high-efficiency filters (half-face or full facepiece). If glove bags are used to contain the ACM during disturbance, either half-face or full facepiece air-purifying respirators with high-efficiency filters may be used.

- **Any O&M activity requiring sawing, cutting, drilling, abrading, grinding, or sanding ACM.** (NOTE: specially equipped tools with local exhaust ventilation should be used for these activities. See 29 CFR 1910.) Powered air-purifying respirator with high-efficiency filters, or full facepiece, air-purifying respirator equipped with high-efficiency filters should be used.

- **Cleanup after a minor asbestos fiber release.** Air-purifying respirator with high-efficiency filters (half-face or full facepiece).

- **Cleanup after a major asbestos fiber release.** Air-supplied respirators, either the "Type C" airline respirator equipped with a backup high-efficiency filter or SCBA (Self-Contained Breathing Apparatus).

The U.S. EPA, in collaboration with NIOSH, has issued a guidance document, "A Guide to Respiratory Protection for the Asbestos Abatement Industry," which recommends levels of respiratory protection for those engaged in large-scale asbestos abatement projects that are beyond routine O&M procedures. Air-supplied self-contained, and "type C" airline respirators are the focus of the EPA/NIOSH document. These respirators allow workers to breathe fresh air supplied through hoses and face masks, and are generally used only by asbestos abatement workers engaged in large-scale asbestos removal projects. They are usually not considered either practical or necessary for most custodial and maintenance jobs.

An industrial hygienist or environmental/occupational healt professional should assist workers with respirator selectio and fitting, and train them in respirator use. Fit-testing (whic means determining whether a particular brand and size c respirator properly fits an individual worker) is essential, sinc respirators which leak at the face seal provide significantly les protection. OSHA requires fit-testing initially and every si months for employees required to wear a negative pressur respirator for protection against asbestos, or for individual exposed at or above the OSHA-specified limits.

A respirator's effectiveness is also influenced by how it i handled, cleaned, and stored. Custodial and maintenance staf should clean their respirators after each use, and disinfect thei respirators at the end of a day's use. This improves comfort and also reduces the chances of skin irritation or infection After cleaning the respirator, custodial and maintenance staf should place the respirator (with the worker's name) in a clear and sanitary location and store the unit in a secure place fo future use. Respirators should be visually inspected by the use before and after each use, during cleaning and at least monthl when not in use. Inspection records should be maintaine accordingly. When the respirator's high-efficiency filters ar discarded, they should be disposed of as asbestos waste.

APPENDIX F

Existing EPA Guidance for Each Step That a Building Owner May Take to Control ACM

Action	Existing EPA Guidance/Regulations*
Appoint Asbestos Program Manager and Develop an Organizational Policy.	"Guidance for Controlling Asbestos-Containing Materials in Buildings" ("Purple Book") EPA publication number: 560/5-85-024
Inspect the facility to determine if ACM is present. Take bulk samples of suspect ACM and assess the material's condition.	"Guidance for Controlling Asbestos-Containing Materials in Buildings" ("Purple Book", chapter 2) EPA publication number: 560/5-85-024
	"Simplified Sampling Scheme for Surfacing Materials" ("Pink Book") EPA publication number: 560/5-85-030a
	"Asbestos-Containing Materials in Schools; Final Rule and Notice" (Asbestos Hazard Emergency Response Act, or AHERA). *Federal Register*— October 30, 1987. (sections 763.85 to 763.88)
	Model training course materials for accrediting asbestos building inspectors in accordance with AHERA (inspection/assessment materials).
Establish an O&M program.	"Purple Book", Chapter 3
	AHERA regulations, sections 763.91 and 763.92
	EPA Guidance for Service and Maintenance Personnel. EPA publication number 560/5-85-018
Implement and Conscientiously Manage the O&M Program; Assess the Potential for Exposure to Asbestos and Select Response Actions.	"Purple Book", Chapter 4
	Model training course materials for accrediting asbestos management planners in accordance with AHERA (assessment materials).
	AHERA regulations, section 763.88 and 793.92
Select and Implement Abatement Actions Other Than O&M When Necessary.	"Purple Book", Chapter 6
	AHERA regulations, section 763.93 (including 763.85 through 763.92)
	AHERA regulation, appendix A; Determining Completion of Response Actions-Methods.
	"Abatement of Asbestos-Containing Pipe Insulation" U.S. EPA; Asbestos-in-Buildings Technical Bulletin 1986-2.
	U.S. EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) Regulations (40 CFR 61)
	Model training course materials for accrediting asbestos management planners in accordance with AHERA (assessment materials).

*Most of these guidance materials are available through EPA's TSCA Assistance Hotline, at (202) 554-1404.

APPENDIX G:

Sample List of Suspect Asbestos-Containing Materials

- Cement Pipes
- Cement Wallboard
- Cement Siding
- Asphalt Floor Tile
- Vinyl Floor Tile
- Vinyl Sheet Flooring
- Flooring Backing
- Construction Mastics (floor tile, carpet, ceiling tile, etc.)
- Acoustical Plaster
- Decorative Plaster
- Textured Paints/Coatings
- Ceiling Tiles and Lay-in Panels
- Spray-Applied Insulation
- Blown-in Insulation
- Fireproofing Materials
- Taping Compounds (thermal)
- Packing Materials (for wall/floor penetrations)
- High Temperature Gaskets
- Laboratory Hoods/Table Tops
- Laboratory Gloves
- Fire Blankets
- Fire Curtains
- Elevator Equipment Panels
- Elevator Brake Shoes
- HVAC Duct Insulation
- Boiler Insulation
- Breeching Insulation
- Ductwork Flexible Fabric Connections
- Cooling Towers
- Pipe Insulation (corrugated air-cell, block, etc.)
- Heating and Electrical Ducts
- Electrical Panel Partitions
- Electrical Cloth
- Electric Wiring Insulation
- Chalkboards
- Roofing Shingles
- Roofing Felt
- Base Flashing
- Thermal Paper Products
- Fire Doors
- Caulking/Putties
- Adhesives
- Wallboard
- Joint Compounds
- Vinyl Wall Coverings
- Spackling Compounds

NOTE: This list does not include every product/material that may contain asbestos. It is intended as a general guide to show which types of materials may contain asbestos.

APPENDIX H:

References

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