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AIRBORNE FIBER COUNTS

in

A CONSUMER SPACKLING

and

DRYWALL REPLACEMENT INSTALLATION PROJECT

Date Sampled: June 21-25, 1977
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SUMMARY AND CONCLUSIONS

Residual asbestos exposure in a two-story residential structure that resulted from two prior consumer uses of asbestos-containing tape-joint compound was measured. Asbestos exposure during and after a consumer spackling and drywall renovation job was also measured. This job consisted of extensive spackling in one room and removal and replacement of approximately three 4' x 8' panels of drywall.

Samples were collected on Millipore filters and counted by optical phase-contrast microscopy in accordance with the March 30, 1977 edition of the NIOSH-OSHA method (P & CAM 239). The absence of significant numbers of short and/or narrow fibers not visible optically in the samples was verified by scanning electron microscope techniques at magnifications of 1,500X and to a limited extent at 15,000X.

The results showed that residual asbestos exposure was somewhat less than 0.01 fibers/cc >5μ and was not changed appreciably by the present test. It is questionable whether this is really different from the natural background.

The combined spackling and drywall renovation operation tested gave a maximum, one-day time-weighted average operator exposure of about 0.3 fibers/cc longer than 5μ and a maximum ceiling exposure (10 minutes) of 0.5 fibers/cc >5μ. Considering the size of the area renovated, these values are consistent with values of 1 - 4 fibers/cc >5μ that have been reported for commercial sanding operations where entire series of rooms (including the ceilings) are sanded in sequence.

General area household samples during the operations ranged from 0.007 to 0.3 fibers/cc >5μ and averaged 0.06 fibers/cc >5μ.

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OBJECTIVES

This study had the following objectives:

1. To measure a residual household exposure to asbestos resulting from consumer use of asbestos-containing spackling compound, tape-joint compound, and the installation and presence of a fireplace log with attached asbestos.

2. To measure asbestos exposure during a consumer spackling and a drywall removal and replacement operation.

TEST LOCATION AND GENERAL PROCEDURE

The tests were run at a two story, brick-veneer dwelling located in Snyder, New York. The house was built in 1939 with all interior walls finished with plaster on perforated wallboard. Two substantial consumer uses of asbestos had occurred in subsequent years which could be the source of residual exposure.

In 1968 the owner finished a recreation room in the basement about 18 feet long and 11 feet wide using drywall on three sides. A dry-mix taping compound was used but the specific product could not be identified. The present tests confirm that it contained asbestos, but the exact amount was not measured. Vinyl-asbestos tile was used on the floor of this room and the ceiling was finished with cellulosic tile. A gas log with asbestos glued on to simulate ashes was also installed at this time.

In 1975 an upstairs bathroom was completely renovated. Extensive repairs were made on the ceiling using several coats of an asbestos-containing taping compound manufactured by Georgia-Pacific. Considerable sanding was done on an area of about 50 square feet. In addition, three sheets of 1/4" x 4' x 8' asbestos-cement sheet were hand sawed and power drilled for the tub enclosure.

The present renovation work covered two operations, spackling and drywall removal and replacement. The work was done at widely separated locations, i.e., 2nd floor and basement, over a five-day sequence as outlined below. These steps follow the installation procedure recommended by the manufacturer of the compound. Specific operating details will be described in connection with the sample collection.

1. Measurement of "background" or residual asbestos level in the house.

2. Preparation of cracks for spackling. Removal of old drywall and hanging of new board. Wet-out of asbestos-containing dry-mix tape joint compound. Application of first coat of compound (including burying of joint tape). Clean up.

3. Application of second coat of compound.

4. Sanding of second coat of compound and application of third coat. Clean up.

5. Sanding of third coat and clean up.

The consumer doing this work was reasonably skilled in small to medium home repair jobs of various types, but had no special skills in handicraft or woodworking. Prior experience with drywall was limited to the installation of the recreation room described previously. The work was done in a manner that was considered to be reasonably representative of "middle-of-the-road" consumer use. No specific precautions were taken to avoid dust but deliberate efforts to cause airborne dust were not made.

RENOVATION PROCEDURE AND SAMPLE COLLECTION

Residual Asbestos Level (6/21/77)

Samples to estimate the residual fiber level in the house and to serve as a reference point were collected in the upstairs bedroom (to be spackled), in the cellar recreation room (to be renovated with new drywall), in the first floor living room (to represent a general living area), and out-of-doors (to give an indication of background). Sample locations are shown in Figure 1. All samples, here and throughout the tests, were collected on Millipore membrane filters of 0.8μ priority with battery-powered M.S.A. pumps calibrated to a flow of two liters per minute.

Preparation and First Application of Compound (6/22/77)

Spackling: The preparation for this operation is illustrated in Figures 2 (a) and (b). The room, ~11' x 18', had three cracks about 18' long running from the lower corners of two windows to the baseboard. Shifting of an entire ceiling section had left a large crack ~3' long in the ceiling below the corner. There were also about 6' of smaller cracks adjacent to this plus an area about 8" x 8" that needed to be filled in to a depth of about 1/8" to conform to the ceiling contours.

The cracks were cleaned out with a chisel to remove loose material and to give enough space to fill. The dust and debris produced were swept up with a pan and brush and deposited in a paper trash bag. Later in the day, drywall compound was applied to the cracks and ceiling with a 3" putty knife. A total width of about 3" along the cracks was covered.

An area air sample was collected over the entire day at the location shown in Figure 2 (a). A composite personal sample on the operator was also collected for the entire day, (except for the wet-out of the compound, which was sampled separately) and included this preparation, clean-up and application. An all-day area sample was collected simultaneously in the first floor living room at the location shown in Figure 1 (b).

Drywall Removal and Replacement: The drywall replacement involved one wall, ~11' long, of a cellar recreation room. The old drywall was first torn out as illustrated in Figure 2 (d). This was accomplished by breaking enough of the board with a hammer to allow access with a pry bar. It was observed during the operation that the tape adhered strongly to the boards and could be pulled off in long sections. There was little or no observed tendency for the joint material to come off the board or powder. The large pieces of drywall were carried outside. The smaller pieces and other dust and debris were swept up with a pan and brush and deposited in the trash barrel shown.

Three pieces of new 3/8" gypsum board were next fitted and nailed to the studding. Where needed, cuts were made by scoring the front of the board, cracking, and cutting the backing paper with a razor blade. These cuts were made out-of-doors to facilitate moving the pieces into the house.

After the handling of the board was completed, a five-pound box of dry-mix tape-joint compound was mixed in a bucket as shown in Figures 3 (a) and (b). The powder was gradually added to the prescribed amount of water with vigorous mixing, allowed to stand, and re-mixed with the viscosity adjusted via additional water in accordance with the manufacturer's instructions. The overall operation took about 17 minutes. Separate operator and area samples were taken during this step. The entire box was mixed at one time and was stored with a reasonably tight cover when not in use for the duration of the job.

The product used was Durabond Wallboard Compound, Ready-to-mix Powder, manufactured by the United States Gypsum Company which was purchased on June 19, 1977. The logo on the box is reproduced in Figures 4 (a) and (b). Note the asbestos warning label and the application directions which have been followed carefully in this test. It should be noted that this box printing has a 1974 copyright and was the last one on the shelf with the asbestos warning label. More recent products from this manufacturer appear to be asbestos free.

After wet-out, the compound was used to implant and cover the tape and a first coat was applied to the nail-heads. A 6" knife was used. A first coat was also applied to the cracks in the upstairs bedroom with a 3" wide knife.

In addition to the separate samples during the wet-out, an area sample was taken for the entire day at the location shown in Figure 2 (c).

Second Application of Compound (6/23/77)

A second application of compound was made in both rooms on the following day. This took a total of one hour and 15 minutes. No visible dust was generated and no air samples were taken.

Sanding of Second Application and Installation of Finish Coat (6/24/77)

When dry, the second coat of compound was hand sanded in both rooms using 150 grit paper attached to a block. This operation is illustrated in Figures 3 (c) and (d). After each sanding step was completed, the dust was swept up with a pan and brush and deposited in a trash bag in the same manner as after the preparation step described previously. Personal and area air samples were collected during the combined sanding and clean up step for each room.

Following sanding, a finish (3rd) coat of compound was applied to the cracks and the drywall. Area samples were taken to cover this time and the remainder of the day. A full-day sample, including the sanding periods, was taken in the first-floor living room.

Sanding of Finish Coat (6/25/77)

The final (second) sanding and clean up and the sample collection pattern for this operation closely duplicated the one just described. The finished work is shown in Figure 5. In addition to the renovation work described, the clothes worn during the test sequence were unfolded and placed in a washing machine in normal fashion. This included shaking out the material held in the cuffs of the pants. A personal sample was taken during this time period.

FIBER COUNTING PROCEDURE

NIOSH-OSHA Optical Phase-Contrast Method

The latest draft of the NIOSH procedure, P & CAM #239 dated March 30, 1977 was used as the general basis for optical counting. This version of the method differs significantly from earlier editions in that:

1. Substantial changes have been made in the selection rule covering which fibers encountered by the reticle are to be included in the count. This largely eliminates systematic bias due to fiber size distribution.

2. The total coefficient of variation is expressed as a function of the total number of fibers counted instead of a single value applicable to all situations. A minimum count of 10 fibers is also required.

These are clearly substantial improvements but the method still has some serious shortcomings particularly when applied to situations where airborne fiber concentrations are low and/or where non-asbestos particulate material is present.(1) Both of these situations exist in the present study and certain refinements in the procedure have been necessary in order to present the results in the most understandable and meaningful fashion. It should be emphasized that these are additions to the procedure and are not believed to be in conflict with it.

The legal basis for refinements to be described is found in the following quotation from P & CAM 239:

> "3. Interferences
>
> In an atmosphere known to contain asbestos, all particulates with a length to diameter ratio of 3 to 1 or greater, and a length greater than 5μ should, in the absence of other information, be considered as asbestos fibers and counted as such." (Emphasis added.)

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(1) See for example, "A Report on the Fiber Content of Eighty Industrial Talc Samples Obtained From, and Using the Procedures of, the Occupational Safety and Health Administration. NBS, May 1977." This report is one of the principle reasons for an international conference on the problem sponsored by NBS and scheduled for July 18-20, 1977.

The approach here emphasizes the development and use of "other information" to obtain the most intelligent assessment of what is seen through the microscope. In this connection it is important to realize that optical fiber counting is not an exact science but an art. It requires a unique blend of talent, training, and concentration. An experienced counter develops both in "eye" and a counting rhythm, which permits him to recognize "fibers", decide which fibers are of the appropriate type and dimensions to be counted, and to move rapidly from field-to-field so the counts do not take an inordinate amount of time. The objective is to provide the experienced operator with a set of ground rules to judge between the various types of fiber and put them in certain classes.

Under phase-contrast illumination, chrysotile asbestos has some very distinctive characteristics. It is typically dark appearing, composed of random-size bundles and flexible hair-like threads with curvature. When chrysotile fibers are short, however, i.e., 5-10μ, perfectly straight, dark rod-like particles occur. Classical chrysotile fibers are illustrated in Figures 6 (a) and (b).

Fibers of amphibole asbestos are usually larger in diameter than chrysotile and more rigid and rod-like in appearance. They can, however, break down into very fine needle-like material. With the exception of crocidolite, the amphiboles also can contain prismatic crystals which usually have the appearance of chips. The amphiboles normally refract light differently than chrysotile under phase contrast and appear brighter. As particle size decreases, however, light refraction and contrast are diminshed and the particle will appear darker and less definitive. At this size it cannot be distinguished from chrysotile fibers of similar dimensions.

Figure 6 (c) illustrates material which is probably amphibole. It is not well defined in the photograph, but the rod-like particles have a narrow bright band along the center axis which shifts as the focus is changed. Unfortunately, there are a number of non-amphibole particles which show the same features. Examples include, but are certainly not limited to certain mineral wool fibers, chips of fiberglass generated by abrasion, wollastonite, and fibrous talc.

In addition to the three kinds of "fiber" just described, i.e., chrysotile, amphibole fibers and chips, and material that looks like the amphiboles, particles are frequently encountered that meet the NIOSH fiber definition of L/D >3μ, L >5μ but are obviously not asbestos in any form. These include such things as fiberglass "poles", some clay and mica particles, organic fibers, and linear agglomerates of non-fibrous material. The bright "wavy" particles in Fiber 6 (d) illustrate this type of material.

On the basis of the optical characteristics discussed tempered with broad operator experience with a wide variety of known particulate materials, fiber counts at this laboratory are made and reported in the categories described below. Material which is obviously not asbestos is not counted even though it meets the L/D = 3, L >5μ criteria.

1. Chrysotile asbestos - Any fiber having an aspect ratio ≥3 and a length ≥5μ that is, in the operator's judgement, chrysotile. In

the event of doubt, any fiber having the proper dimensions and dark appearance will be included as chrysotile. On this basis the short, dark amphibole fibers, where present, would be reported as chrysotile.

2. Possible amphibole - Any fiber of the appropriate dimensions that is not judged to be chrysotile and is not obviously material other than asbestos. This would include all amphiboles and materials similar in appearance.

It is evident that this classification is oriented towards a more reliable assessment of the airborne level of chrysotile asbestos. It does not address the problem of identifying amphiboles or distinguishing them from similar appearing non-asbestos materials. We believe it provides significant added information in situations where chrysotile is of predominent interest and have used it in the counting of the filters collected in this test. For tape-joint compounds chrysotile is an important ingredient, any "possible amphibole" originates as impurities in other mineral ingredients.

The other counting problem encountered relates to the very low airborne asbestos concentrations found in most of the samples. The NIOSH procedure sets an optimum fiber density on the filter of 50 to 100 fibers per 100 viewing fields and states a minimum density of 10 fibers/100 fields. Within these limits the method is claimed to be applicable to a concentration range of 0.1 to 60 fibers/cc with a total coefficient of variation of 0.26 - 0.4.

The validity of these claims, particularly with regard to accuracy, is a subject of considerable controversy at this time. The discussion of this question is well beyond the scope of this study. For the present work, sample times were adjusted, within the limits set by the nature of the operation, to deposit the proper density of fiber on the filter. Where this was not possible, additional fields were counted in increments of 100 fields, until the minimum of 10 fibers was achieved. Separate results for chrysotile and possible amphibole are reported at values rounded to one significant figure. Fibers/100 fields and the total number of fields counted are also shown in all cases to provide more complete information.

Scanning Electron Microscope Examination

The application of electron microscope techniques to samples collected on Millipore filters is complicated by the fibrous nature of the filter. The most widely used technique at present involves the deposition of a carbon film on the surface of the filter to fix the particles in place, placement of the filter with the carbon side down on a grid, and a slow dissolution of the filter with vapor. This is a tedious process and unless a very careful technique is used, some loss of fibers occurs.

Union Carbide is working on a much simpler approach where a controlled exposure to vapor collapses and consolidates the filter surface so it is relatively smooth without dissolving it to the point where the fibers sink out of sight. The treated filter can then be carbon or gold coated and individual fibers identified by electron diffraction analysis for chemical constituents. The method is admittedly less versatile for identification than transmission techniques, but is also very much faster. It is illustrated in Figure 7 where

7 (a) is the untreated filter, 7 (b) is the treated filter, gold coated and 7 (c) is a representative "Edax" pattern for chrysotile asbestos. Magnification here is 2000X.

Samples were prepared by this technique from 6 mm^2 segments from samples M-30, M-28, M-36, N-79, and N-72. These were scanned randomly at 1500X. Samples M-30 and M-28 were checked systematically for 50 viewing fields of 0.0048 mm^2 area each. Sample M-30 was also scanned at 15,000X. Asbestos fibers were found to be extremely rare and it was clear that within the limits of resolution set by the magnifications used there was not a multiplicity of short or narrow fibers that were missed by phase contrast optical methods. Quantitative measurements on these samples are in progress.

PRESENTATION AND DISCUSSION OF RESULTS

A detailed listing of all samples taken including location, operation tested, collection time, and the counting results is provided in Table I. These airborne fiber concentrations are summarized by work location and the kind of operation being conducted in Table II to provide an overall picture of the results that is easy to visualize. Each day's operation will be discussed in detail in this section.

Residual Level (6/21/77)

"Blank" samples were taken before and after the test. These samples were removed from the carrying case, set aside unopened, and then counted in the same manner as the other samples. The number of fibers found in 500 fields is compared with the results for the two samples collected out-of-doors in the following table:

Sample Identification	Fibers >5μ Found in 500 Fields		Fibers/cc >5μ	
	Chrysotile	Possible Amphibole	Chrysotile	Possible Amphibole
Blank				
M-21	3	1	-	-
N-81	4	0	-	-
Outdoor Samples				
M-32	9.5	5.5	0.003	0.002
N-97	3	2	0.0004	0.0002

In general, the blank samples run about 1 fiber in 100 fields and the outdoor samples ranged from about the same to three times higher. Since most of the samples collected during the testing had filter loadings substantially above 1 fiber/field no corrections were made for the blank.

Indoor samples were taken in three rooms in the house before the start of the work and after it was completed and cleaned up. The results are shown and are also compared with the outdoor samples in the following table:

Airborne Fiber Concentrations[1]
Before and After Renovation

Sample Location	Before Renovation		After Renovation	
	Chrysotile	Possible Amphibole	Chrysotile	Possible Amphibole
Bedroom (2nd Floor)	0.009	0.001	0.007	0.001
Living Room (1st Floor)	0.01	0.0	0.006	0.001
Rec. Room (Cellar)	0.006	0.002	0.002	0.001
Outdoors	0.003	0.002	0.0004	0.0002

(1) All results expressed as fibers/cc longer than 5μ.

Total fiber concentrations in the house were all 0.01 fiber/cc or less (range 0.003-0.01) and averaged 0.008 fiber/cc. The renovation work did not appear to cause any increase. Considering the uncertainties in the analytical method it is questionable whether these levels were actually different from the natural background. In any case, neither the prior consumer work with asbestos-containing materials nor the present renovation represent a significant source of continued asbestos exposure in this house.

Preparation and First Application of Compound (6/22/77)

On this day the wall cracks were cleaned out and opened up with a chisel, the old drywall was ripped out and replaced, the dry-mix compound was wet-out, the drywall tape was buried and a first coat of spackling was applied. Both working areas were also cleaned up before the compound was applied. Area samples were collected throughout the day in each of the three rooms. A composite personal sample was obtained on the operator over the same time period. Separate area (cellar only) and personal samples were obtained for the wet-out of the compound. The fiber concentrations found are summarized in the following table:

Airborne Fiber Concentrations[1]
During Preparation and First Application of Compound

Sample Location	Chrysotile	Possible Amphibole
Bedroom (Spackling)	0.02	0.08
Living Room (No work)	0.02	0.009
Rec. Room (Drywall)		
General construction	0.3	0.007
Wet-out of compound	0.03	0.04
Operator		
General construction[2]	0.2	0.0
Wet-out of compound	0.1	0.2

(1) All results expressed as fibers/cc longer than 5μ.

(2) Covers both bedroom and recreation room.

The main sources of airborne fiber were the rip-out of the old drywall and the wet-out of the dry-mix. Total fiber concentrations in the operator's breathing zone of about 0.3 fibers/cc were reached in both of these operations. The area samples show that preparation for spackling raised the level in the bedroom from ~0.01 to ~0.1 while the living room, where no work was done, went from 0.001 to 0.03 and the drywall tear out in the cellar gave 0.03. Since all of these samples, both personal and area, were collected for nearly eight hours, the results can be considered as representing of eight-hour time-weighted averages.

The types of fiber found are shown in Figure 8. Both chrysotile and possible amphibole are illustrated.

Second Application of Compound (6/23/77)

This was a wet operation with no visible dust. Air samples were not collected.

Sanding of Compound and Application of Finish Coat (6/24/77)

This operation covered sanding the dry compound in both rooms where it had been applied, clean-up after sanding, and application of the second coat of compound. Personal and area samples were collected during sanding in each room. Day-long area samples were taken after sanding in all three rooms. The results are shown in the following table:

Airborne Fiber Concentrations(1)
During Sanding of Compound and Application of Finish Coat

Sample Location	During Sanding		After Sanding	
	Chrysotile	Possible Amphibole	Chrysotile	Possible Amphibole
Bedroom (Spackling)				
Area Samples	0.2	0.07	0.0	0.07
Personal Samples	0.1	0.09	-	-
Living Room (No work)				
Area Sample	← 0.02/0.0 →			
Rec. Room (Drywall)				
Area Samples	0.2	0.03	0.01	0.004
Personal Samples	0.08	0.02	-	-

(1) All results expressed as fibers/cc longer than 5μ.

The total fiber concentrations during the actual sanding operation were in the 0.1 - 0.3 fiber/cc range which is similar to the tear-out operation of the previous day. The sanding and clean-up operations only lasted 93 minutes. These concentrations, therefore, represent maximum or ceiling values that would be combined with 387 minutes of zero exposure to calculate an 8-hr. time-weighted average since the operator left the house after completion of sanding.

Thus:

$$TWA = \frac{(20)(0.19) + (73)(0.1) + (387)(0)}{480} = 0.02 \text{ fibers/cc } >5\mu$$

After sanding the levels dropped sharply to the range of 0.01 to 0.1. TWA values calculated from the results of this sample and past sample that cover a total period of nearly eight hours were 0.08, 0.02 and 0.02 fibers/cc >5μ for the bedroom, living room and cellar, respectively.

Sanding of Finish Coat (6/25/77)

The last day's operation consisted of the sanding of the final coat of tape-joint compound, clean up with a pan and brush, and replacement of furniture. Area and personal samples were taken at the same locations and in the same manner as the previous day. Results are summarized as follows:

Airborne Asbestos Concentrations(1)
During and After Sanding of Finish Coat

Sample Location	During Sanding		After Sanding	
	Chrysotile	Possible Amphibole	Chrysotile	Possible Amphibole
Bedroom (Spackling)				
Area Samples	0.02	0.02	0.007	0.001
Personal Samples	0.09	0.0	-	-
Living Room (No work)				
Area Sample	← 0.006/0.001 →			
Rec. Room (Drywall)				
Area Samples	0.07	0.01	0.002	0.001
Personal Samples	0.03	0.008	0.5(2)	0.03

(1) All results expressed as fibers/cc longer than 5μ.

(2) During shake out of clothes and placing in washing machine.

The sanding here was less intense than the previous day and the maximum fiber count for the operator was about 0.1 fiber/cc with an 8-hr. TWA of 0.005. (Operator again not present for remainder of the day.) After the clean-up, the levels in all three rooms were back to the less than 0.01 fiber/cc level that had been observed prior to the tests. Overall TWA values for the total period sampled were 0.009, 0.007 and 0.01 fibers/cc >5μ.

The highest level found throughout the test sequence, 0.5 fibers/cc, occurred as a short (10 minute) ceiling sample while the work clothes were placed in the washing machine. In this operation four shirts were opened up, the pockets were checked and the shirts were dropped into the washing machine. The pants cuffs were shaken into a trash bag and the pants were also dropped into the machine. The corresponding 8-hour TWA for this operator was 0.02 fibers/cc based on exposure to an average level of (0.008 + 0.007 + 0.003)/3 = 0.006 for the remainder of the day.

Summary of Results During Renovation Operations

The TWA values so far described for the various operations are summarized below:

	Preparation, Installation & Clean up		Sanding & Clean up		Sanding & Clean up	
	Ceiling(1)	TWA(1)	Ceiling	TWA	Ceiling	TWA
Personal						
#1	-	0.3	0.3 & 0.1	0.02	0.09 & 0.04	0.005
#2	-	-	-	-	0.5	0.02
Area						
Spackling	-	0.1	0.3	0.08	0.04	0.009
No operations	-	0.03	-	0.02	-	0.007
Drywall renovation	-	0.3	0.2	0.02	0.08	0.01

(1) All results expressed as fibers/cc >5μ.

The highest ceiling exposure for the operator was 0.5 fibers/cc >5μ and the highest full-day time weighted average was 0.3 fibers/cc >5μ. For the three days where asbestos dust generating operations were in progress the TWA in the three rooms monitored ranged from 0.007 to 0.3 fibers/cc >5μ and averaged 0.06 fibers/cc >5μ.

It is also relevant to point out here that the concentrations found are in reasonable accord with values of 1-4 fibers/cc reported(1) for commercial sanding operations where a series of rooms are sanded in succession. Using a value of 0.2 fibers/cc >5μ for one wall, four walls might be expected to result in a level around 1 fiber/cc >5μ. A ceiling, where the dust drops downward instead of tending to flow down the wall could double this to 2 fibers/cc >5μ. Allowing for variations in asbestos content in the compound, application and sanding techniques, ventilation, etc. the test results appear quite reasonable.

It should also be pointed out that substantial consumer uses of drywall compound occurred in this residence three times in nine years. When it is considered that such uses take place only when substantial repairs are made or for such things as finishing a basement, attic, or adding a room it is suggested that this frequency is considerably higher than average. A rate of something like once in ten years is suggested as more typical.

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(1) "Asbestos and Silica Dust in the Drywall Industry", H. B. Rhodes and B. L. Ingalls, GDCI Drywall, Jan./Feb. 1976, pp. 8

CONCLUSIONS

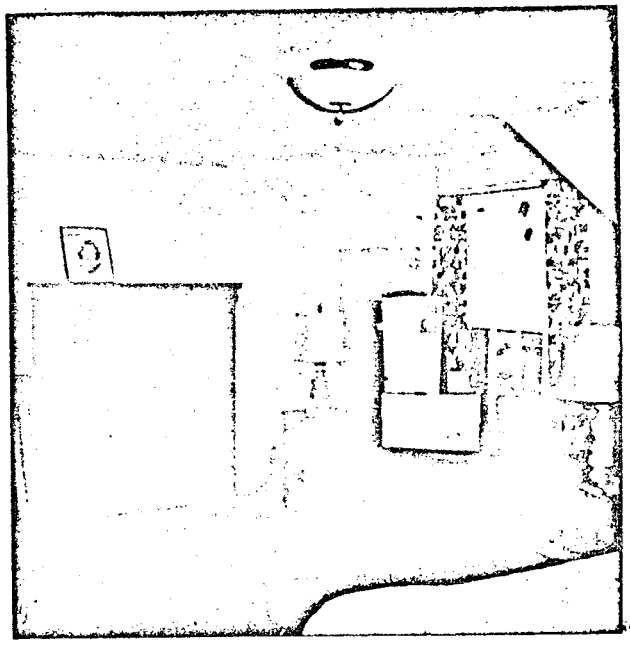
Recognizing that there may be some serious limitations on the reliability of the analytical procedure, the data, as obtained, support the following conclusions:

1. The three, fairly substantial consumer uses of asbestos-containing taping compound at this residence have resulted in a residual asbestos exposure of somewhat less than 0.01 fibers/cc longer than 5μ. It is questionable whether this is different from the natural background.

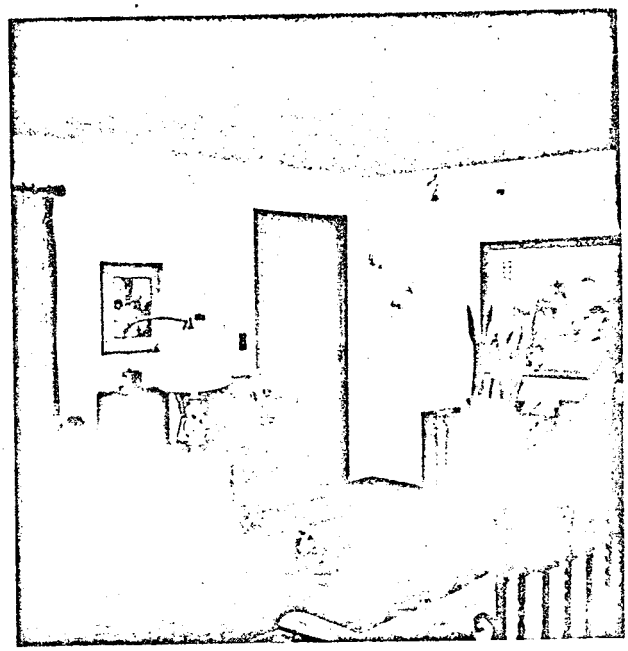
2. The combined spackling and drywall renovation operation tested gave a maximum, one-day time-weighted average operator exposure of about 0.3 fibers/cc longer than 5μ and a maximum ceiling exposure (10 minutes) of 0.5 fibers/cc >5μ. Considering the size of the area renovated these values are consistent with values of 1-4 fibers/cc >5μ that have been reported for commercial sanding operations where entire residences and apartments (including the ceiling) are sanded.

3. The values found are substantially below the current OSHA proposal of 5 fibers/cc ceiling and 0.5 fibers/cc TWA and the NIOSH proposal of 0.5 and 0.1 fibers/cc for daily occupational exposure for a full working lifetime.

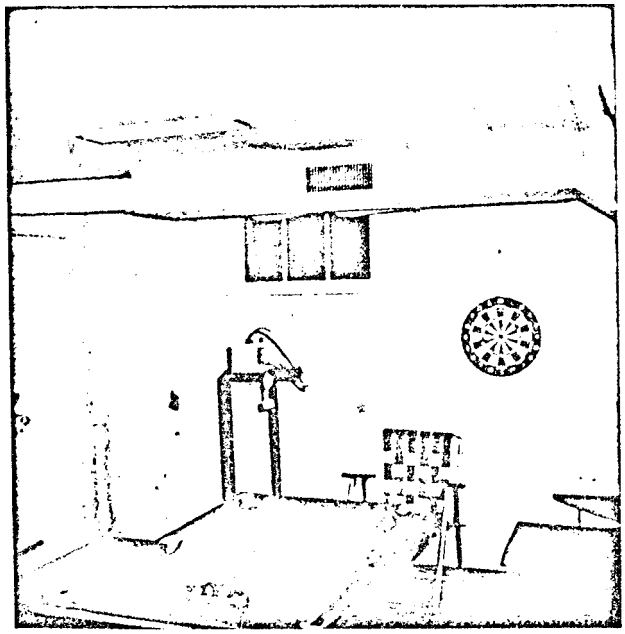
SAMPLE LOCATIONS - PRIOR TO TESTING



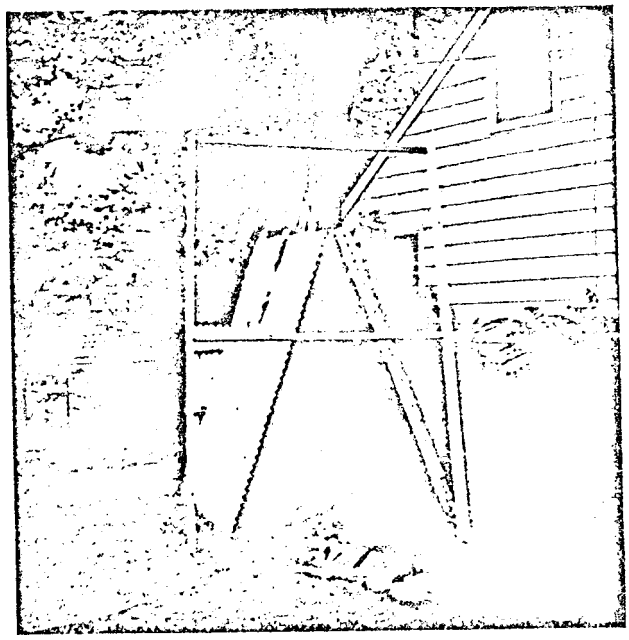
1 (a) Upstairs bedroom. Cracks to be patched are under the window(s) and in the ceiling above the window.



1 (b) 1st floor living room.



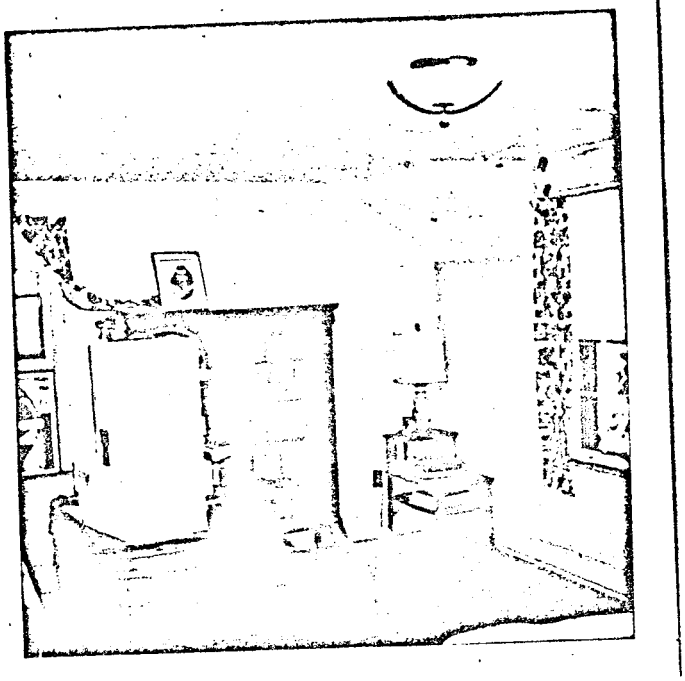
1 (c) Cellar recreation room. Wall to be replaced.



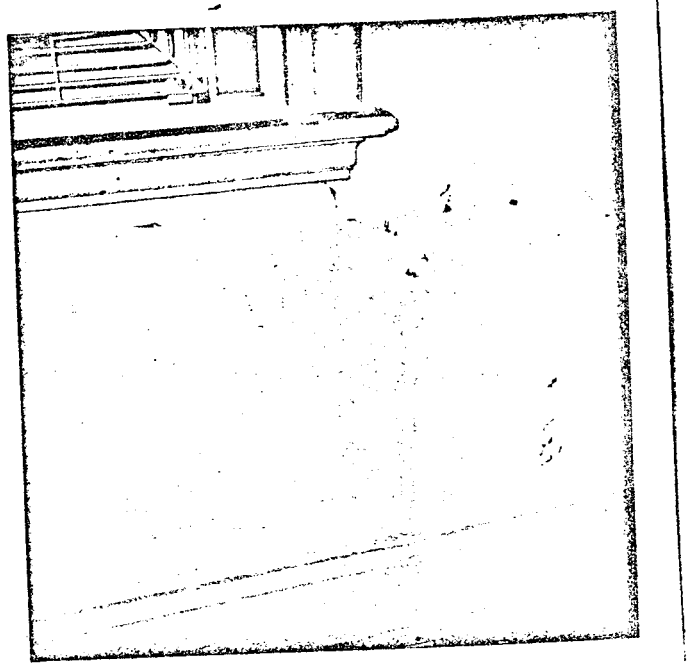
1 (d) Outdoor sample.

Figure 1.

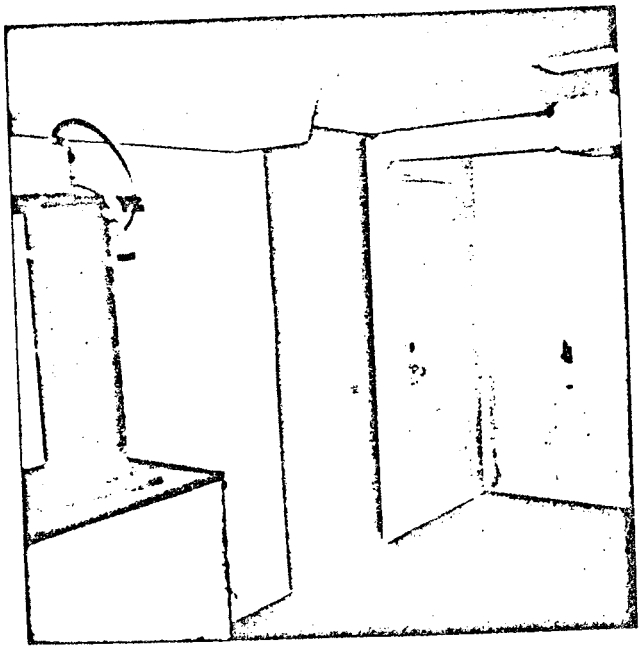
PREPARATION-SPACKLING AND DRYWALL INSTALLATION



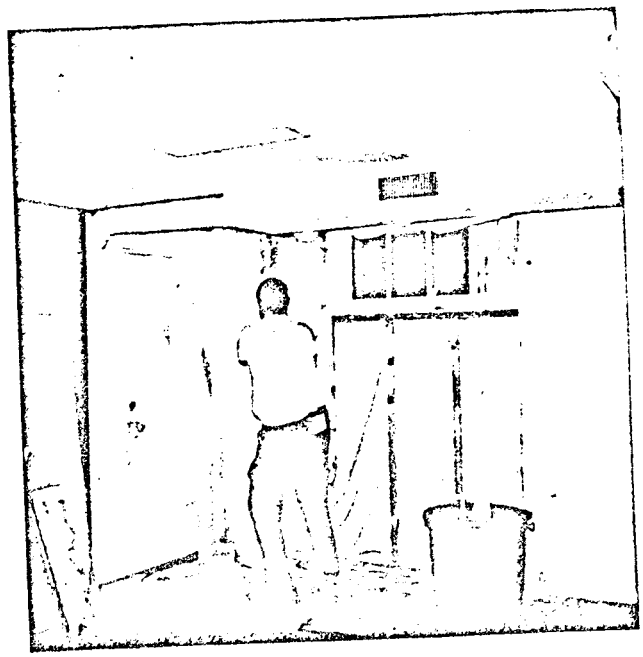
2 (a) Sample location for spackling operation



2 (b) Wall crack ready for application of spackling compound.



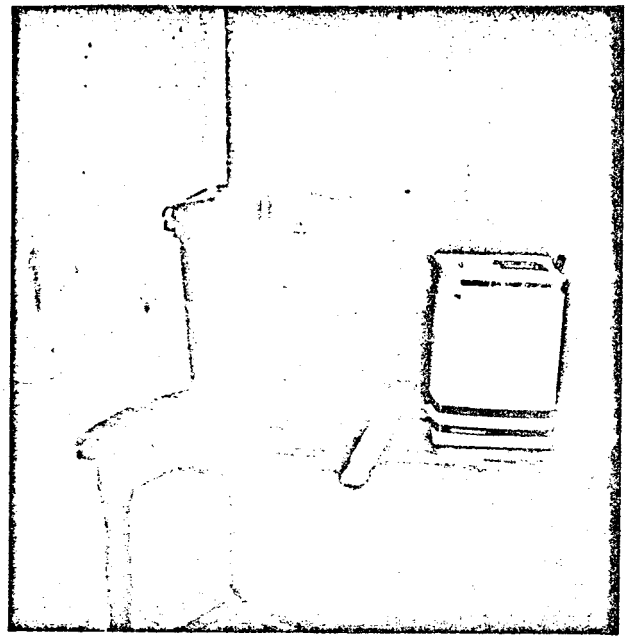
2 (c) Sample location for drywall replacement.



2 (d) Removal of old drywall.

Figure 2.

INSTALLATION OF SPACKLING AND DRYWALL



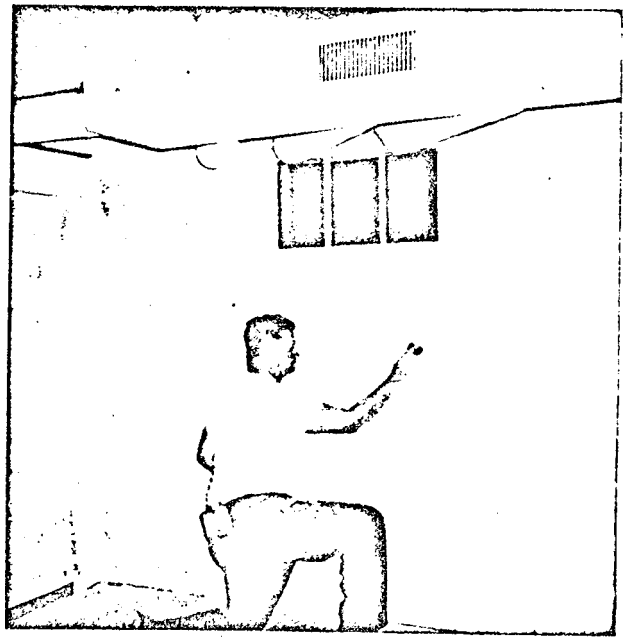
3 (a) Tape-joint compound used.



3 (b) Wet-out of compound.



3 (c) Operator hand sanding spackling.

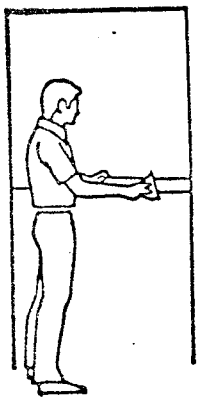


3 (d) Operator hand sanding drywall.

Figure 3.

DURABOND® WALLBOARD COMPOUND

Ready-to-mix powder



For treating joints
in interior
gypsum panels.

Drying-type formulation for
do-it-yourself application

UNITED STATES GYPSUM

DURABOND WALLBOARD COMPOUND

Ready-to-mix powder

DURABOND WALLBOARD COMPOUND

This all-purpose compound is designed for embedding tape, finishing joints and concealing nailheads in gypsum panel walls and ceilings. Also used to produce a light texture prior to painting.

This is a drying-type compound and should not be mixed with chemically hardening-type materials.

DIRECTIONS FOR USE

MIXING: Mix compound in a clean container, using 3 to 3½ pints tap water to 5 lbs. compound. Sift powder compound into water while stirring. Mix vigorously for about 3 min., or until powder is thoroughly wet. Allow to soak a few minutes, then re-mix to a smooth consistency. Adjust mix if necessary after second stirring by adding small amounts of water or compound. Additional water is required when compound is to be used as a texturing material. Mixture is then ready for use or may be held for several days. Do not intermix with other materials.

APPLICATION: Drive in nails, leaving dimple in surface paper of gypsum panels, to receive DURABOND Compound. Butter compound into channel formed by tapered edges of panels, filling fully and evenly. Center tape and force down into fresh compound. Leave sufficient compound under tape for proper bond. Remove excess. As soon as tape is embedded, cover with thin layer of compound. Apply first covering coat of compound over all nailheads.

After first coat is completely dry, apply second coat, feathering edges about 2 in. beyond channel edges. Second-coat nailheads. After second coat is dry, sand lightly. Apply a thin finishing coat to joints and nailheads. Feather joint edges an inch or two beyond second coat. Sand lightly when dry.

For texturing, use brush, roller or trowel for desired texture effect. May be painted when completely dry.

During cold-weather application, provide heat to maintain 55°F. min. temperature.

CAUTION: Contains asbestos fibers. Avoid creating dust. Breathing asbestos dust may cause serious bodily harm.

KEEP OUT OF THE REACH OF CHILDREN

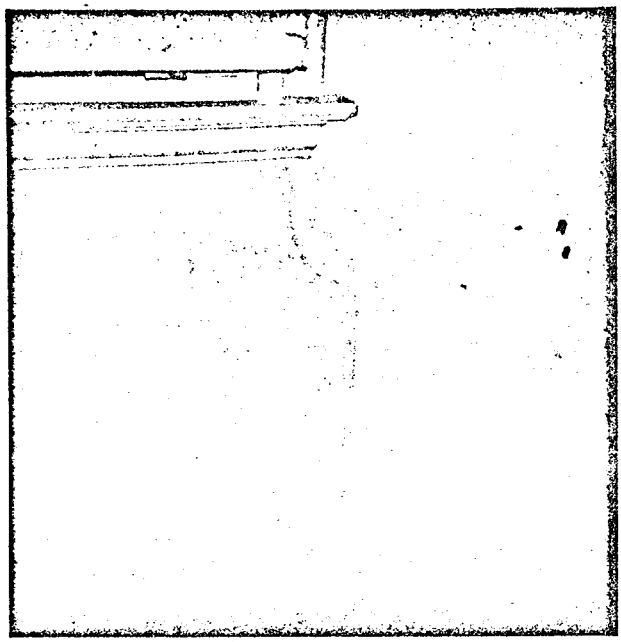
For warranty, disclaimer and notice requirements, read current U.S.G. Instructions and specifications, copies of which are free on request.

UNITED STATES GYPSUM

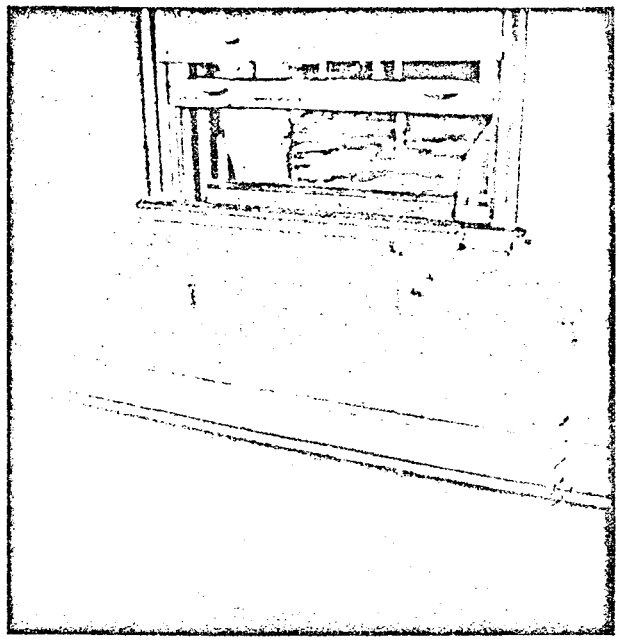
DURABOND WALLBOARD COMPOUND

Ready-to-mix powder

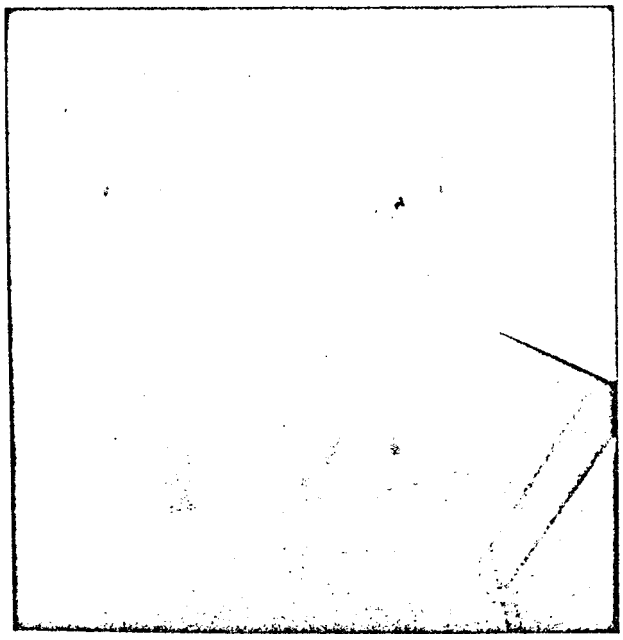
FINISHED SPACKLING AND DRYWALL



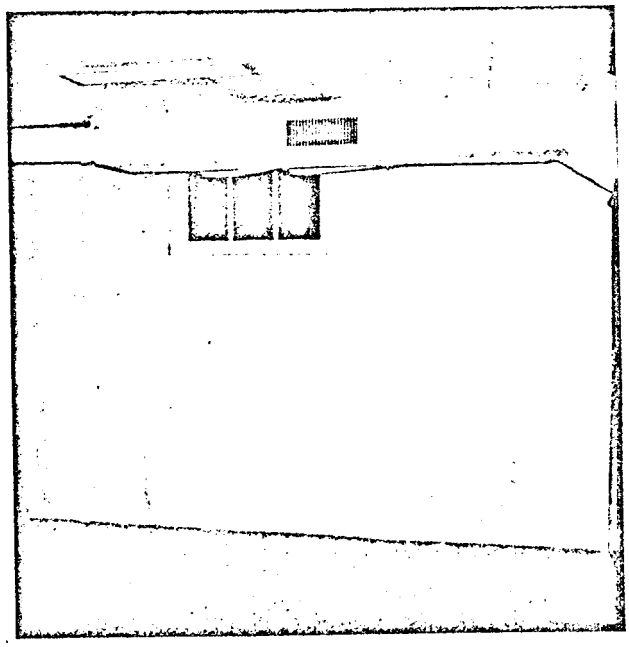
4 (a) Finished wall crack.



4 (b) Finished wall cracks.



4 (c) Finished ceiling cracks.

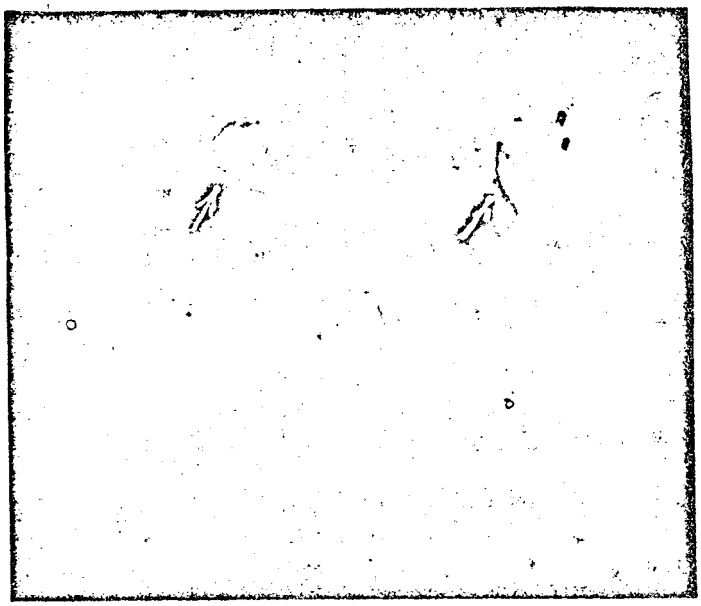


4 (d) Finished drywall installation.

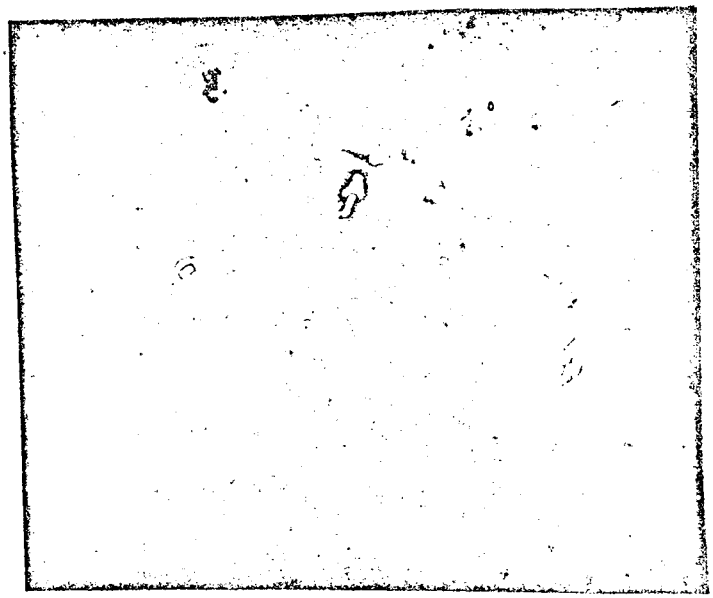
Figure 5

CHRYSOTILE, POSSIBLE AMPHIBOLE, NON-ASBESTOS "FIBERS"

(Phase Contrast Illumination, 400X)



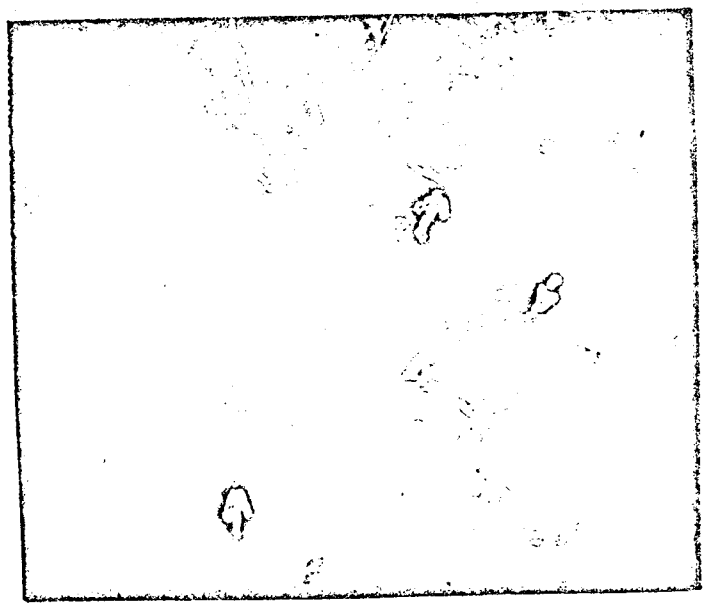
6 (a) Chrysotile Asbestos (M-22)



6 (b) Chrysotile Asbestos (M-22)



6 (c) Possible Amphibole (B-27)

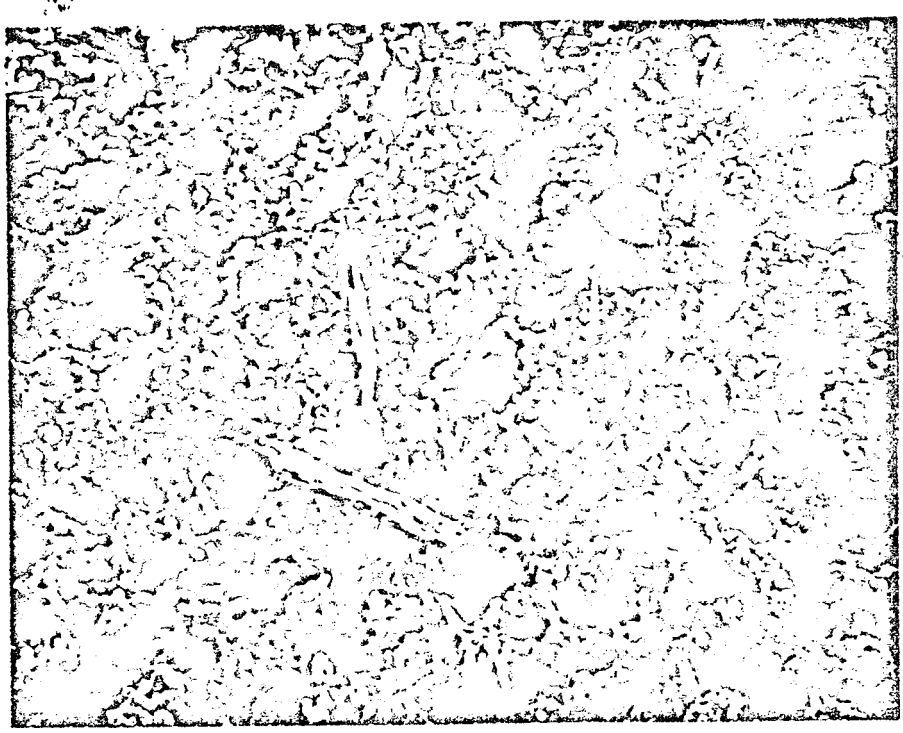


6 (d) Possible amphibole and non-asbestos "fibers" (B-27)

5μ

Figure 6

SCANNING ELECTRON MICROSCOPE
ANALYSIS ON MILLIPORE FILTER
(2000X)

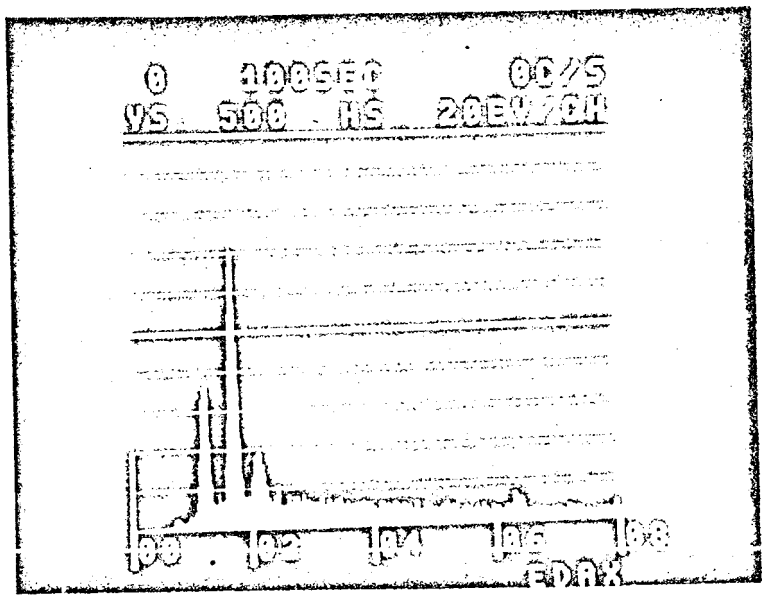


7 (a) Untreated Filter



7 (b) Treated Filter

Figure 7

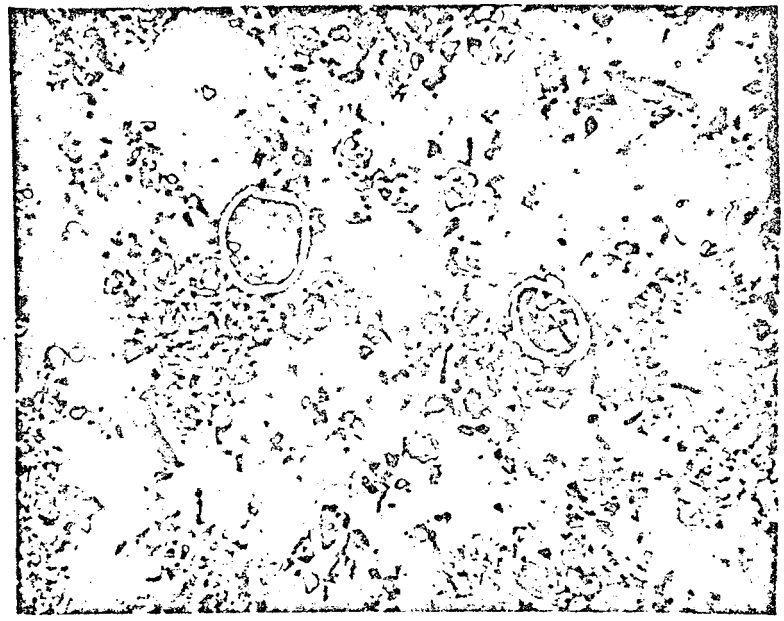


7 (c) Edax Read-out

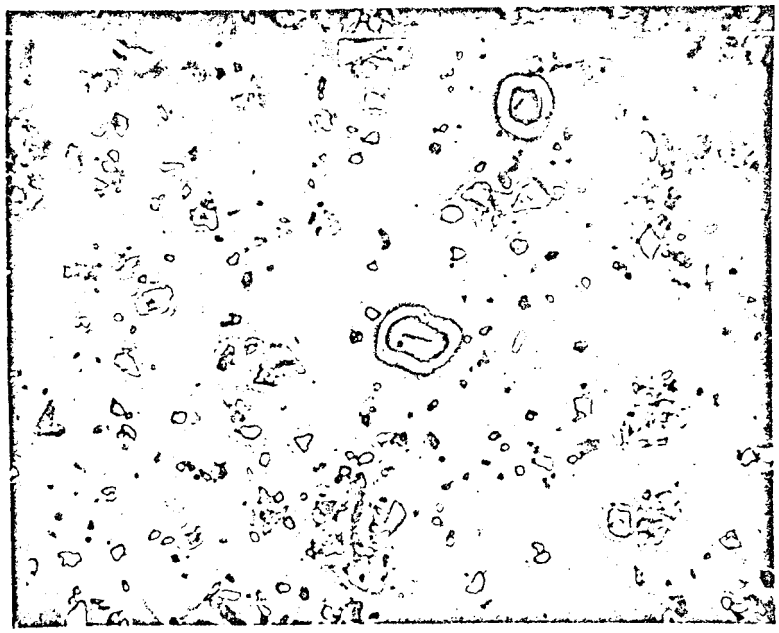
Figure 7

AIRBORNE FIBERS DURING DRYWALL REMOVAL
AND WET-OUT OF COMPOUND

(Phase Contrast Illumination 400X)



8 (a) Drywall Removal (M-24)



8 (b) Wet-out of Tape Joint Compound (M-30)

Figure 8

5μ

TABLE

SUMMARY OF AIRBORNE "F

CONSUMER SPACKLING AND

ACKGROUND PRIOR TO TEST (6/21/77)

ample No.	Date	Air Sample On	Air Sample Off	Air Sample Minutes	Description of Operation	No. of Fields Counted	No. of Filter Section Use
-32	6/21/77	11:07A	7:16P	489	Outdoors- about 4' in air. See Figure 1 (d).	500	2
-21	6/21	Blank	-	-	-	500	2
-25	6/21	12:58P	9:10P	492	Bedroom-~4' off floor, 3 1/2' from side wall, 9' from end wall. See Figure 1 (a).	200	1
-37	6/21	11:27A	7:27P	480	Living room-~4' off floor, 3 1/2' from side wall. See Figure 1 (b).	200	1
-23	6/21	10:55A	7:20P	505	Recreation room - Center about 4' off floor. See Figure 1 (c).	300	2
EPARATION AND INSTALLATION (6/22/77)							
24	6/22	9:00A 3:58P	2:48P 5:39P	429	Personal sample. Operator preparing cracks for spackling. Removing old drywall. Cleanup after three operations. Installation of drywall. Spackling and taping with "wet" compound. (Taping in same area as TJC wet out.)	100	1
30	6/22	3:38P	3:55P	17	Personal sample. Operator wetting out dry tape joint compound.	200	1
28	6/22	9:18A 4:10P	2:42P 5:48P	422	Bedroom- 8' from side wall. See Figure 2 (a). During preparation, cleanup, and spackling.	100	1
27	6/22	8:57A 4:09P	2:41P 5:45P	440	Living room - Same location as M-37. During various activities on other floors as noted.	100	1
36	6/22	9:10A 4:30P	2:40P 5:40P	400	Cellar- 4' from side wall. 12' from wall replaced. 4' from floor. See Figure 2 (b). During drywall removal.	100	1
18	6/22	3:38P	4:30P	70	Cellar- Same location as M-36. During wet out of TJC and immediately following.	200	1
NDING OF SECOND COAT AND APPLICATION OF FINISH COAT (6/24/77)							
26	6/24	7:10A	7:30A	20	Personal sample. Operator sanding spackling. Upstairs bedroom. Cleanup after sanding.	200	1
-35	6/24	7:11A	7:31A	20	Bedroom - During sanding and cleanup. Same location as M-28.	200	1
-27	6/24	7:32A	3:00P	448	Bedroom - After sanding and cleanup. Same location as M-28.	100	1
-29	6/24	7:10A	2:54P	464	Living room - During and after sanding and cleanup of spackling and application of finish coat.	100	1

R" CONCENTRATIONS
WALL INSTALLATION

Airborne "Fiber" Concentrations				
Chrysotile		Possible Amphibole "Fiber"		
Fibers/100 Fields	Fiber/cc >5μ	Fibers/100 Fields	Fiber/cc >5μ	Comments
1.9	0.003	1.1	0.002	
0.6	-	0.2	-	
6.5	0.009	1.25	0.001	
8.5	0.01	0.0	0.0	
4.8	0.006	0.6	0.001	
141	0.2	0.0	0.0	Too heavily loaded to count accurate Better than 1/6 of field obscured by particulate. Particulate in 5μ rang may not be chrysotile.
3.5	0.1	5.0	0.2	
14.0	0.02	4.5	0.08	
11.0	0.02	6	0.009	
167.5	0.3	4	0.007	Loaded with small particulate fibers, short but within 5μ range. Some evidence of asbestos.
3.0	0.03	4	0.04	
3.25	0.1	2.5	0.09	
6.0	0.2	2	0.07	
0.0	0.0	47.5	0.07	Geometric chunky material present. Al rod-shaped with light refractive inde
12.5	0.02	0	0.0	

-79	6/24	7:37A	8:50A	73	Personal sample. During sanding of drywall in cellar. Cleanup after sanding. Application of finish coat.	100	1
-22	6/24	7:37A	7:52A	15	Cellar - during sanding and cleanup. Same location as M-36.	300	1
-34	6/24	7:54A	2:55P	421	Cellar - after sanding and cleanup. Same location as M-36.	200	1
INAL SANDING AND CLEANUP (6/25/77)							
-66	6/25	12:43P	12:57P	14	Personal sample. Operator sanding spackling. Upstairs bedroom. Cleanup after sanding.	500	2
-60	6/25	12:42P	12:58P	16	Bedroom - during sanding and cleanup. Same location as M-28.	500	2
-68	6/25	12:59P	8:00P	421	Bedroom - after sanding and cleanup. Same location as M-28.	300	2
-64	6/25	12:15P	8:00P	465	Living room - During and after second sanding and cleanup.	300	2
-72	6/25	1:03P	1:36P	33	Personal sample. Operator sanding TJC in cellar. Cleanup after sanding.	500	2
-65	6/25	1:03P	1:37P	34	Cellar - During sanding and cleanup. Same location as M-36.	300	1
-12	6/25	1:45P	7:11P	326	Cellar - After sanding and cleanup. Same location as M-36.	500	2
-22	6/25	1:55P	2:05P	10	Personal sample. Handling of work clothes after sanding. Other clothes sorted and added to washing machine during most of period. (Operator #2)	200	1
-81	-	Blank	-	-	-	500	2
-97	7/9 & 7/10	10:30A 11:00A	7:25P 7:20P	1025	Outdoor sample. Same location as M-32.	500	2

8.0	0.08	2.0	0.02
3.5	0.2	0.6	0.03
6.25	0.01	2.5	0.004
1.9	0.09	0	0.0
0.5	0.02	0.5	0.02
4.6	0.007	0.6	0.001
4.3	0.006	1.0	0.001
1.3	0.03	0.4	0.008
3.5	0.07	0.06	0.01
1.0	0.002	0.6	0.001
6.75	0.5	0	0.03
0.8	-	0.0	-
0.6	-	0.4	-

TABLE II

AIRBORNE "FIBER" CONCENTRATIONS[1] BY LOCATION AND OPERATION DURING CONSUMER SPACKLING AND DRYWALL RENOVATION OPERATIONS

	Residual-Before Tests 6/21/77	Preparation of Job & First Installation of Compound 6/22/77		Second Application of Compound 6/23/77	Sanding of Compound Application of Finish Coat 6/24/77		Sanding of Finish Coat 6/25/77	
		Preparation, Clean up, Application	Wet-out of Compound[5]		During Sanding	After Sanding[5]	During Sanding	After Sandir
l-Floor Bedroom								
)ackling)								
Area Samples	0.009/0.001[2]	0.02/0.08	-	No samples taken.	0.2/0.07	0.0/0.07	0.02/0.02	0.007/0.001
Personal Samples	-	-	-		0.1/0.09	-	0.09/0.0	-
-Floor Living Room								
) repair work. :neral exposure.)								
Area Samples	0.01/0.0	0.02/0.009	-	"	← 0.02/0.0 →		← 0.006/0.001 →	
ent Recreation Room								
ywall removal id replacement.)								
Area Samples	0.006/0.001	0.3/0.007	0.03/0.04	"	0.2/0.03	0.01/0.004	0.07/0.01	0.002/0.001
Personal samples	-	0.2/0.0[3]	0.1/0.2		0.08/0.02	-	0.03/0.008	0.5/0.03[4]
)rs								
Area Samples	0.003/0.002	-	-			-	-	0.0004/0.000

All results expressed as fibers/cubic centimeter longer than 5 micrometers.

The first number given refers to chrysotile asbestos, the second to "possible amphibole", i.e., 0.009 fibers/cc >5μ of chrysotile and 0.001 fibers/cc >5μ of possible amphibole. See Section for discussion of these fiber categories.

Also includes spackling preparation, clean up, and application of compound.

During shake out of work clothes and placing in washing machine.

APPENDIX

Operations Log

6/21/77

Sampling for ~8 hours in bedroom, living room, and cellar.

6/22/77

9:30 a.m. - 10:05 a.m.	Preparation of wall and ceiling cracks in bedroom. Including clean up.
10:05 a.m. - 11:45 a.m.	Removal of cellar drywall.
11:45 a.m. - 12:00 Noon	Clean up after drywall removal.
12:00 Noon - 12:30 p.m.	Lunch (Pump running.)
12:30 p.m. - 3:38 p.m.	Fitting and nailing of drywall.
3:38 p.m. - 3:55 p.m.	Wet-out of drywall compound.
4:00 p.m. - 4:20 p.m.	Spackling upstairs bedroom.
4:20 p.m. - 5:40 p.m.	Fill cracks in wallboard. Apply tape, cover. Fill nail holes and corner joints.

6/23/77

7:45 a.m. - 9:00 a.m.	Apply second coat to cracks and to wallboard.

6/24/77

7:10 a.m. - 7:30 a.m.	Sanding and clean up of spackling in bedroom.
7:37 a.m. - 8:12 a.m.	Sanding and clean up of drywall in cellar.
8:12 a.m. - 8:53 a.m.	Finish coat of mud applied to drywall.
8:58 a.m. - 9:10 a.m.	Finish coat of mud applied to spackling in bedroom.

6/25/77

12:40 p.m. - 12:55 p.m.	Final sanding and clean up of spackling.
1:03 p.m. - 1:37 p.m.	Final sanding and clean up of wallboard.
1:55 p.m. - 2:05 p.m.	Clothes in washer. Job complete.

IN OPERATOR BREATHING ZONE

DURING WET-OUT OF DRY MATERIALS

AND

CLEANUP AFTER SANDING

