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AIRBORNE ASBESTOS FIBER COUNTS

during

CONSUMER INSTALLATION OF DRYWALL IN A LARGE ROOM

Dates Sampled: August 3-11, 1977
Date Reported: August 29, 1977

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SUMMARY AND CONCLUSIONS

Asbestos exposure during and after consumer installation of drywall for the finishing of a 12' x 24' basement recreation room was measured. Nineteen panels of wallboard, each 4' x 8', were required to cover three walls and the ceiling of this room. About 80 pounds of ready-mix taping compound, containing 1.75% by weight asbestos as manufactured and 2.6% by weight when dry, was used.

Personal and area samples were collected throughout the installation, using 0.8μ porosity Millipore filter and precalibrated MSA pumps. The filters were mounted and counted by optical phase contrast microscopy in accordance with the latest, March 30, 1977, draft of the NIOSH method (P&CAM 239).

The maximum ceiling exposure for any of the operators was 1.3 f/cc[1] which occurred during cleanup after sanding. Eight-hour, time-weighted average operator exposures ranged from 0.1 to 0.2 f/cc with an overall average of 0.2 f/cc.

General area exposure levels did not exceed 0.1 f/cc on an 8-hour, time-weighted average basis in the work area (cellar) or 0.02 f/cc in the living room. A general house survey on the day after the job was completed showed that all values were well below 0.01 f/cc and had not been changed appreciably by the present installation. It is questionable whether this is different from the ambient background.

(1) f/cc means asbestos fibers having an L/D $\geq$3, and $\geq$5 micrometers in length, per cubic centimeter of air.

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OBJECTIVES

This study had the following objectives:

1. To measure asbestos exposure during the consumer installation of 19 panels (4' x 8') of drywall.

2. To measure residual household exposure to asbestos after completion of the drywall installation.

TEST LOCATION AND GENERAL PROCEDURE

The tests were run at a one story, wood and brick, single family dwelling located in Lewiston, New York. The house was approximately 20 years old and accommodates ~2000 ft.^{2} of living area. The original construction utilized plaster walls and no known subsequent consumer or professional use of materials capable of releasing substantial quantities of free-form asbestos fiber had occurred.

In this test, studding was installed over three walls (east, south, and west) and the ceiling of a 12' x 24' basement recreation room. Nineteen 4' x 8' panels of 3/8" gypsum board were then fitted and nailed into place. The joints were finished by the following procedure:

1. Compound was hand trowelled over all of the joints and the tape was embedded and covered. The nail holes were filled in at the same time.

2. When the initial taping had dried, a second coat of compound was added and sanded when completely dry.

3. Following the sanding, a finish coat of compound was applied.

4. When completely dry, the finish coat was sanded.

About 1-1/2 cans (62.5 lbs. each) of compound (mud) were used in this installation. The mud was a ready-mix obtained from Florida Rolling Mills, Inc. of Ft. Lauderdale, Florida. It contained 1.75% asbestos by weight as received and dried to 2.6% by weight.

The drywall finishing was done by a couple whose previous experience with drywall had been limited to the patching of a single seam in a prior residence. They received intermittent instruction over a period of about 1-1/2 hours at the start of the taping from another consumer with limited experience, and completed the job on their own. The work was done in a manner that was considered to be reasonably representative of "middle-of-the-road" consumer use. All joints were sanded to give a good smooth finish. No specific precautions were taken to avoid dust during sanding and cleanup but deliberate efforts to create airborne dust were also not made.

The installation divided naturally into five steps and both area and personal air samples were collected to monitor any significant generation of airborne asbestos fiber as follows:

1. The completion of the studding, the hanging of drywall panels, and start of taping.

2. Completion of the taping and application of the second coat of compound. (No samples taken.)

3. First sanding, cleanup and application of the finish coat of compound.

4. Second sanding and cleanup.

5. Residual exposure after completion of installation.

SAMPLE COLLECTION AND FIBER COUNTING PROCEDURES

The latest draft of the NIOSH sample collection and counting procedure, P and CAM #239, dated March 30, 1977, was used as the general basis for this test. Samples were collected on Millipore filters of 0.8μ porosity using M.S.A. pumps precalibrated at 2 liters per minute.

The counting procedure specified in this draft 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 total count of ten 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 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 confernece 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 an "eye" and a counting rhythm, which permit 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-sized bundles and flexible hair-like threads with curvature. When chrysotile fibers are short, however, i.e., 5-10μ, they often appear as perfectly straight, dark rod-like particles.

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 diminished and the particle will appear darker and less definitive. At this size it cannot be distinguished from chrysotile fibers of similar dimensions.

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 $\geq$3, 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 nonfibrous 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 $\geq$3, L >5μ criteria.

1. Chrysotile asbestos - Any fiber having an L/D $\geq$3 and a length $\geq$5μ that is, in the operator's judgment, 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.

In this approach, all doubts are resolved in favor of including particles as chrysotile or amphibole so it is biased to give a high count for all possible "asbestos" particles without masking results by including

particulate that is neither asbestos nor fibrous. It is backed by counter experience gained in approximately 250 on-site sample collections and the counting of over 1500 filters. A photo library and a reference sample collection of a wide variety of known materials which contain amphibole or amphibole-like materials are maintained. It falls within the "other information" allowed in the NIOSH procedure.

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 0.24 - 0.36.

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 or a minimum of 500 fields were counted. Separate results for chrysotile and possible amphibole are reported at values rounded to the nearest significant figure. Fibers/100 fields and the total number of fields counted are also shown in all cases to provide more complete information.

PRESENTATION AND DISCUSSION OF RESULTS

A detailed listing of all samples taken including location, operation tested, collection time, and counting results is provided in Table I. In this section these airborne fiber counts will be related to the corresponding drywall installation step. The ceiling and eight-hour, time-weighted average exposures for the consumers involved are described.

Completion of Studding, Hanging Drywall, and Start of Taping (8/3/77, 8/4/77, 8/5/77)

Figures 1(b)(c) and 2 show various stages in the hanging of the 19 sheets of gypsum board. Seven of the 19 sheets used in the ceiling and four of the sheets used in the walls required cutting and trimming in varying amounts to achieve proper fit. Figires 3(a), (b), and (c) continue the job through the application of the tape and the second coat of compound over both the tape and the nail heads.

Area air samples were collected on 8/3/77 in the living room (see Figure 1(a) and the cellar (see Figures 1(b) and 1(c)) prior to the use of the mud. Personal samples were then collected on both operators during the start of the taping. An area and a personal sample were collected in the cellar on the following day (8/4/77) while a single operator completed the first installation of compound. No samples were taken on 8/5/77 when the second coat of compound was applied.

The fiber count results are summarized in Table I and include samples N-73, N-52, B-3, J-2, N-53, and N-70. The upstairs area sample showed a concentration of 0.004 f/cc prior to the use of the compound. The highest value found in the working area was 0.3 f/cc for Operator #1 during taping.

Both operators were in the area about 11-1/2 hours on 8/3/77 but time-weighted average (TWA) exposures have been based on 8 hours (480 minutes) in accordance with NIOSH procedures as follows:

Operator #1

$$TWA = \frac{(607)(0.08) + (87)(0.28)}{480} = 0.15 \text{ f/cc}$$

Operator #2

$$TWA = \frac{(607)(0.08) + (84)(0.108)}{480} = 0.12 \text{ f/cc}$$

The completion of the initial taping on 8/4/77 took Operator #2 a little over four hours. At that point he left the house. Both the personal and area samples during this step were 0.02 f/cc so that his actual TWA exposure would be:

$$TWA = \frac{(0.02)(252)}{480} = 0.01 \text{ f/cc}$$

If he had elected to remain the rest of the day in the work area in the cellar, his TWA would not have exceeded 0.02 f/cc.

No samples were taken while the second coat of compound was applied on 8/5/77. The completed job is shown in Figure 3(d). Note that the joints are covered with compound for a width of a foot or more.

First Sanding, Cleanup, and Application of Finish Coat of Compound, 8/6/77

After the second coat of compound was dry, the joints and the covered nail heads were hand sanded smooth using 150 grit paper mounted on a sanding block. This operation is shown in Figure 4(a), (b), and (c). After completion of sanding, the dust on the floor was swept into piles with a broom and transferred with a dust pan to a bag and deposited with the trash. The sweeping is shown in Figure 4(d). A finish coat of compound was then applied to all joints and nail heads.

Personal samples were collected in the breathing zone of both operators during the sanding and subsequent cleanup. Separate area samples were also obtained during sanding and during cleanup. Area samples were obtained in both rooms (cellar and first floor living room) for the remainder of the day during the installation of the finishing coat of compound.

Relevant samples here are N-76, N-89, B-14, N-94, B-18, N-75, N-71, B-30, B-31, and B-10 (Table I). Personal exposures during sanding ranged from 0.5 to 0.9 f/cc and were 0.7 and 1.3 f/cc for operators 2 and 3, respectively, during cleanup. The cellar area samples showed 0.2 f/cc during sanding, 0.7 f/cc during cleanup, and dropped to an average of 0.03 f/cc over the remainder of the day. The living room sample was 0.013 f/cc during the application of the compound.

Operator #2 was present in the house for about 5-1/2 hours. On this basis his actual 8-hour TWA exposure would be:

$$TWA = \frac{(44)(0.9) + (28)(0.52) + (12)(1.3) + (237)(0.033)}{480} = 0.162 \text{ f/cc}$$

If it is assumed he remained in the cellar at an exposure of 0.033 f/cc for the remainder of the day, the TWA would be 0.172 while the remainder of the day in the living room at 0.013 f/cc would yield 0.166 f/cc. It is realistic to round all these values to 0.2 f/cc.

In this same sequence, Operator #3 had 415 minutes accounted for and was largely in the upstairs area or out of the house for the 65 minutes needed to complete 8 hours. Using the 0.013 f/cc level found for the living room, a TWA of 0.19 f/cc results (round to 0.2 f/cc).

Second (Final) Sanding and Cleanup (8/10/77)

After the finish coat of compound was completely dry, it was sanded in the same manner as just described. This operation is shown in Figure 5 and the corresponding cleanup is shown in Figure 6. The large amount of dust generated is clearly evident. This cleanup differs from the previous one in that after the dust had been swept into piles, it was taken up with a shop vacuum cleaner instead of a dust pan.

The 17 samples relevant to this operation are too numerous to list individually but appear in Table I [SECOND SANDING AND CLEANUP (8/10/77)]. Personal samples during sanding ranged from 0.2 to 0.9 f/cc and a level of 1.2 f/cc was found during cleanup. This latter value is not significantly different from the 1.3 f/cc found in the previous cleanup.

The area samples in the cellar ranged from 0.1 to 0.5 f/cc during sanding and cleanup and dropped to an average of 0.04 f/cc for the remainder of the day. The living room showed a level of 0.02 f/cc throughout the entire day.

Operator #2 was present for about two hours during this operation. On this basis, his actual 8-hour TWA exposure would be 0.16 f/cc. If it is assumed he remained in the cellar or in the living room for the remainder of the day, his TWA's would be 0.19 and 0.17 f/cc, respectively. These all round off to 0.2 f/cc.

Operator #3 had 382 minutes of personal sampling accounted for and was in the general area of the living room for the remainder of the 8 hours. A TWA of 0.17 (round to 0.2) results.

Residual Exposure After Completion of Installation (8/11/77)

On the day following the completion of the drywall installation, the first floor rooms adjacent to the cellar entrance were cleaned with a household vacuum cleaner. A personal sample was obtained on the operator during the cleaning and area samples were taken for the remainder of the day in the living room, kitchen, stairwell to the cellar, and in the completed recreation room. The results are listed in Table I as samples A-72, A-76, Z-4, A-70, and P-56.

The results ranged from 0.001 to 0.006 f/cc and averaged 0.003 f/cc. Within the limitations of the method, this is not different from the value of 0.004 f/cc for sample N-73. It is also in the range of the general background exposure and the household is not being subjected to continued high exposure to asbestos as a result of this consumer drywall installation.

Summary of Results During Drywall Installation

The ceiling and eight-hour TWA values so far described for the operators during the various steps in the installation are summarized below. The corresponding TWA values for the cellar and the living room are also shown.

	8/3/77 Completion of Studding, Hanging Drywall Start Taping		8/4/77 Completion of Tape Installation		8/5/77 Second Coat of Compound	8/6/77 First Sanding, Cleanup Finish Coat of Compound		8/10/77 Sanding of Finish Coat Cleanup		8/11/77 House Cleanup After Installation	
	Ceiling[1]	TWA[1]	Ceiling	TWA	—	Ceiling	TWA	Ceiling	TWA	Ceiling	TWA
Personal					No Samples Taken						
Operator #1	0.3	0.2	-	-		-	-	-	-	-	-
Operator #2	0.1	0.1	0.02	0.01-0.02		1.3	0.2	0.9	0.2	-	-
Operator #3	-	-	-	-		0.7	0.2	1.2	0.2	0.004	0.004
Area											
Cellar (Work Area)	-	0.08	-	0.02		-	0.1	-	0.1	-	0.004
Living Room	-	0.004	-	-		-	0.01	-	0.02	-	0.006

(1) All results expressed as fibers/cc $\geq 5\mu$.

The highest ceiling exposure for any of the operators was 1.3 f/cc which occurred during cleanup. For the three days when asbestos-containing dust generating operations were in progress, the TWA's for the operators involved ranged from 0.1 to 0.2 f/cc and averaged 0.2 f/cc. The sanding and cleanup operations with two people working took 2-3 hours

The area TWA's in the cellar where the work was being done ranged from 0.08 to 0.1 f/cc during operations but was measured at 0.004 f/cc for the day after the installation was completed. The living room showed the highest value of only 0.02 f/cc during sanding but recorded only 0.004 f/cc before and 0.006 f/cc after the project. It is clear that there was no significant contamination of the rest of the house during the operation nor any residual contamination after it was completed.

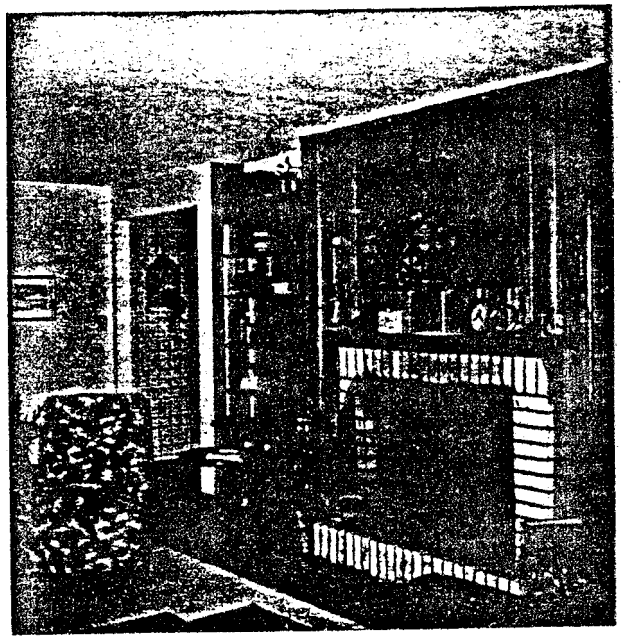
CONCLUSIONS

The data, as obtained and reported herein, support the following conclusions:

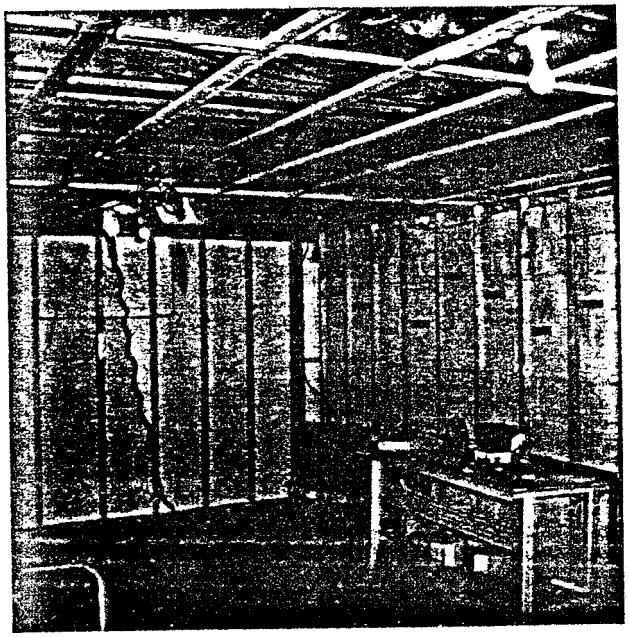
1. Consumer installation of full-room drywall panelling with tape-joint compound containing approximately 2.5% asbestos (dry weight) gives asbestos exposures substantially less than both the present OSHA standard of 10 f/cc ceiling and 2 f/cc for an eight-hour, time-weighted average and the proposed standard of 5 f/cc ceiling and 0.5 fibers TWA. These standards are designed to protect the worker for daily exposure for an entire working lifetime.

2. Household exposures after the installation were substantially below 0.01 f/cc and had not been changed appreciably by the present activities. It is questionable whether this is different from natural background.

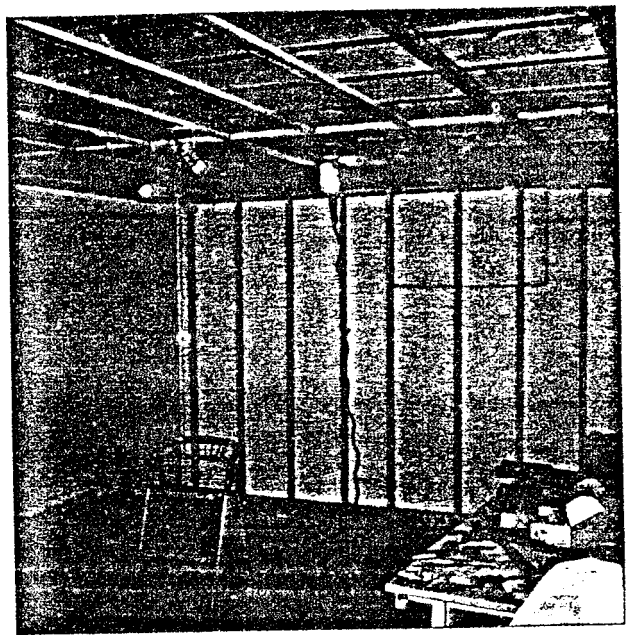
SAMPLE LOCATIONS - PRIOR TO DRYWALL INSTALLATION



1 (a) First Floor Living Room - Monitor Located over Fireplace mantle



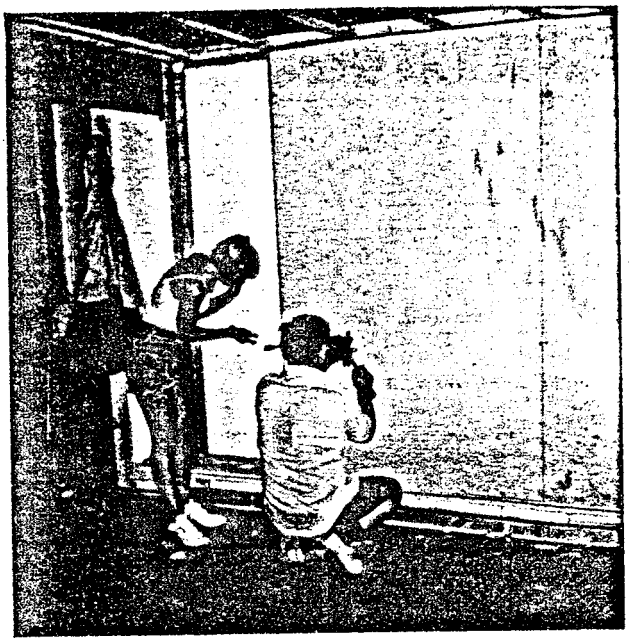
1 (b) Cellar Recreation Room with with studding in place. South and East walls



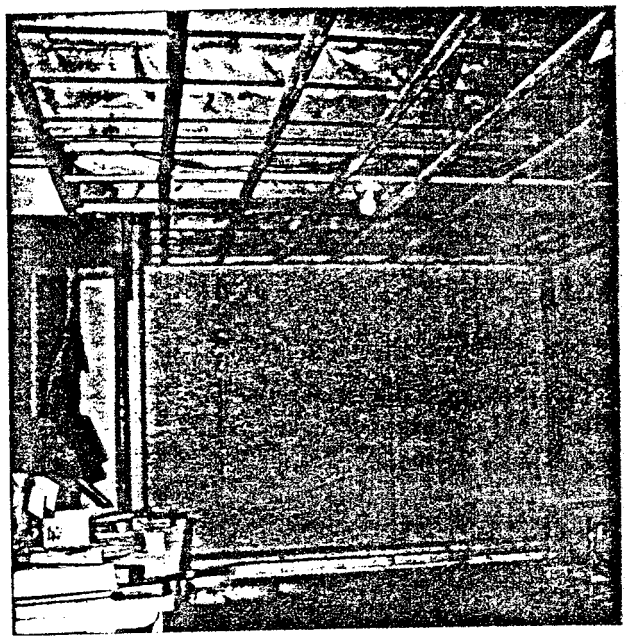
1 (c) Cellar Recreation Room with studding in place. North and East walls

FIGURE 1

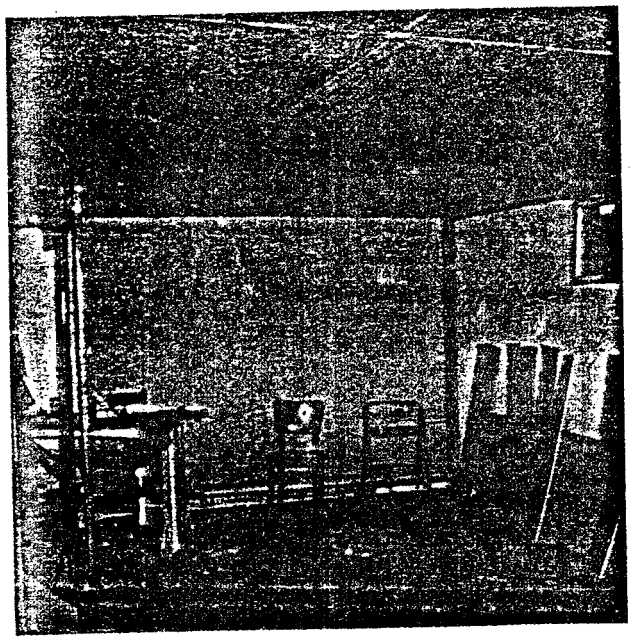
INSTALLATION OF DRYWALL PANELING



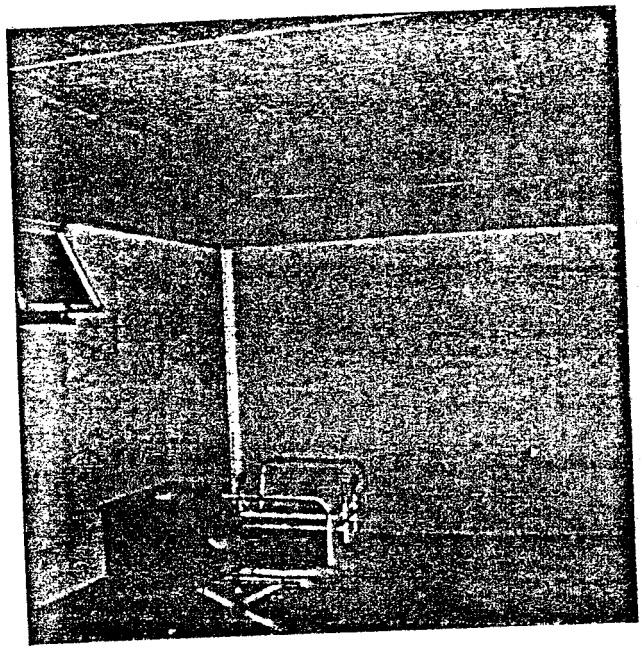
2 (a) Nailing Drywall to studding



2 (b) West wall of cellar



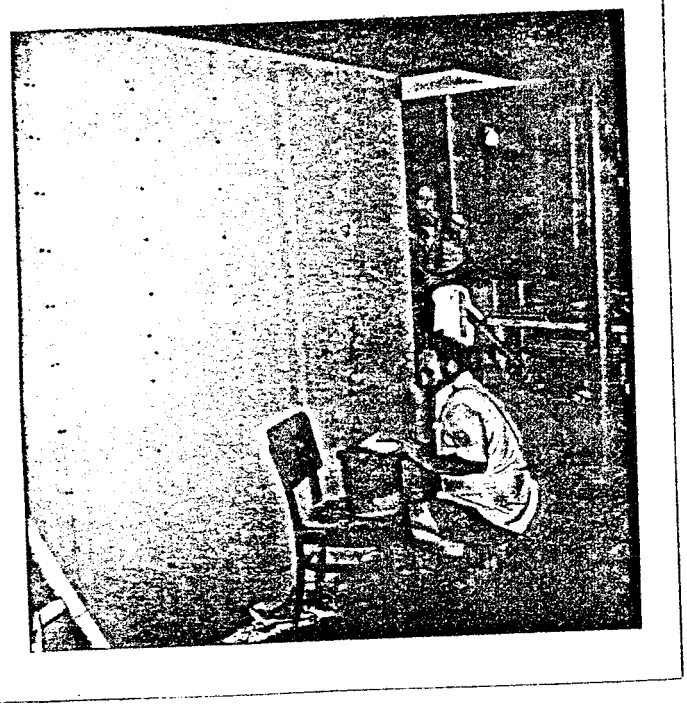
2 (c) West wall and ceiling



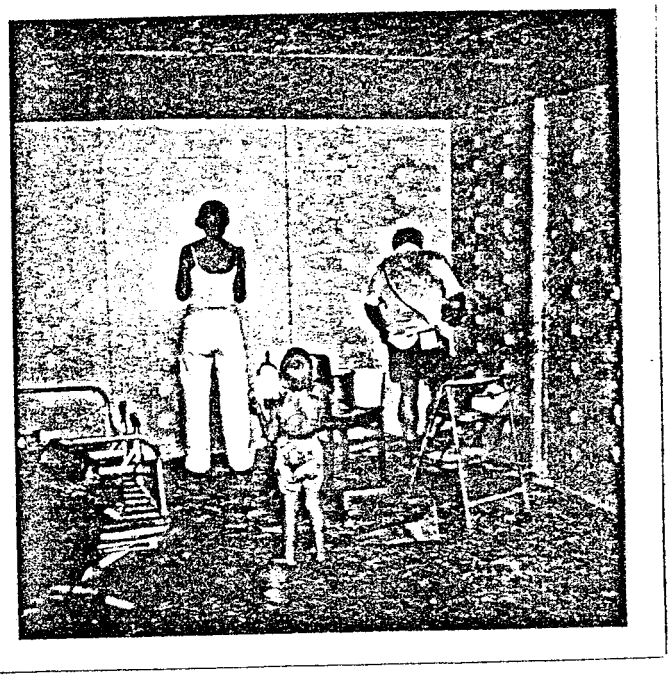
2 (d) East wall and ceiling

FIGURE 2

APPLICATION OF TAPE & JOINT COMPOUND



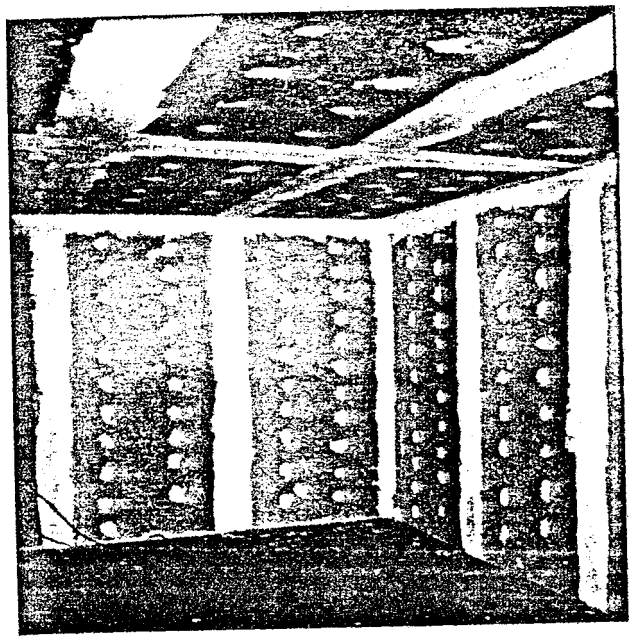
3 (a) Covering nail holes with tape joint compound



3 (b) Applying tape & joint compound between drywall seams



3 (c) Applying tape & joint compound to ceiling drywall



3 (d) After taping and second application of tape joint compound

FIGURE 3

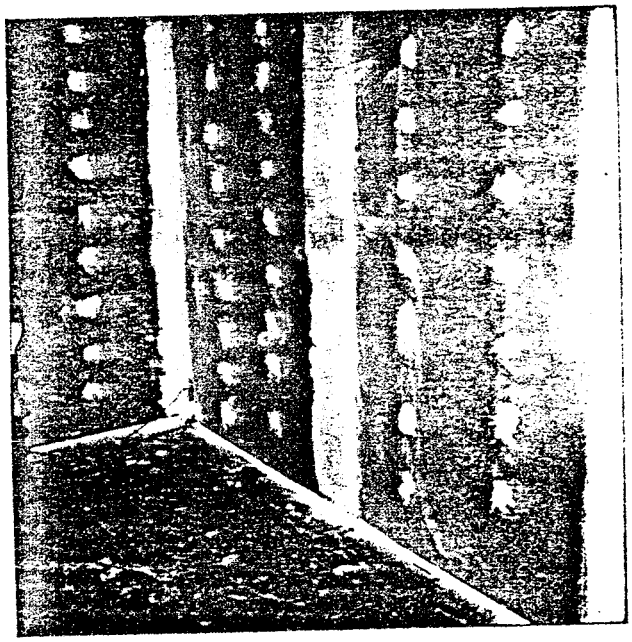
FIRST HAND-SANDING OF TAPE-JOINT COMPOUND



4 (a) Sanding wall tape-joints



4 (b) Sanding ceiling tape-joints



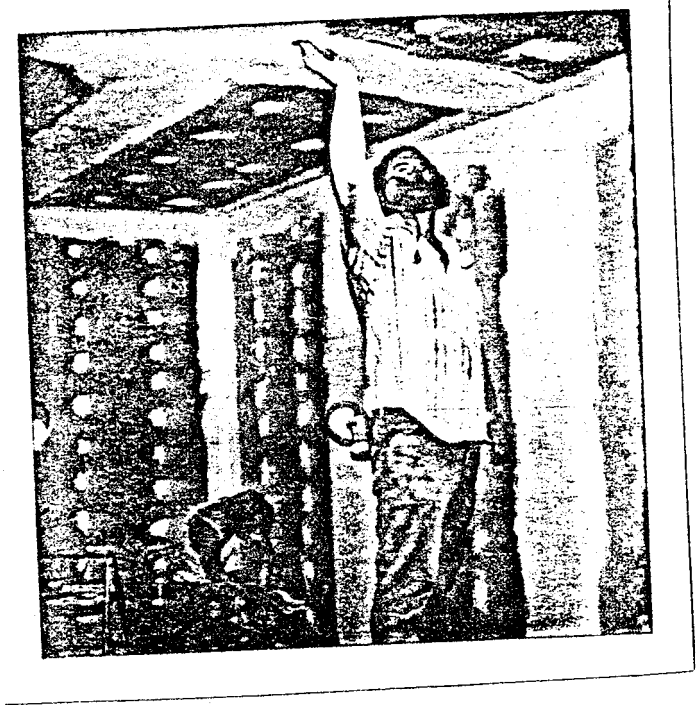
4 (c) Dust accumulation after initial sanding



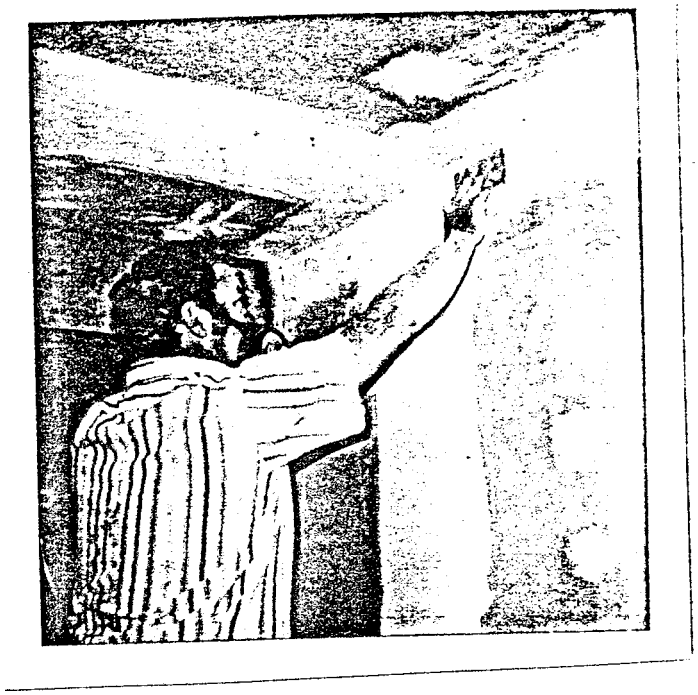
4 (d) Sweeping after first sanding.

FIGURE 4

SANDING OF FINISH COAT



5 (a) Sanding ceiling joints



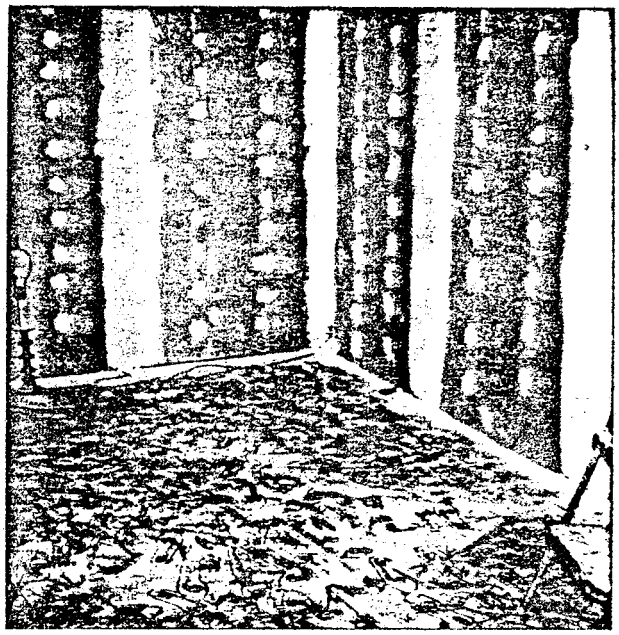
5 (b) Sanding wall and ceiling joints



5 (c) Sanding wall joints

FIGURE 5

CLEANUP AFTER FINAL SANDINGS



6 (a) Dust accumulation after final sanding



6.(b) Sweeping after final sanding



6 (c) Vacuuming after initial sweeping with broom

FIGURE 6

TABLE I

SUMMARY OF AIRBORNE FIBER CONCENTRATIONS
CONSUMER DRYWALL INSTALLATION

Sample No.	Date	Air Sample On	Air Sample Off	Air Sample Minutes	Description of Operation	No. of Fields Counted	No. of Filter Sections Used	Airborne Fiber Concentrations: Chrysotile Fibers/100 Fields	Chrysotile Fiber/cc >5μ	Possible Amphibole Fibers/100 Fields	Possible Amphibole Fiber/cc >5μ
COMPLETION OF STUDDING - HANGING DRYWALL - START OF TAPING (8/3/77)											
N-73	8/3/77	8:30A	6:30P	600	Area-Before handling compound. Located in living room 1st floor ~6' above floor on mantel of fireplace.	500	5	3	0.004	0	0
N-52	8/3	8:20A	6:27P	607	Area-Before handling of asbestos. Located in construction area ~6' above floor on north wall ~ center of room.	100	1	63.5	0.08	0	0
B-3	8/3	7:43P	9:10P	87	Personal (Operator #1) Taping joints with ready mix.	100	1	25.5	0.2	10.5	0.08
J-2	8/3	7:46P	9:10P	84	Personal (Operator #2) Taping joints with ready mix.	100	1	16	0.1	1	0.008
COMPLETION OF INSTALLATION AND COVERING OF TAPE (8/4/77)											
N-53	8/4	9:36A	1:48P	252	Personal (Operator #2) Taping joints with ready mix.	200	2	7.25	0.02	0	0
N-70	8/4	9:35A	1:48P	253	Area - During taping. Located ~6' above floor area near center of north cellar wall.	200	1	5.5	0.02	0	0
APPLICATION OF SECOND COAT OF COMPOUND (8/5/77)											
----- No air samples taken. ----											
FIRST SANDING CLEANUP AND APPLICATION OF FINISH COAT OF COMPOUND (8/6/77)											
N-76	8/6	10:00A	10:44A	44	Personal (Operator #2). Hand sanding. Tape joint compound.	100	1	53.5	0.8	6.5	0.1
N-89	8/6	11:00A	11:28A	28	Personal (Operator #2). Hand sanding. Tape joint compound	100	1	21.5	0.5	1	0.02
B-14	8/6	11:58A	12:10P	12	Personal (Operator #2). Sweep up after first sanding.	100	1	17.5	1.0	4.5	0.3
N-94	8/8	10:01A	10:47A	46	Personal (Operator #3). Hand sanding. Tape joint compound.	100	1	43	0.7	2.5	0.04
B-18	8/6	10:55A	11:29A	34	Personal (Operator #3). Hand sanding. Tape joint compound.	100	1	35	0.7	5	0.1
N-75	8/6	11:57A	12:11A	14	Personal (Operator #3). Sweeping up after first sanding.	100	1	15	0.7	0	0
N-71	8/6	9:59A	11:23P	84	Area. During first sanding of tape joint compound. Located ~6' above floor near center of north wall (cellar).	100	1	25.5	0.2	0	0
B-30	8/6	11:57A	12:12P	15	Area - During sweep up after first sanding Located ~6' above floor near center of north wall cellar.	100	1	14.5	0.7	0	0
B-31	8/6	12:39P	4:46P	237	Area. After sanding and sweep up. During final application of tape joint. Located near center of north wall (cellar).	100	1	10	0.03	1	0.003
B-10	8/6	12:23P	4:39P	256	Area. After sanding and sweep up. During final application of tape joint compound. Located first floor upstairs. Living room on mantle of fireplace.	300	3	8.5	0.01	2	0.003

TABLE I (CONTINUED)

SUMMARY OF AIRBORNE FIBER CONCENTRATIONS
CONSUMER DRYWALL INSTALLATION

SECOND SANDING AND CLEANUP (8/10/77)

Sample No.	Date	Air Sample On	Air Sample Off	Minutes	Description of Operation	No. of Fields Counted	No. of Filter Sections Used	Airborne Fiber Concentrations: Chrysotile Fibers/100 Fields	Chrysotile Fiber/cc >5μ	Possible Amphibole Fibers/100 Fields	Possible Amphibole Fiber/cc >5μ
B-17	8/10/77	9:27A	10:01A	34	Personal - Operator #2. Sanding TJC	100	1	22.5	0.5	2	0.04
N-86	8/10	10:02A	10:28A	26	Personal - Operator #2. Sanding	100	1	13.5	0.4	0	0
P-60	8/10	10:29A	10:46A	17	Personal - Operator #2. Sanding (ceiling).	100	1	23	0.9	1	0.04
N-4	8/10	10:48A	11:09A	21	Personal - Operator #2. Sanding (ceiling).	100	1	20.5	0.7	0	0
N-7	8/10	11:18A	11:43A	25	Personal - Operator #2. Sanding (ceiling).	100	1	22.5	0.6	0	0
B-8	8/10	9:25A	10:00A	35	Personal - Operator #3. Sanding	200	1	8	0.2	0	0
B-20	8/10	10:01A	10:30A	29	Personal - Operator #3. Sanding	200	1	8.75	0.2	0.5	0.01
P-65	8/10	10:31A	11:12A	41	Personal - Operator #3. Sanding	100	1	20	0.3	0	0
N-8	8/10	11:13A	11:43A	30	Personal - Operator #3. Sanding	100	1	23	0.5	0	0
N-10	8/10	11:52A	12:13P	21	Personal - Operator #3. During sweep up and vacuuming after sanding.	100	1	35.5	1.2	0.5	0.02
A-75	8/10	12:47P	4:33P	226	Personal - Operator #3. After final sanding and cleanup. Performing normal household duties including laundering of work clothes used during taping and sanding.	100	1	17	0.05	0	0
N-85	8/10	9:24A	12:18P	174	Area. During second sanding and cleanup. Located first floor living room ~6' above floor on mantle of fireplace.	300	3	11	0.02	0	0
N-55	8/10	9:27A	10:15A	48	Area. During second sanding of TJC. Located ~6' above floor near center of north wall cellar.	200	2	9.75	0.1	0.5	0.007
A-74	8/10	10:17A	11:44A	87	Area. During second sanding of TJC. Located ~6' above floor near center of north wall cellar.	100	1	29	0.2	2	0.02
N-6	8/10	11:52A	12:14P	22	Area. During sweep up and vacuuming after sanding. Located ~6' above floor on north wall.	100	1	15.5	0.5	0	0
A-77	8/10	12:19P	5:58P	339	Area. After final sanding and cleanup. Located first floor living room ~6' above floor on mantel of fireplace.	100	1	10.5	0.02	0	0
A-71	8/10	12:17P	5:59P	342	Area. After final sanding and cleanup. Located ~6' above floor in north wall of cellar.	100	1	18	0.04	0	0
RESIDUAL EXPOSURE AFTER COMPLETION OF INSTALLATION (8/11/77)											
A-72	8/11/77	8:53A	9:10A	17	Personal (Operator #3). Vacuuming first floor living room, kitchen and den after final sanding and cleanup.	500	4	0.1	0.004	0	0
A-76	8/11	9:12A	5:00P	468	Area. Day following completion of work in basement. Located in kitchen area ~6' above floor.	500	3	0.8	0.001	0	0
Z-4	8/11	9:13A	5:00P	467	Area. Day following completion of work in basement. Located on mantle of fireplace ~6' above floor.	500	4	3.7	0.006	0	0
A-70	8/11	8:45P	5:01P	496	Area. Day following completion of work in basement. Located in stairway of cellar ~7' above cellar floor.	500	3	1.0	0.001	0	0
P-56	8/11	8:42P	5:01P	499	Area. Day following completion of work in basement. Located on north wall of	500	4	2.6	0.004	0	0