BD

CONSUMER "SAFETY" IN PLASTICS SYSTEMS CONTAINING BOUND ASBESTOS FIBERS

Harrison B. Rhodes, Dr. Eng. Sci.
Technology Manager
"Calidria" Asbestos

Paper presented at the Society of Plastics Engineers NATEC Meeting, Denver, Colorado, November 8-10, 1977.

UNION CARBIDE CORPORATION
Metals Division
Niagara Falls, New York
November 9, 1977

ABSTRACT

Asbestos consumption in the United States in 1976 was 726,000 tons, mostly chrysotile. Of this total, 65% was used in a wide variety of plastics-based materials. Extensive airborne asbestos exposure data are presented for tape joint compounds, roofing products, and coatings. The highest consumer exposure found was 1.2 fibers/cc ceiling and only several tenths of a fiber/cc on a time-weighted average basis. A risk estimation procedure devised by the Consumer Product Safety Commission was used to calculate the risk to the consumer from these highest levels measured,which occurred during drywall installation. The risk was found to be only very slightly different from zero, but the CPSC is moving to ban asbestos in this application on the basis of a regulatory philosophy of "no safe level for a carcinogen" and "absolute zero risk" as an appropriate regulatory policy. The consequences of this regulatory approach are discussed and an alternative is proposed.

TABLE OF CONTENTS

INTRODUCTION

In view of the wide publicity that has been given to the health hazards of asbestos, both real and imagined, over the past ten years, it may come as a surprise to many that asbestos is still in wide use, and more of a surprise that anyone is willing to write about it. In fact, over 700,000 tons of asbestos are used annually and much of it is in various plastics-based systems. This paper will touch briefly on the kinds of plastics products which contain asbestos and the quantities of asbestos used in these products. Results of airborne asbestos fiber measurements during the use of a wide variety of asbestos-containing plastics materials will be presented. The data are mostly for commercial operations but substantial consumer-use information is provided for one product. A risk assessment procedure currently favored by the Consumer Product Safety Commission will be used to calculate the consumer risk from the exposure levels found. This risk will be related to the current governmental regulatory Philosophies. The consequences of these philosophies are discussed, and a rational approach to the overall problem is suggested.

ASBESTOS USE IN THE UNITED STATES

As shown in Table 1[1], about 726,000 tons of asbestos, mostly chrysotile, were used in this country in 1976. Of this, approximately 125,000 tons were from domestic production, largely from California and Vermont, and the remainder was imported, primarily from Canada. If the term "plastics" is defined broadly to include naturally occurring tars, resins, and other materials that cure to a permanent set, as well as the usual synthetics, a total of 472,000 tons of asbestos, or 65% of the annual consumption, is associated with "plastics" of one kind or another. The product areas that make up this total are indicated by arrows on Table I. The largest use, 253,600 tons, is in roofing products, largely asphaltic-based, but some epoxy is used in the high-performance products.

A0025

Included in this group are emulsified coatings, trowelable patching compounds, and some tar papers. The next largest application is 113,500 tons in flooring products, including both vinyl asbestos tile and sheet vinyl flooring. This is followed by friction products at 63,800 tons, used primarily in phenolic-based materials for automotive and railroad brakes and for clutch facings. The list concludes with the Plastics and Coatings and Compounds categories at about 20,000 tons each. These include a wide variety of products such as the familiar phenolic-based electrical fixtures, anthophyllite-filled polypropylene for heat-sensitive applications, maintenance coatings, block coatings, foundation coatings, automotive undercoatings and sound deadeners, caulks, sealants, adhesives, tape-joint compounds, and so forth. It is clear that there continues to be a very substantial involvement of asbestos with plastics and that about half of it is with the familiar vinyl, phenolic, alkyd, and epoxy resins.

The specific reasons for the inclusion of asbestos in each of these product types varies but is generally related to several of the important properties of this material. Asbestos is inert, "fireproof" or heat resistant, and imparts strength and dimensional stability to plastics both at ambient conditions and when subjected to high temperatures. These properties are particularly important for friction products. The strength plus resistance to mildew, rot, and weathering are important for roofing and flooring materials. When used in small quantities in liquid systems, asbestos has a profound effect on rheological properties. It makes the materials sprayable or pumpable but sag resistant after application. Examples of this include flow control of paints and coatings, trowel workability of tape-joint compounds, and the flow of caulks and sealants during application. The fact that asbestos is in wide use after six years of stringent regulations and tremendous adverse publicity

A0025[illegible]

attests to its value and to the difficulty of finding suitable replacements which are safe and/or not regulated.

AIRBORNE ASBESTOS EXPOSURE - PLASTICS PRODUCTS

The Union Carbide Corporation, in 1963, initiated commercial mining and milling of a short fiber asbestos from a unique deposit in central California. This material is sold only as fiber and no asbestos-containing products are manufactured. In the "plastics" applications categorized previously in Table I, this asbestos is used in flooring products, roofing products, in a variety of coatings, in compounds and in some plastics. It is not used in friction products.

Monitoring has been conducted at the asbestos plant since 1963; and, in 1972, the Corporation initiated an asbestos dust monitoring service to assist the product users to provide a safe and healthful workplace for their employees and to comply with the applicable governmental regulations. The data to be presented here were obtained as part of this program. Unless otherwise noted, all of the samples were collected under field conditions during normal and routine operations.

Sample Collecting and Counting Procedure

Sample collection and fiber counting were carried out in accordance with the prescribed NIOSH procedure[2] in effect at the time of collection. Since this procedure is described in detail by NIOSH, it is only necessary to touch on it briefly. Samples were collected on 37 mm. Millipore AA filters (0.8μ porosity) with small MSA battery-driven vacuum pumps. Figure 1 shows two consumers wearing pumps and filters. The filter cassette is attached in the collar area of the worker so that it is suspended facing downward in his

A0025

breathing zone. The pump draws the dust-laden air through the filter and dust is deposited on the filter paper. Only data from such personal samples are reported.

For fiber counting, a pie-shaped wedge is cut from the filter, mounted on a slide with the prescribed clearing solution, and the fibers are counted at 400X with a Nikon microscope with Huygenian eyepieces. A Porton reticle is used for field definition.

The NIOSH procedure was originally developed to measure airborne dust concentrations where asbestos was the principle constituent. The ability of this procedure to distinguish between asbestos and other particulates of the prescribed dimensions is quite limited and well recognized[3]. This lack of definition presents particular problems in the present study. Many of the samples were generated by spraying or by abrasion of plastics materials containing other mineral ingredients besides asbestos: fiberglass, mica, various clays, fibrous talc, mineral wool, etc.

The NIOSH procedure permits the use of "other information" to avoid counting non-asbestos fibers but does not specify the nature of such information or how it is to be used. The Union Carbide laboratory collects bulk samples of known materials wherever practicable and maintains a "library" of reference samples and photographs. Scanning electron microscopy is also used to a limited extent. All fibrous particles meeting the NIOSH criteria of length greater than 5μ and aspect ratio greater than 3 are counted as asbestos fibers unless an experienced counter can recognize them with a high level of confidence as not being asbestos. This criterion was used for all of the Union Carbide data reported herein.

A00257

Asbestos Exposure - Tape-Joint Compounds

The largest body of asbestos exposure data available is for the installation of drywall with tape-joint compound. The drywall system consists of gypsum board, usually 4 feet long and 8 feet wide, manufactured with a small beveled depression about 4-inches wide on the long edges of the sides to be finished. For installation, the boards are first nailed to the studding, compound or "mud" is applied to the joints, and paper tape about 2" wide is buried in the mud. The nail holes on other parts of the board are also filled with compound. After the initial coat is dry, a second coat is applied. When this is dry it is sanded, generally lightly to remove high spots and a finish coat of mud is applied. After drying this is sanded if a smooth wall finish is desired, or left "as is" if the wall is to be textured.

The taping compound or mud is made up primarily of finely-ground limestone with lesser amounts of mica, clay, and asbestos. A representative formulation for ready-mix is shown below. The asbestos content typically ranges from 2 - 5% by weight on a dry basis. The binder is vinyl-acetate latex, starch, casein, or polyvinyl alcohol. The compound is available as a dry powder which must be added to water at the time of use, or as a ready-mix which can be used with no preparation.

COMPOSITION OF TYPICAL READY-MIX TJC

INGREDIENT	PERCENT BY WEIGHT	
	WET BASIS	DRY BASIS
WATER	31	--
LIMESTONE	41	60
MICA (AND CLAY)	16	23
BINDER	7	10
ASBESTOS	3	4
MISCELLANEOUS	2	3
	100	100

The potential for exposure to airborne asbestos fiber exists during the wet-out of the dry compound when it is used and during sanding and clean-up for both types. Exposure data for professional and consumer operations are available from a variety of sources.

The first published information on commercial use was that of Rohl et al[4], where a test was conducted at a location in New York City using professional installers. These results are summarized in Table II. A more extensive study was conducted in late 1975 by Rhodes and Ingalls[5] with the cooperation of the Gypsum Drywall Contractors International. Here a variety of routine commercial sanding operations were sampled in six states. Results are shown in Table III. Additional commercial sanding, wet-out, and clean-up data from State and Federal OSHA compliance inspections have been compiled by Equitable Environment Health Inc.[6] as part of an industry-sponsored study of asbestos exposure in the construction industry. The compliance data and data from one short survey conducted by EEH are summarized in Tables IV and V.

Consumer use data are limited to two studies recently conducted by Union Carbide Corporation. In one case, extensive spackling was carried out in one room and a 7' x11' section of dry wall was removed and replaced in a second room located two floors away. In the other, drywall was installed to cover three walls and the ceiling in a 12' x 22' basement recreation room. In both cases the three-coat installation procedures described previously and recommended by the manufacturers of the compound were followed. A complete listing of samples and results for these two studies are provided in Tables VI and VII.

In order to visualize this rather extensive compilation of data, the range of airborne fiber concentrations measured for each basic operation at each location, together with the corresponding arithmetic mean, have been

A0025

shown graphically in Figures 2 and 3. Figure 2 gives the airborne asbestos fiber concentrations measured during the actual sanding operations. The commercial operations are on the left, and the consumer uses on the far right. The type of sanding, i.e, hand or pole, and the number of samples included in the average are indicated along the horizontal axis.

The data on the far left are those of Rohl et al[4]. Their results range basically from about 1 to 20 fibers/cc >5μ with averages of 10.0 and 5.3 fibers/cc >5μ for pole and hand sanding, respectively.

The next group of results are those obtained by Union Carbide in the survey of commercial operations in six different cities.

Results range from about 0.2 to about 4 fibers/cc. The range found corresponds reasonably with the intensity of sanding, the room size and ventilation conditions, and the number of men operating in the same room. This reference also includes measurement of respirable dust and crystalline silica, which follow the same patterns as the asbestos, and may be of general interest.

The OSHA compliance and Equitable Environmental Health[6] data are shown next. These fiber concentrations fall in the same range as the results just discussed.

The consumer-use data are shown on the far right. The first case is for the extensive spackling and the installation of three panels of drywall. The second is for the three walls and the ceiling of a large basement recreation room. This latter mud contained 2.6% asbestos by weight on a dry basis. Exposures in these tests were only 0.2 to 1.2 fibers/cc >5μ, which correspond roughly to the lower end of the range found for commercial use.

Data for the two other operations in tape-joint installation which present the possibility of exposure to free-form asbestos fiber, i.e, the addition of the dry powder compound to water and the cleanup after sanding, are shown in Figure 3.

Here, in order to get the Rohl et al data on the graph, it was necessary to run the scale from zero to sixty rather than from zero to twenty as in the previous Figure. Otherwise, the graph follows the same format and shows a very similar pattern. The Rohl et al[4] data are far higher than the OSHA results, and the consumer values are below or in the lower end of the range found for commercial use.

When the large differences between the Rohl and Union Carbide studies first became apparent, filters from three of the Union Carbide locations were counted "blind" by two other laboratories. The results shown in the next table demonstrate that the differences were not due to improper counting by the authors of that work.

INTERLABORATORY COMPARISON
ASBESTOS FIBER COUNTS[5]

Sample Source		Airborne Asbestos Fiber Concentration (Fibers/cc longer than 5µm) By UCC	By Lab A	By Lab B
Location I	(Filter #1)	0.4	0.3	0.2
"	(Filter #2)	0.4	0.0	0.2
Location II	(Filter #1)	1.5	1.0	1.6
"	(Filter #2)	1.3	1.0	0.6
Location III	(Filter #1)	0.6	0.0	0.9
"	(Filter #2)	0.4	0.2	0.2

Unfortunately, Rohl provides no details on the nature of the operation sampled, i.e., whether it was run as a specific test or as the sampling of a routine commercial installation, the asbestos content of the mud, the number of men sanding in a room, the size of the room or rooms sanded, or the presence or lack of ventilation. There is no way to evaluate the influence of the specific test conditions on the results reported or to determine how they may relate to other commercial operations. The tests also appear to cover a total sanding time of no more than 15 minutes for pole sanding and about the same time for hand sanding. It can be questioned whether this is a representative sample of commercial operations but there is insufficient information to really explain the differences.

The concentrations just described were obtained during the actual dust-generating operations. In virtually all cases, even the commercial operators do not engage in these operations for a full shift so that the 8-hour time-weighted average will be considerably less than the exposure while dust is being generated. Values for the sanding conditions in the study by Rhodes and Ingalls[5] and the 8-hour time-weighted averages are shown in the following table. The results ranged from 0.1 f/cc >5μ to the highest value of 0.9 f/cc >5μ.

SUMMARY OF AIRBORNE ASBESTOS

FIBER CONCENTRATIONS DURING DRYWALL SANDING[5]

Location	Ceiling Exposure (Fibers/cc >5μm)	Exposure Time During Sanding (Hours)	Estimated 8-Hour TWA Exposure (Fibers/cc >5μm)
New York City, NY	0.4	8.0	0.3
Hialeah, FL	1.0	4.0	0.4
Ft. Lauderdale, FL (Hand)	1.1	1.0	0.1
Detroit, MI	1.3	8.0	0.9
Dallas, TX	1.8	0.5	0.1
Ft. Lauderdale, FL (Pole)	3.4	3.3	0.6
Niagara Falls, NY	3.6	0.6	0.2

Eight-hour time-weighted average exposures have also been calculated for the two consumer installations and the highest exposure found was 0.2 fiber/cc >5μ for two days while asbestos-containing dust was being generated. In general it appears, therefore, that consumer operations may be characterized with ceiling exposures in the order of 1-2 fibers/cc >5μ and eight-hour time-weighted average exposures of several tenths of a fiber/cc >5μ.

A00202

Asbestos Exposure - Roofing Compounds

It was shown in Table I that about 253,600 tons of asbestos are used annually in asphaltic-based roofing compounds. The asbestos is an important ingredient in emulsified and cut-back coatings, trowelable patching and sealing compounds and in some tar papers. It is not used in hot-melt roof coatings.

Data for the spraying of emulsified and cut-back asphaltic coatings is shown in Table VIII. Similar data that include both rip-off and installation of built-up roofs with asbestos-containing materials are shown in Table IX. These data were presented by the Flintkote Company and Johns-Manville Corporation, respectively, in response to an EPA proposal[7] to change the current Asbestos National Emission Stnadard for spraying of asbestos-containing materials. The results from eight field locations and one test sequence ranged from 0.0 to 0.6 fibers/cc >5μ and averaged 0.1 fibers/cc >5μ.

Asbestos Exposure - Coatings Compounds, and Plastics

These categories encompass a myriad of products consuming about 41,400 tons of asbestos annually. Typical examples include high-performance maintenance coatings, special purpose trade paints such as block coatings, caulks, sealants, adhesives, and certain laminating resins. In these products the asbestos functions primarily as a rheological agent and is usually present in small quantities such as 0.5-3% and seldom exceeds 5% by weight. Some of these products are normally applied by spraying and those based on thermoset resins may in some cases be subject to abrasion during finishing or in the process of subsequent removal.

Data on the airborne asbestos levels during the spraying of nine different systems at twelve locations are provided in Tables X and XI and are summarized in the following table:

A00203

SPRAYING OF COATINGS AND RESINS CONTAINING ASBESTOS

	WT. % ASBESTOS	NO. OF LOCATIONS	NO. OF SAMPLES	AIRBORNE ASBESTOS CONCENTRATION (FIBERS/CC >5μ) RANGE	AVERAGE
EPOXY AND EPOXY-COAL TAR COATINGS	1 - 1.5	3	5	0.0 - 0.2	0.1
CHEMICAL-RESISTANT POLYESTER COATING	0.7 - 1.4	2	5	0.0 - 0.4	0.3
VINYL AND ALKYD COATINGS	1.1 - 6.0	2	6	0.0 - 0.04	0.03
VINYL AND ACRYLIC LATEX COATING	0.7 - 3.7	2	4	0.0 - 0.2	0.05
POLYESTER LAMINATING RESIN	0.5	3	7	0.0 - 0.6	0.2
	0.5 - 6	12	27	0.0 - 0.6	0.15

The highest asbestos content in the resins examined was 6%, with values in the 0.5 - 3% range much more common. Fiber counts ranged from 0.0 to 0.6 fibers/cc >5μ. It should be noted that the highest values occurred during the simultaneous use of fiberglass with a "chopper" gun, and fiberglass chips undoubtedly made a substantial contribution to the "asbestos" total reported.

Data for the sanding of polyester laminating resin and a vinyl latex paint are shown in Table XII and are summarized in the following table:

A06264

SANDING AND GRINDING OF RESINS CONTAINING ASBESTOS

APPLICATION	WT. % ASBESTOS	NO. OF LOCATIONS	NO. OF SAMPLES	AIRBORNE ASBESTOS CONCENTRATION (FIBERS/CC >5μ) RANGE	AVERAGE
POLYESTER LAMINATING RESINS	0.5 - 3	5	12	0.0 - 0.4	0.2
VINYL LATEX COATING	1.1	1	4	0.0 - 0.3	0.1
	0.5 - 3	6	16	0.0 - 0.4	0.15

Results for six locations ranged from 0.0 to 0.4 fibers/cc >5μ and averaged 0.16 fibers/cc >5μ. Here, too, there were counting problems due to unidentifiable particles of non-asbestos material being included in the reported asbestos count.

CONSUMER SAFETY

Next it is desirable to consider how much risk the levels of exposure just described pose to the consumer. It is important to recognize, first of all, that consumer exposure is quite different from that encountered by the worker who is manufacturing a product or the professional who installs it. These workers are exposed to the level of airborne fiber characteristic of their particular operation for a full working day over extended time periods up to a full working lifetime. The consumer, on the other hand, may have a brief exposure while the particular product is being used and spend the rest of his life without measurable exposure from the particular item.

Basically, the evaluation of risk involves the selection of a model, calibration of the model with the epidemiological data that is available which, incidentally, is usually at high and poorly defined exposures, and then extrapolation to predict the effects of very low exposure levels. The results are very

A00205

sensitive to the model chosen and there is widespread disagreement among workers in this field.

The best known correlation and extrapolation procedure for the risk of lung cancer from asbestos exposure is that of Enterline and Henderson[8]. These authors carefully list the eight assumptions upon which the model is based. Since the Enterline correlation deals mainly with continuous exposure, Dr. Steven Bayard[9] of the Consumer Products Safety Commission, modified the approach to apply to occasional exposures. He introduces an additional assumption that the effect of dose is cumulative. This builds a geometric increase in risk into the model which can be seriously questioned, but this is not the place to debate the issue.

The Bayard modification has been used here to calculate cumulative risk for periods of 40 and 100 years from onset of exposure for the consumer exposure levels reported here and for exposures of 1 fiber/cc >5μ for two days. The latter level is about the same as the highest level found for commercial operations by Rhodes and Ingalls[5]. The results are summarized below:

RISK FROM CONSUMER EXPOSURE

DURING OPERATIONS	ANNUAL EXPOSURE (FIBERS/CC/YEAR)	MEAN LATENT PERIOD TO TUMOR (YEARS)	CALCULATED ASBESTOS-INDUCED RESPIRATORY CANCER DEATHS/MILLION	
			40 YEARS	100 YEARS
0.2 FIBERS/CC FOR TWO 8-HOUR DAYS	0.004	621	>0.00001	0.00014
1 FIBERS/CC FOR TWO 8-HOUR DAYS	0.02	288	0.00022	1.8

The highest time-weighted average of 0.2 fibers/cc for two days found for the consumer application gives an annual exposure of 0.004 fibers/cc per day for one year, a mean latent period to tumor of 621 years, and something less than 0.00001 deaths per million of population from asbestos-induced cancer in a 40-year period after exposure. If the period examined is extended to 100 years, the number of deaths per million population predicted would be 0.00014, which is obviously still far less than a single death. The corresponding values for the 1 fiber/cc assumption are 288 years median time to tumor, a risk estimate of 0.00022 deaths per million over a 40-year period, and 1.8 deaths per million over a 100-year time span.

For the roofing application, it seems very likely that the occurence of roof spraying by consumers is extremely rare since special equipment is required. The removal of old built-up roofing and replacement with new tar paper and trowelable emulsions by the consumer is undoubtedly quite common. The commercial data available indicates that exposures during installation would be substantially below those for tape-joint compounds, but quite possibly would still be detectable.

The situation for the various coating and laminating resins is similar. While the consumer may not have access to many of these products, it is possible that he may occasionally sand certain of the coatings and finished products. In these cases a low, but still not zero, exposure to fiber can occur. In both of these cases the estimated risks will be well below the corresponding values for tape-joint compounds.

REGULATORY ACTIONS

Regardless of the exposures found for the use of tape-joint compounds and the risks predicted therefrom, the Consumer Product Safety Commission is proceeding to ban the use of asbestos for this application. This is true even though the product has been in widespread use for over 35 years and it has not been implicated in a single case of cancer in a consumer. More importantly, the CPSC is very actively looking for other asbestos-containing products that will be subjected to the same kind of treatment.

The rationale for this action can be found in a philosophy which is very popular with most of the regulatory agencies today. This philosophy has two key elements:

1. A <u>single molecule</u> of a carcinogen (or a single fiber of asbestos) is capable of causing cancer in the rare person who is particularly susceptible. This leads to the general statement that there is no absolutely safe or "threshold" exposure level for a carcinogen.

2. A zero level of risk is an appropriate regulatory goal.

The firstof these is ostensibly a scientific concept. However, until the background level of cancer from unidentified sources is eliminated or the mechanism of induction of cancer is fully understood, this concept can neither be proven nor disproven. Today it is, at best, a very controversial hypothesis and its use in regulatory matters is a policy rather than a scientific decision.

The second is clearly a socio-political question:"How much risk from what sources is society willing to accept?" Extensive application of the zero risk criteria by the CPSC and other agencies to the more than 2000 suspected carcinogens will have a massive and chaotic impact on our way of life. A more rational approach is urgently needed and we would like to suggest consideration of the concept described most lucidly in a recent book by Lowrance[10]. In this reference "safe" is defined as:

"A thing is safe if its risks are found to be acceptable."

The risks are assessed and are then balanced against the benefits to society to serve as a basis for a decision on where it isappropriate to use the product. The balancing of risks and benefits is admittedly a difficult and controversial activity, but there is really no alternative. There is much that needs to be

A00208

done to protect the worker on the job and the public at large. An emotion-driven zero risk approach will be self-defeating in the long run and possibly in the short run as the Saccharin controversy suggests. Awareness, concern, and constructive rational action, not emotion, are urgently needed.

SUMMARY AND CONCLUSIONS

Asbestos consumption in the United States in 1976 was about 726,000 tons, mostly chrysotile. Of this total 472,000 tons, or 65% of the total, were used in asphaltic or synthetic plastics-based materials. The largest use was roofing products at 253,600 tons followed by flooring products at 113,500 tons, friction products at 63,800 tons, and coatings, compounds and plastics at a total of about 40,000 tons.

Extensive airborne asbestos exposure data for both commercial and consumer use of one plastics-based material, tape-joint compound, were presented. The consumer results show a short-term peak exposure of 1 - 2 fibers/cc >5μ and an 8-hour time-weighted average of several tenths of a fiber/cc >5 μ. Such exposures can be expected to occur for only several days out of a lifetime so that their effect on a person's overall exposure cannot be distinguished from the naturally occurring background.

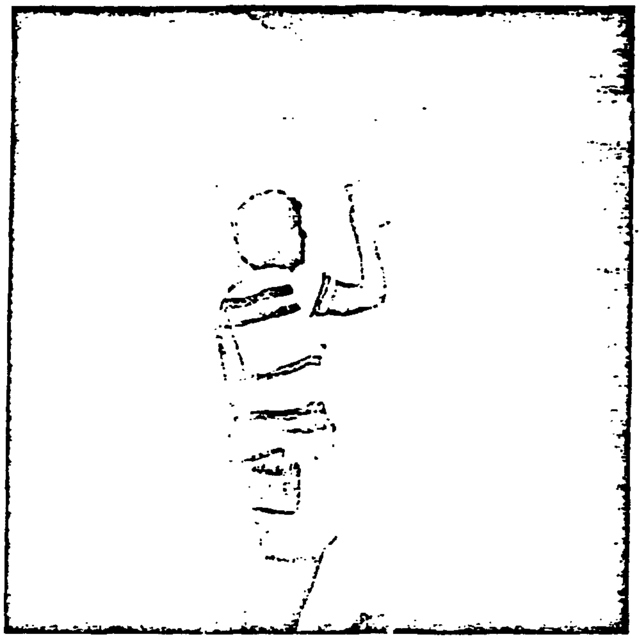
Data for exposures during the commercial use of roofing materials and during spraying and abrasion of a variety of coatings showed levels which were substantially below those for tape-joint compounds. Consumer exposures for the few of these products adaptable for consumer use is expected to be considerably lower than the commercial operations but are quite possibly still distinguishable from background during the time the product is actually in use.

Risk from this level of exposure was estimated using a procedure developed by the Consumer Product Safety Commission and was found to be only slightly different from zero. In spite of this, the CPSC is moving ahead with a ban on asbestos in tape-joint compounds and is actively looking for other asbestos-containing products for the same treatment. The rationale for this action is found in dual policy decisions that there is no safe level for a carcinogen and that an absolutely zero level of risk is an appropriate regulatory approach. Extensive application of this approach to the more than 2000 carcinogens now suspected will have a massive and chaotic impact on our way of life. A more rational, realistic and workable approach where risk is balanced against benefits is suggested.

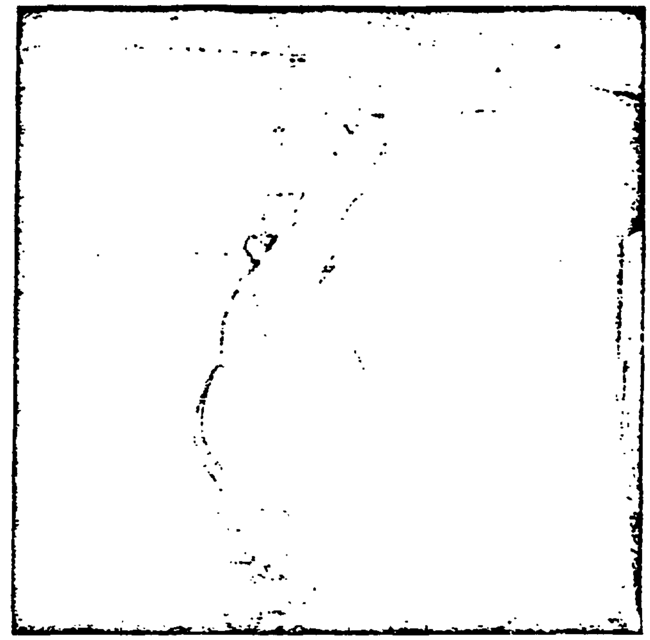
A00270

REFERENCES

1. Clifton, R.A., Asbestos-1977, U.S. Department of the Interior, Bureau of Mines, 1977.
2. NIOSH, Analytical Method, P & CAM 239, Nov. 1975, March 30, 1976, March 30, 1977.
3. LaFleur, P.D. et al. "A Report on the Fiber Content of Eighty Industrial Talc Samples", National Bureau of Standards, Washington, D.C., May 1977.
4. Rohl, A.N., Langer, A.M., Selikoff, I.J., and Nicholoson, W.J., Science, Volume 189, August 15, 1975, pp. 552.
5. Rhodes, H.B., and Ingalls, B.L., GDCI Drywall, January/February 1976.
6. Personal communication from Mr. Ken Dow, 1977.
7. 42 CFR No. 41, pp. 12122, March 2, 1977.
8. Enterline, P. and Henderson, V., IOEH Newsletter No. 51, Enclosure 9. Presented at Conference on Problems of Extrapolating the Results of Laboratory Animal Data to Men and Extrapolating the Results from High Dose Level Experiments to Low Dose Level Exposure, Pinehurst, North Carolina, March 12, 1976.
9. Bayard, S., CPSC Memorandum to Don Clay dated June 3, 1977.
10. Lowrance, W.W., Of Acceptable Risk, William Kaufmann, Inc., Los Altos, CA, 1976, pp. 8.



4 (a) Sanding wall tape-joints



4 (b) Sanding ceiling tape-joints

4 (c) Sweeping after first sanding

FIGURE 1

AIRBORNE ASBESTOS FIBER CONCENTRATION DURING SANDING (Fibers/cc longer than 5 micrometers)

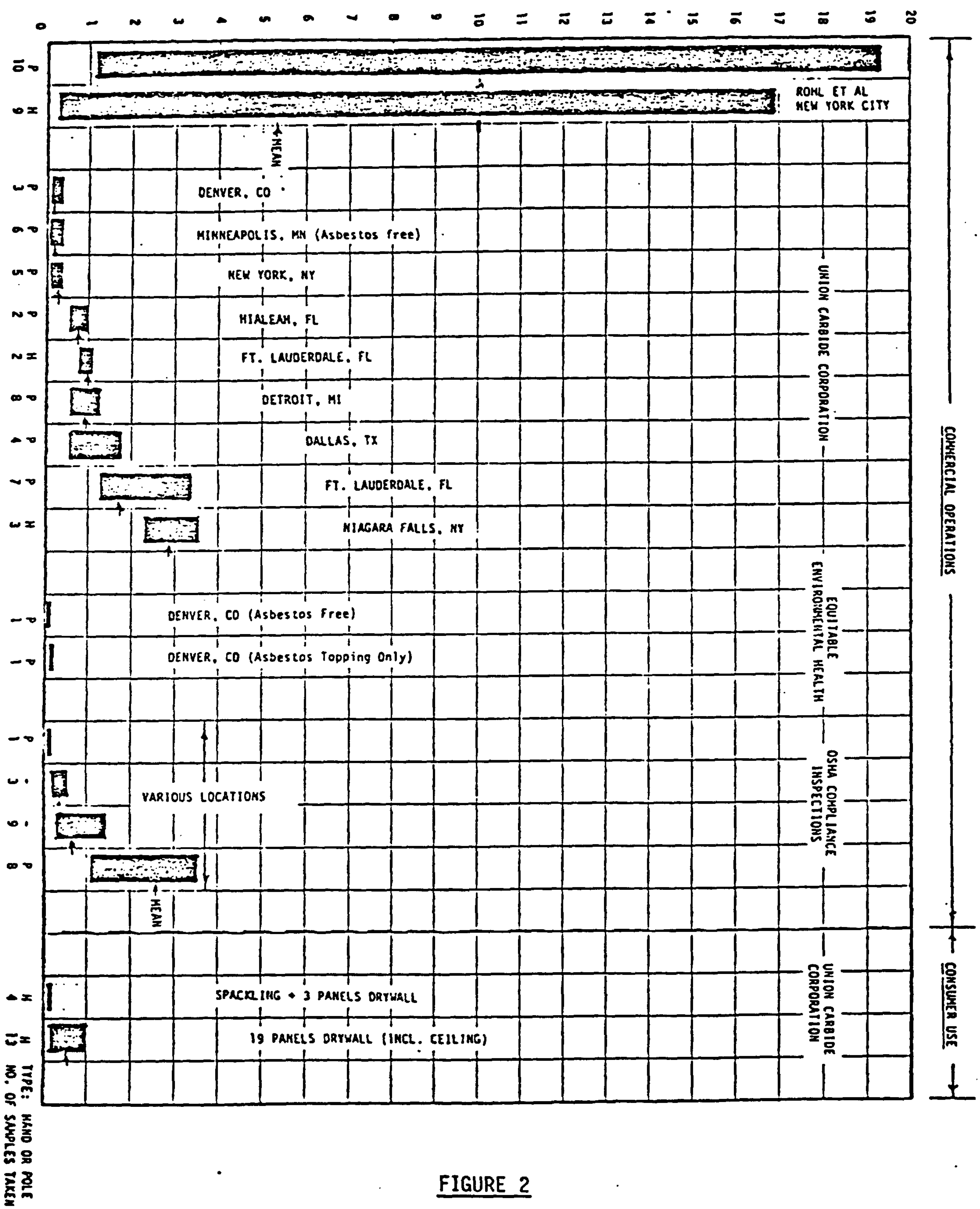


FIGURE 2

A00273

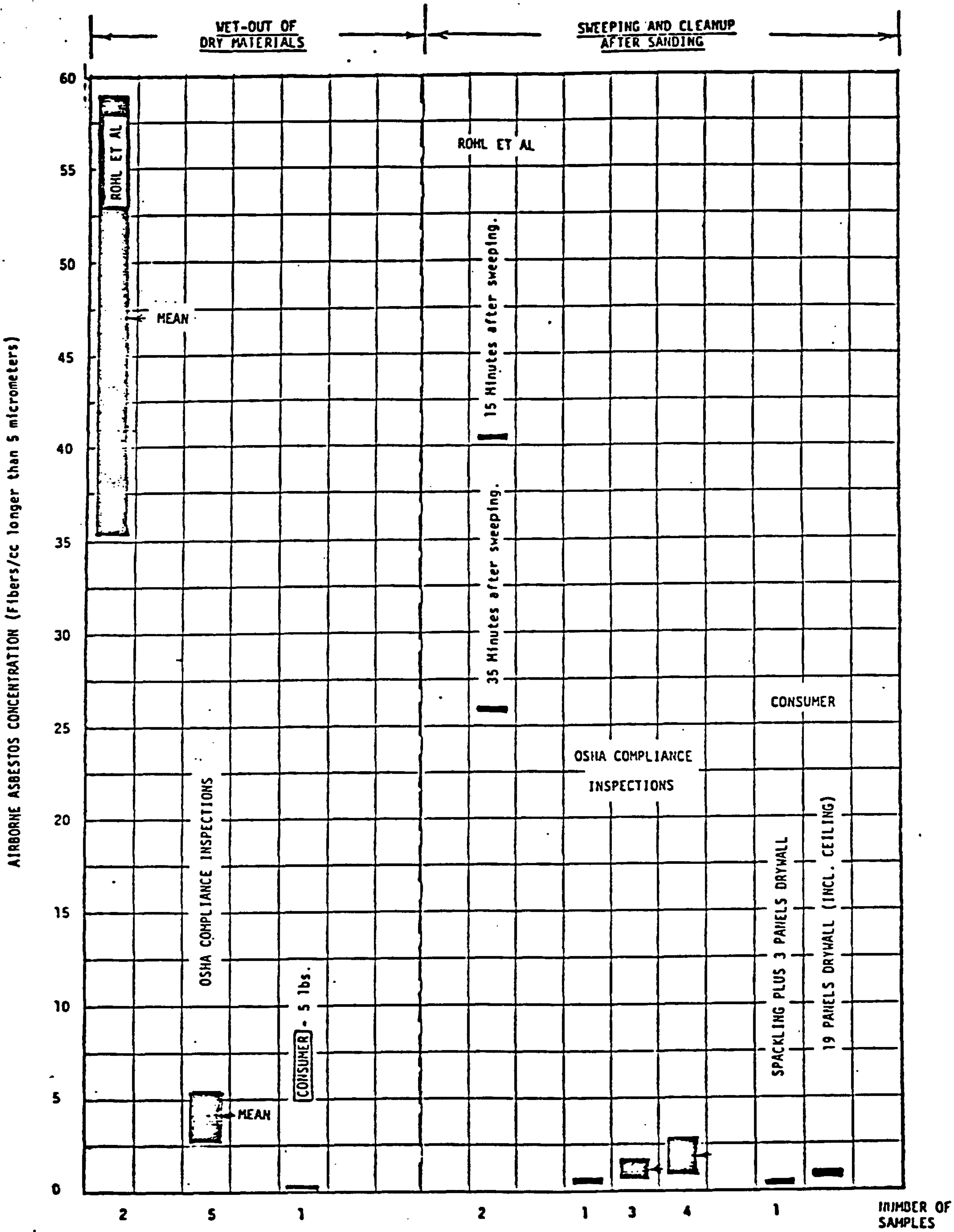


FIGURE 3

A00274

TABLE I

ASBESTOS DISTRIBUTION BY END USE AND TYPE, 1976 (*)

(Short Tons)

	CHRYSOTILE	CROCIDOLITE	AMOSITE	ANTHOPHYLLITE	TOTAL ASBESTOS
ASBESTOS CEMENT PIPE	116,800	20,300	2,900	-	140,000
ASBESTOS CEMENT SHEET	22,400	-	200	100	22,700
FLOORING PRODUCTS	113,500	-	-	-	113,500
ROOFING PRODUCTS	253,600	-	-	-	253,600
PACKING AND GASKETS	20,000	100	-	-	20,100
INSULATION, THERMAL	6,500	-	100	-	6,600
INSULATION, ELECTRICAL	2,300	-	-	-	2,300
FRICTION PRODUCTS	63,400	-	100	300	63,800
COATINGS AND COMPOUNDS	19,900	-	-	-	19,900
PLASTICS	19,700	700	-	1,100	21,500
TEXTILES	7,400	-	-	-	7,400
PAPER	30,700	300	-	-	31,000
OTHER	22,700	-	1,200	-	23,900
	698,900	21,400	4,500	1,500	726,300

(*) Asbestos - 1977, R. A. Clifton, U.S. Department of the Interior, Bureau of Mines, 1977

TABLE II

AIRBORNE ASBESTOS FIBER CONCENTRATIONS SANDING, DRY-MIXING AND SWEEPING(*)

Operations	Number of Samples	Peak Fiber Concentration (Fibers Per Milliliter) Mean	Range
Pole Sanding (1 to 1.5 m)	10	10.0	1.2 to 19.3
Background (2.5 m), same room	3	8.6	3.5 to 19.8
Background (7.5 m), adjacent room	2	4.8	0.7 to 8.8
Hand Sanding (1 to 1.5)	11	5.3	1.3 to 16.9
Background (2.5 m), same room	2	2.3	2.1 to 2.5
Background (4.5 m), adjacent room	2	4.3	1.5 to 7.1
Dry Mixing (1 to 1.5 m)	2	47.2	35.4 to 59.0
Background (3 to 6 m), same room	3	5.8	0.5 to 13.1
Background (5 to 10 m), adjacent room	2	2.6	2.1 to 3.1
Sweeping Floor (3 to 15 m)			
15 Minutes after sweeping	1	41.4	
35 Minutes after sweeping	1	26.4	

(*) A.N. Rohl, A.M. Langer, I.J. Selikoff and W.J. Nicholson, Science, Vol. 189, August 15, 1975, p. 52

TABLE III

A00277

AIRBORNE ASBESTOS FIBER CONCENTRATIONS DURING SANDING OF TAPE-JOINT COMPOUND (*)

DATA FROM UNION CARBIDE CORPORATION

Location	Structure	TJC Definition: App. Tool	TJC Definition: Type	Sanding Definition: Tool	Sanding Definition: Walls	Sanding Definition: Ceiling	Sanding Definition: Description	Sample Definition: Total Sample Time (Hrs.)	Sample Definition: No. Samples	Airborne Asbestos Fiber Concentration (Fibers/cc >5μ): Range	Airborne Asbestos Fiber Concentration (Fibers/cc >5μ): Average
New York City, NY	High rise apt. building. Windows open, light breeze. 13, 14, 15th story. Humid ~750ft.^{2} of floor area per apt.	Hand	General Purpose, Ready-Mix	Pole & Hand	x	x	Finishing touch-up operation by tapers. Scraping, sanding (generally light) & filling. 5 man crew, 1 man/room.	5	5 Personal 1 Area	0.1-0.4 0.2	0.3 0.2
Ft. Lauderdale, FL	Condominium apt. bldg. Windows in and generally closed. Little breeze.	Ames	General Purpose, Ready-Mix	Pole	x	x	Steady sanding by laborer. 10-15 minutes to complete 1 B.R. apt., ~500 ft.^{2} of floor area.	1.5	7 Personal 7 Area	1.3-3.4 0.3-1.5	1.8 0.9
				Hand	x	-	Spot sanding bad areas.	0.5	2 Personal	0.8-1.1	1.0
Hialeah, FL	Condominium apt. bldg. Windows in and generally closed. Little breeze.	Ames	General Purpose, Ready-Mix	Pole	x	-	Steady sanding by laborer. 15-20 minutes to do a 3-5 room apt.	1	2 Personal 1 Area	0.6-1.0 0.6	0.8 0.6
Dallas, TX	Single level residential dwelling. ~2000 ft.^{2} floor area. Windows in and closed.	Ames	General Purpose, Ready-Mix	Pole	x	x	Steady sanding by 2 laborers. 30 minutes to do complete house.	1	4 Personal 1 Area (after)	0.6-1.8 0.1	1.1 0.1
Niagara Falls, NY	Remodeled office. 12'x10'x12' No ventilation.	Hand	General Purpose, Ready-Mix	Hand	x	-	One man, heavy sanding.	0.6	3 Personal	2.3-3.6	2.9
Detroit, MI	Multilevel residential dwelling. ~3000 ft.^{2} of floor area. No ventilation.	Ames	Topping Compound, Dry Mix	Pole	x	x	Steady sanding by laborer. ~4 hours to complete.	4	8 Personal 1 Area	0.6-1.3 0.5	1.0 0.5
Minneapolis, MN	Two-level residential dwelling. ~2300 ft.^{2} of floor area. Moderate ventilation.	Ames	Topping Compound, Dry- Mix <u>Asbestos Free</u>	Pole	x	x	Steady, heavy sanding. 1 man ~4 hours	4	6 Personal 3 Area	0.1-0.4 0.0-0.4	0.2 0.2
Denver, CO	Two-story medical bldg. Two-story hall, many small rooms. Rain, no ventilation.	Hand	Ready-Mix to bury tape. Non-asbestos Ready-Mix Topping.	Pole	x	x	One man, moderate sanding. ~30 mins.	3	3 Personal 2 Area	0.1-0.4 0.2	0.2 0.2

(*) H. B. Rhodes, R. J. Ingalls, GDCI Drywall, January/February 1976

TABLE IV

AIRBORNE ASBESTOS FIBER CONCENTRATIONS
DURING SANDING OF TAPE-JOINT COMPOUNDS(*)

Location	Structure	TJC Definition: App. Tool	TJC Definition: Type	Sanding Definition: Tool	Sanding Definition: Walls	Sanding Definition: Ceiling	Sanding Definition: Description	Sample Definition: Total Sample Time (Hrs.)	Sample Definition: No. Samples	Airborne Asbestos Fiber Concentration (Fibers/cc >5μ): Range	Airborne Asbestos Fiber Concentration (Fibers/cc >5μ): Average
DATA FROM OSHA COMPLIANCE INSPECTIONS(1)											
A	-	-	Ready-mix	Pole	X	X	Apparently 3 men sanding.	0.5-2	8 Personal 4 Area	1.5-5.0 1.0-10.0	4.3 (**) 5.0 (**)
F	-	-	-	Pole	-	-	-	0.7	1 Personal	0.1	0.1
H	-	-	-	-	-	-	-	-	9 Personal	0.3-1.5	0.7
I	-	-	-	-	-	-	-	1.2	3 Personal	0.2-0.6	0.4
DATA FROM EQUITABLE ENVIRONMENTAL HEALTH, INC. (6)											
CO	One story annex to existing building.	-	Non-asbestos for tape, finished with asbestos-containing.	Pole	-	X	Heavy sanding. One man on stilts.	0.5	1 Personal 2 Area	0.2 0.1	0.2 0.1
	"	-	Non-asbestos throughout.	Pole	-	X	"	0.5	1 Personal 1 Area	0.1 0.1	0.1 0.1

(*) Supplied to Equitable Environmental Health, Inc. as part of a study of asbestos exposure in the construction industry. Specific locations not identified.

(**) Includes all particles L/D >3 L>5μ . Estimated by TEM proceeding to be about 50-70% chrysotile plus amphibole. No split on relative amounts is available.

TABLE V

AIRBORNE FIBER CONCENTRATIONS FROM OSHA COMPLIANCE INSPECTIONS (*) DURING WET-OUT OF DRY PRODUCT AND CLEANUP AFTER SPRAYING OR SANDING

Location	Product Identification	Operation	Sample Time (Min.)	Ceiling Concentration Fibers/cc >5μ
B	All purpose TJC	Wet-out	10	5.4
C	Spray Texture (**)	"	10	4.4
E	Spray Texture (**)	"	20	4.9
G	TJC	"	2	4.0
H	TJC (Mortar)	"	-	2.7
D	TJC	Sweeping	15	2.7
		"	15	2.5
		"	15	2.0
		"	30	0.9
	TJC	Sweeping and Scraping	15	1.5
		"	15	0.6
		"	15	1.6
H	TJC	Sweeping	-	0.6

(*) Supplied to Equitable Environmental Health, Inc.[6] as part of a study of asbestos exposure in the construction industry. Specific locations not identified.

(**) Spray texture compounds are generally similar in composition to dry-mix tape-joint compounds with texturing material added.

A0627

TABLE VI

SUMMARY OF AIRBORNE "FIBER" CONCENTRATIONS

CONSUMER SPACKLING AND DRYWALL INSTALLATION

Sample No.	Date	Air Sample On	Air Sample Off	Air Sample Minutes	Description of Operation	No. of Fields Counted	No. of Filter Section Used	Airborne Asbestos Concentration Fibers/100 Fields	Airborne Asbestos Concentration Fiber/cc >5μ	Comments
M-32	6/21/77	11:07A	7:16P	489	Outdoors- about 4' in air. See Figure 1 (d).	500	2	3	0.005	
M-21	6/21	Blank	-	-	-	500	2	0.8	-	
M-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	7.75	0.01	
M-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	8.5	0.01	
M-23	6/21	10:55A	7:20P	505	Recreation room - Center about 4' off floor. See Figure 1 (c).	300	2	5.4	0.007	
PREPARATION AND INSTALLATION (6/22/77)										
M-24	6/22	9:00A 3:50P	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	141	0.2	Too heavily loaded to count accurately. Better than 1/6 of field obscured by particulate. Particulate in 5μ range may not be chrysotile.
M-30	6/22	3:38P	3:55P	17	Personal sample. Operator wetting out dry tape joint compound.	200	1	8.5	0.3	
M-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	18.5	0.1	
M-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	17.0	0.03	
M-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	171.5	0.3	Loaded with small particulate fibers, short but within 5μ range. Some evidence of asbestos.
M-18	6/22	3:38P	4:30P	70	Cellar- Same location as M-36. During wet out of TJC and immediately following.	200	1	7.0	0.07	

A00280

TABLE VI (Continued)

SUMMARY OF AIRBORNE "FIBER" CONCENTRATIONS

CONSUMER SPACKLING AND DRYWALL INSTALLATION

Sample No.	Date	Air Sample On	Air Sample Off	Air Sample Minutes	Description of Operation	No. of Fields Counted	No. of Filter Section Used	Airborne Asbestos Concentration Fibers/100 Fields	Airborne Asbestos Concentration Fiber/cc >5μ	Comments
SANDING OF SECOND COAT AND APPLICATION OF FINISH COAT (6/24/77)										
M-26	6/24	7:10A	7:30A	20	Personal sample. Operator sanding spackling. Upstairs bedroom. Clean-up after sanding.	200	1	5.75	0.2	
M-35	6/24	7:11A	7:31A	20	Bedroom - During sanding and cleanup. Same location as M-28.	200	1	8.0	0.3	
B-27	6/24	7:32A	3:00P	448	Bedroom - After sanding and cleanup. Same location as M-28.	100	1	47.5	0.07	Geometric chunky material present. Also rod-shaped with light refractive index.
M-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	12.5	0.02	
M-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	10.0	0.1	
B-22	6/24	7:37A	7:52A	15	Cellar - during sanding and cleanup. Same location as M-36.	300	1	4.1	0.2	
M-34	6/24	7:54A	2:55P	421	Cellar - after sanding and cleanup. Same location as M-36.	200	1	8.75	0.01	
FINAL SANDING AND CLEANUP (6/25/77)										
M-66	6/25	12:43P	12:57P	14	Personal sample. Operator sanding spackling. Upstairs bedroom. Cleanup after sanding.	500	2	1.9	0.09	
M-60	6/25	12:42P	12:58P	16	Bedroom - during sanding and cleanup. Same location as M-28.	500	2	1.0	0.04	
M-68	6/25	12:59P	8:00P	421	Bedroom - after sanding and cleanup. Same location as M-28.	300	2	5.2	0.008	
M-64	6/25	12:15P	8:00P	465	Living room - During and after second sanding and cleanup.	300	2	5.3	0.007	
M-72	6/25	1:03P	1:36P	33	Personal sample. Operator sanding TJC in cellar. Cleanup after sanding.	500	2	1.7	0.04	
M-65	6/25	1:03P	1:37P	34	Cellar - During sanding and cleanup. Same location as M-36.	300	1	3.6	0.08	
B-12	6/25	1:45P	7:11P	326	Cellar - After sanding and cleanup. Same location as M-36.	500	2	1.6	0.003	
M-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	6.75	0.5	
M-81	-	Blank	-	-	-	500	2	0.8	-	
M-97	7/9 & 7/10	10:30A 11:00A	7:25P 7:20P	1025	Outdoor sample. Same location as M-32.	500	2	1.0	-	

TABLE VII

SUMMARY OF AIRBORNE FIBER CONCENTRATIONS
FULL ROOM CONSUMER DRYWALL INSTALLATION

COMPLETION OF STUDDING - HANGING DRYWALL - START OF TAPING (8/3/77)

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 Asbestos Concentration Fibers/100 Fields	Airborne Asbestos Concentration Fiber/cc >5
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	0.004
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
3-3	8/3	7:43P	9:10P	87	Personal (Operator #1) Taping joints with ready mix.	100	1	36.0	0.3
J-2	8/3	7:46P	9:10P	84	Personal (Operator #2) Taping joints with ready mix.	100	1	17.0	0.1

COMPLETION OF INSTALLATION AND COVERING OF TAPE (8/4/77)

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 Asbestos Concentration Fibers/100 Fields	Airborne Asbestos Concentration Fiber/cc >5
N-53	8/4	9:36A	1:48P	252	Personal (Operator #2) Taping joints with ready mix.	200	2	7.25	0.02
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

APPLICATION OF SECOND COAT OF COMPOUND (8/5/77)

----- No air samples taken. ----

A002002

TABLE VII (Continued)

SUMMARY OF AIRBORNE FIBER CONCENTRATIONS
FULL ROOM CONSUMER DRYWALL INSTALLATION

ımple ιo.	Datb	Air Sample On	Air Sample Off	Air Sample Minutes	Description of Operation	No. of Fields Counted	No. of Filter Sections Used	Airborne Asbestos Concentratio Fibers/100 Fields	Airborne Asbestos Concentratio Fiber/cc >5
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	60.0	0.9
N-89	8/6	11:00A	11:28A	28	Personal (Operator #2). Hand sanding. Tape joint compound	100	1	22.5	0.5
B-14	8/6	11:58A	12:10P	12	Personal (Operator #2). Sweep up after first sanding.	100	1	22.0	1.3
N-94	8/8	10:01A	10:47A	46	Personal (Operator #3). Hand sanding. Tape joint compound.	100	1	45.5	0.7
B-18	8/6	10:55A	11:29A	34	Personal (Operator #3). Hand sanding. Tape joint compound.	100	1	40.0	8.8
N-75	8/6	11:57A	12:11A	14	Personal (Operator #3). Sweeping up after first sanding.	100	1	15.0	0.7
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
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
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	11.0	0.03
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	10.5	0.01

A00200

A06204

SUMMARY OF AIRBORNE FIBER CONCENTRATIONS
FULL ROOM CONSUMER DRYWALL INSTALLATION

OND SANDING AND CLEANUP (8/10/77)

ple .	Date	Air Sample On	Air Sample Of	Minutes	Description of Operation	No. of Fields Counted	No. of Filter Sections Used	Airborne Asbestos Concentration Fibers/100 Fields	Airborne Asbestos Concentration Fiber/cc $>5\mu$
7	8/10/77	9:27A	10:01A	34	Personal - Operator #2. Sanding TJC	100	1	24.5	0.5
6	8/10	10:02A	10:28A	26	Personal - Operator #2. Sanding	100	1	13.5	0.4
0	8/10	10:29A	10:46A	17	Personal - Operator #2. Sanding (ceiling).	100	1	24.0	0.9
	8/10	10:48A	11:09A	21	Personal - Operator #2. Sanding (ceiling).	100	1	20.5	0.7
	8/10	11:18A	11:43A	25	Personal - Operator #2. Sanding (ceiling).	100	1	22.5	0.6
	8/10	9:25A	10:00A	35	Personal - Operator #3. Sanding	200	1	8.0	0.2
0	8/10	10:01A	10:30A	29	Personal - Operator #3. Sanding	200	1	9.35	0.2
5	8/10	10:31A	11:12A	41	Personal - Operator #3. Sanding	100	1	20.0	0.3
	8/10	11:13A	11:43A	30	Personal - Operator #3. Sanding	100	1	23.0	0.5
0	8/10	11:52A	12:13P	21	Personal - Operator #3. During sweep up and vacuuming after sanding.	100	1	36.0	1.2
5	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	0.05
5	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	0.02
5	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	10.25	0.1
4	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	31.0	0.2
	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
7	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
1	8/10	12:17P	5:59P	342	Area. After final sanding and cleanup. Located ~ 6' above floor in north wall	100	1	18.0	0.04

TABLE VII (Continued)

SUMMARY OF AIRBORNE FIBER CONCENTRATIONS
FULL ROOM CONSUMER DRYWALL INSTALLATION

mple).	Date	Air Sample On	Air Sample Off	Air Sample Minutes	Description of Operation	No. of Fields Counted	No. of Filter Sections Used	Airborne Asbestos Concentratio Fibers/100 Fields	Airborne Asbestos Concentratio Fiber/cc
ESIDUAL EXPOSURE AFTER COMPLETION OF INSTALLATION (8/11/77)									
-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
-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
-4	8/11	9:13A	5:00P	467	Area. Day following completion of work in basement. Located on mantle of fire-place ~6' above floor.	500	4	3.7	0.006
-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
-56	8/11	8:42P	5:01P	499	Area. Day following completion of work in basement. Located on north wall of cellar ~6' above floor.	500	4	2.6	0.004

A00236

TABLE VIII

AIRBORNE ASBESTOS FIBER CONCENTRATIONS SPRAYING OF FIBRATED ROOF COATINGS(*)

DATE	BINDER	APPROXIMATE WT. % ASBESTOS	AIRBORNE ASBESTOS CONCENTRATION (FIBERS/CC >5μ)
9/25/74	Cutback Asphalt	7.7	0.003
			0.006
10/9/74	Cutback Asphalt	7.7	0.072
			0.027
12/10/74	Asphalt Emulsion	2.8	0.01
			0.02
5/19/76	Asphalt Emulsion	2.8	0.3

(*) Data from response by the Flintkote Company to "Changes in the National Emission Standards for Hazardous Air Pollutants (40 CFR, Part 61) proposed by the EPA (42 CFR No. 41, p. 12122, March 2, 1977) (7)

A0023

TABLE IX

AIRBORNE ASBESTOS FIBER CONCENTRATIONS TEAR-OFF AND APPLICATION OF BUILTUP ROOFING(*)

Date	Location	Operation	Airborne Asbestos Concentration (Fibers/cc >5μ)
3/14/74	Wisconsin	New Application	0.2 - 0.6
4/10/74	Indiana	Tear-off	0.1 - 0.4
5/21/74	Pennsylvania	Tear-off and Replace	0.0 - 0.2
7/25/74	Indiana	Tear-off and Replace	0.1 - 0.3
11/20/74	Colorado	New Application	0.1 - 0.2
12/16/75	Colorado	New Application	<0.1
8/16/76	Indiana	Tear-off and Replace	0.0
8/16/76	Indiana	New Application	0.0

(*) Data from response by the Johns-Manville Corporation to "Changes in the National Emission Standards for Hazardous Air Pollutants (40 CFR, Part 61) proposed by the EPA (42 CFR No. 41, p. 12122, March 2, 1977) [7]

A00207

TABLE X

AIRBORNE ASBESTOS FIBER CONCENTRATIONS

SPRAYING OF HIGH-PERFORMANCE INDUSTRIAL AND TRADE COATINGS

Sample Designation	Commercial Application	Date	Binder	Approximate Wt. % Asbestos (*)	Spray Gun Type	Operation	Sample Time (Min.)	Airborne Asbestos Concentrations (Fibers/cc >5μ)
A. Epoxy								
K-3	Ship coating.	10/2/74	Epoxy	1.5	Airless	Operator spraying outside & under a ship.	33	0.2
K-10	"	"	"	1.5	"	"	8	0.2
M-45	Coating dry dock	10/1/74	Epoxy + Coal Tar	1	Airless	Operator spraying side of dry dock from suspended platform.	11	0.2
M-1	"	"	"	1	"	Operator spraying side of dry dock from fixed scaffold.	38	0
K-3	Coating pipe interiors.	"	"	1	Air-supported wand.	Operator spraying interior of 3", 6" and 12" diameter pipe.	37	0.1
B. Chemical Resistant Polyester								
J-21	Fiber-glass pipe manufacture. (Mandrel coating)	8/13/74	Chemical resistant resin.	1.4	Airless	Operator adjacent to automatic spray machine coating 28' mandrels.	23	0.1
H-26	"	"	"	1.4	"	Operator wiping mandrels. In area near spraying.	14	0.4
J-5	Below waterline. Ship coating.	10/3/74	"	0.7	Air-supported wand.	Roll-out man. In spray area about 1/4 of time.	65	0.4
J-7	" "	"	"	0.7	"	Operator spraying ship hull in drydock.	41	0.4
M-28	" "	"	"	0.7	"	"	23	0.0

TABLE X (Continued)

AIRBORNE ASBESTOS FIBER CONCENTRATIONS

SPRAYING OF HIGH-PERFORMANCE INDUSTRIAL AND TRADE COATINGS

Sample Designation	Commercial Application	Date	Binder	Approx-imate Wt. % Asbestos (1)	Spray Gun Type	Operation	Sample Time (Min.)	Airborne Asbestos Concentrations (Fibers/cc >5μ)
C. Vinyl and Alkyd Resins								
H-7	Painting building exterior.	10/6/74	Alkyd resin.	6'	Airless gun.	Operator spraying building exterior wall.	9	0
M-35	"	"	"	6'	"	"	5	0.06
J-11	Painting building interior.	3/8/77	Vinyl-Acrylic resin.	1.1	Airless gun.	Operator spraying interior walls.	23	0.03
J-7	"	"	"	1.1	"	"	23	0.06
J-87	Painting building exterior.	"	"	1.1	"	Operator spraying exterior walls.	16	0.00
F-48	"	"	"	1.1	"	"	16	0.04
D. Latex Based								
H-5	Wall and Roof Spray.	10/4/74	Vinyl latex	3.7	Air supported.	Operator spraying vertical wall panel.	15	0.0
J-3	"	"	"	2.8	"	"	12	0.2
M-43	Roof Spray.	9/30/74	Acrylic latex.	0.7	Airless	Operator spraying downward onto a large roof.	28	0.0
M-49	"	"	"	0.7	"	"	14	0.0

(*) Based on total formulation as sprayed.

30024

TABLE XI

AIRBORNE ASBESTOS FIBER COUNTS - SPRAYING OF LAMINATING RESIN

Sample Designation	Commercial Application	Date	Binder	Approximate Wt. % Asbestos (*)	Spray Gun Type	Operation	Sample Time (Min.)	Airborne Asbestos Concentration (Fibers/cc >5μ)
69	Boat Manufacture	12/7/72	General pupose polyester resin	0.5	Air-supported chopper	Operator spraying resin and chopped fiberglass.	24	0.6
L-13	Boat Manufacture	10/31/74	General purpose polyester resin	0.5	Air-supported chopper	Operator spraying resin and chopped fiberglass.	16	0.1
N-28	" "	"	"	"	"	"	5	0.4
N-30	" "	"	"	"	"	"	4	0.4
N-34	Boat Manufacture	10/8/75	General purpose polyester resin	0.5	Airless	Operator-spraying resin only. No fiberglass.	55	0.0
N-40	" "	"	"	"	"	"	53	0.03
I-12	" "	"	"	"	"	"	35	0.1

(*) Based on total formulation as sprayed.

A00290

TABLE XII

AIRBORNE ASBESTOS FIBER COUNTS-

GRINDING AND SANDING OF RESIN-BASED SYSTEMS CONTAINING ASBESTOS

Sample Designation	Commercial Application	Date	Asbestos Type	Asbestos Approx. Wt. %	Operation	Sample Time (Min.)	Airborne Asbe Concentrati (Fibers/cc >
A. THERMOSET RESIN (Polyester)							
1929-82-3	Fabrication of reinforced fiberglass pipe.	2/27/73	RG-144	2-3	Operator pulls pipe along line. Saws off end with circular saw.	19	0.1
1929-82-4	"	"	"	2-3	Same operation as 1929-82-3.	49	0.1
1929-82-5	"	"	"	2-3	Operator removing end of pipe with scarfing machine.	45	0.04
I-13	"	8/13/74	RG-244	1.4	Operator shaping end of pipe with bell & spigot machine.	16	0.3
I-6	"	"	"	1.4	Operator cutting off pipe end and light grinding on exterior surface.	17	0.2
I-26	Fabrication of FRP tanks and pipe.	8/13/74	RG-244	1.5	Operator grinding inside of 13' I.D. x 26' tank.	16	0.4
G-8	"	"	"	1.5	Continuation of same operation as I-26.	5	0.3
I-39	"	"	"	1.5	Operator grinding edges of miscellaneous small parts.	25	0.3
1929-84-4	Production of artificial bricks.	3/8/73	RG-244	2.0	Operator cutting with sabre saw.	44	0.1
1929-84-5	"	"	"	2.0	Operator trimming with sabre saw.	39	0.2
N-20	Production of fiberglass boats.	11/26/74	RG-244	0.5	Operator grinding inside of boat hull.	11	0.0
N-25	"	"	"	0.5	Operator grinding.	4	0.0
B. VINYL LATEX RESIN							
J-33	Sanding of vinyl latex paint.	3/8/77	T-135	1.1	Operator hand sanding overhead panel.	12	0.3
R-43	"	"	"	1.1	"	11	0.06
J-35	"	"	"	1.1	Operator hand sanding wall panel.	16	0.1
J-4	"	"	"	1.1	"	16	0.0

A00201