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NIOSH-00192664

Review of NIOSH Testing of 30 Hand Held and Standing Hair Dryers for Asbestos Release

Report to CPSC

Contract # CPSC-C-78-0109

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Introduction

This report is in response to a request by the Consumer Product Safety Commission (CPSC) to review the National Institute for Occupational Safety and Health (NIOSH) study of asbestos emissions from various hand held and standing hair dryers. The review includes a discussion of the sampling and analytical techniques utilized by NIOSH, a comparison of results obtained by NIOSH with other environmental asbestos measurements, and, in an appendix, a discussion of possible health consequences from asbestos concentrations that are found in the effluent of some hair dryers.

Sampling and Analytical Techniques

The procedures developed to sample the effluent air from hair dryers are, by far, the best utilized in any available report to date. Care is taken to assure that clean air, uncontaminated by asbestos fibers, enters the dryer and a good determination is made of total dryer effluent and the fraction collected for analysis. While isokinetic sampling was not utilized, this would be difficult to achieve under the circumstances of testing high velocity air streams from a variety of dryers. The absence of isokinetic conditions may result in an underestimate (as the air velocity through the sampling head exceeded the duct air velocity), but this would be a relatively small effect.

A greater underestimate of fiber release from the dryers may occur from the analytical procedures used to quantitate the number and mass of asbestos fibers released. Firstly, collection of fibers on Millipore filters and the subsequent dissolution of the filters by a Jaffe wick method can lead to significant fiber loss (perhaps up to 80%) unless extreme care is taken.

This loss occurs because many fibers are trapped deep in the interstices of the Millipore filters and are not enmeshed in the carbon coating of the surface of the filter. During the subsequent cleaning of the filter by acetone vapor, these loose fibers can be lost. Secondly, scanning for asbestos fibers was done at a magnification of 1700X. At this magnification a large number of the smaller chrysotile fibers and fibrils will be missed. This, as well as the procedure of counting clumps of fibers as one structure, can have a significant effect on the quantitation of the number of asbestos fibers but would have a lesser effect on estimate of mass.

RESULTS

It is clear that asbestos fibers are released during the operation of most hair dryers tested, in some cases in considerable quantities. Table 1 depicts the distribution of asbestos air concentrations measured in effluent of all dryers sampled compared with 209 samples of ambient air and 57 samples taken in other circumstances of severe environmental contamination. (The background and data for these 265 samples are provided in Appendix 1, along with some perspectives on their possible health consequences). As can be seen, the range of dryer effluent concentrations exceeds that of the other environmental concentrations and extends much beyond those of the ambient air. This is so even though there may be underestimates of some of the dryer effluents. Of all samples collected (60) (including two of a hobby gun) four showed asbestos concentrations exceeding 500 ng/m^3 and two concentrations exceeding 1000 ng/m^3. While some dryers emitted high concentrations of asbestos, sixty to seventy

percent of the effluents measured were typical of the ambient air. However, without further data it is not possible to determine if this is an attribute of the model tested or the particular dryer tested (in its current state of use). Special concern must be paid to standing dryers because of the possibility of their nearly continuous use, often in confined spaces, in hair salons. Here a build up of asbestos concentrations in excess of that in dryer effluents can occur.

SUMMARY

Using analytical techniques which may underestimate the concentration of asbestos, NIOSH has clearly demonstrated that some hair dryers release considerable quantities of asbestos fiber. The fiber concentrations in the effluent of some dryers exceeded the highest we have measured in eight years of surveillance of environmental asbestos contamination. Appendix 1 discusses the possible health risks of such concentrations. While the risk to an individual from the intermittent use of an asbestos emitting hair dryer is less than that from many current occupational asbestos exposures, the large number of individuals that may be exposed clearly calls for the elimination of the exposure.

TABLE 1

Distribution of asbestos concentrations in the effluent of various hair dryers, several circumstances of environmental contamination, and the ambient air

Asbestos concentration (ng/m3) Less than	Hair dryer effluent measurements		Asbestos contamination measurements		Ambient air measurements	
	Number of samples	Percentage of samples	Number of samples	Percentage of samples	Number of samples	Percentage of samples
1	28	46.7				
2	30	50.0			61	29.2
5	36	60.0			120	57.4
10	41	68.3	0	0.0	168	80.4
20	49	81.7	4	7.0	184	88.0
50	54	90.0	9	15.8	200	95.7
100	55	91.7	20	35.1	206	98.6
200	56	83.3	32	56.1	209	100.0
500	56	93.3	43	75.4		
1,000	58	96.7	52	91.2		
2,000	58	96.7	55	96.5		
5,000	59	98.3	56	98.2		
10,000	60	100.0	57	100.0		

Appendix 1

ENVIRONMENTAL ASBESTOS CONTAMINATION AND HUMAN HEALTH EFFECTS

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ENVIRONMENTAL ASBESTOS DISEASE

Disease from other than occupational exposure to asbestos has been known since 1960. In that year Wagner et al published a review of 47 cases of mesothelioma found in the Northwest Cape Providence of South Africa in the previous five years.[1] Approximately half the cases described were in individuals who had, decades before, simply lived or worked in an area of asbestos mining. The hazard from environmental asbestos exposure was further documented in the findings of Newhouse and Thompson,[2] who showed that mesothelioma could occur among individuals whose potential asbestos exposure consisted of having resided near an asbestos factory or in the household of an asbestos worker. Twenty of 76 cases from the files of the London Hospital were the result of such exposures. More recent data of Anderson et al[3] have shown that 35% of 678 family contacts of former asbestos factory workers had abnormalities characteristic of asbestos exposure. To date, five deaths from mesothelioma have occurred among the family contacts of these same factory workers. Additionally, numerous reports of mesothelioma from environmental asbestos exposure continue to appear in the medical literature.[4]

Unfortunately, no data exist on the air concentrations of asbestos present in the circumstances that has led to such disease. Nevertheless, some appreciation of possible exposure can be obtained from the analysis of air samples taken in circumstances believed to be similiar to those which led to documented disease. To obtain these estimates of environmental asbestos exposure, measurements have been made of chrysotile concentrations about buildings while asbestos-containing fireproofing material was sprayed on steelwork, in buildings with damaged asbestos surfacing material, and in the homes of asbestos workers.

The contamination from spray sites was extensive, with asbestos debris often covering the sidewalks and streets adjacent to the building. Attempts were made on some job sites to contain the spray by tarpaulins, but these were often torn, loosely secured, and ineffective as containment. It is difficult to imagine contamination about a factory, even forty years ago, exceeding that from the direct spraying of asbestos materials into a community from a building 40 or more stories high. The evaluation of building air was in schools in which damage, sometimes extensive, had occurred to friable asbestos surfacing material in hallways or cafeterias. In some schools, the students had reached up to the ceiling and physically dislodged asbestos material. The household measurements were made in the homes of workers employed in chrysotile mining operations in California and Newfoundland. At the time neither shower facilities nor adequate change rooms were available to the workers. Thus, the households sampled occassionally had visible asbestos fibers in the living areas of the house as well as dusty clothes awaiting cleaning in laundry facilities.

ANALYTICAL TECHNIQUES

In these measurements, the same analytical techniques have been utilized as were originally developed for the analysis of ambient air samples of chrysotile asbestos.[5] Thus, there is a direct comparability in the results of all analyses reported here. All samples were collected on 0.8 μm pore size membrane filters and analyzed using electron microscopic techniques that determined the amount of chrysotile asbestos in each specimen. This variety of asbestos was quantitated because it could easily be identified on the basis of its unique tubular structure. Amphibole asbestos (either amosite or crocidolite) could also be present in the air of buildings or in the ambient air, but it is much less commonly found. However, if present in the air sampled, such asbestos would add to the concentrations reported here.

To prepare a sample for analysis, a portion of the sample, mounted on a microscope slide, was ashed in a low temperature-activated oxygen furnace for approximately four hours. This served to remove the membrane filter material, all organic material in the collected sample, soot and other carbonaceous material. The residue, consisting mostly of fly ash and mineral matter, was dispersed on microscope slides in a solution of 1% nitrocellulose in amyl acetate. Upon evaporation of the amyl acetate, the dispersal was scanned for uniformity and representative areas were chosen for transfer to electron microscope grids for scanning. The samples thus prepared were scanned at magnification of 20,000X. Typically, four to eight 100 μm squares of separate grids from each sample were scanned, and the mass of chrysotile fibers was determined by sizing each individual fiber. Control blank filters were processed with each set of four samples and background levels of chrysotile determined from them subtracted from that found on sample filters.

OUTDOOR ASBESTOS CHRYSOTILE CONCENTRATIONS

Asbestos of the chrysotile variety has been found to be a ubiquitous contaminant of ambient air. A study of 187 quarterly composite samples collected in 48 United States cities during 1969 to 1970 showed chrysotile asbestos to be present in virtually all metropolitan areas.[6] Table 1 lists the distribution of values obtained in that study. Each value represents the chrysotile concentration in a composite of from five to seven 24-hour samples and thus averages over possible peak concentrations which could occur periodically or randomly. Of the three samples greater than 20 ng/m^3, one was in a city having a major shipyard and another in a city that had four brake manufacturing facilities. Thus, these samples may include a contribution from a specific source in addition to that of the general ambient air. In a study of the ambient air of New York City, in which samples were taken only during daytime working

hours, higher values than those mentioned above were obtained.[7] These were six-to-eight hour samples collected between 8:00 A.M. and 5:00 P.M., and reflect what could be intermittently higher concentrations during those hours compared to night time periods, for example. Table 2 records the chrysotile content of 22 samples collected in the five boroughs of New York. It should be noted that the samples analyzed in all of the studies discussed above were taken during a period when fireproofing high rise buildings by spraying asbestos-containing materials was permitted. The practice was especially common in New York City. While no sampling station was known to be located adjacent to an active construction site, unusually high levels could nevertheless have resulted from the procedure. Other sources that may have contributed to these air concentrations include automobile braking, other construction activities, consumer use of asbestos products and maintenance or repair activities of asbestos-containing materials (thermal insulation, for example).

CHRYSOTILE ASBESTOS CONCENTRATIONS ABOUT CONSTRUCTION SITES

To determine if construction activities could indeed be a significant source of chrysotile fiber in the ambient air, six-to-eight hour daytime sampling was conducted in lower Manhattan in 1969 about sites where extensive spraying of asbestos-containing fireproofing material was taking place.[4,7] Eight sampling sites were established about the World Trade Center construction site during the period when asbestos materials were sprayed on the steelwork of the first tower. Table 3 shows the results of those sites located within one-half mile of the Trade Center site and demonstrated that spray fireproofing can contribute significantly to asbestos air pollution. In some instances, chrysotile asbestos levels approximately 100 times the concentrations typically found in the ambient air were observed.

CHRYSOTILE ASBESTOS CONCENTRATIONS IN U. S. SCHOOL BUILDINGS

Of particular concern recently has been the finding of extensive asbestos use in public school buildings. Asbestos surfaces have been found in more than 10% of pupil areas in schools of New Jersey with two-thirds of these surfaces having some evidence of damage. As these values appear typical of conditions in many other states, it has been estimated that from two to six million pupils and 100,000 to 300,000 teachers may be exposed to released asbestos fibers in schools across the nation.[8] To obtain a measure of contamination for this use of asbestos, ten schools were sampled in the urban centers of New York and New Jersey and suburban areas of Massachusetts and New Jersey. Schools were selected for sampling because of visible damage, in some cases extensive, and thus are not typical of all schools.

Table 4 lists the distribution of chrysotile concentrations found in samples taken over four to eight hours in these ten schools. Chrysotile asbestos concentrations ranged from 9 ng/m^3 to 1950 ng/m^3 with an average of 217 ng/m^3. Outside air samples at three of the schools varied from 3 ng/m^3 to 30 ng/m^3 with an average of 14 ng/m^3. In all samples but two (which measured 320 ng/m^3) no asbestos was visible on the floor of the area sampled although surface damage was generally present near the area sampled. The highest value (1950 ng/m^3) was in sample following routine sweeping of a hallway in a school with water damage to the asbestos surface. However, no visible asbestos was seen on the hallway floor. Because the schools were selected on the basis of visible damage, these results cannot be considered typical of all schools with asbestos surfaces. They do, however, illustrate the extensive contamination that can occur.

CHRYSOTILE CONCENTRATIONS IN THE HOMES OF WORKERS

The finding of asbestos disease in family contacts of individuals occupationally exposed to the fiber directs attention to air concentrations in the homes of such workers. Thirteen samples have been collected in the homes of asbestos mine and mill employees and analyzed for chrysotile. The workers were employed at mine operations in California and Newfoundland and did not, at the time of sampling (1973 and 1976) have access to shower facilities nor commonly change clothes before going home. Table 5 lists the concentrations range of these samples. Three samples taken in homes of non-miners in Newfoundland yielded concentrations of 32, 45, and 65 ng/m^3. In contrast, the workers homes were much higher, pointing to the need for appropriate shower and change facilities in asbestos workplaces. As asbestos cancers have been documented in family contacts of workers, concentrations such as seen here should be viewed with particular concern.

DISCUSSION

Three sets of data have been obtained demonstrating significant environmental contamination by asbestos in different circumstances. Seventeen samples collected at various sites about the World Trade Center during the spraying of asbestos materials on the steelwork for fireproofing purposes were analyzed for chrysotile asbestos. Twenty-seven samples collected in public schools with damaged asbestos surfaces and 13 in the homes of asbestos mine and mill employees were also studied. In all cases the sampling was designed to reflect the more serious instances of contamination in these circumstances. The severity of some of the conditions sampled was sufficiently great that it is difficult to imagine conditions even in past years, more egregious than those considered here.

Of 57 air samples collected and analyzed for chrysotile asbestos to assess the degree of environmental contamination, 37 exceeded 50 ng/m^3 (Tables 3 - 5). In contrast only three of 209 ambient air samples exceeded this value (Tables 1,2) and, in each of the three, source contamination may have been an important contributor of asbestos. Nevertheless, only two of the 57 samples were in excess of 1000 ng/m^3. In the absence of any other data to the contrary, these concentrations appear to be the representative of serious environmental contamination. Thus, prudence would dictate that the findings of such air concentrations in environmental circumstances should lead to appropriate control or remedial action. In the absence of appropriate action, asbestos-related malignancies could develop in large populations so exposed. Parenthetically, the data on asbestos concentrations about spray asbestos sites did lead to the prohibition of the process by various states and municipalities in 1971 and 1972 and by the EPA in 1973. [9]

A second consideration also indicates that air concentrations approaching 1000 ng/m^3 in environmental circumstances be rapidly controlled. Data suggest that workers exposed to concentrations of 2 f longer than 5 microns per ml of air (the current occupational asbestos standard) in a British chrysotile products manufacturing facility may develop serious asbestos disease.[10] In this factory 2 f/ml was determined to be equivalent to 120,000 ng/m^3.[11] As some non-fibrous material may have been included in the conversion determination, a better relationship suggests that 2 f/ml is approximately 60,000 mg/m^3. [12] Epidemiological data of this factory's current mortality experience suggests that 10% of the deaths of long-term employees will be occupationally related at 2 f/ml. [10] The excess

would primarily consist of deaths from mesothelioma and lung cancer.

Other data are in hand linking the incidence of lung cancer in workers engaged in asbestos mining and milling and asbestos products manufacturing to total dust concentrations in the workplace.[13,14] The best fit to these data demonstrate a linear relationship between total dust and the rate of excess mortality from bronchogenic carcinoma. Even though fiber concentrations are unavailable in these studies, the linear relationship, with no evidence of a threshold below which disease does not appear, suggests that any extrapolation of the risk of asbestos disease in occupational circumstances to environmental exposures should utilize a linear relationship. If 10% of the deaths in workers exposed to 60,000 ng/m^3 are asbestos related, such an extrapolation suggests that 1/6000 deaths will be asbestos related at daily environmental exposures of 100 ng/m^3 and 1/600 at 1000 ng/m^3. If the exposures are intermittent, the risk would be correspondingly reduced.

While these risks are considerably less than those of occupational circumstances, concern arises from the fact that millions of people may be exposed to multiple sources of lower concentrations through the daily use of such products as asbestos insulated hair dryers, habitation of public and private buildings containing asbestos materials as fireproofing, acoustic or thermal insulation, and in other environmental circumstances.

Table 1

Distribution of 24-hour chrysotile asbestos concentrations in ambient air of United States cities 1969 - 1970

Asbestos concentration (ng/m^3) Less than	Number of samples	Percentage of samples
1	61	32.6
2	119	63.6
5	164	87.7
10	176	94.2
20	184	98.5
50	185	99.0
100	187	100.0

Table 2

Distribution of 4- to 8-hour daytime chrysotile asbestos concentrations in the ambient air of New York City 1969 - 1970

Asbestos concentration (ng/m^3) Less than	Number of samples	Percentage of samples
1	0	0.0
2	1	4.5
5	4	18.1
10	8	36.4
20	16	72.7
50	21	95.4
100	22	100.0

Table 3

Distribution of 6- to 8-hour chrysotile asbestos concentrations within one-half mile of the spraying of asbestos materials on building steelwork 1969 - 1970

Asbestos concentration (ng/m^3) Less than	Number of samples	Percentage of samples
5	0	0.0
10	3	17.6
20	8	47.1
50	14	82.3
100	16	94.1
200	16	94.1
500	17	

Table 4

Distribution of chrysotile asbestos concentrations in 4- to 8-hour samples taken in public schools with damaged asbestos surfaces

Asbestos concentration (ng/m^3) Less than	Number of samples	Percentage of samples
5	0	0.0
10	1	3.7
20	1	3.7
50	6	22.2
100	12	44.4
200	19	70.4
500	25	92.6
1000	26	96.3
2000	27	100.0

Table 5

Distribution of 4-hour chrysotile asbestos concentrations in the air of homes of asbestos mine and mill employees

Asbestos concentration (ng/m^3) Less than	Number of samples	Percentage of samples
50	0	0.0
100	4	30.8
200	8	61.5
500	10	76.9
1000	12	92.3
2000	12	92.3
5000	13	100.0

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