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MEMORANDUM

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

TO : Gale Wyer
Science Directorate
Consumer Product Safety Commission

DATE: October 18, 1979

FROM : Director, Division of Physical Sciences
and Engineering
National Institute for Occupational
Safety and Health

SUBJECT: Final Report - Interagency Agreement 79-29: Testing of Hair Dryers for Asbestos Emissions

Attached is the final report of work performed under Interagency Agreement 79-29 with the U.S. Consumer Product Safety Commission for the testing of hair dryer effluent for asbestos. Institute personnel involved with the study and their contributions are:

Charles L. Geraci, Jr., Ph.D. - Overall project direction, dryer sampling, and reporting

Paul A. Baron, Ph.D. - Design, construction and testing of test apparatus

Donald J. Murdock - Design and construction of test system

James W. Carter - TEM analysis of filter samples

Michele Bolyard - " " " " "

David L. Smith - Sampling of dryer effluent.

Walter M. Haag
Walter M. Haag

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WITH PORTIONS REMOVED:
11/7/03

TESTING OF HAIR DRYERS FOR ASBESTOS EMISSIONS

Charles L. Geraci, Jr., Ph.D.
Paul A. Baron, Ph.D.
James W. Carter
David L. Smith

Interagency Agreement NIOSH IA-79-29

with

U.S. Consumer Product Safety Commission

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U. S. Department of Health, Education, and Welfare
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Physical Sciences and Engineering
Cincinnati, Ohio

September, 1979

REPORT TO THE U.S. COMSUMER PRODUCT SAFETY COMMISSION ON TESTING OF HAIR DRYERS FOR ASBESTOS EMISSIONS

BY

THE DIVISION OF PHYSICAL SCIENCES AND ENGINEERING
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Background

Beginning in April 1979, the National Institute for Occupational Safety and Health (NIOSH) furnished to the Consumer Product Safety Commission (CPSC) the laboratory and other support services necessary to test the effluent air of hand-held hair dryers for asbestos fibers. The need to determine the possible release of asbestos fibers from hand-held hair dryers containing asbestos insulation materials was realized by CPSC as a result of news media disclosure of asbestos release and a petition by the Environmental Defense Fund, Inc. (EDF). The petition presented by EDF requested that CPSC proceed under the Consumer Product Safety Act to remove hair dryers containing asbestos from the consumer marketplace. Preliminary evidence was presented by EDF which allegedly demonstrated the ability of several hair dryers containing asbestos insulation material to emit asbestos fibers. To fully evaluate the potential consumer exposure to asbestos from asbestos containing hand-held hair dryers CPSC determined that the identification and quantitation of fibers emitted by the dryers having lengths and diameters of as little as 1 micrometer (um) or less would be necessary. To accomplish this task any samples generated would require analysis by a transmission electron microscope (TEM) capable of performing energy dispersive analysis of x-rays (EDAX) and selected area electron diffraction (SAED). The actual sampling of effluent air from the hair dryers would also require expertise and capabilities in the area of

air sampling and the fabrication of controlled atmosphere test systems. Both the sampling and analysis experience necessary to perform a study of this type reside within the Division of Physical Sciences and Engineering (DPSE) of NIOSH. On April 12, 1979, NIOSH and CPSC entered into an interagency Agreement to accomplish the task of evaluating potential consumer exposure to asbestos released by hair dryers.

Objective

The primary objective of the project was to quantitate and identify asbestos structures in the effluent air of hand-held hair dryers during operation. Making this determination would require the following:

1. A count of asbestos structures and fibers sampled during operation of the product.

2. Qualitative identification by EDAX or SAED of fibers sampled as being asbestos or non-asbestos.

3. Determination of the size distribution of sampled asbestos fiber lengths and diameters.

4. Determination of fiber count and fiber mass per cubic meter of effluent air.

To meet the needs of the project a system to determine asbestos emissions from hair dryers was fabricated and validated by NIOSH. A sampling of hair dryers, new and used, that contained asbestos was collected by CPSC and submitted to NIOSH for testing. All dryers were

tested as received from CPSC.

Test System

The valid determination of asbestos release from the hair dryers demanded the test system meet several requirements. Previous tests (1-4) indicated that a valid determination of the amount of asbestos emitted by various hair dryers would require a clean sampling system capable of accurately determining asbestos concentrations over a wide range. Therefore, the air entering the hair dryers in the test system was filtered to eliminate the possibility of external asbestos contamination and to reduce the amount of background particulate that might interfere with the electron microscope analysis of the samples. The high flowrate of air through many of the dryers precluded complete collection of the effluent. Therefore, the test system was designed to obtain an accurate representative sample of the hair dryer effluent.

The hair dryer test system consisted of several components including a clean air source, a sampling duct assembly, several types of monitoring equipment and filter samplers. A schematic of the test system is shown in Figure 1.

The high flowrate (up to 2 m^3/min) produced by some hair dryers required a high flowrate, clean air source to eliminate background interferences during testing. A test tunnel in the NIOSH dust laboratory was adapted for these tests. Two 60 cm x 60 cm high efficiency particulate air (HEPA) filters in series were used to remove ambient particulate. The ducting around the high flowrate blower was sealed to prevent

recontamination of the air introduced into the specially constructed clean air test chamber (volume $\sim$ 1 m^3). The airstream entering the test chamber was deflected by a metal plate and diffused through a punched-hole screen. Excess air exhausted from the test chamber via a 25 cm square port through which the sampling duct entered. With the entire system operational and a hair dryer operating, a positive pressure in the hood of approximately 0.15 cm H_2O was obtained. This pressure was low enough to preclude any significant effect on hair dryer operation. The air velocity through the exit port was high enough (100 cm/sec) to prevent turbulent back diffusion of ambient air into the hood. That portion of the test system in which the dryer was placed is herein referred to as the clean air hood.

A dry box glove was fitted to the side of the hood to permit manipulation of the hair dryer controls during a test run without contaminating the hood with ambient air.

The air exhausting from the sampling duct was fed back into the inlet of the test tunnel HEPA filter to prevent potential asbestos escape into the laboratory.

A velocity profile was obtained in the return air duct in order to estimate the total air flow through the clean air supply. The velocity in the 12.7 cm diameter duct was uniformly 762 cm/sec indicating a flowrate of 5.78 m^3/min.

The sampling duct assembly consisted of a one meter length of 18 cm diameter duct and various tapered adapters which allowed direct connection to the outlet of various shaped hair dryers. The duct was selected to be

large enough to easily contain three side by side 37 mm filter cassette samplers. The sampling protocol was subsequently changed to use a single Millipore aerosol open-type 47 mm filter holder with a stainless steel body and support screen. The walls of the duct and tapered sections were coated with oil to prevent reentrainment of particles from the surface of the duct, thereby assuring that particulate from any one dryer would not be detected during subsequent tests.

Based on work by Liu and Agarwal (5) the losses in the duct of particles smaller than 5 um aerodynamic diameter were expected to be less than 10% for the flowrates of all the hair dryers tested. The air flow through the duct for these flowrates was in the turbulent regime indicating that the potential source of any primary particle losses expected would be turbulent impaction on the of the duct rather than gravitational setteling of the particles.

Sampling the hair dryer air supply and effluent was accomplished by using 37 mm and 47 mm filter cassettes, respectively, and 0.8 um pore size mixed cellulose ester membrane filters. These filters have greater than 99% efficiency for all particles of interest (6).

A vacuum pump was used to draw 69.4 liters per minute of air through the 47 mm filter cassettee. The sampling system was calibrated using an American Meter Company 150 liter spirometer. An MSA Model G pump was used to sample the supply air at 2 liters per minute with a 37 mm open-face cassette. Calibration of this system was accomplished with a soap film bubble meter.

Sampling at 69.4 L/min allowed collection of a sufficient volume of effluent in a reasonable amount of time to allow an accurate determination of airborne particulate concentrations. Any possible error because of the resulting anisokinetic sampling was judged negligible since the major source of error lies with particles larger and heavier than those expected from the hair dryers. Also, most treatments of anisokinetic sampling error assume laminar flow in the sample stream. As stated previously, the flow in the sampling duct was turbulent and not laminar.

Three different real time particle monitors were used during the assembly and initial testing of the hair dryer test system. These instruments included a Royco Model 225 connected to a multichannel analyzer, a Particle Measuring Systems (PMS) ASAS-X particle spectrometer and a GCA Fibrous Aerosol Monitor (FAM). All of these instruments detect particles by their light scattering properties.

The Royco Model 225 was used to determine the uniformity of distribution of particles across the sampling duct. Monodisperse, 12 um potassium biphthalate particles were generated using a TSI, Berglund-Liu generator. These particles were injected into the duct just downstream of an operating hair dryer which produced a duct air velocity of 58 cm/sec. A probe connected to the Royco particle counter was inserted into the duct at the sampling location and nine representative locations across the duct were sampled. The coefficient of variation at these nine traverse point locations was less than 0.08, indicating acceptably uniform distribution of particles within the duct. Sampling the hair dryer effluent at various locations within the duct was thus expected to be representative of the

entire effluent.

The PMS ASAS-X aerosol spectrometer was used to monitor the effectiveness of the air cleaning system. Particles in the 0.15 to 0.30 um range were monitored with the ASAS-X since this size produced a rapid instrument response and was expected to have the highest penetration into the clean air system. Ambient particle concentrations (0.15 - 0.30 um) were reduced by a factor of 40 in the clean air hood (see Table 1). Background filter samples were found to be quite clean by electron microscopy, so no further effort was made to reduce this concentration. The production of particles by some of the hair dryers was also noted with the ASAS-X.

TABLE I

Particles Larger than 0.15 um Using ASAS-X Spectrometer

Ambient air	35-50 particles/cm^3
Clean air hood	1-2 particles/cm^3
Test duct, dryer on	2-4 particles/cm^3

These particles were apparently generated by motor bearing or electrical brush wear, although these concentrations were barely above the clean air background.

The clean air system was found to be entirely adequate to supply air to all the dryers. Using the ASAS-X, it was found that the particle concentration in the hood was brought down to its baseline level less than one minute after the high volume blower was turned on.

The third monitoring instrument used was the FAM. This device was used

to indicate the fiber concentration in the hair dryer effluent. The FAM responds only to the larger fibers (and not just to asbestos) visible by light microscopy. The FAM was used with several hair dryers. In some cases, a single fiber was noted in a two hour period, and in others, none were detected. A one fiber count in a two hour period indicated approximately 0.01 fibers/cc. The statistical significance of one fiber counted in the size range limitations of the FAM was questionable for this study. Use of the FAM on this study was discontinued because of its lack of sensitivity at such low concentrations. It should be noted that the FAM was designed to operate primarily in the 0.1 to 20 fiber/cc range to meet the requirements of the OSHA standard for asbestos (7).

Sampling Procedure

Before positioning the dryer to be tested in the clean air hood, the appropriate reducer was attached to the sampling duct. Various size reducers were fabricated to ensure the best interface possible between the dryer and sampling duct. The dryer was firmly clamped into position and sealed to the sampling duct reducer with duct tape. The dryer was then plugged into the power supply located inside the clean air hood. The clean air supply blower was then turned on and allowed to flush the clean air hood for 15 minutes and the dryer was then turned on. An air velocity profile was determined in the sampling duct using a Sierra Instruments Model 440 thermo-anemometer. A uniform velocity profile indicated a good placement of the dryer. If the velocity profile indicated nonhomogeneous flow, the dryer was repositioned to produce uniform flow. Dryer velocities

were determined with a Taylor rotating vane anemometer. Dryer flow rates were also checked by interfacing a 2 inch plastic pipe to the dryer inlet and determining the air velocity with the thermo-anemometer.

A 47 mm diameter filter, Millipore AAWP, was placed in the stainless steel filter holder and the assembly placed in the sampling duct. Also, a 37 mm filter, Millipore AAWP preloaded in a styrene open-faced cassette was positioned inside the clean air hood near the dryer inlet. Pumps for both filter samplers were started and the dryer effluent was sampled for 2 hours. The dryer was accessed when necessary during the high-heat-low-heat cycle via the glove port in the clean air hood wall. At the end of the sampling period the 47 mm filter sample was removed from the filter holder and carefully placed in a 47 mm petri dish and brought to the TEM laboratory for examination. Background samples were obtained both in the clean air hood and at the end of the sampling tunnel while operated without a dryer in the test chamber.

TEM Analysis

The asbestos analyses for the study were performed on a JEOL 100B electron microscope equipped with both selected area electron diffraction (SAED) and energy dispersive analysis of x-rays (EDAX). The microscope magnification was calibrated using 0.5 um Latex spheres, and during the course of the study individual fibers were identified on a random basis by diffraction patterns and metal content.

Due to the light loading of fibers seen on samples obtained early in the study, the decision was made to scan the entire grid in order to

to acquire a representative sample. Each grid contained approximately 200 fields each measuring 80 x 80 um. Counting time varied from 2 hours for lightly loaded samples to 3.5 days for the most heavily loaded samples. Background samples of the supply air showed very clean, fiber free filters. A detection limit of one fiber per grid would result in a sensitivity of 9 x 10^{-5} fiber/cc. Representative photomicrographs are presented in Appendix I.

Sample Preparation

The Millipore AA filters used in sampling the effluent from the hair dryers were prepared for analysis following the standard NIOSH procedure described in Technical Information Bulletin #77-204 (8). A disk was removed from the center of each filter with a No. 5 cork bore. The sample disks were affixed to a clean glass slide and allowed to clear in acetone vapor for 5 minutes. The samples were then coated with a thin carbon film in a vacuum evaporator to provide an electron beam transparent surface to which the collected particles could adhere. After coating, the cleared filter disks were cut out and placed upside down on pre-coated 200 mesh copper grids which had been placed in a petri dish on absorbent Whatman #41 filters. The Whatman filters were carefully saturated with acetone and left to sit overnight to allow complete dissolution of the sample filters. When dry, the preparations were ready for analysis by electron microscopy.

Fiber Count

The sample grids were scanned initially to ensure that at least 70% of the preparation remained intact. A fiber search was carried out at a magnification of 1700X and fibers were sized and counted at a magnification of 10,000X. Fiber clumps and bundles which exhibited unequal or ambiguous

dimensions were sized in segments or were assigned an average diameter based on 3 or more measurements. In all cases, multiple measurements taken on fiber bundles, clumps, and clusters were bracketed in the data record to indicate that they be treated as a single airborne structure in calculating air concentrations.

The length and diameter of each individual fiber was determined to allow calculation of the volume of each fiber. Calculating the volume of each fiber allowed an accurate estimation of fiber mass. The only assumption made was that each fiber approximated a solid cylinder.

All recorded data were reduced by computer to obtain air concentrations and fiber size distributions. A description of the calculation can be found in Appendix I, Test Data.

Summary

During the testing program conducted for CPSC, 30 dryers were tested. Of these, 25 were home use hand-held appliances, 3 were table-top hooded models, one was a hobby heat gun, and one was a heavy duty commercial salon style dryer. Airborne asbestos concentrations generated by these dryers ranged from 0 to 0.11 structures/cc and the mass concentrations ranged from 0 to 7652 ng/m^3. During the test program, one asbestos fiber was detected in the entire group of background samples. The pooled results of these background samples resulted in a background concentration of 3×10^{-5} fibers/cc.

The pairs of results obtained by running each hair dryer on high heat versus cycled heat were used to determine an upper limit on the variability of the sampling and analysis. The geometric mean of the ratios of the

structures/cc concentrations of high heat to cycled heat for 21 pairs of non-zero results was 1.19 with a 95% confidence interval of 0.82 to 1.73. Thus, the successive sample ratio for each dryer cannot be considered significantly different from unity, indicating no significant differance between samples taken at high heat or at cycled heat. The paired samples were evaluated to find the variability due to sampling and analysis techniques. The geometric standard deviation was used to determine the upper and lower 95% confidence limits on any measurement, N. These limits can be determined by respectively multiplying and dividing N by the factor 3.4. In other words, at a 95% confidence the true value for any measurement, N, is between N X 3.4 and N/3.4.

Figures 2 and 3 show frequency distribution graphs of the hair dryer test results as a function of the number of asbestos structures emitted and the mass of asbestos emitted, respectively. In each figure, the bar on the extreme left indicates the number of dryers from which zero emissions were observed.

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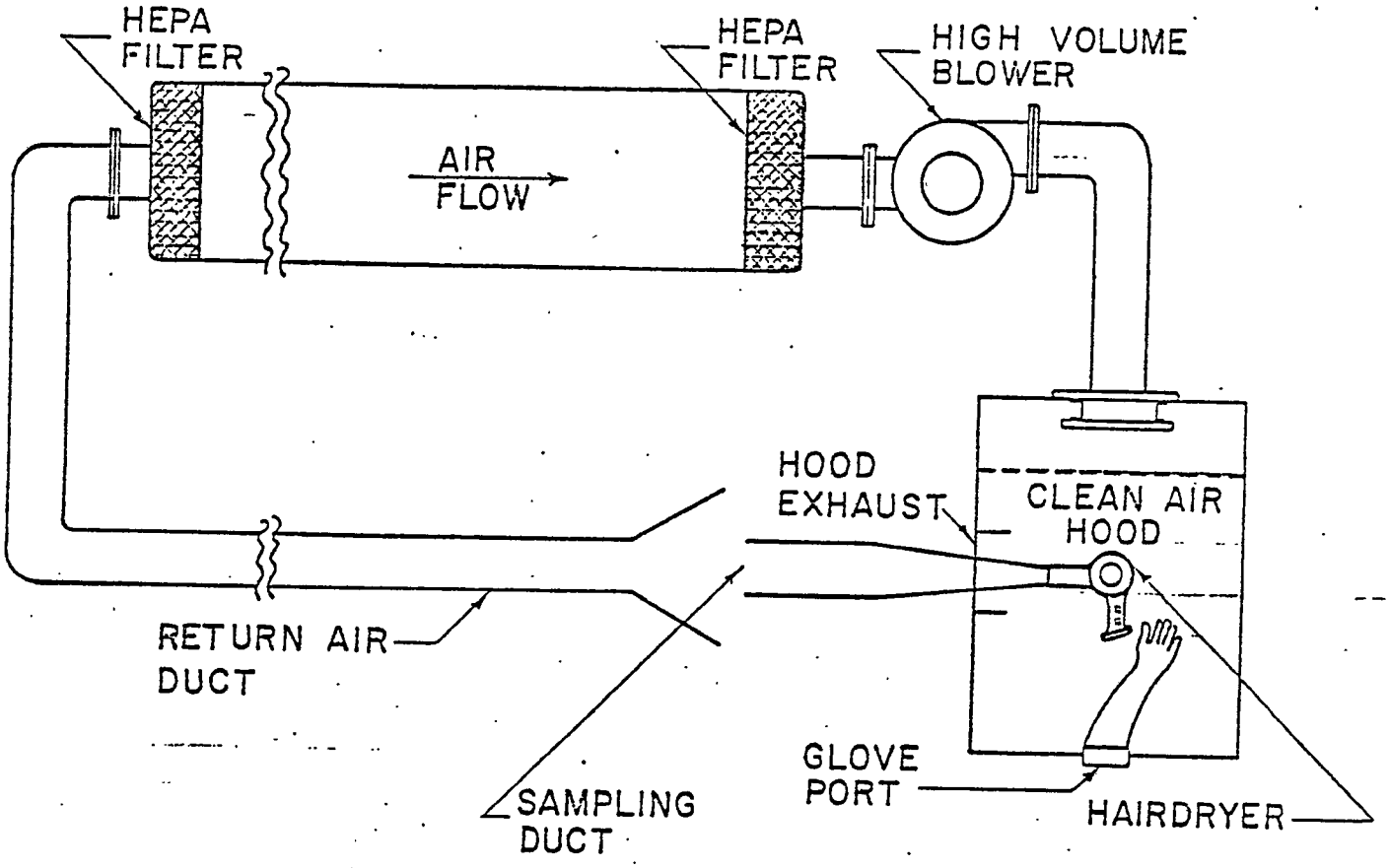


Figure 1. Schematic of Test System

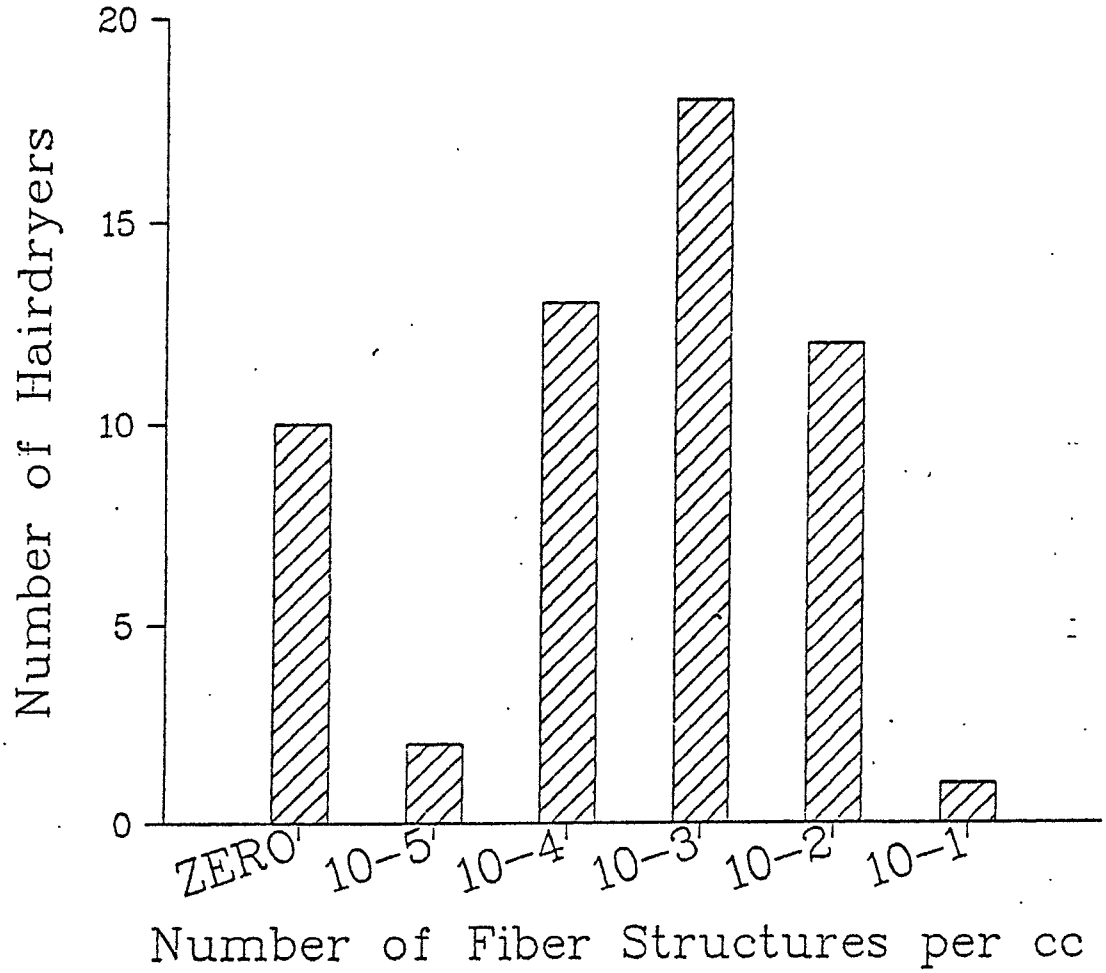

Number Concentration Frequency
Number of Hairdryers
20
15
10
5
0
ZERO'
10-5'
10-4'
10-3'
10-2'
10-1'
Number of Fiber Structures per cc

Figure 2

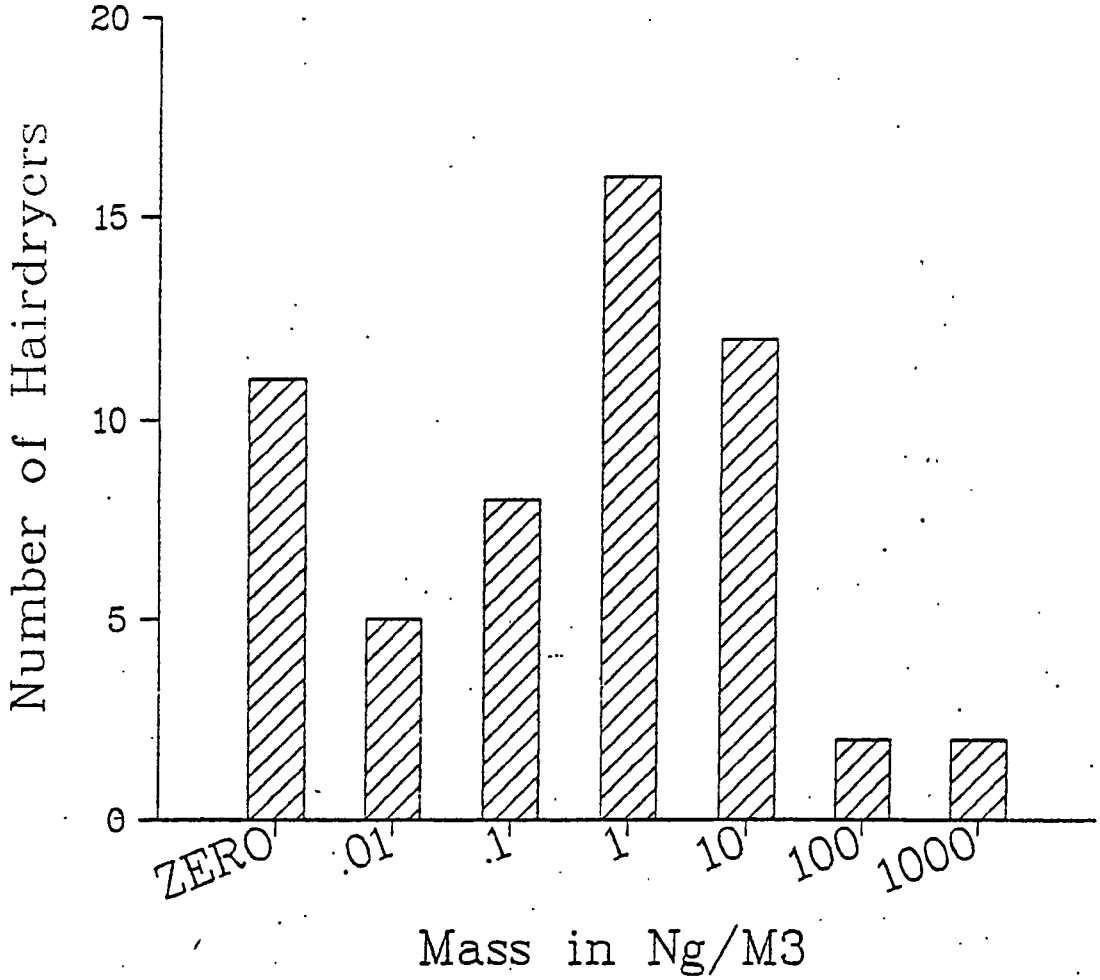

Mass Concentration Frequency
Number of Hairdryers
20
15
10
5
0
ZERO
.01
.1
1
10
100
1000
Mass in Ng/M3

Figure 3

APPENDIX I

TEST DATA AND SAMPLING AND ANALYSIS INFORMATION

1. Sampling rate: 69.4 L/min (2.45 cfm)

2. Sampling time: 2 hours

3. Fiber counts are presented as follows:

   I = Individual fibers not part of a clump or bundle

   B/C = Number of bundles or clumps

   T = Number of individual fibers (I) plus the number of fibers contained in each clump or bundle

4. The structures/cc calculation treats each bundle or clump as one airborne structure e.g.: from a count of I = 5, B/C = 7, and T = 45 the number used to calculate structures/cc would be I + B/C = 12.

$$\text{Structures/cc} = \frac{(FC/TEM) \times ECA}{VOL}$$

   FC = Total structures counted (I + B/C)
   TEM = TEM grid area examined (mm^2)
   ECA = Effective filter collecting area (960 mm^2)
   VOL = Sample volume in cc

Example Calculation:

   If: I = 55 TEM = 1.22 mm^2
   B/C = 30 VOL = 8328000 cc

   Then: Airborne structures/cc = $\frac{(85/1.22)960}{(8328000)} = 0.008$

If effluent volume is 170 m^3, total airborne structures in effluent = (0.008 structures/cc) x (1.7×10^8 cc) = 1.36 X 10^6 structures

5. The volume of each fiber counted, both individual fibers and those in clumps (T value), is calculated and its mass determined using a density of 2.4 grams/cc for chrysotile asbestos. Total fiber mass as reported is a sum of individual massess.

Sample Number: D-870-5361

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	673	673
Effluent Volume (L):	8.1×10^4	8.1×10^4
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=171 B/C=4 T=181	I=23 B/C=1 T=25
Airborne Structures/cc:	1.6×10^{-2}	7.1×10^{-3}
Total Structures in Effluent:	1.3×10^6	5.7×10^5
Fiber Mass (ng/m^3):	13.9	8.8
Total Fiber Mass in Effluent (ng):	1121	709
Fiber Length Range (um):	0.6-26	0.8-23
Mean Fiber Length (um):	3.7	4.1
Fiber Diameter Range (um):	0.05-1.2	0.005-0.8
Mean Fiber Diameter (um):	0.21	0.22
Total TEM Fie Field Area Examined (mm^2):	1.24	0.39

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: D-835-3535

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos insulation was present as a tubular lining to the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	2632	2632
Effluent Volume (L):	3.16×10^5	3.16×10^5
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=6 B/C=0 T=6	I=13 B/C=2 T=20
Airborne Structures/cc:	5.2×10^{-4}	1.3×10^{-3}
Total Structures in Effluent:	1.6×10^5	4.1×10^5
Fiber Mass (ng/m^3):	0.22	2.2
Total Fiber Mass in Effluent (ng):	71	693
Fiber Length Range (um):	0.8-13.2	0.7-9.0
Mean Fiber Length (um):	5.0	3.5
Fiber Diameter Range (um):	0.06-0.3	0.05-1.2
Mean Fiber Diameter (um):	0.2	0.2
Total TEM Field Area Examined (mm^2):	1.32	1.3

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: CPSC-8

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	849	849
Effluent Volume (L):	95880	95880
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=18 B/C=6 T=30	I=21 B/C=6 T=56
Airborne Structures/cc:	2.5×10^{-3}	2.7×10^{-3}
Total Structures in Effluent:	2.4×10^{5}	2.6×10^{5}
Fiber Mass (ng/m^3):	15	8.6
Total Fiber Mass in Effluent (ng):	1438	1822
Fiber Length Range (um):	0.5-12	0.7-22
Mean Fiber Length (um):	3.4	3.2
Fiber Diameter Range (um):	0.05-2	0.05-1.2
Mean Fiber Diameter (um):	0.31	0.23
Total TEM Field Area Examined (mm^2):	1.2	1.25

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-352

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer.
The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1284	1284
Effluent Volume (L):	154080	154080
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=1 B/C=0 T=1	I=4 B/C=0 T=4
Airborne Structures/cc:	1.15×10^{-4}	4.2×10^{-4}
Total Structures in Effluent:	1.77×10^{4}	6.5×10^{4}
Fiber Mass (ng/m^3):	0.096	7.7
Total Fiber Mass in Effluent (ng):	14.7	1.2×10^{3}
Fiber Length Range (um):	no range	3.8-36
Mean Fiber Length (um):	7.1	12.9
Fiber Diameter Range (um):	no range	0.05-1
Mean Fiber Diameter (um):	0.25	0.5
Total TEM Field Area Examined (mm^2):	1.0	1.05

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-377

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer.
The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1035	1035
Effluent Volume (L):	124200	124200
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=16 B/C=1 T=18	I=92 B/C=6 T=108
Airborne Structures/cc:	1.7×10^{-3}	9.3×10^{-3}
Total Structures in Effluent:	2.1×10^{5}	1.2×10^{6}
Fiber Mass (ng/m^3):	2.9	17
Total Fiber Mass in Effluent (ng):	361	2148
Fiber Length Range (um):	0.8-25	0.7-45
Mean Fiber Length (um):	6.9	5.2
Fiber Diameter Range (um):	0.03-0.7	0.05-1.0
Mean Fiber Diameter (um):	0.25	0.22
Total TEM Field Area Examined (mm^2):	1.17	1.2

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-840-5924

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Hand-held hair dryer. The asbestos insulation was present as a lining to the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	418	418
Effluent Volume (L):	170160	170160
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=7 B/C=1 T=13	I=1 B/C=0 T=1
Airborne Structures/cc:	7×10^{-4}	1.1×10^{-4}
Total Structures in Effluent:	1.2×10^{5}	1.8×10^{4}
Fiber Mass (ng/m^3):	39	0.098
Total Fiber Mass in Effluent (ng):	6609	16
Fiber Length Range (um):	1.0-25	no range
Mean Fiber Length (um):	8.6	5.3
Fiber Diameter Range (um):	0.03-3.0	no range
Mean Fiber Diameter (um):	0.8	0.3
Total TEM Field Area Examined (mm^2):	1.31	1.06

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-380A

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Hand-held hair dryer. No asbestos was visible.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1219	1219
Effluent Volume (L):	1.5×10^5	1.5×10^5
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=0 B/C=0 T=0	I=0 B/C=0 T=0
Airborne Structures/cc:		
Total Structures in Effluent:		
Fiber Mass (ng/m^3):		
Total Fiber Mass in Effluent (ng):		
Fiber Length Range (um):		
Mean Fiber Length (um):		
Fiber Diameter Range (um):		
Mean Fiber Diameter (um):		
Total TEM Field Area Examined (mm^2):	1.35	1.35

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-361

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held, comb type dryer. The asbestos was present as a lining to the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	184	Dryer has only one setting
Effluent Volume (L):	19017	
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=7 B/C=3 T=17	
Airborne Structures/cc:	1.1×10^{-3}	
Total Structures in Effluent:	2.1×10^{4}	
Fiber Mass (ng/m^3):	2.2	
Total Fiber Mass in Effluent (ng):	42	
Fiber Length Range (um):	1-21	
Mean Fiber Length (um):	6.4	
Fiber Diameter Range (um):	0.05-0.8	
Mean Fiber Diameter (um):	0.25	
Total TEM Field Area Examined (mm^2):	1.06	

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-376

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1104	1104
Effluent Volume (L):	132480	132480
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=2 B/C=1 T=4	I=5 B/C=0 T=5
Airborne Structures/cc:	3.0×10^{-4}	4.6×10^{-4}
Total Structures in Effluent:	4.0×10^{4}	6.1×10^{4}
Fiber Mass (ng/m^3):	0.22	0.16
Total Fiber Mass in Effluent (ng):	29	21
Fiber Length Range (um):	3.5-17	1.5-5.5
Mean Fiber Length (um):	9.75	3.44
Fiber Diameter Range (um):	0.08-0.3	0.07-0.4
Mean Fiber Diameter (um):	0.17	0.2
Total TEM Field Area Examined (mm^2):	1.16	1.25

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-360

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos was present as a component of the support for the heating element.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	618	618
Effluent Volume (L):	74160	74160
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=314 B/C=24 T=386	I=177 B/C=8 T=206
Airborne Structures/cc:	3.4×10^{-2}	2.0×10^{-2}
Total Structures in Effluent:	2.5×10^{6}	1.5×10^{6}
Fiber Mass (ng/m^3):	34	21
Total Fiber Mass in Effluent (ng):	2.5×10^{3}	1.6×10^{3}
Fiber Length Range (um):	0.3-50	0.4-40
Mean Fiber Length (um):	4.1	3.5
Fiber Diameter Range (um):	0.05-1.3	0.05-1.1
Mean Fiber Diameter (um):	0.2	0.2
Total TEM Field Area Examined (mm^2):	1.23	1.22

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-390

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held, comb type dryer. The asbestos was present as a conical lining around the heating element.
* Uncountable due to high background level of amorphous,opaque material from the dryer. Insulation material in dryer was identified as chrysotile asbestos.
** Low speed inoperative; therefore, only high heat test conducted.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	99	**
Effluent Volume (L):	11880	
Sample Volume (L):	8328	
Airborne Asbestos Structures Counted:	*	

Airborne Structures/cc:

Total Structures in Effluent:

Fiber Mass (ng/m^3):

Total Fiber Mass in Effluent (ng):

Fiber Length Range (um):

Mean Fiber Length (um):

Fiber Diameter Range (um):

Mean Fiber Diameter (um):

Total TEM Field Area Examined (mm^2):

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-355

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1417	1417
Effluent Volume (L):	1.7×10^5	1.7×10^5
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=28 B/C=5 T=41	I=8 B/C=4 T=30
Airborne Structures/cc:	3.1×10^{-3}	1.1×10^{-3}
Total Structures in Effluent:	5.3×10^5	1.9×10^5
Fiber Mass (ng/m^3):	3	0.35
Total Fiber Mass in Effluent (ng):	5.15×10^2	60
Fiber Length Range (um):	0.5-48	0.7-10.5
Mean Fiber Length (um):	4.9	2.9
Fiber Diameter Range (um):	0.03-0.7	0.02-0.4
Mean Fiber Diameter (um):	0.19	0.12
Total TEM Field Area Examined (mm^2):	1.18	1.16

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-375

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1398	1398
Effluent Volume (L):	1697760	1697760
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=37 B/C=0 T=37	I=8 B/C=1 T=10
Airborne Structures/cc:	3.6×10^{-3}	1.1×10^{-3}
Total Structures in Effluent:	6×10^{5}	1.8×10^{5}
Fiber Mass (ng/m^3):	0.44	0.69
Total Fiber Mass in Effluent (ng):	740	1179
Fiber Length Range (um):	0.8-23	1.8-13
Mean Fiber Length (um):	4.7	5.7
Fiber Diameter Range (um):	0.05-8	0.15-1.4
Mean Fiber Diameter (um):	0.2	0.4
Total TEM Field Area Examined (nm^2):	1.19	0.95

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-805-1292

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held comb type dryer. The dryer was of a configuration such that the inside could not be inspected for asbestos position.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	98.7	98.7
Effluent Volume (L):	11844	11844
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=0 B/C=0 T=0	I=1 B/C=0 T=1
Airborne Structures/cc:		9.1×10^{-5}
Total Structures in Effluent:		1.1×10^{3}
Fiber Mass (ng/m^3):		0.02
Total Fiber Mass in Effluent (ng):		0.25
Fiber Length Range (um):		no range
Mean Fiber Length (um):		20
Fiber Diameter Range (um):		no range
Mean Fiber Diameter (um):		0.25
Total TEM Field Area Examined (mm^2):	0.98	1.27

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: CPSC-3

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	863	863
Effluent Volume (L):	103560	103560
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=267 B/C=16 T=304	I=139 B/C=10 T=163
Airborne Structures/cc:	0.031	0.016
Total Structures in Effluent:	3.2×10^6	1.6×10^6
Fiber Mass (ng/m^3):	16	1.9
Total Fiber Mass in Effluent (ng):	1.6×10^3	2×10^2
Fiber Length Range (um):	0.3-55	0.4-24
Mean Fiber Length (um):	3.5	2.5
Fiber Diameter Range (um):	0.02-0.9	0.02-0.5
Mean Fiber Diameter (um):	0.12	0.1
Total TEM Field Area Examined (mm^2):	1.15	1.11

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-354

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	696	696
Effluent Volume (L):	83400	83400
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=32 B/C=8 T=64	I=9 B/C=5 T=27
Airborne Structures/cc:	4.4×10^{-3}	1.5×10^{-3}
Total Structures in Effluent:	3.7×10^{5}	1.3×10^{5}
Fiber Mass (ng/m^3):	5.3	1.4
Total Fiber Mass in Effluent (ng):	439	118
Fiber Length Range (um):	0.8-12	0.4-14
Mean Fiber Length (um):	3.3	3.2
Fiber Diameter Range (um):	0.05-1.4	0.05-1.0
Mean Fiber Diameter (um):	0.22	0.18
Total TEM Field Area Examined (mm^2):	1.13	1.13

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: CPSC-2

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer.
The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1089	1089
Effluent Volume (L):	39960	39960
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=8 B/C=4 T=29	I=5 B/C=1 T=9
Airborne Structures/cc:	1.4×10^{-3}	6.5×10^{-4}
Total Structures in Effluent:	5.6×10^{5}	2.6×10^{5}
Fiber Mass (ng/m^3):	15	13
Total Fiber Mass in Effluent (ng):	604	536
Fiber Length Range (um):	0.6-15	1.3-11.5
Mean Fiber Length (um):	3.8	3.8
Fiber Diameter Range (um):	0.05-1	0.1-1.3
Mean Fiber Diameter (um):	0.25	0.31
Total TEM Field Area Examined (mm^2):	0.98	1.07

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-359

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1064	1064
Effluent Volume (L):	127680	127680
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=1 B/C=1 T=3	I=0 B/C=0 T=0
Airborne Structures/cc:	1.9×10^{-4}	
Total Structures in Effluent:	2.4×10^{4}	
Fiber Mass (ng/m^3):	0.23	
Total Fiber Mass in Effluent (ng):	29	
Fiber Length Range (um):	1.5-9.5	
Mean Fiber Length (um):	4.5	
Fiber Diameter Range (um):	0.15-0.6	
Mean Fiber Diameter (um):	0.35	
Total TEM Field Area Examined (mm^2):	1.2	1.24

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: CPSC-1

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos insulation was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1104	1104
Effluent Volume (L):	132480	132480
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=256 B/C=27 T=318	I=141 B/C=15 T=181
Airborne Structures/cc:	2.9×10^{-2}	1.5×10^{-2}
Total Structures in Effluent:	3.8×10^{6}	2.0×10^{6}
Fiber Mass (ng/m^3):	8.7	4.3
Total Fiber Mass in Effluent (ng):	1200	560
Fiber Length Range (um):	0.5-42	0.3-35
Mean Fiber Length (um):	2.6	3.0
Fiber Diameter Range (um):	0.01-1	0.03-7
Mean Fiber Diameter (um):	0.14	0.14
Total TEM Field Area Examined (mm^2):	1.25	1.23

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: CPSC-9

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos was present as a tubular lining of the barrel.

* Fiber dimensions could not be determined

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1398	1398
Effluent Volume (L):	167760	167760
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=0 B/C=1 T=2	I=0 B/C=1 T=1
Airborne Structures/cc:	1×10^{-4}	1×10^{-4}
Total Structures in Effluent:	1.7×10^{4}	1.7×10^{4}
Fiber Mass (ng/m^3):	1.1×10^{-2}	*
Total Fiber Mass in Effluent (ng):	1.9	
Fiber Length Range (um):	1.5-2.5	
Mean Fiber Length (um):	2.0	
Fiber Diameter Range (um):	0.05-.15	
Mean Fiber Diameter (um):	0.1	
Total TEM Field Area Examined (mm^2):	1.17	0.96

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-353

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The asbestos was present as a tubular lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	987	987
Effluent Volume (L):	118440	118440
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=1 B/C=0 T=1	I=1 B/C=0 T=1
Airborne Structures/cc:	1.1×10^{-4}	1.5×10^{-4}
Total Structures in Effluent:	1.3×10^{4}	1.8×10^{4}
Fiber Mass (ng/m^3):		
Total Fiber Mass in Effluent (ng):	17	3.1
Fiber Length Range (um):	no range	no range
Mean Fiber Length (um):	4.6	4.1
Fiber Diameter Range (um):	no range	no range
Mean Fiber Diameter (um):	0.4	0.15
Total TEM Field Area Examined (mm^2):	1.09	0.75

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-358

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held, comb type dryer. The asbestos was present at both ends of the outlet duct.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	618	618
Effluent Volume (L):	74160	74160
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=2 B/C=0 T=2	I=0 B/C=0 T=0
Airborne Structures/cc:	2×10^{-4}	
Total Structures in Effluent:	1.5×10^{4}	
Fiber Mass (ng/m^3):	0.14	
Total Fiber Mass in Effluent (ng):	10	
Fiber Length Range (um):	4-17	
Mean Fiber Length (um):	10.5	
Fiber Diameter Range (um):	0.15-0.3	
Mean Fiber Diameter (um):	0.22	
Total TEM Field Area Examined (mm^2):	1.18	

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-100-374

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, table top hood type dryer. The asbestos insulation was present as a sheet under the heating element.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1302	1302
Effluent Volume (L):		
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=12 B/C=0 T=12	I=15 B/C=0 T=12
Airborne Structures/cc:	1.1×10^{-3}	1.4×10^{-3}
Total Structures in Effluent:	1.7×10^{5}	2.2×10^{5}
Fiber Mass (ng/m^3):	19.8	0.278
Total Fiber Mass in Effluent (ng):	3104	43
Fiber Length Range (um):	1.3-48	1.1-6
Mean Fiber Length (um):	7.5	2.8
Fiber Diameter Range (um):	0.1-1.5	0.05-0.3
Mean Fiber Diameter (um):	0.3	0.17
Total TEM Field Area Examined (mm^2):	1.22	1.21

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: CPSC-26

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, table top bonnet type dryer. The position of any asbestos insulation was not noted.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	277	277
Effluent Volume (L):	33240	33240
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=0 B/C=0 T=0	I=0 B/C=0 T=0
Airborne Structures/cc:		
Total Structures in Effluent:		
Fiber Mass (ng/m^3):		
Total Fiber Mass in Effluent (ng):		
Fiber Length Range (um):		
Mean Fiber Length (um):		
Fiber Diameter Range (um):		
Mean Fiber Diameter (um):		
Total TEM Field Area Examined (mm^2):	1.23	1.1

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: CPSC-22

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, table top hood type dryer. The asbestos was present as a pad under the heating element.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	2207	2207
Effluent Volume (L):	264840	264840
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=0 B/C=0 T=0	I=0 B/C=0 T=0
Airborne Structures/cc:		
Total Structures in Effluent:		
Fiber Mass (ng/m^3):		
Total Fiber Mass in Effluent (ng):		
Fiber Length Range (um):		
Mean Fiber Length (um):		
Fiber Diameter Range (um):		
Mean Fiber Diameter (um):		
Total TEM Field Area Examined (mm^2):	1.13	1.23

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-850-5327

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, stand mounted professional dryer. The asbestos insulation was present as a lining to the barrel.

	High Heat	High-Heat-Low-Hear Cycle
Dryer Flow Rate (L/min):	1044	1044
Effluent Volume (L):	125312	125312
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=650 B/C=137 T=1375	I=450 B/C=72 T=720
Airborne Structures/cc:	0.11	0.08
Total Structures in Effluent:	1.3×10^7	9.6×10^6
Fiber Mass (ng/m^3):	7652	651
Total Fiber Mass in Effluent (ng):	918211	78088
Fiber Length Range (um):	0.15-95	0.2-95
Mean Fiber Length (um):	7.1	6.1
Fiber Diameter Range (um):	0.04-15	0.01-3.5
Mean Fiber Diameter (um):	0.4	0.3
Total TEM Field Area Examined (mm^2):	0.83	0.73

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-860-1440

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held hair dryer. The insulation was present as a lining to the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	687	687
Effluent Volume (L):	82440	82440
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=18 B/C=1 T=20	I=17 B/C=5 T=37
Airborne Structures/cc:	2×10^{-3}	1.9×10^{-3}
Total Structures in Effluent:	1.6×10^{5}	1.6×10^{5}
Fiber Mass (ng/m^3):	1.1	9.6
Total Fiber Mass in Effluent (ng):	89	789
Fiber Length Range (um):	1.0-11.5	0.9-31.5
Mean Fiber Length (um):	3.5	5.0
Fiber Diameter Range (um):	0.05-0.7	0.7-1.4
Mean Fiber Diameter (um):	0.2	0.25
Total TEM Field Area Examined (mm^2):	1.08	1.3

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-805-1291

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Hand-held dryer.
Its asbestos insulation was present as a lining to the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	829	829
Effluent Volume (L):	99480	99480
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=360 B/C=17 T=410	I=148 B/C=8 T=174
Airborne Structures/cc:	3.3×10^{-2}	1.4×10^{-2}
Total Structures in Effluent:	3.6×10^{6}	1.5×10^{6}
Fiber Mass (ng/m^3):	26	30
Total Fiber Mass in Effluent (ng):	2627	2975
Fiber Length Range (um):	0.3-43	0.1-95
Mean Fiber Length (um):	3.2	4.9
Fiber Diameter Range (um):	0.03-1.2	0.05-1.5
Mean Fiber Diameter (um):	0.18	0.2
Total TEM Field Area Examined (mm^2):	1.3	1.32

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: D-815-0580

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Hand-held hobby heat gun. The asbestos insulation was present as a lining of the barrel.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	182	182
Effluent Volume (L):	21840	21840
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=324 B/C=20 T=439	I=100 B/C=6 T=121
Airborne Structures/cc:	3.8×10^{-2}	1.3×10^{-2}
Total Structures in Effluent:	8.4×10^{5}	2.9×10^{5}
Fiber Mass (ng/m^3):	4154	168
Total Fiber Mass in Effluent (ng):	91395	3700
Fiber Length Range (um):	0.8-90	0.4-60
Mean Fiber Length (um):	6.3	6.2
Fiber Diameter Range (um):	0.05-13	0.03-3.5
Mean Fiber Diameter (um):	0.36	0.33
Total TEM Field Area Examined (mm^2):	1.05	0.93

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

Sample Number: E-840-4024

Manufacturer/Distributor:

Dryer Name:

Model/Series:

Asbestos Use and Comments: Used, hand-held dryer.
No asbestos was present in the dryer. It was run as a control.

	High Heat	High-Heat-Low-Heat Cycle
Dryer Flow Rate (L/min):	1284	1284
Effluent Volume (L):	154080	154080
Sample Volume (L):	8328	8328
Airborne Asbestos Structures Counted:	I=0 B/C=0 T=0	I=0 B/C=0 T=0
Airborne Structures/cc:		
Total Structures in Effluent:		
Fiber Mass (ng/m^3):		
Total Fiber Mass in Effluent (ng):		
Fiber Length Range (um):		
Mean Fiber Length (um):		
Fiber Diameter Range (um):		
Mean Fiber Diameter (um):		
Total TEM Field Area Examined (mm^2):	0.83	1.29

I=Individual Fibers
B/C=Bundles or Clumps

I+B/C=Airborne Structures Counted
T=Individual Fibers Plus Estimated Number of Fibers in Bundles or Clumps

APPENDIX II

PHOTOMICROGRAPHS

1. (Plate 479) - Supply air sample showing absence of dust and fibers in supply air (Mag. = 1000X).

2. (Plate 548) - Very long asbestos fibers associated in a loose cluster (Mag. = 2000X).

3. (Plate 549) - Typical asbestos fiber bundle showing splayed ends and small fibril fragments (Mag. = 2700X).

4. (Plate 555) -Typical asbestos clump/bundle association showing random orientation of some fibril. (Mag. = 5000X).

5. (Plate 551) - A large cluster of individual fibers, large bundles, and clumps deposited as a single structure on filter (Mag. = 3300X).

6. (Plate 562) - Numerous asbestos fibers and bundle structures deposited in close proximity on filter (Mag 1300X).

7. (Plate 553) - Typical small chrysotile fiber bundle deposited singly (Mag = 2000X).

8. (Plate 556) - Extremely large chrysotile bundle 15 to 25 um in diameter deposited on filter. (Mag = 1700X).

9. (Plate 552) - Asbestos fiber bundles with organic globular particulates adhering to surface (Mag = 6700X).

10. (Plate 563) - Large asbestos bundles deposited as a single structure on filter (Mag =1700X).

11. (Plate 560) - Large asbestos fibers associated in a single cluster. (Mag = 1200X).

12. (Plate 560) - Large asbestos bundle and fibrils associated as a single structure. (Mag = 2000X).

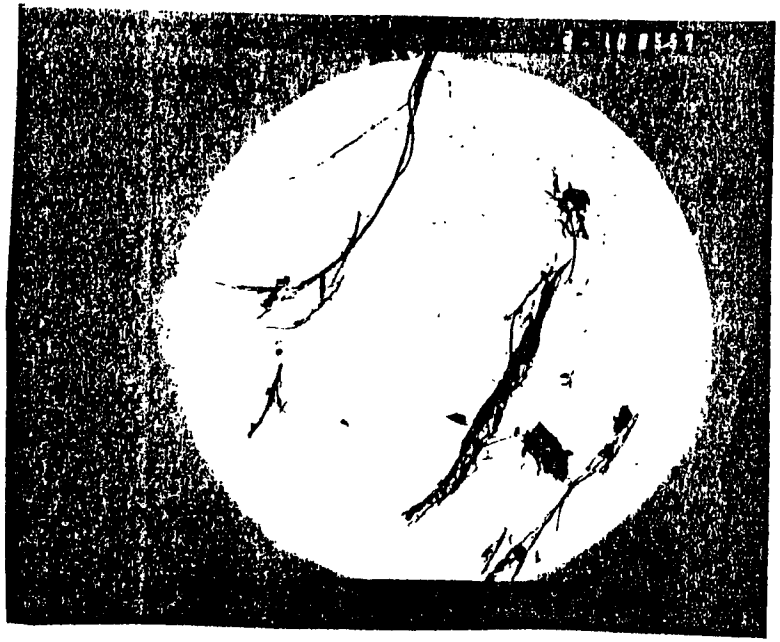
13. (Plate 557) - Typical heavy loading of asbestos structures on filter. (Mag = 1000X).

14. (Plate 465) - Sample of bulk insulation material taken from a dryer.

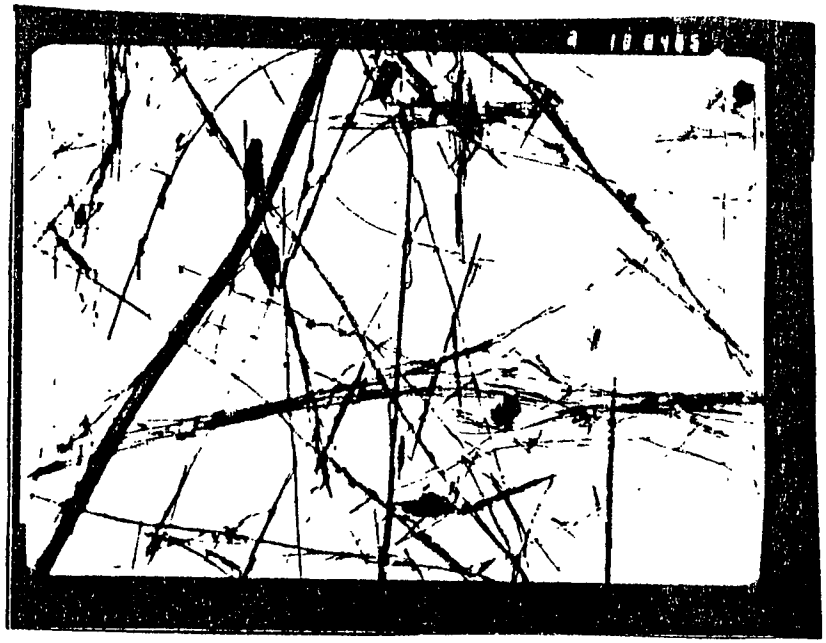
15. Example EDAX spectrum from a dryer air sample.

9

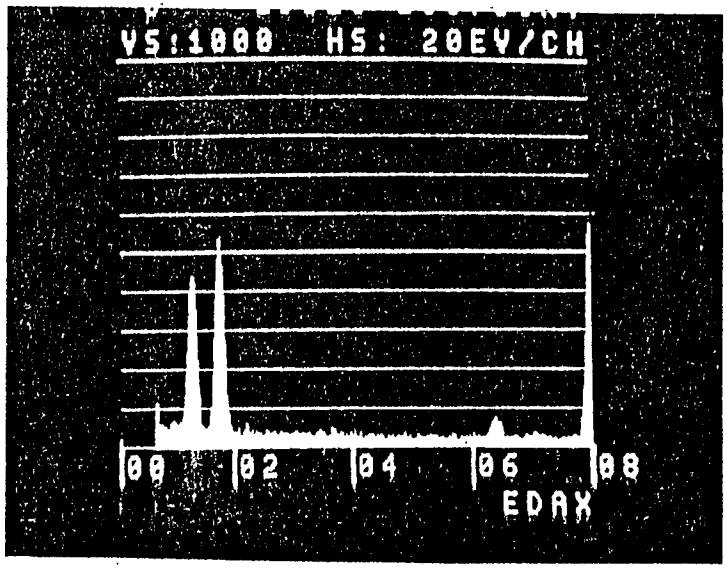
10



13



14

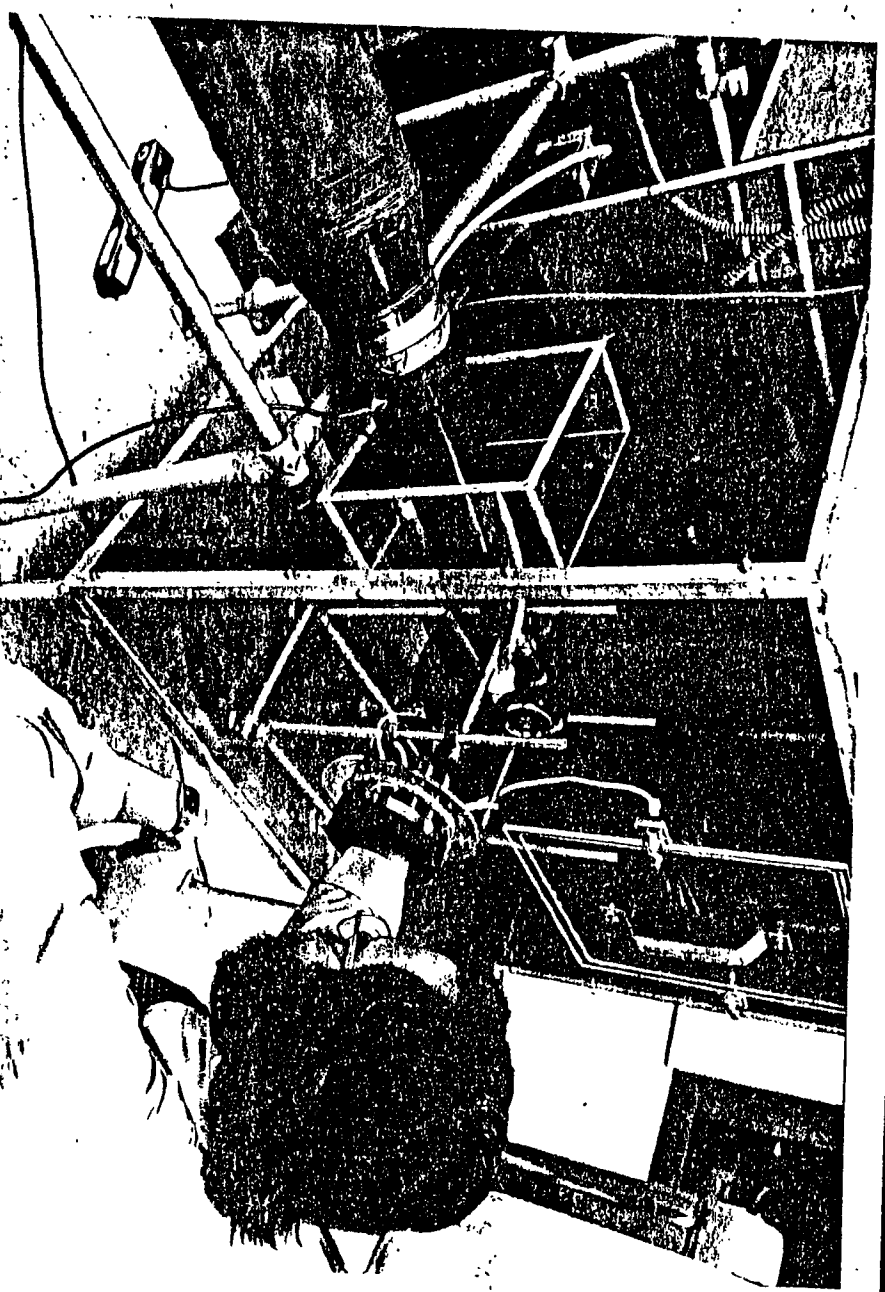


15

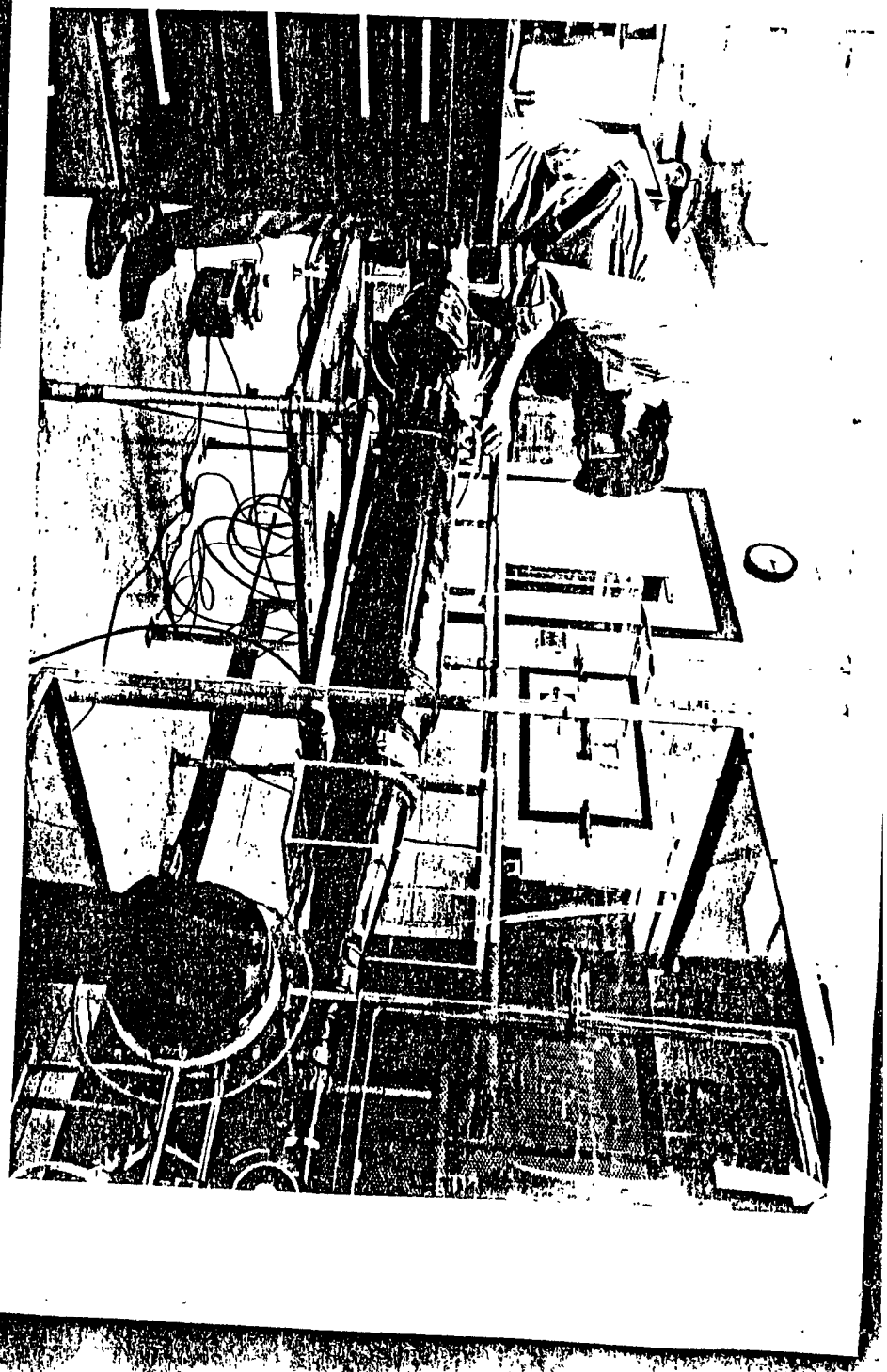
APPENDIX III

PHOTOGRAPHS OF TEST SYSTEM

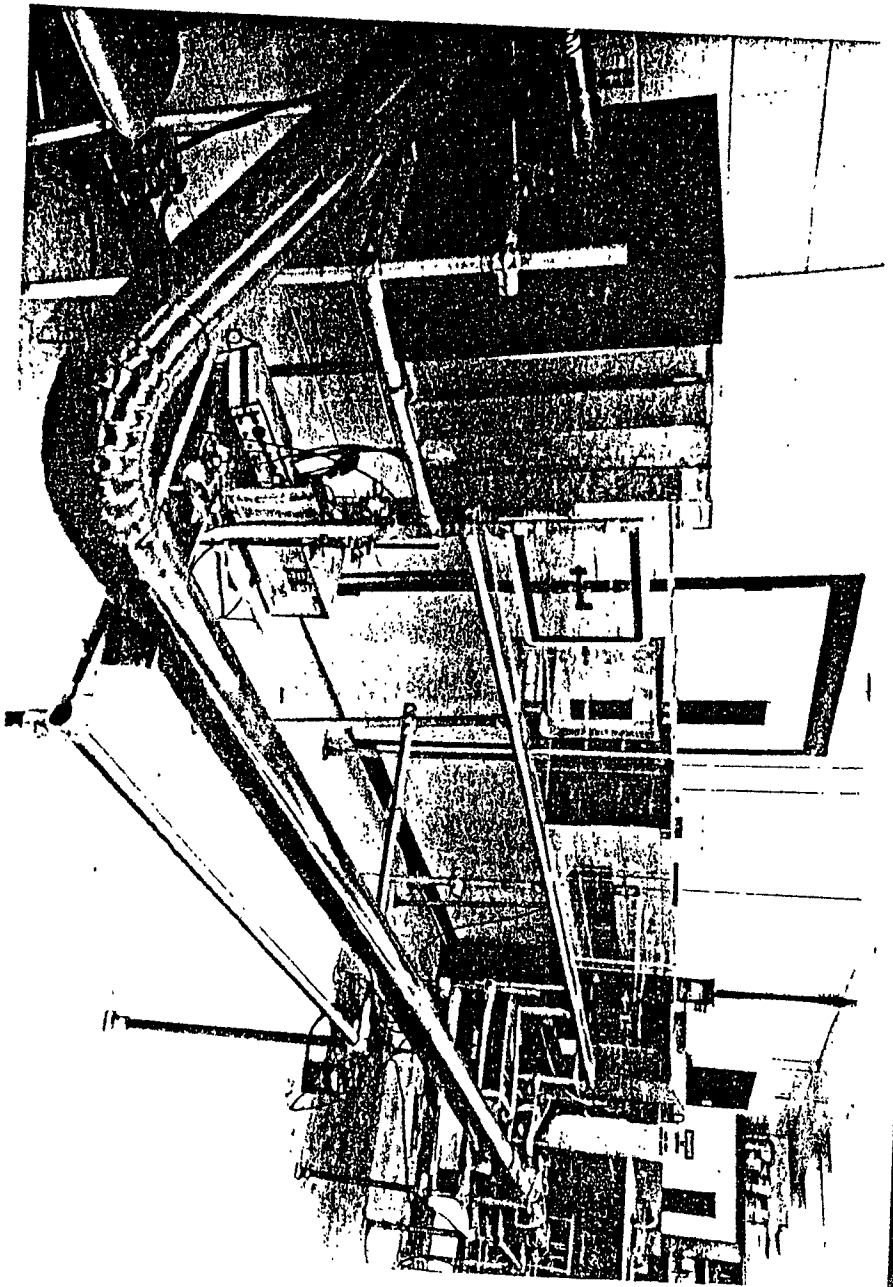
Turning on dryer- starting the test



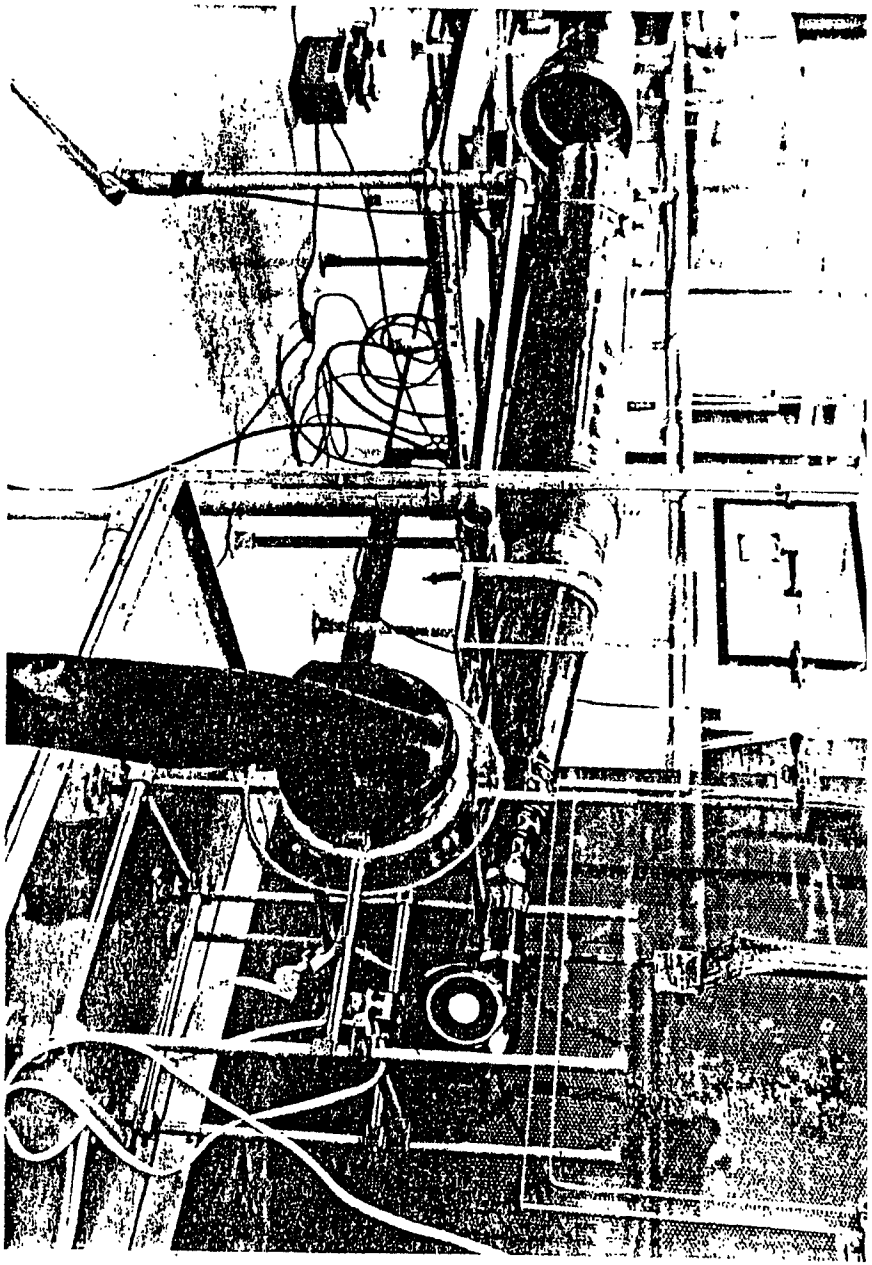
Engineer installing sample filter in the wind tunnel for the hair dryer test



Test set-up for hair dryers insuring a clean air supply



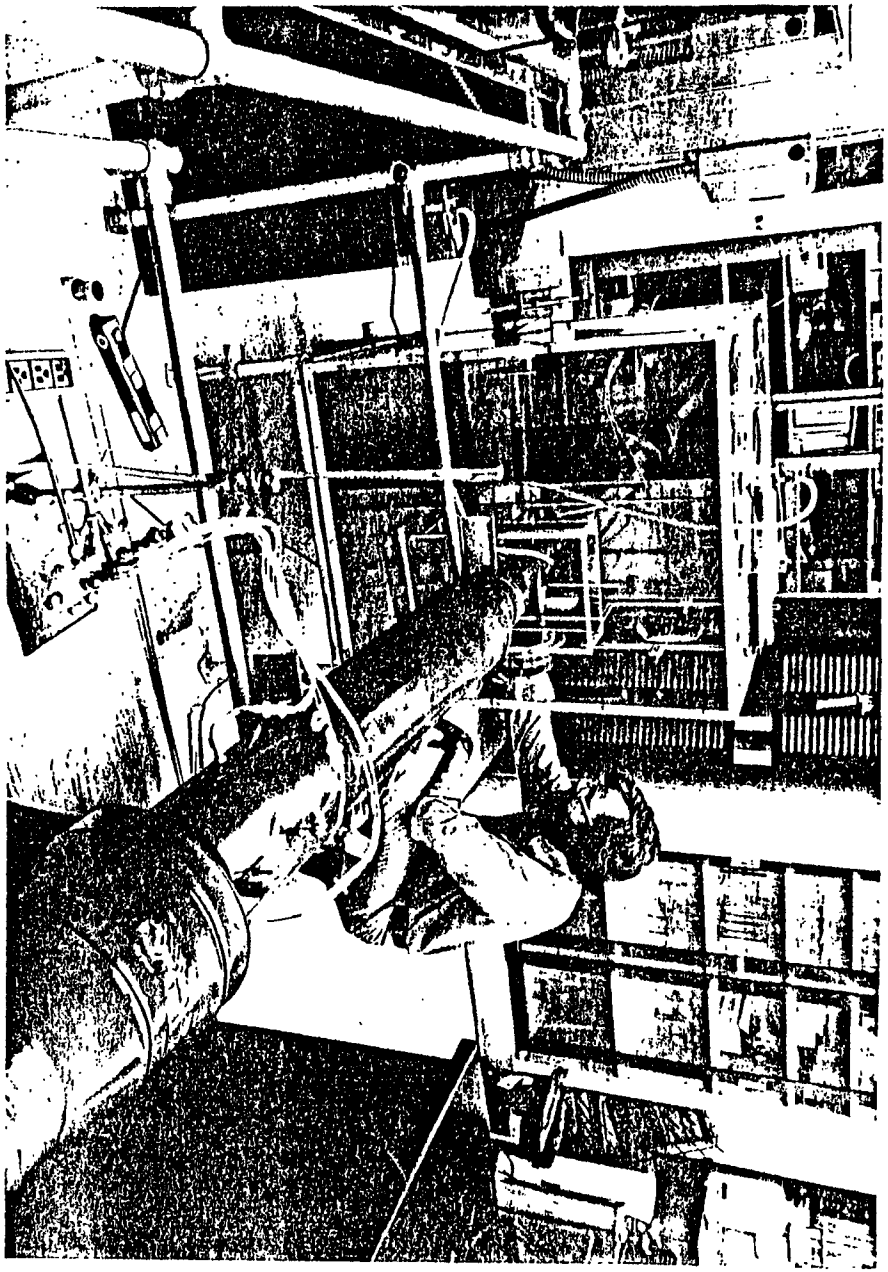
Test set-up for hair dryers insuring a clean air supply

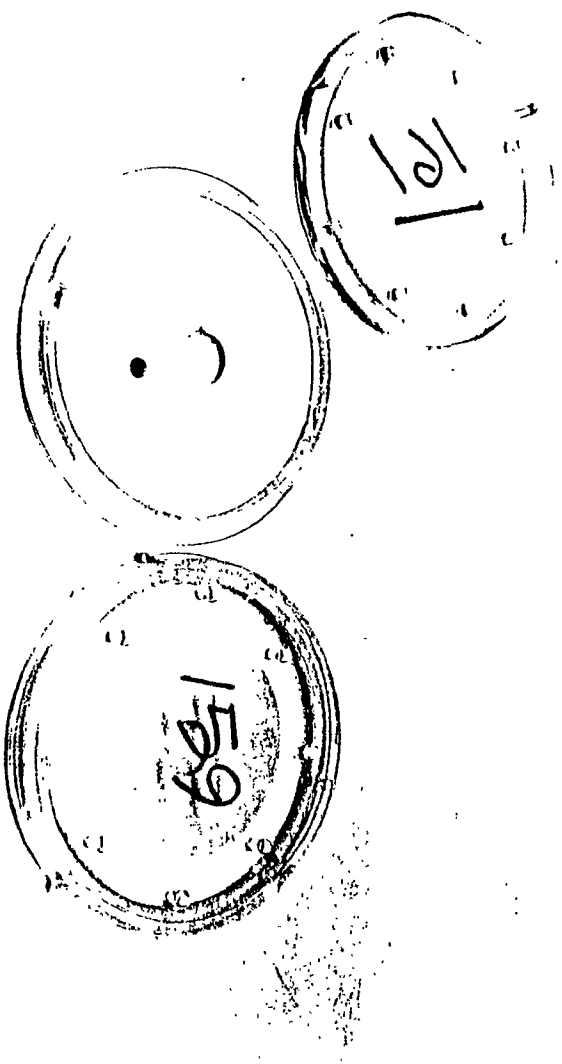


Chemist identifying & analyzing the fibers from a hair dryer test on a transmission electron microscope

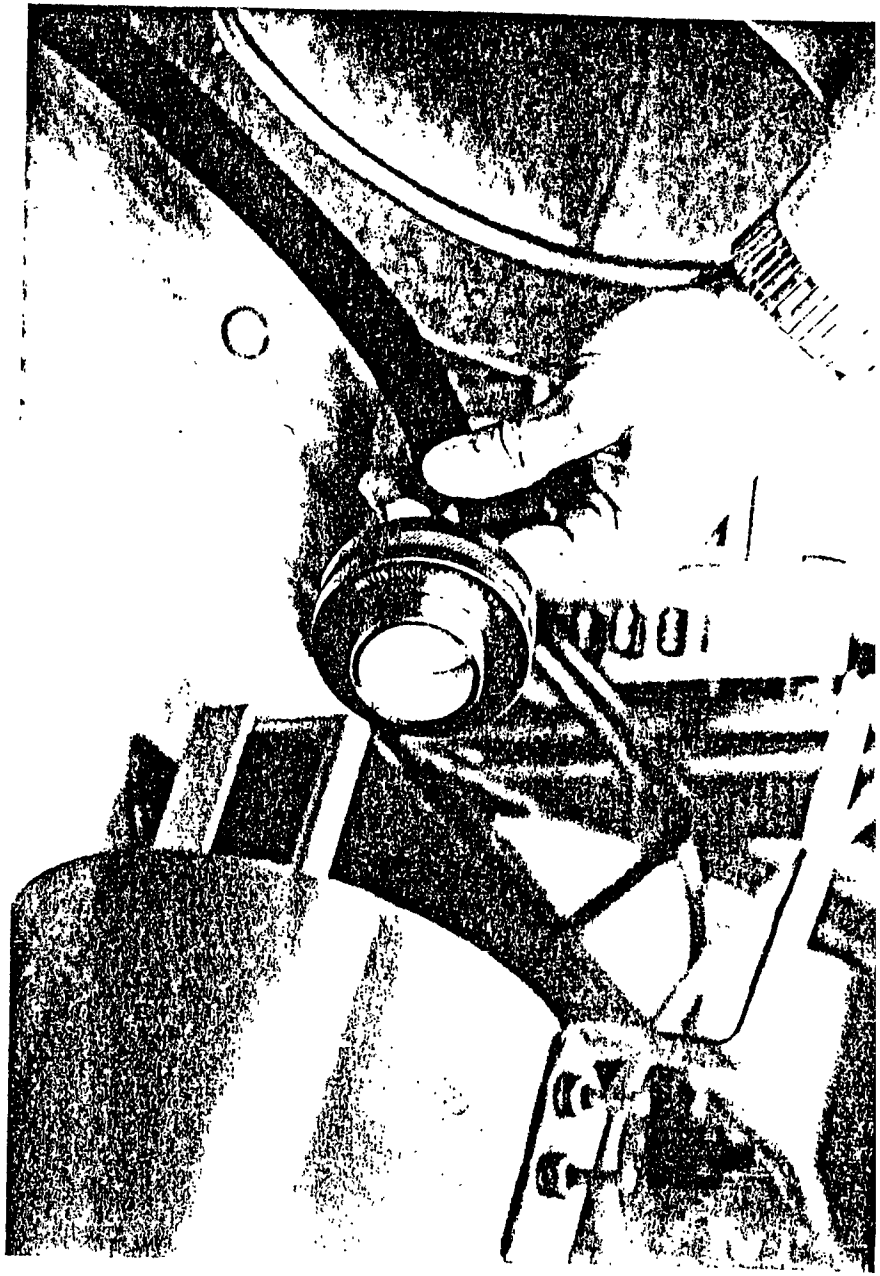


Turning on the dryer - starting the test





Filter samples in petri dishes showing size of portion removed and TEM grid (left)



Open- face aerosol sampler loaded with a membrane filter