

VACUUM CLEANER EVALUATION

AMERICAN CLEANING EQUIPMENT CORP.
Addison, Illinois

Clayton Environmental Consultants, Inc.

INTRODUCTION

American Cleaning Equipment Corporation retained Clayton Environmental Consultants to conduct an evaluation of a vacuum cleaner identified as "Model No. 380-15A." The primary purpose of the test was to determine the effectiveness of the unit for containment and control of emissions of asbestos during use in cleaning asbestos-containing dust. It is understood that these vacuum cleaners are intended to be used in automotive service centers for dust cleanup associated with brake rebuilding operations, including the removal of dust from brake drums and dust produced by grinding and fitting of brake shoes. Results of this evaluation, conducted by Mr. Dennis D. Zaebst of Clayton Environmental Consultants on May 19, 1976, are presented in this report.

DESCRIPTION OF TEST PROCEDURE

The spatial arrangement and relative locations of the vacuum cleaner, air sampling devices, and operators are shown in Figure 1. The tests were carried out in a relatively small confined room (room volume was approximately 800 cubic feet) which was sealed to prevent air movement into or out of the room during each test. The only circulation of air within the room was that generated by the exhaust action of the vacuum cleaner. These conditions were imposed for the purpose of maximizing the severity of use conditions.

During each of three tests, the operator of the vacuum cleaner cleaned approximately ten pounds of asbestos-containing brake dust (described below) from a cardboard container placed on the floor of the room. During each test, one air sample was taken in the breathing zone of the operator and two area samples were taken at stationary

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locations equidistant from the vacuum cleaner exhaust port. An additional area sample, located in the northeast corner of the room, was taken immediately after the vacuum cleaner was turned off. The room was then ventilated for approximately two hours to minimize the possibility of interference with subsequent tests. To reduce the possibility that fibrous dust, which might normally be present in the indoor air, or fibers generated by a previous test might interfere with the analyses of the test samples, "control" samples were taken immediately prior to each of the tests before any handling of the asbestos-containing dust.

Since it would be difficult, if not impossible, to simulate with a commercial asbestos product actual "brake dust," with respect to particle and fiber size distributions and thus to simulate the efficiency with which the fibers were removed by the vacuum cleaner filtration system, it was desirable to use for the evaluation actual asbestos-containing dust generated in a manner similar to that associated with automobile maintenance procedures, e.g., grinding of brake shoes. A bulk sample of dust produced by grinding of brake shoes was obtained from a local automotive axle plant. This dust had been collected by fabric filters incorporated in the plant's local exhaust ventilation systems. The physical appearance of the dust was that of a very fine, dry, greyish-brown powder similar in consistency to talcum or face powder. No other dust was mixed with the brake dust during or after entrainment by the exhaust-filtration systems. The dust was analyzed in the Clayton laboratory for percent fiber and fiber length distribution by phase contrast microscopy at 400X magnification. The results indicated that the dust was composed of approximately 19.4 percent fiber (i.e., fiber to particle ratio), and that fiber lengths ranged from approximately four micrometers to greater than fifty micrometers. Approximately four percent of the fibers were less than six micrometers in length, about forty-two percent measured between six and twelve micrometers, and the remaining fifty-four percent measured greater than twelve micrometers in length.

SAMPLING AND ANALYTICAL METHODS

Both general area and breathing zone samples were collected by drawing air at a nominal flowrate of two liters per minute through 37-mm diameter cellulose ester membrane filters (Millipore, Type AA, nominal pore size 0.6 micrometers) mounted in a three-piece cassette with the cover removed, using portable battery-operated pumps (Nine

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Safety Appliances Company, Model G). Breathing zone samples were obtained by fastening the pump to the operator's belt and the filter head to the outside of his collar at approximate breathing zone height. Thus, the breathing zone sample was representative of the time-weighted average conditions to which the operator was exposed during the sampling period.

Each sample was analyzed subsequently for asbestos fibers using the method specified by the National Institute for Occupational Safety and Health. Briefly, this method consists of the following steps: a pie-shaped section of each filter is cut carefully from the filter and mounted on a standard microscope slide using a high viscosity solution of membrane filter material in a 1:1 mixture of diethyl oxylate and dimethyl phthalate to render the filter transparent. Asbestos fibers, defined as particles having an aspect ratio (apparent length to width) of three or greater, which were observable on the surface of the filter were counted using a 10X eyepiece and a 40X objective with phase contrast illumination. A minimum of 100 fields, selected at random on the sample, were examined and fibers greater than five micrometers in length were counted. The microscopic analysis, that is, fiber count data, was used in conjunction with field sampling data (air flowrates and duration of sampling) to calculate the concentrations of asbestos fibers in air corresponding to each sample in units of fibers, greater than five micrometers in length, per cubic centimeter of air.

This procedure is consistent with the method used by the Occupational Safety and Health Administration in its compliance effort. Data thus obtained were then compared to applicable standards promulgated by the Occupational Safety and Health Administration (OSHA) and by the American Conference of Governmental Industrial Hygienists (ACGIH). The present OSHA and ACGIH standards limit eight-hour, time-weighted average exposures of workers to a concentration of five fibers (greater than five micrometers in length) per cubic centimeter of air. Effective July 1, 1976, the OSHA limit for eight-hour, time-weighted average exposures is scheduled to be reduced to two fibers per cubic centimeter of air. The present OSHA standard also establishes a ceiling (or peak) exposure limit of ten fibers per cubic centimeter of air. On October 9, 1975, OSHA issued proposed rule-making to lower the present standard such that eight-hour, time-weighted average exposures would be limited to 2.5 fiber per cubic centimeter of air, and ceiling exposures measured over a period up to fifteen minutes would be limited to five asbestos fibers per cubic centimeter of air. The proposed standard is based largely on the relative toxicity of asbestos to humans.

PRESENTATION OF DATA

Bulk Brake Dust

Results of microscopic analysis of the bulk sample of brake dust for percent fiber and fiber length distribution are presented in Table I. Examination of these data indicate that the bulk sample was composed of 19.4 percent fibrous material (by count) and fiber lengths ranged from approximately four micrometers to greater than fifty micrometers.

Air Samples

Results of microscopic analysis of the filter samples taken during the vacuum cleaning tests are summarized in Table II. These data indicate that the background level of airborne asbestos in the room prior to any testing was approximately 0.04 fiber per cubic centimeter of air. Control samples taken just before the second and third tests indicated that airborne concentrations of fibrous dust were <0.06 and 0.27 fibers/cc of air, respectively. Airborne concentrations of fibrous dust as measured by the stationary monitors ranged from 0.08 to 0.42 fibers per cubic centimeter of air for all tests. The personal breathing zone samples indicated that airborne concentrations of fibrous dust in the operator's breathing zone ranged from 0.09 to 0.33 fibers per cubic centimeter.

CONCLUSIONS

Interpretation of the sampling data leads to the following conclusions:

1. General airborne concentrations of fibrous dust, as measured by area monitors strategically located in the enclosed room, ranged from 0.08 to 0.42 fiber per cubic centimeter during vacuuming tests, well below the proposed OSHA ceiling concentration of five fibers per cubic centimeter of air, the most stringent occupational health standard applicable to short (15 minutes or less) exposures. In fact, the concentrations were below the proposed limit for eight-hour, time-weighted average exposures of 0.5 fiber/cc. Due to the extreme severity of the test conditions (small, confined room, no dilution of room air, vacuuming of a very large quantity of brake dust), these data indicate that under

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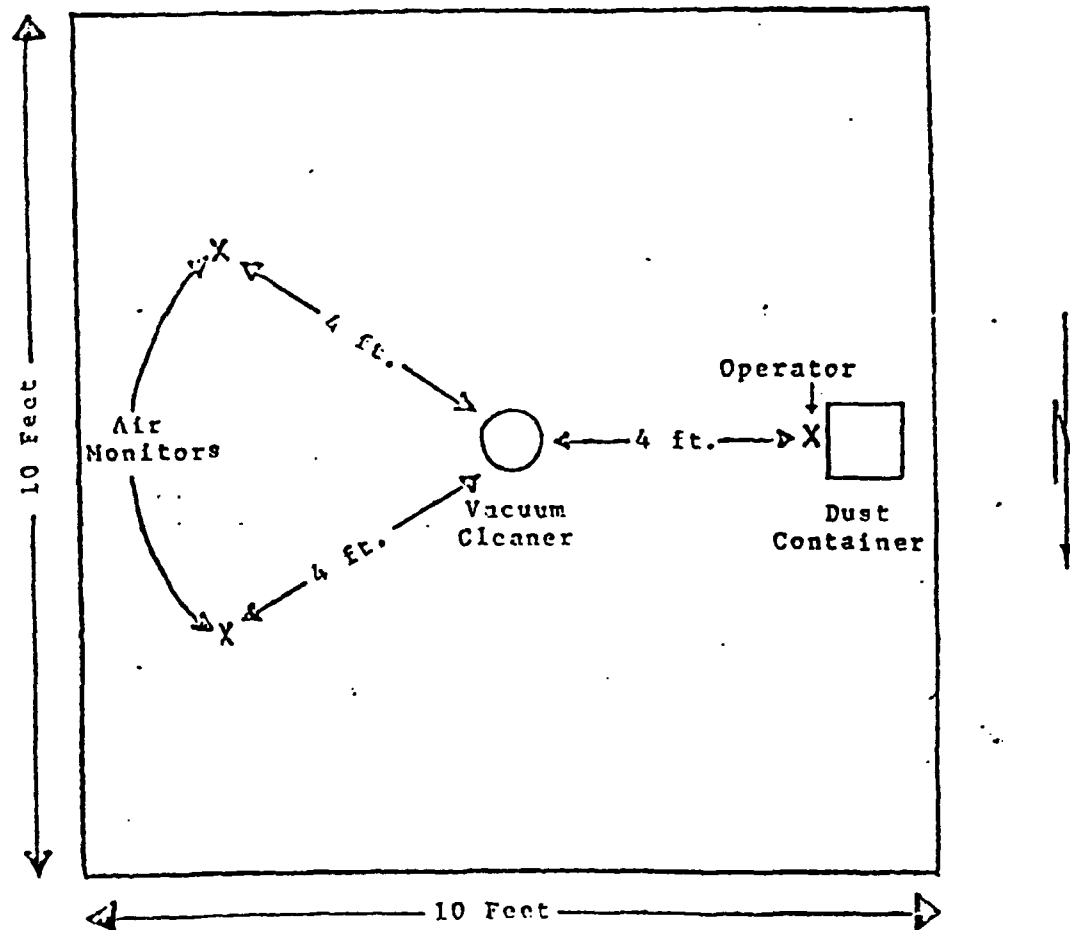
normal conditions of use, emissions of fibrous (asbestos) dust from the tested vacuum cleaner are not likely to result in room air concentrations in excess of present or proposed OSHA standards, assuming proper use and maintenance of the vacuum cleaner and its filtration system.

2. Airborne concentrations of fibrous dust in the breathing zone of the operator ranged from 0.09 to 0.33 fiber/cc during vacuuming test procedures, again well below the proposed OSHA ceiling limit for short-term exposures, and also below the proposed OSHA limit for eight-hour, time-weighted average exposures. Again, due to the severity of the test conditions, it is concluded with reasonable confidence that, under normal use conditions, workers using the vacuum cleaner are not likely to be exposed to concentrations of airborne fibrous (asbestos) dust in excess of present or proposed OSHA standards, assuming proper use and maintenance of the vacuum cleaner and filtration system.

FIGURE 1

Diagram of Test Room Used for Evaluation of Vacuum Cleaner

Floor to Ceiling Height - Eight Feet



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TABLE 1

CLAYTON ENVIRONMENTAL CONSULTANTS, INC.
MICROSCOPIC SIZING DATA FOR GLASS FIBER DUST

Date 5/19/76 Sample No. Bulk brake dust
 Plant American Cleaning Equipment Objective Phaco 40X
 Process Corp. Eyepiece Periplan 10X
 Total Magnification 400X

SIZE DISTRIBUTION OF FIBERS:*

Length Range, μ m	Mean Length,	No. of Fibers	Size Distribution by Count	
			% of Total	Cumulative %
0.8-1.1	0.95	-	-	-
1.1-1.6	1.35	-	-	-
1.6-2.2	1.90	-	-	-
2.2-3.1	2.65	-	-	-
3.1-4.4	3.75	-	-	-
4.4-6.2	5.3	4	4.1	4.1
6.2-8.6	7.5	14	14.3	18.4
8.8-12.5	10.6	27	27.6	46.0
12.5-17.7	15.1	11	11.2	57.2
17.7-25.0	21.3	17	17.3	74.5
25.0-35.2	30.1	17	17.3	91.8
35.2-50.0	42.6	4	4.1	95.9
>50.0	>50.0	4	4.1	100.0
		<u>96</u>		

Ratio, fibers:total particles = 121 : 625

Fibrous Content, Percent 19.4

* Any particle which has an aspect ratio of 3 or greater is considered a fiber.

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TABLE 11-A

CLAYTON ENVIRONMENTAL CONSULTANTS, INC.
INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant American Cleaning Equipment Corp.

Material(s) Fibrous Dust

Addison, Illinois

Date 12/76	Sample Number	Description	Sampling Period		Sample Weight	Sample Volume (Liters)	Concentration		
			Start	Stop			Fibers/ cc		
		FIRST TEST	12:00	12:11					
3/19	AA-07	Control, center of room, elevation four feet	09:09	11:39		394	0.04		
5/19	AA-04	Southeast corner of room, four feet from vacuum exhaust, elevation four feet	11:58	12:11		34	0.09		
5/19	AA-06	Personal breathing zone of operator	11:58	12:11		31	0.09		
5/19	AA-05	Northeast corner of room, elevation four feet	11:58	12:11		34	0.09		
5/19	AA-03	Northeast corner of room, after vacuum shut off	12:14	12:25		29	0.10		
		SECOND TEST	14:23	14:33					
3/19	AA-02	Control, center of room, elevation four feet	13:53	14:12		50	<0.06		
3/19	AA-12	Northeast corner of room, elevation four feet	14:22	14:33		29	0.20		
5/19	AA-11	Southeast corner of room, four feet from vacuum ex- haust, elevation four feet	14:22	14:33		29	<0.10		
5/19	AA-01	Personal breathing zone of operator	14:22	14:33		26	0.33		
5/19	AA-13	Northeast corner of room, after vacuum shut off	14:36	14:50		37	0.08		

* Fibers greater than five micrometers in length, and an aspect ratio (length to width) of 3:1 or greater.

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TABLE II-B

CLAYTON ENVIRONMENTAL CONSULTANTS, INC.
INDUSTRIAL HYGIENE SAMPLING SUMMARY

American Cleaning Equipment Corp.
Addison, Illinois

Material(s) Fibrous Dust

Date	Sample Number	Description	Sampling Period		Sample Weight	Sample Volume (Liters)	Concentration		
			Start	Stop			Fiber/cc		
		THIRD TEST	16:26	16:36					
7/12	AA-14	Control, center of room, elevation four feet	16:07	16:22		42	0.27		
7/12	AA-16	Northeast corner of room, elevation four feet	16:23	16:36		29	0.10		
7/12	AA-15	Southeast corner of room, four feet from vacuum exhaust, elevation four feet	16:23	16:36		29	0.4		
7/12	AA-17	Personal breathing zone of operator	16:23	16:36		26	0.22		
7/12	AA-18	Northeast corner of room, after vacuum shut off	16:38	16:50		32	0.18		
		Acceptable OSHA eight-hour, time-weighted average concentration (TWA)					5		
		OSHA eight-hour, time-weighted average concentration limit effective 7/1/76					2		
		OSHA ceiling limit					10		
		Proposed OSHA standard					0.5 (TWA) 5 (ceiling)		

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