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Asbestos Emissions From Railroad Brake Shoes

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Samples of airborne emissions from three brands of composition railroad brake shoes were collected during tests on a full-scale-railroad-wheel-testing dynamometer under controlled conditions simulating a high-energy-dissipation braking. Asbestos-fiber concentrations, as measured by individual samples, ranged from zero to 0.067 fiber longer than 5 microns/cm³ – far less than the current permissible occupational exposure limits of 2 fibers longer than 5 microns/cm³ of air specified on the OSHA Asbestos Standards.</td></tr>
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Conversion Factors

1 mph	=	0.447 m/s
1 hp	=	0.746 kW
1 rpm	=	0.105 rad/s
1 inch	=	25.4 mm
1 foot	=	0.3048 m
1 lb	=	4.45 N
1 ton	=	0.907 tonne

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[2] Introduction

In recent years, the use of composition brake shoes instead of cast-iron brake shoes has been generally accepted by the railroad industry, and practically all cars being constructed have brake system components designed for the use of composition shoes. Also, the brake-system components in many of the older cars in service are being modified so that composition shoes can be used. Modification of older cars is necessary because with composition shoes only half the brake-shoe pressure needed with cast-iron shoes is required to produce the same retardation. The average coefficient of friction of composition shoes is about 0.30, whereas that of cast-iron shoes is about 0.15. Consequently, the railroad favors the use of composition shoes because of their greater braking efficiency.

There are three principal suppliers of composition brake shoes to the domestic railroad industry. Each manufacturer has developed a brake shoe containing various components that are bonded together by resin compounds. Their compositions are considered proprietary, but the service performance of all types has been similar.

Inasmuch as one of the components of composition brake shoes was reported to be asbestos, the subject study was proposed by the Federal Railroad Administration, Office of Rail Safety Research, because of concern that the airborne emissions that result from decomposition of the brake shoes during braking might contain sufficient asbestos fibers to create a health hazard.

The criterion for determining whether a health hazard exists is the present OSHA Asbestos Standard which establishes a permissible occupational exposure limit of 2 fibers longer than 5 microns per cubic centimetre of air, based on an 8-hour time-weighted average exposure. The Standard also states that exposures shall not exceed 10 fibers/cubic centimetre for any period during the workday. OSHA has proposed to reduce the 8-hour exposure limit to O.S fiber/cm^3, with a ceiling-limit of 5 fibers/cm^3, as determined over a period of up to 15 minutes.

[3] <u>Materials and Experimental Work</u>

<u>Wheel-Testing Dynamometer</u>

The railroad wheel-testing dynamometer at the U. S. Steel Research Laboratory in Monroeville, Pennsylvania was used to perform controlled tests of simulated railroad braking conditions with composition brake shoes. Samples of airborne emissions were obtained both under confined atmospheric conditions and under conditions simulating the actual turbulent-air-mixing effects resulting from train operations.

The wheel-testing machine, Figure 1, is a large inertia dynamometer driven by a mill-type electric motor with a power output up to 450 hp and speeds up to 1500 rpm. Standard full-scale railroad wheels from 30 to 40 inches in diameter can be tested, Figure 2, under conditions of loading and braking that simulate normal existing railroad service, or under exaggerated conditions of loading and braking far in excess of those encountered in service.

Tests Conducted

For the tests used in this study, a high-energy-dissipation braking condition known as drag braking was simulated so that a sustained heat buildup would occur and the brake shoe would decompose at a relatively high rate. This drag braking is similar to that which would occur in normal railroad service when a loaded 70-ton car with 33-inch-diameter wheels is retarded in descending a grade. The dynamometer was fitted with a 33-inch-diameter wheel and a single composition brake shoe. A braking force of 1500 pounds was exerted by the shoe onto the wheel tread for 50 seconds of each minute for a duration of 9 minutes, with the equivalent translatory speed of the wheel maintained at 45 miles per hour. The energy-dissipation rate for these conditions was 50 hp. During the tests, air samples were simultaneously collected for analysis, as will be described in a later section, at locations 6 inches, 6 feet, and 17 feet from the brake shoe, Figures 3, 4, and 5.

Similar tests were conducted with brake shoes of the compositions produced by the three principal manufacturers, which are designated in this report as A, B, and C. Each type of brake shoe was also tested under two different air-circulation conditions, the first with the wheel rotating in nonturbulent air, and the second in a turbulent-air condition produced by an exhaust fan to simulate braking of a train in motion.

[4] Air Sampling and Analysis

Air samples were collected and analyzed in accordance with the USPHS/NIOSH membrane-filter method for evaluating airborne asbestos fibers. Samples were collected by drawing air at a rate of 2.0 litres per minute through a cellulose ester membrane filter (Millipore Type AA, O.B micron pore size) by means of a battery-powered personal sampling pump. During sampling, the top cover of the plastic filter cassette was removed to provide an even particle distribution over the entire filter. Sampling pumps were calibrated immediately, prior to, and after, the survey.

After collection, a wedge-shaped section was taken from each filter, rendered transparent in a one-to-one solution of dimethyl phthalate and ethyl oxalate, and examined for asbestos count and characteristics under phase-contrast microscopy at 450X magnification.

The asbestos-fiber-count procedure consists of comparing fiber length with calibrated circles, and counting all fibers greater than 5 micrometres in length within a given counting field area. The Porton reticle, a glass plate inscribed with a series of circles and rectangles, is used for this purpose. The reticle, placed in the eyepiece of the microscope, is calibrated with a stage micrometer. The square on the left side of the reticle, divided into six rectangles, is defined as the counting field.

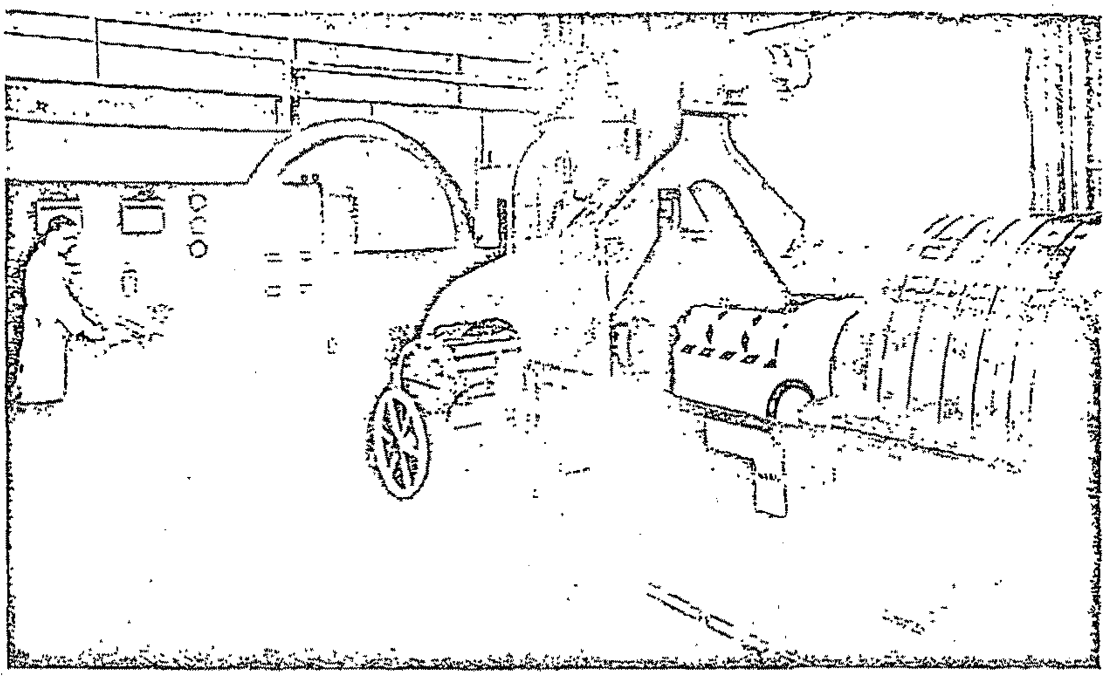
Discussion and Summary

As is shown in Table I, the airborne asbestos concentrations emitted during simulated severe railroad drag braking by each of the brake-shoe compositions tested were negligible. The measured concentrations were in the range zero to 0.067 fiber/cm^3, far lower than the permissible limits of both the present and proposed OSHA Asbestos Standard. One hundred counting fields were examined on each sample filter, and at most, only one fiber was observed per 100-field area. These extremely low fiber counts may possibly be attributed to background levels alone.

Table I

Asbestos Emissions From Composition
Brake Shoes During Drag Braking
Energy Dissipation Rate, 50 hp
Sampling Duration, 9 minutes

Air Circulation Past Wheel	Sample Collection Distance From Brake Shoe	Asbestos Concentration for Different Brake Shoes, fibers/cm^3		
		A	B	C
None	6 inches	0.000	0.000	0.000
None	6 feet	0.000	0.067	0.067
None	17 feet	0.000	0.067	0.067
Turbulent	6 inches	0.000	0.000	0.067
Turbulent	6 feet	0.000	0.000	0.000
Turbulent	17 feet	0.000	0.000	0.000



VIEW OF WHEEL–TESTING DYNAMOMETER
U. S. STEEL RESEARCH LABORATORY, MONROEVILLE, PA.

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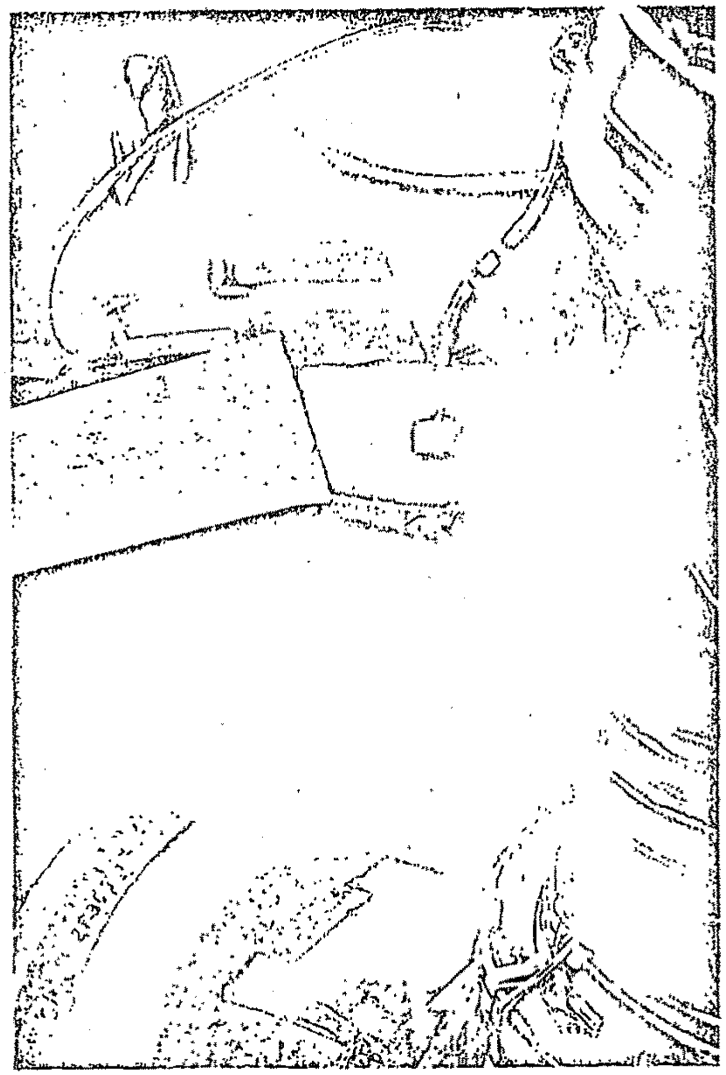
Figure 1



VIEW SHOWING 33-INCH-DIAMETER WHEEL IN DYNAMOMETER.

Figure 2

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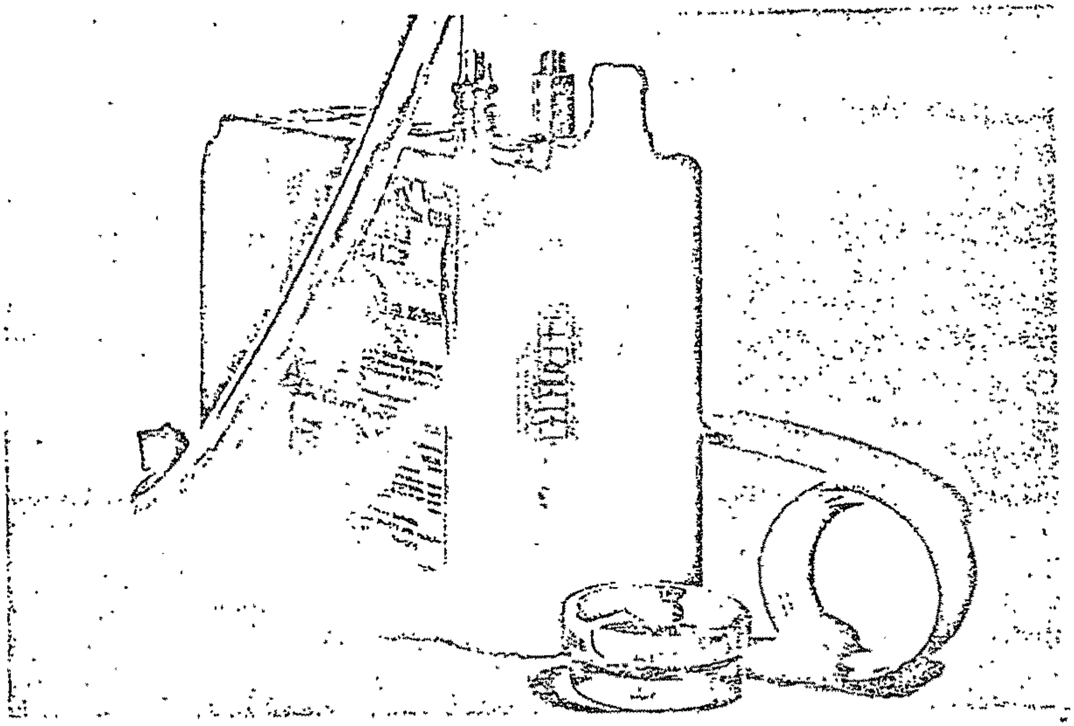

PORTABLE AIR-SAMPLING PUMP AND FILTER CASSETTE.

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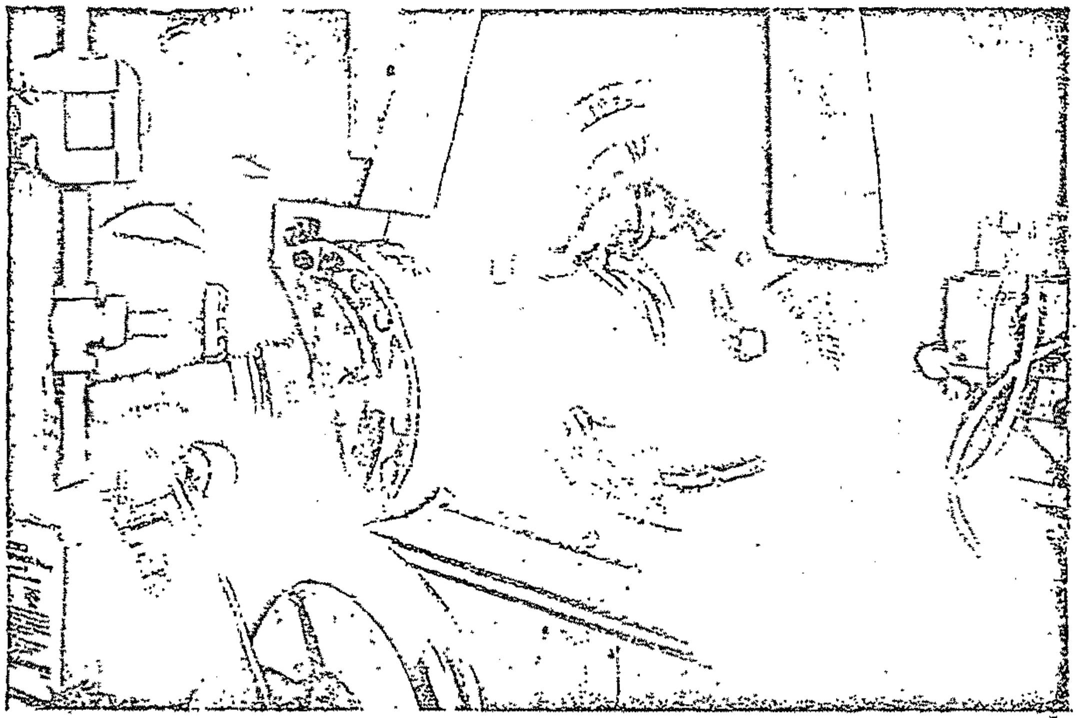
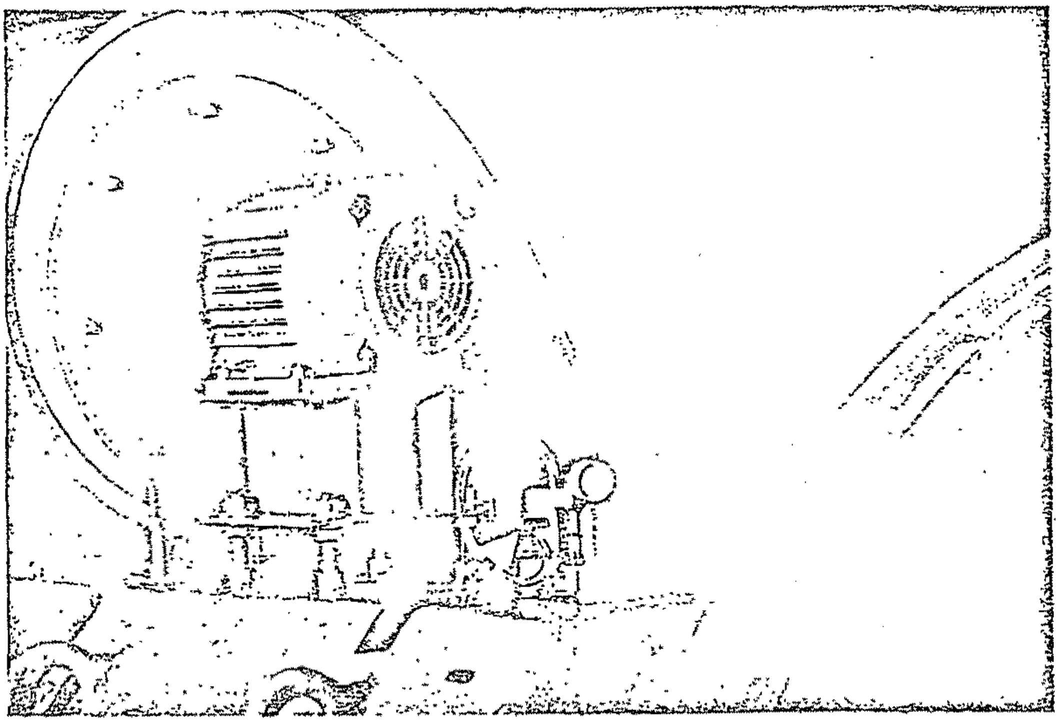
Figure 3



VIEW SHOWING SAMPLING PUMPS LOCATED 6 INCHES AND 6 FEET FROM BRAKE SHOE.



VIEW SHOWING SAMPLING PUMP LOCATED 17 FEET
FROM BRAKE SHOE.