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Report of Results: MVA8473

**Fiber Release During Activities
Involving a Caterpillar Brake Band**

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Introduction

This report presents the results of a study of asbestos fiber release during several activities involving a Caterpillar brake band. The Caterpillar brake band used in the study was one of three Caterpillar bands received at MVA Scientific Consultants on 2 July 2010 from Gary Fletcher of The Simmons Firm. According to the information provided, the Caterpillar brake bands were pre-1970 items from D4 and D6 crawlers. They had been purchased from an equipment company in Illinois in June of 2010.

The bands were assigned the unique MVA laboratory sample numbers V1257 through V1259. The two smaller brake units (V1257 and V1258) appear to be similar in size (Figure 1). They each form a circle that is approximately 8-10 inches in diameter. The width of the brake material (and the metal band) is approximately $2\frac{7}{8}$ inches. The metal band is approximately $\frac{5}{32}$ inch thick and the brake material is about $\frac{1}{4}$ inch at its thickest. One end is thinner where it has worn. The larger brake unit forms a circle approximately 13-15 inches in diameter (Figure 2). The width of the brake material (and the metal band) is approximately $3\frac{1}{2}$ inches. The metal band tapers from approximately $\frac{1}{4}$ inch to $\frac{3}{32}$ inches thick. The thickest part of the brake material is approximately $\frac{7}{32}$ inch thick.

The samples were analyzed for asbestos and one band (V1257) was tested to determine fiber release during rivet removal, drilling, cleaning with compressed air and cutting with an abrasive blade. The experiment was performed on 22 July 2010. Sample numbers for the air samples collected during the activities are shown in Table 1. The analyses were done in the MVA laboratory during the period 8 July through 30 July 2010.

Methods

The brake bands were initially examined under an Olympus SZ-40 stereomicroscope. Portions of the particulate were mounted in appropriate refractive index liquids for analysis using an Olympus BH-2 polarized light microscope (PLM). The PLM analysis followed the analytical procedures recommended by the U.S. Environmental Protection Agency (1). The PLM results for asbestos are given in terms of percent by volume.

In order to concentrate possible amphibole material for analysis, an acid/base digestion procedure (2, 3) was used to eliminate the soluble fraction. A portion of sample V1257 was ashed and the residue remaining was transferred to a 100 ml round-bottom flask containing 80 ml of acid ($2N H_2SO_4$) and fitted with a reflux condenser. The suspension was boiled for one hour. The residue was collected by centrifugation and the reflux procedure was repeated with sodium hydroxide (4N). The residue was then suspended



in water and a known aliquot was extracted and filtered through a 0.22 µm pore size filter. The filter was dried and grids prepared following standard direct preparation procedures (AHERA/ISO10312) for analysis by transmission electron microscopy (TEM) using a Philips EM420 100 kV transmission electron microscope (TEM) equipped with an Oxford EDS (energy dispersive spectrometry) x-ray analysis system. A laboratory blank sample following all the procedures except the addition of test material was prepared in a similar way. The TEM results for asbestos are given in terms of percent by weight.

The air samples collected during the studies were analyzed using the phase contrast microscopy (PCM) NIOSH Method 7400 and transmission electron microscopy (TEM) NIOSH Method 7402 procedures.

Study Design

This fiber release study involved rivet removal, drilling, cleaning with compressed air and cutting the brake band with an abrasive blade in a controlled area while air samples were collected. Mr. Chris DePasquale, CIH, of Compass Environmental, Inc. of Kennesaw, GA performed the activities. Air samples were collected in the breathing zone on both sides of the worker (Mr. DePasquale) while the activities were performed. Area air samples were collected approximately 5 feet from the activities. The sample collection period for each test is shown in Table 2.

A ball-peen hammer and drift (punch) were used to remove the rivets from the brake unit. Holes were drilled in the composite brake material using a drill press (Central Machinery Model 44506). Compressed air (60 psi) was used to blow the debris off the brake material and the equipment after removal of the rivets and drilling the holes. A hand-held grinding tool with a 3.5 cm diameter abrasive blade was used to make one cut across the brake piece. The flow rates of the two personal samples collected for each test were 0.52 and 1.91 liters per minute. The area sample was collected at 5 liters per minute.

Study Site

The study was conducted in a specially built test chamber in Duluth, Georgia. The test chamber work area was approximately 9 ft high by 10 ft wide by 12 ft long. The study area had a High Efficiency Particulate Absolute (HEPA) air filtration device (AFD) which was used to clean the area of particulate including asbestos before and between the two activities of compressed air blowing and cutting. The HEPA unit ran at a low flow-rate during each test and then at a high flow-rate between the compressed air clean-up and drilling tests. The HEPA unit ran at a high flow-rate during the cutting test. While inside the study area, Mr. DePasquale was protected by an air purifying respirator and complete head and body coverings.



Results

The Caterpillar brake band tested (Sample V1257) is a composite material (Figures 3 and 4). Polarized light microscopy (PLM) bulk analysis showed it to contain approximately 40-60% chrysotile asbestos by volume. TEM analysis following the matrix dissolution treatment showed sample V1257 to contain approximately 0.01% tremolite-actinolite amphibole asbestos by weight. The bulk sample analysis results are summarized in Table 1.

No asbestos was detected in the blank samples or in the sample collected in the chamber before the testing began. No asbestos was detected in the abrasive disc used for cutting.

The asbestos level in the breathing zone of the worker during rivet removal was 0.2 fiber/cc (F/cc); during drilling was 0.2 F/cc; during cleaning with compressed air was approximately 3 F/cc and during cutting with an abrasive disc was 48 F/cc. The area sample (approximately 5 feet away) collected during the combined task of rivet removal, drilling and cleaning was 0.6 F/cc. The asbestos level during cutting with an abrasive disc was 6 F/cc at a distance of approximately 5 feet away. The asbestos fiber per cc values were calculated using the average PCM NIOSH 7400 values multiplied by the TEM NIOSH 7402 percent asbestos determinations. The basic data are shown in Table 2.

Representative photographs and micrographs taken during the study are shown in Figures 5 through 12. Representative TEM images of asbestos fibers released during the activities are shown in Figures 13 through 15.

References

1. U. S. Environmental Protection Agency, "Test Method EPA/600/R-93/116 -- Method for the Determination of Asbestos in Bulk Building Materials."
2. "Analysis of Amphibole Asbestos in Chrysotile and Other Minerals" by J. Addison and L.S.T. Davies. Ann. Occup. Hyg. Vol. 34. No. 2. pp. 159-175, 1990.
3. Millette JR, A. Harmon, P. Few, W.L. Turner, Jr., and W.R. Boltin. Analysis of amphibole asbestos in chrysotile-containing ores and a manufactured asbestos product. Microscope, 57(1):19-22, 2009.

Table 1. Bulk Sample Information and Results

MVA#	Sample Information	PLM Analysis Results % Chrysotile	TEM Analysis Results % Amphibole Asbestos
V1257	Caterpillar Brake Band ~8-10 inches Dia	40-60%	0.01 %
V1258	Caterpillar Brake Band ~8-10 inches Dia	15-25%	NA
V1259	Caterpillar Brake Band ~13-15 inches Dia	40-60%	NA

NA - Not Analyzed

Table 2. Results of Asbestos Analysis During Rivet Removal, Drilling, Cleaning with Compressed Air and Cutting with an Abrasive Disc

MVA #	Description	Duration Minutes	Volume Liters	7400 F/cc	7402 %Asb	AHERA Str/cc
V1383	Before Activities	60	300	NA*	0%	BDL <0.01
V1420	Rivet Removal Personal (Pers.)	8	15.28	0.21	83%	NA
V1421	Rivet Removal Pers.	8	4.16	BDL	NA	NA
V1422	Drilling Pers.	8	15.28	0.32	75%	NA
V1423	Drilling Pers.	8	4.16	BDL	NA	NA
V1424	Cleaning Compressed Air Pers.	3	5.73	4.52	NA	NA
V1425	Cleaning Compressed Air Pers.	3	1.56	3.85	73%	NA
V1426	Cutting with Abrasive Disc Pers.	3	5.73	35	NA	NA
V1427	Cutting with Abrasive Disc Pers.	3	1.56	62	100%	NA
V1428	Blank Filter	0	0	-	0%	NA
V1429	Blank Filter	0	0	-		NA
V1430	Rivet Removal, Drilling, 1 minute of Cleaning and change of samplers Area	22	110	0.55	99%	NA
V1431	Cutting with Abrasive Disc Area	3	15	6.04	100%	NA

*NA – Not Analyzed



Figure 1. Caterpillar Brake Band Samples V1257 (left) and V1258 (right).

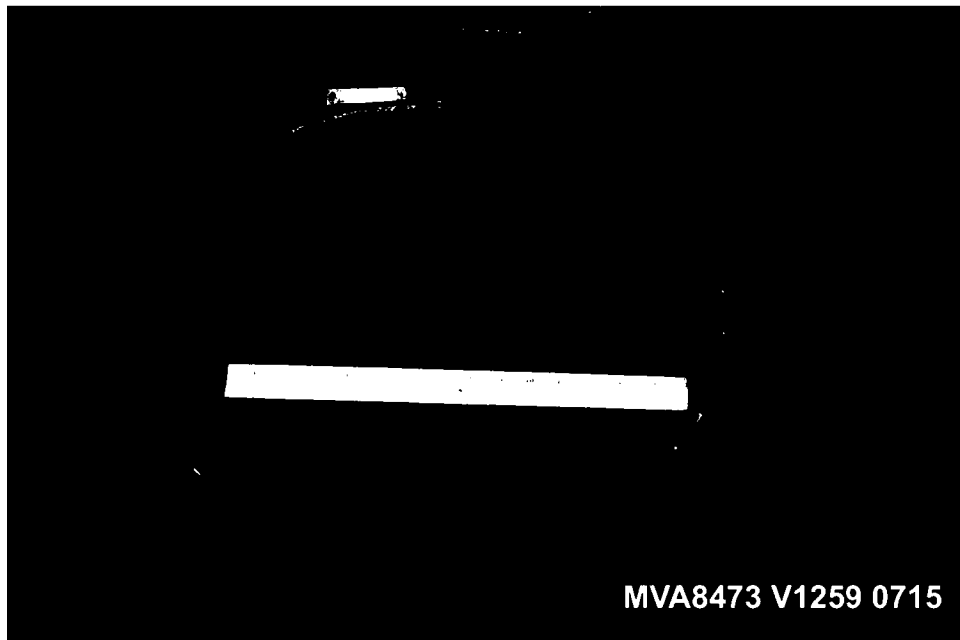


Figure 2. Caterpillar Brake Band Sample V1259.



Figure 3. Close-up view of a piece of Caterpillar Brake Band Sample V1257.

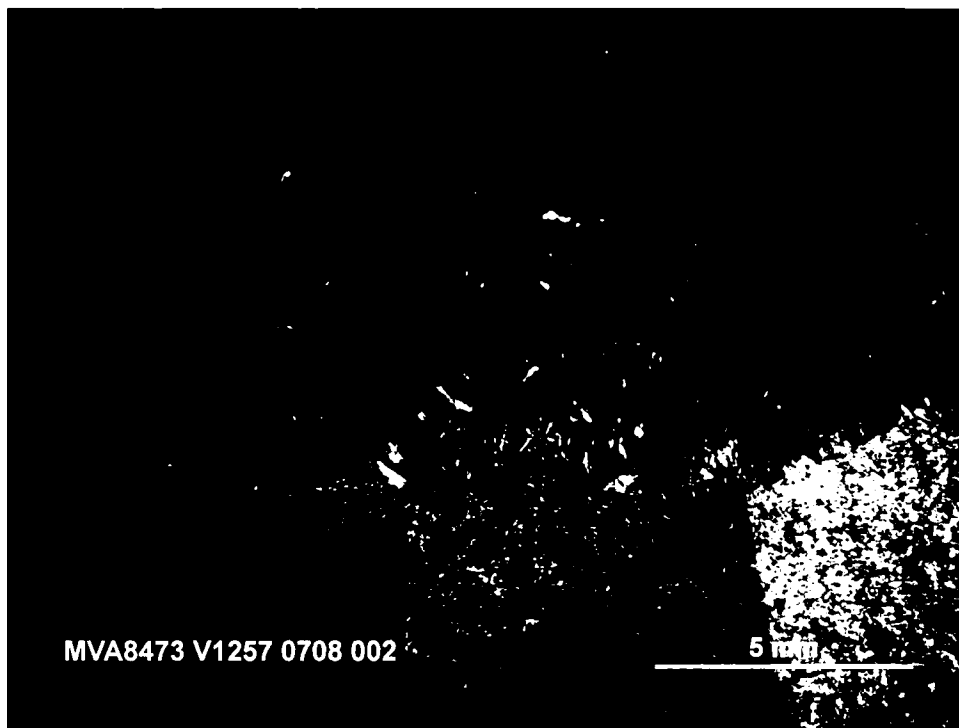


Figure 4. Close-up view of a piece of Caterpillar Brake Band Sample V1257.



Figure 5. Removing rivets from Caterpillar Brake Band.

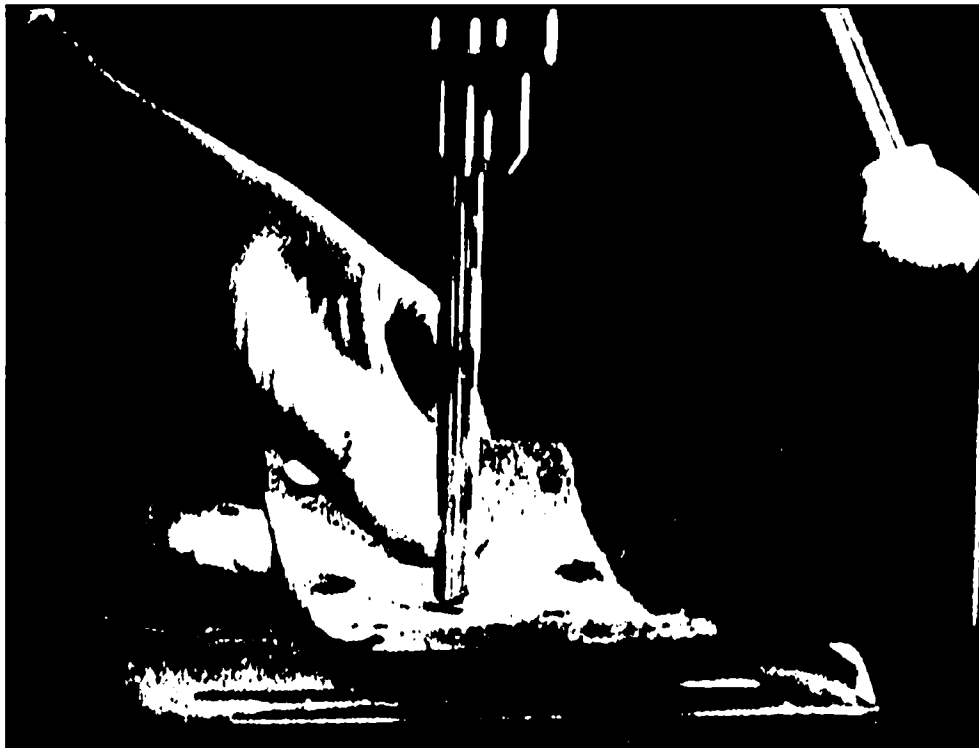


Figure 6. Drilling Caterpillar Brake Band.



Figure 7. Using compressed air in cleaning up the dust and debris from removing rivets and drilling the Caterpillar Brake Band.



Figure 8. Using compressed air in cleaning up the dust and debris from removing rivets and drilling the Caterpillar Brake Band (Tyndall beam on).



Figure 9. Cutting the Caterpillar Brake with an abrasive disc (No Tyndall beam).



Figure 10. Cutting the Caterpillar Brake with an abrasive disc (No Tyndall beam).

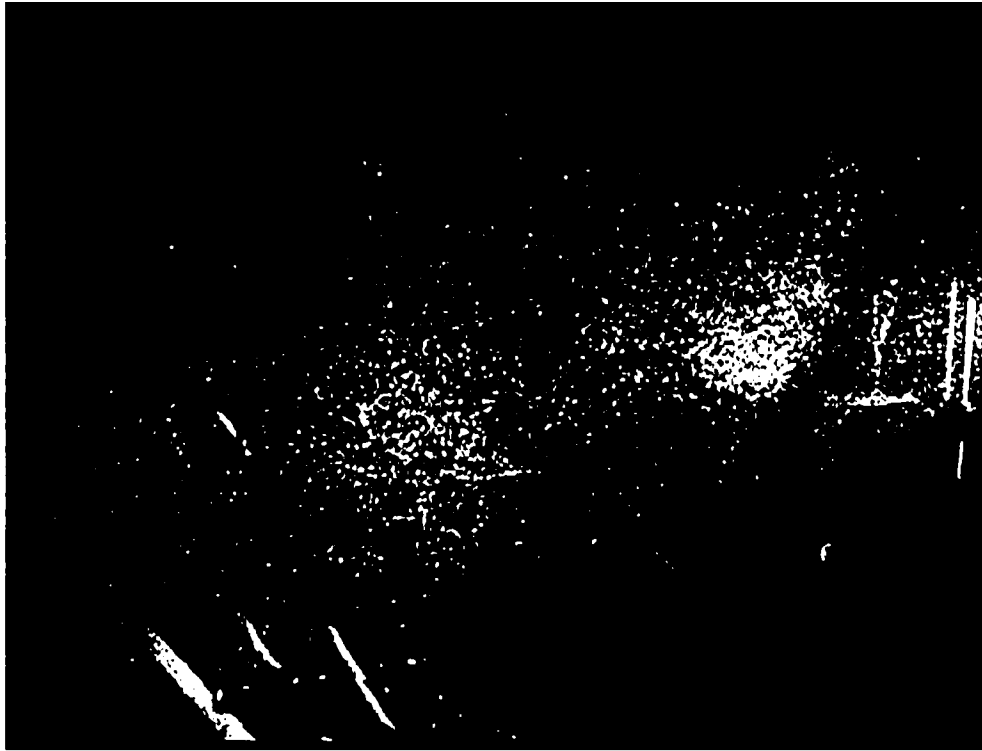


Figure 11. Room air in Tyndall beam after cutting the Caterpillar Brake with an abrasive disc.



Figure 12. Room air without Tyndall beam after cutting the Caterpillar Brake with an abrasive disc. Image from less than 1 minute after image shown in Figure 11.

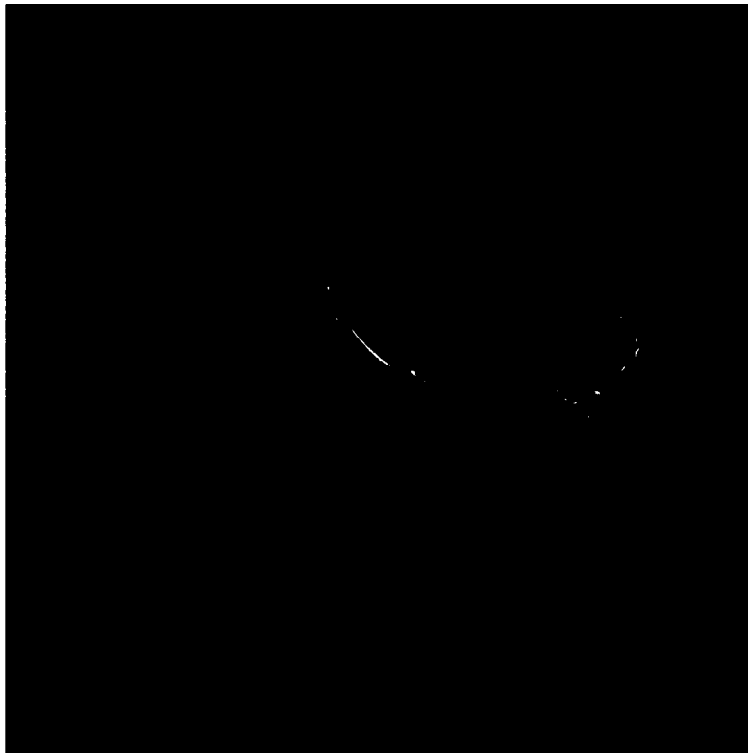


Figure 13. TEM image of chrysotile asbestos fiber released to the air during drilling of Caterpillar brake material.

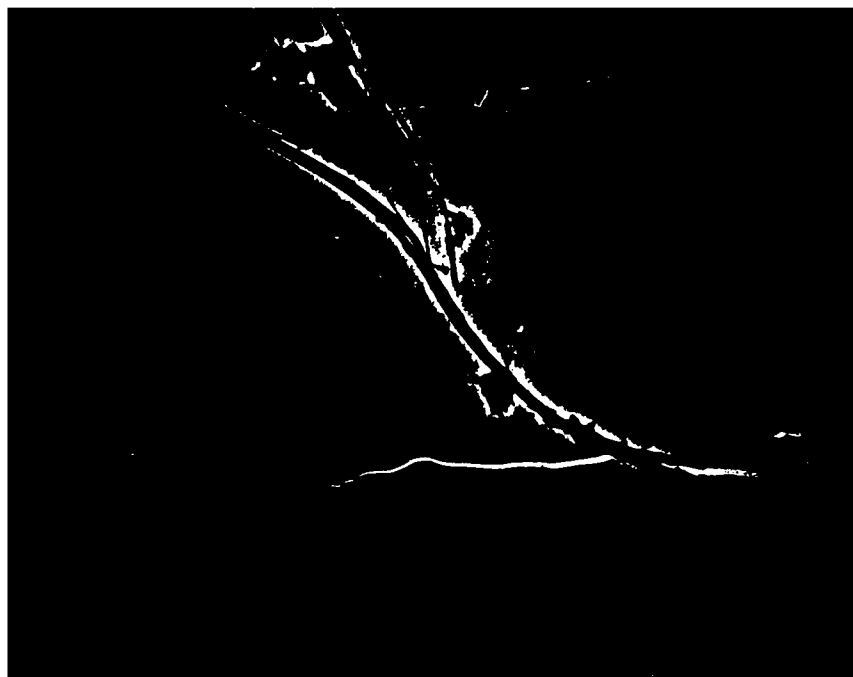


Figure 14. TEM image of chrysotile asbestos fiber released to the air during cutting of Caterpillar brake material.

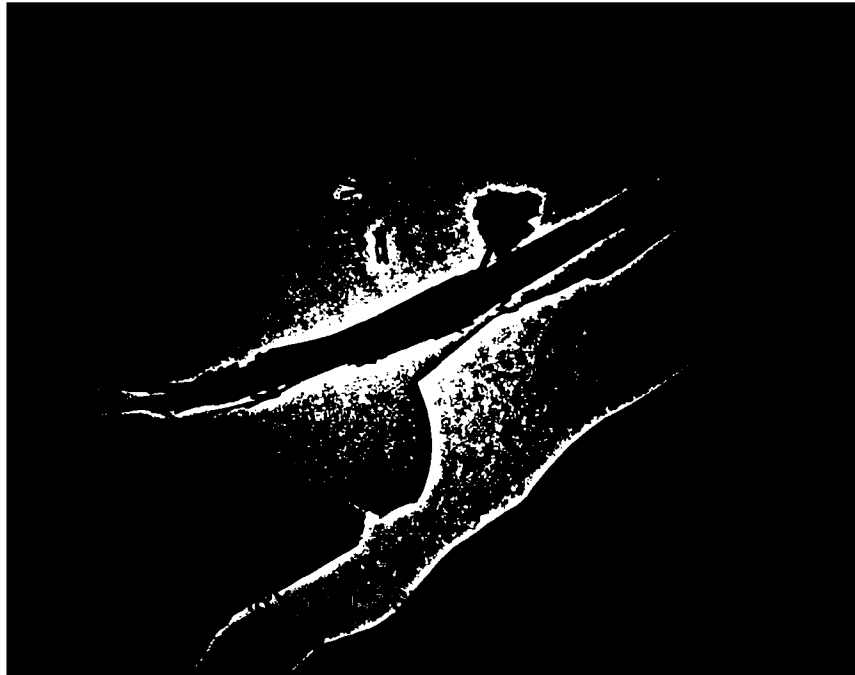


Figure 15. TEM image of chrysotile asbestos fiber released to the air during cutting of Caterpillar brake material.