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COPY

Dr. U. J. Nicholson
Mount Sinai Medical Center
1 Gustav Levy Place
New York, N.Y. 10029

Dear Dr. Nicholson:

As I indicated in my letter of February 9, 1979, we sent copies of your draft to our Asbestos Study Committee, and would forward additional comments if received.

We have been forwarded comments by Mr. James R. Weber, Corporate Manager for Safety and Protection Services at the Bendix Corporation. His comments pertain primarily to the references in Section III of your draft to work done by Dr. M. G. Jacko of Bendix Reasearch Laboratories. I will quote directly from the comments forwarded by Mr. Weber:

After having reviewed the attached draft report entitled "Asbestos Health Hazards in Brake Repair and Brake Maintenance: Materials, Work Practices and Exposure Levels" with Dr. M. G. Jacko of Bendix Research Leboretories, it is felt that the following comments are in order. For ease of reference, the attached document has been notated A, B, C, etc. The following remarks will address each notation.

A - X-ray diffraction cannot separate asbestos fiber from non-fibrous serpentine.

E - The 15% figure is rare and probably due to poor lining quality. Typically, a good lining will usually produce no more than 1.5% free fiber in wear debris even under the most severe conditions (automoitve applications).

C - To be technically correct, this should read:

This followed from the analysis of over 100 samples of disc brake and drum brake dust in which the percentage of asbestos range from 0.013% to 1.65% and 0.003% to 1.42%, respectively. It should be noted that 89% of this unconverted asbestos, comprising about 140,000 pounds of chrysotile, is released as brake wear debris to the environment annually from brake and clutch degradation. This brake wear debris consists of very few free fibers. Most of the asbestos is contained in pyrolyzed resin-bound particles.

III. ASBESTOS FIBER CONCENTRATIONS DURING BRAKE REPAIR AND MAINTENANCE

A. Brake Lining Degradation Process

The degradation products of brake linings reflect the surface temperature at the drum-lining interface during braking operations.[4,8,9,10] Chrysotile has a major dehydroxylation peak at between 650° - 680° C and recrystallizes to fosterite at about 810° - 820° C[11,12] but variations about these temperatures occur depending upon fiber size and heating conditions. Some changes occur, albeit slowly, at much lower temperatures.

Generally, during light braking average temperatures of 350° C or less are maintained. However, during moderate braking action, average temperatures as high as 500° C may occur.[4,9] In very localized "hot spots" temperatures of from 800° to 1000° C have been reported.[4] Under these conditions it has been suggested that, in addition to binder pyrolysis, chrysotile dehydroxylates and "reduces to powder" when it is swept off the brake facing. However, others have pointed out that, in addition to thermal wear, abrasive and shearing degradation occur[9,10] and that brake lining disintegration can occur at temperatures well below those which alter chrysotile fibers. Thus, both altered and unaltered chrysotile fibers may be present in brake dust.

Rohl et al analyzed 10 samples of brake drum dust using optical microscopy, X-ray diffraction, and transmission and scanning electron microscopy techniques.(4) X-ray difraction analysis, including step-scanning, demonstrated the presence of chrysotile in all samples. The proportion ranged from 2% to 15% with an average of about 4%. The presence of small amounts of fosterite was suggested, but could not be demonstrated conclusively. The

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presence of chrysotile was also found by transmission electron microscopy. The amount determined by this procedure was lower than that of X-ray diffraction, as fibers present in clumps of binder material could not be unequivocally identified.

An earlier estimate of brake lining decomposition products is that of Lynch[13] who analyzed 15 brake drum samples by transmission electron microscopy. (B) He found that under extreme braking activities up to 15% of the debris could be free chrysotile asbestos fibers. On the other hand the vast majority of samples, which were taken during light or normal braking conditions, showed less than 1% of free fiber to be present in the decomposition products. Hickish and Knight[14] also reported chrysotile to be present in brake dust in quantities of less than 1%, compared with original lining contents from 40-60%.

The most definitive study of brake degradation products and their fate is that of Jacko et al,[9] who estimated that 99.7% of eroded asbestos in brake lining is converted to other products. (C) This followed from the analysis of over 100 samples of brake drum dust in which the percentage of asbestos ranged from 0.003% to 1.65%. It should be noted that 89% of this unconverted asbestos, comprising about 140,000 pounds of chrysotile, is released to the environment annually from brake and clutch degradation.

Limited data exist on other degradation products. Some are tabulated by Jacko et al[8] and Anderson et al[15] on wear debris materials from brake drums. These data are listed in Tables 2 and 3.

The vast majority of the chrysotile fibers released from brake degradation are shorter than 5μ, Limited data of Rohl et al[7] on the analysis of ten drum samples indicated that 83% of the fibers were shorter 0.37μ (Table 4).

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Optical microscopic data of Hatch[16] suggested that of fibers longer 2μ 94% were shorter than 5μ in length. Combining these two data would suggest that over 99% of the asbestos fibers from brake lining erosion would be less than 5μ in length. (E) However, no direct data exist that would establish this point.

The finding that the vast majority of fibers in an asbestos aerosol are shorter than 5μ is not uncommon. In other work circumstances where chrysotile is released into the air, size distribution measurements have indicated that between 95% and 99.5% of the fibers released are shorter than 5μ.[17] Thus, the size distribution of brake lining dust aerosols may not be too different from those produced by other uses of asbestos products.

B. Fiber Concentrations During Brake Repair and Maintenance Work

A variety of measurements have been made of asbestos air concentrations during brake lining repair and maintenance activities in the United States and Great Britain. These include both long-term sampling over a working day to obtain information on time weighted average exposures to workers, and short-term sampling to document the concentrations during various work practices.

The largest set of samples of brake maintenance work is that obtained by NIOSH during the years 1975 through 1976 where 283 samples were taken in five brake repair facilities, including 152 over a one week period in one facility, documenting both long-term, time weighted average (TWA) exposures and asbestos concentrations in specific brake repair activities[18]. Unfortunately, no documentation exists as to the number of brake jobs performed in a facility or by workmen during sampling periods or on the work practices utilized during the repair and maintenance work. The limited information available

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once every two days). As each job takes about an hour to complete, the long-term TWA average asbestos exposure of typical garage mechanics would be considerably less than 0.5 f/ml, even with air blowing of drums during changes of bonded linings. Such a value corresponds well with long-term TWA exposures measured by NIOSH during 1975-76. In earlier years, when riveted brake linings were maintained, long-term average exposures of garage mechanics might be in the range of 0.5 f/ml to 1 f/ml. However, mechanics employed in brake repair specialty shops or men working extensively in riveting or machining operations could be exposed to higher concentrations.

The existing data indicate that the majority of garage employees are not likely to have been exposed to long-term (over months or years) asbestos concentrations in excess of the current standard of 2 f/ml. The data also show that virtually all asbestos dust is released during easily controlled work activities and that with proper practices TWA asbestos concentrations can be reduced to about 0.1 f/ml or less.

C. Industrial Hygiene Research Needs

1. Size distribution determination

Electron microscopic size distributions of the asbestos in aerosols generated during brake repair are required. Existing data are extremely limited and applicable only to drum dusts.

2. Environmental Assessment of Garage Mechanics during Brake Repair

Data on the average asbestos concentrations experienced by workmen over the course of a brake job are needed. These evaluations should be made during work practices characteristic of earlier years utilized during the changing of both bonded and riveted linings.

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(H)

Table 2

Estimated chemical composition of brake wear debris

Description	Present	
Low molecular weight degradation products	2-10	20-30
Polymeric components	12-20	
Carbonaceous material	1-5	
Inorganics		
mineral	~ 10-30	70-80
olivine	~ 20-40	
Oxides (from lining)	0-10	
Fe_2O_3 (from drum)	5-15	
asbestos	<1	

From: Jacko, M. G., R. T. DuCharme, and J. H. Somers Soc. Auto. Eng. paper 730548, Auto. Eng. Meeting, May 14-18, 1973

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1. Much of the historical information on the development of friction products was obtained from interviews with Edward W. Drislane, Friction Materials Standards Institute, Paramus, N. J., Harry H. Wagner, Jr., Molded Materials Co., Ridgway, Pa.

2. Keasbey and Mattison products catalog, 1926. Ambler, Pa.

3. Friction materials on automotive brakes. Fleet Owner, (August 1963)

4. Carroll, W. G. The manufacture of brake linings. British Plastics 414-417 (August 1962)

5. Anderson, A. E., and R. Gealer. Ford Motor Co., Detroit, MI. Unpublished notes.

6. White, Andrew J., Brake Dynamics: an introduction to brakes at the inspection station level. Motor Veh. Resh. of N. H., Lee, N. H., Chapter 11, 463-472. (1968)

7. Rohl, A. N., et al. Asbestos exposure during brake lining

8. Jacko, M. G., R. R. DuCharme and J. H. Somers. Brake and clutch emissions generated during vehicle operation. Soc. Auto. Eng. paper 730548. (May 14-18, 1973)

(I) 9. Jacko, M. G., R. R. DuCharme and J. H. Somers. How much asbestos do vehicles emit. Automotive Eng. 81, 38-40 (1973)

10. Rhee, S. K. Wear mechanisms for asbestos-reinforced automotive friction materials: Wear 29, 391-393 (1974)

11. Martinez, E. Chrysotile asbestos: Relationship of the surface and thermal properties to the crystal structure. Canadian Mining and Metall. Bull. 69, 414-420 (1966)

12. Harris, A. M. The effects of grinding on the structural and thermal properties of chrysotile asbestos fibers. In Proc. 2nd Intl. Conf. Physical-Chemical Asbestos Minerals. Louvain Univ. 6-9 paper No. 3:2A, 6 pp. (September 6-9, 1971).p.

13. Lynch, J. R. Brake lining decomposition products. J. Air Pollution Control Assoc. 18, 824-826. (1968)

14. Hickish, D. E., and K. L. Knight. Exposure to asbestos during brake maintenance. Ann. Occup. Hyg. 13, 17-21. (1970)

15. Anderson, A. E., et al. Asbestos emissions from brake dynamometer tests. Soc. Auto. Eng. paper 730549 (May 14-18, 1973)