Arrests Excessive Levels
Police Stops

FMSI 06023

FMSI-4 for ID
8/23/82

Y-2 SAME AS Y-1

Y-18 " Y-11

Y-25 " Y-20

Y-28
Y-29
Y-30 " Y-16
Y-31
Y-32

Y-34 " AA-37

ASBESTOS INTERNATIONAL ASSOCIATION

(Limited by Guarantee)

68 GLOUCESTER PLACE, LONDON W1H 3HL

MEMORANDUM

TO: All Member Associations AIA/7/3

FROM: Sir Neville Stack 10 July 1979

RESEARCH REPORT - ASBESTOS
INVESTIGATIONS INTO HEALTH HAZARDS THROUGH DUSTS EMITTED
BY BRAKE LININGS CONTAINING ASBESTOS
Issued by the German Federation of Industrial Accident Insurance
and Industrial Safety Corporations e.V.

Attached is a translation of the significant parts of the above-mentioned document which indicate that it is a very important piece of research. The report is the result of considerable work by more than one independent institution, and therefore should carry considerable weight with authorities. The main conclusion is that when a brake has been in use the dust emitted from the lining contains virtually no asbestos, which means that the effect on the environment is almost nil.

However, it is stated that all the investigations have been done on German brakes, and it is understood that there is a considerable difference in the asbestos content of American brakes.

It is also pointed out that there is a difference in usage between America and Germany; the Americans use a larger brake pad and do not drive so fast, which means that less heat is generated when the brake is applied.

We are obtaining copies of the original German report, which will be sent to Member Associations. Would you please make sure that companies within your Associations which manufacture brake linings are advised of this report.

TN Stack

Sir Neville Stack

FMSI 06026 Y-1 (25)

RESEARCH REPORT

ASBESTOS

INVESTIGATIONS INTO HEALTH HAZARDS THROUGH DUSTS EMITTED BY BRAKE LININGS CONTAINING ASBESTOS.

Issued by the German Federation of Industrial Accident Insurance and Industrial Safety Corporations e.V.

FMSI 06027

FOREWORD

Because of its particular physical and chemical properties, asbestos has become a much sought-after natural product. Its resistance to high temperatures, inflammability and fibrous structure have helped to solve numerous technological problems to the extent that we now encounter asbestos in a multitude of products. Unfortunately however, asbestos is hazardous to health - especially its carcinogenic properties have arrested the attention of the public in more recent times.

Long before asbestos made the headlines, the Industrial Accident Insurance and Industrial Safety Corporations of Germany studied the risks of asbestos, and by issuing an accident prevention code were able to implement and intensify technical and occupational medical preventive measures. One of the questions posed in this process was whether the dust emitted by brake linings which contain asbestos is also capable of causing asbestos illnesses. This is a vital question, since upon its answer depends whether or not a large number of motor vehicle mechanics in particular need to undergo regular medical examinations. The present scientific investigations are intended to throw light on this subject.

The many forms which the problem took in actual research however is demonstrated by the fact that four scientific institutes took part in the research project. Organisational procedures too entailed many problems; as one example, to ensure the scientific validity of the results more than 200 motor vehicle mechanics and employees in the brake lining industry in the Federal Republic had to be found who had had more than 10 years of exposure to dust, in order to have them examined at the Institute for Occupational and Social Medicine in Erlangen.

The final phase of the joint investigations revealed yet another important aspect: similar investigations in the USA had come to conclusions that did not always coincide with our own. This is due to the fact that American brake linings are essentially different from German in terms of composition and hardness, a requirement which has to do with different driving habits in the USA (speed limits). We shall have to deal with this new aspect in the near future, especially since increasing numbers of American motor vehicles are to be expected on the German market.

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Foreword - continued.

This research project was financed with the aid of the Federation of German Industrial Accident Insurance and Safety Corporations, the General Committee of the Iron and Steel IAISC and the IAISC of the Chemical Industry.

May we express our thanks to all those who have contributed to the successful outcome of this report.

Hopf
Chairman

Dr. Bischoff
Vice-Chairman

Bonn, December 1978

CONTENTS

SUMMARY

The investigations into the dangers of dusts emitted by brake linings containing asbestos carried out by the Dust Research Institute of the Federation of Industrial Accident Insurance and Industrial Safety Corporations and the Bavarian State Institute for Occupational Safety within the scope of the overall research programme may be summarized in terms of their results as follows:

1. Brake linings used in the brake systems of motor vehicles contain 10 to 70 % by weight of asbestos; this value usually lies between 20 and 30 % by weight. In all the cases examined, the asbestos used was Chrysotile; other types of asbestos are obviously not used.

2. The principal dust sources encountered in the handling of asbestos brake linings are :

a) in manufacture, the finishing stage comprising the operations grinding, drilling, turning, sawing and milling,

b) in the vehicle workshops, the brake service centres with the operations grinding and turning of brake linings as well as flushing the dust from brake drums.

3. In the finishing stage of lining manufacture, the operations grinding and drilling may as a rule be regarded as ongoing operations. The average expsoure time for the operative is

6-8 h/shift for grinding

4-6 h/shift for drilling.

The operations sawing, turning and milling are carried out only occasionally and only by some lining manufacturers.

In motor vehicle workshops, the operations that suggest the emission of asbestos dust are grinding, turning and flushing, although these operations are generally short-term only. The time of exposure for operatives in the workshop is difficult to assess accurately, but we can assume the following averages

< 1 h/shift, usually < 3 h/week for grinding and turning

< 1-3 h/shift for brake drum flushing.

4. The Chrysotile asbestos content in suspended dust found at the finishing stage of brake lining manufacture is on average 20 % by weight and thus in the order of the volume of asbestos contained in brake linings themselves. Conditions in vehicle workshops for the operations grinding and turning are similar, although the values are on average lower here.

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4. continued.

It was not possible to find clear evidence of the presence of Chrysotile in dusts caused by brake drum flushing. By the fact of its morphology the dust contained practically no fibres at all.

5. The microdust concentrations of Chrysotile asbestos during the operations grinding, drilling, sawing, turning and milling in finishing during brake lining manufacture were just above and below the limit value of 0.15 mg/m³.

In the brake maintenance departments of motor vehicle workshops, the limit for Chrysotile asbestos during the actual operations of grinding and turning is in fact exceeded. In the workshop area however the average values were considerably below this limit. Since no evidence of asbestos in dusts caused by brake drum flushing can be provided, the assessment was based on the MAK value for inert dust of 8.0 microdust/m³. This value was considerably exceeded during the actual flushing operation. Concentration in the work area however was on average below this MAK value.

6. Test bed and laboratory experiments showed that :

a) by mechanical loading (microgrinding) the fibres located in the friction area during the braking process are destroyed to such an extent that practically no fibres can be found in the resulting friction dust, in terms of morphology.

b) Under the influence of temperature, the crystalline lattice of Chrysotile probably transforms into an amorphous intermediate phase. It must be assumed that local temperatures in excess of 500°C are generated in the friction surface.

c) The tempering of samples taken from crushed brake linings in the laboratory at over 800°C causes the formation of Forsterite. Under test bed conditions, Forsterite in the friction dust could only be found with very high asbestos contents (some 60%) in the friction lining. In none of the examined cases was it possible to detect Forsterite in brake drum dust as generated by flushing in the vehicle workshops.

CONCLUSIONS

The results of the supplementary investigations confirmed that the asbestos content in brake friction dust is considerably lower than in the brake linings themselves. There were however wide variances in the extent of asbestos contained in the friction dust. While only traces of Chrysotile asbestos (10^{-3} to $5 \cdot 10^{-1}$ %) were detected in the friction dust samples from 40 German vehicle workshops, there are American brake linings whose friction dust may contain 10 to 30 % Chrysotile asbestos. Asbestos in the order of 2 to 4% has been detected in the friction dust from French workshops.

The reasons for this should first of all reside in the varying composition of the friction linings themselves, and secondly in the variety of conditions under which they are used. Thus European and Japanese linings contain as a rule 10 to 30 % asbestos, while American products contain as much as 60%. In addition, American vehicles are fitted with larger brakes than, say, German vehicles and are generally driven at lower speeds with the result that the heat loading on American brakes is lower. However, the wear and hence the dust emission of the linings is largely determined by the temperature. Even the type of bonding agent used is significant. Thus linseed oil which is used as a bonder for linings in light-duty brakes starts to decompose at as low as 230°C.

These investigations into the asbestos content of brake lining friction dust in motor vehicle brake drums represent an important supplement to the pertinent results of the research programme into hazards to health caused by dusts emitted by asbestos friction linings. They confirm those findings and support the conclusions from them in so far as German brake linings are concerned, but demonstrate on the other hand that other circumstances may be encountered, at least in the case of American linings. The reasons for these differences have yet to be fully clarified.

DISCUSSION OF RESULTS

Man's need for fast transport facilities is as old as civilization itself. However, the high speeds made possible by modern technologies have brought about many new dangers. Apart from fire and war, the braking of energies of motion is perhaps the greatest among the self-induced, exogenous hazards to human life. In order to minimize these risks, people employed in the friction lining industry, the lining processing sectors of the motor vehicle industry and the brake maintenance departments of vehicle workshops and garages are contributing valuable work. Friction linings on the other hand contain asbestos, a material hazardous to health, although in composite form. The amount of Chrysotile asbestos in friction linings is between 10 and 73%, usually between 20 and 30 %. According to American assessments, each private car consumes some 3 or 4 sets of brake linings and 2 clutch linings in its life, while goods vehicles and public transport vehicles require many more. In the highly motorized industrial nations, this fact is expressed as a production figure for brake and clutch linings containing asbestos, of which not less than 6500 t and 7000 t were produced in the Federal Republic of Germany in the first quarter of 1971 and 1972 respectively. The annual asbestos consumption of the USA for the manufacture of brake linings was approx. 55,000 t and approx. 2000 t for the production of clutch linings.

The latest estimates for 1972 in the USA gave a total figure of 907,871 persons potentially exposed to lining dust through their occupations: 833,535 motor mechanics, 67,679 garage workers and some 6,657 employees in the friction lining industry.

There are no reliable figures on persons in the Federal Republic of Germany currently exposed to lining dust and hence to asbestos in the course of their work. And there is even less information available in Germany on the nature and extent of the health hazards that can be causally attributed to such exposure with the degree of probability required for purposes of statutory accident prevention.
So what is the current state of medical knowledge on this ?

Bibliographical material on the subject shows that persons occupationally exposed to brake lining dust can expect a fibrogenous and even carcinogenic health risk as a result of asbestos effects. Thus in the USA in 1963, out of 7510 employees in the friction lining industry 29 deaths of asbestos pulmonary cirrhosis were recorded (= 3.86%). In 21 of the 29 deaths, asbestosis was the primary cause.

More recent epidemiological findings by Selikoff's working party point especially to the asbestos risk among New York automobile mechanics. A provisional cross-sectional study of 84 active and 6 retired (for age reasons) automobile mechanics each with at least 10 years working experience behind them, and of whom some 2/3 had been engaged in brake maintenance, revealed diminished vital capacities in no less than 29% of the subjects and radiological changes in terms of asbestos inhalation effects in 27%. More particularly, these 24 subjects revealed minor irregular shadows of type s or t with a scatter of 1/0(9 x), 1/1(6 x), 1/2(2 x) and 2/2(2 x) as well as indications of pleural fibrosis ($\geq$ 1 a) and/or pleural calcification

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(5 x).

In Great Britain 14 out of 718 recently diagnosed asbestosis cases (= 2 %) in the years 1955-1969 are persons occupationally exposed to brake lining dust. Epidemiological investigations in Italy revealed 59 cases of asbestosis out of 204 employees in the friction lining industry. In Switzerland on the other hand, of 39 persons in automobile brake maintenance, there was only one questionable instance of asbestosis. Neverthless regular control examinations of this occupational group are regarded as necessary.

Less comprehensive is the available knowledge of carcinogenic asbestos risks in exposure to friction lining dust. In Great Britain in 1965 Newhouse and Thompson recorded 1 mesothelioma patient following occupational crocidolite (blue asbestos or ironstone) exposure during brake lining manufacture and in 1974 Greenberg and Davies recorded a further case of mesothelioma after exposure of a motor mechanic.

In the USA, Enterline and Kendrick - 1967 - reported indications of a marginally increased mortality rate from carcinomae of the breathing organs among employees in the friction lining industry. From Canada, McDonald and his colleagues in 1970 reported 2 cases of mesothelioma following occupational exposure to asbestos in the fitting of brake linings plus a further case of mesothelioma after exposure during brake lining manufacture.

In West Germany in 1972, Otto published the case of a 50-year-old fitter with pathological-anatomical pleuramesothelioma after many years employed in the fitting of brake linings.

A study of available subject literature - especially with regard to fibrogenous asbestos risks - shows however that the particular circumstances of exposure to brake lining dust were frequently inadequately investigated to facilitate a differentiated consideration of the hazards. More particularly, it is essential to distinguish exposure to dust from new or used brake linings. Technical investigations into dust in recent years have repeatedly shown that the dust generated by lining friction - as opposed to dust during the finishing and handling of new linings - as a rule contains only traces of free Chrysotile fibres, i.e. of the order of 1%.

Even Schütz' working party was unable to provide clearer infrared-spectrographical evidence of Chrysotile within the scope of this joint research programme, using site measurements as well as laboratory and test-bed experiments on dusts caused by brake drum flushing with compressed air. Under phase-contrast and electron-microscopic scrutiny, the dust contained merely isolated fibres which could not even be definitely identified as asbestos. The assessment of dusts in the air-flushing of brake drums was therefore initially based on the MAK value for inert microdust of 8.0 mg/m³.

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By contrast we find some reports from the USA with partially high fibre concentrations in brake drum dust during peak samples lasting several seconds. Hatch for example has found peak values of 43 ± 2.1 fibres/ml during drum flushing, while Knight and colleagues have found as many as 87 fibres/ml. The latest findings by Selikoff's working party on flushing operations of car brake drums point in the same direction, with recordings of 6.6, 13.6, 13.8 and 29.4 fibres per ml.

The hypothesis posited at the beginning of this discussion must be seen against this background: Does occupational exposure over many years to dusts emitted by asbestos brake linings of employees in the 3 most important risk sectors have medically probable, demonstrable and detrimental subsequent effects on the pulmo-cardial system, especially in terms of specific fibrogenous asbestos inhalation consequences ?

Our occupational medical and epidemiological investigative results are thus based upon the knowledge of work-specific differences in occupational exposure to brake lining dust. As a result, 3 aspects are of particular importance:

1. The formation of adequate random sampling.
2. The representativeness of occupational characteristics for the following areas:
   - industrial finishing in friction lining manufacture (risk group a)
   - brake maintenance services, with exposure primarily during the operations of grinding and turning of linings (risk group b) and
   - brake maintenance services, with exposure primarily during flushing and brushing out of brake drum dust (risk group c).
3. A period of 10 years or more occupational exposure to the development of asbestos effects.

Thus far, the epidemiological artifice of a casuistic cross-sectional study with retrospective assessment would seem to be adequate for the hypothesis under scrutiny. However, the results obtained are unable to give any answers to the following essential questions:

A) What type and how great are the carcinogenic risks of occupational exposure to brake lining dust ?

B) Does the surprisingly often demonstrated finding of so-called chronic-obstructive bronchitis, as opposed to fibrogenous asbestos-inhalation, represent an overfrequent risk of occupational exposure to brake lining dust ?

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Discussion of Results - continued.

C) What effect has the change in workplace conditions since the beginning of the Fifties had on the prevalence of the consequences of asbestos inhalation, e.g. through

- improvements in dust protection by way of extraction technology,
- increasing use of disc brakes for private cars, and
- flushing of brake drums by means of cleaning detergents.

The answers to questions A), B) and C) would require specific longitudinal - as opposed to cross-sectional -studies including future measurements as well as suitable comparative groups.

Re 1:

Our random samples from the individual risk groups each containing between 43 and 63 persons were kept satisfactorily large. With 50 separate companies throughout West Germany and the resultant organisational difficulties, this was only possible in close cooperation with the Headquarters for Accident Prevention and Occupational Medicine of the Federation of Industrial Accident Insurance and Safety Corporations in Bonn.

Re 2:

The representative..ess of activities in the 3 key risk groups was ensured in a variety of ways:

- The selection of each subject and the collation of important dust-protection data at the workplace was carried out by experienced technical supervisors with many years service in occupational safety;
- The investigative results reported by Schütz' working party on dust hazards through asbestos brake linings relate to approx. 85% of the workplaces in those companies in which our subjects were employed;
- The additional detailed survey of occupational and industrial case histories carried out by an occupational physician extends to the entire working life of each subject.

In this way it was found that a sharp delineation in brake maintenance services between activities involving exposure to dusts emitted by new linings on the one hand and brake drum dust on the other does not appear admissible, at least for the period of the subject's entire past working life. In other words, the random sample of risk group c) contains not just employees who have only always flushed or brushed out brake drum dust. It is difficult to ascertain the time spent on operations such as grinding or drilling of unused linings. Thus for example of the

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19 men with suspected findings in terms of initial consequences of asbestos inhalation (Type II), or with minimal (Type III) and equivalent findings (Type IV), no less than 11 stated that they had handled unused brake linings in the manner mentioned in addition to their primary activities of flushing and brushing out brake drums.

Re 3:

With regard to the exposure period, a process of elimination guaranteed a minimum of 10 years occupational exposure to brake lining dust in each case. This fact is expressed in the left-shift spread of exposure periods with arithmetical averages between 16 and 21 years and maximum values between 25 and 44 years (cf. Table 6 and Fig. 2).

The foregoing points indicate both possibilities and limits of a discussion of results, on the assumption that the occupational medical appraisal of the findings on a person exposed to asbestos dust must today be basically three-dimensional. By this we mean both the aspect of occupational disease diagnosis and rival health hazards, which could cast doubt on suitability for hazardous work in accordance with the principles of the industrial safety corporations. This situation was taken into account by the definition of types of findings as I = $\hat{=}$ AIF probable, II $\hat{=}$ AIF possible (suspect findings), and III = $\hat{=}$ AIF unlikely on the one hand, and on the other the rival finding designated as IV $\hat{=}$. This in turn was based on suitable procedures of primary and secondary data gathering, such that the detailed information on each subject could be reduced from more than 100 target features - with the extensive elimination of perturbances - to one or two types of findings. The risk assessment is thus based on the frequency of peculiarities noted according to types of findings in work-specific sub-groups. After consideration of the pros and cons the assertion of a tolerable residual risk for findings in terms of probable asbestos inhalation consequences Type I) of less than 1 % would appear acceptable under the prevailing circumstances.

If we look through the results submitted, we find that there is evidence - with the degree of probability decisive for the area of statutory accident insurance - that many years of occupational exposure to brake lining dust can lead causally to fibrogenous asbestos inhalation effects. But an assessment differentiated by risk groups points to apparent differences in the risk of disease, these differences arising out of the frequency of symptoms in findings group type I and to a certain extent in II. We should point out here that the definition of findings type I - as opposed to type II - in terms of occupational medicine is based on a "reasonable suspicion" of an occupational disease under Section 5 of the 7th BKVO*.

*BKVO = Berufskrankheitsverordnung - Occupational Disease Code.

The number of occupational diseases to be indicated under Figure 30 of the Appendix to the 7th BKVO is 3 in risk group a) and 2 in risk group b). In relative terms, 5.9% and 3.2% respectively of the male subjects in both risk groups clearly exceed the tolerable residual risk of less than 1 %. To this fact must be added that the employees in risk group a), while being some years older on average, had nevertheless had some years less exposure to brake lining dust than the subjects in risk group b). The relative frequency of insured persons with suspect findings in terms of potential asbestos inhalation effects (Type II) is 16% in both sub-groups. For these persons intensified monitoring by for example more frequent examinations is to be recommended in accordance with principle G 1 of the industrial accident insurance corporations. All in all, we may assume that the male groups are exposed to a somewhat higher disease risk in the finishing stage of the lining manufacturing industry (risk group a) than in motor vehicle maintenance, especially with exposure to dust from new and used brake linings (risk group b).

Female employees are only engaged in lining manufacture to any noteworthy extent. The random sample of 43 female workers did not reveal any peculiarities compared to their male counterparts in terms of age distribution and length of exposure to brake lining dust (Table 6 and Fig. 2). The results of the investigations however differ considerably. The probable presence of fibrogenous asbestos inhalation effects (Type I) was found in none of the subjects, while potential effects (suspect findings, Type II) were only approx. half as frequent (7%) as in males. The length of exposure to dust from the drilling (twice) and grinding (once) of unused linings for the 3 women of findings Type II was 18, 20 and 11 years respectively. The reasons for the differences between the sexes with regard to probable and possible inhalation effects may be discussed as follows:

- the known difficulties of early radiological diagnosis of fibrogenous asbestos inhalation effects in women through mammary shadow superimposition;
- the high percentage of non-smokers among women (approx. 70%), as opposed to their male colleagues (approx. 24% non-smokers), and
- less dust concentrations at women's workplaces despite nominally similar work in drilling, grinding, sawing and turning, e.g. as a result of smaller workpieces.

Rival findings of Type IV are numerically predominant in the female employees. Their relative frequency exceeds by approx. 35% that of the three male random samples (Table 8). The main cause of an assumed unsuitability for activities at risk through asbestos dust for 12 out of the 15 women (80%) - despite the large proportion of non-smokers - is represented by varying degrees and configurations of chronic-obstructive bronchitis. The same statement is also true

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for 10 of the 12 male workers (83%) with Type IV findings in risk group a). A long way behind comes obesity in terms of excessive or extreme overweight as the second most frequent cause of unsuitability in males (once) and females (3 times) in risk group a). Only approximately half the men (45%) and women (51%) in this risk group showed a spectrum of findings in the normal range (Type V). These included subjects of both sexes with as much as 25 years length of occupation. One of the causes of these varying effects of quantitatively and qualitatively potentially equivalent conditions of exposure can be stated as the individual's disposition.

The two employees in risk group b) with Type I findings already mentioned have certain particular features. Investigations in each case detected the combination of findings of Type I with those of Type IV. In both instances, the effects of asbestos inhalation are rivalled by chronic-obstructive bronchitis with nicotine abuse and moderate overweight. In addition, the duration of exposure to brake lining dust with grinding and turning and to brake drum dust during flushing or brushing out of brake drums of 29 and 37 years is high in relation to the ages of 43 and 53 respectively. Hence the age of entry into the risk occupation is calculated as being 14 and 16 years respectively. In 5 of the 10 employees with findings of initial asbestos inhalation effects (type II) also, the age of entry into the brake maintenance trade is 14 to max. 18 years (cf. Fig. 5). The average exposure period of all 10 employees in this group is 20 years and thus also comparatively high. The frequency of findings in the normal range (Type V) in risk group b) employees with many years of exposure corresponds - at 47.6% - with that of risk group a).

The lack of evidence of fibrogenous inhalation effects (Type I) in the 53 men in risk group c) may be taken as an indication of a relatively low workplace risk factor, especially in view of their long years of exposure. The reader is moreover referred to the detailed casuistic description of the examination results on 4 employees with findings of initial inhalation effects (Type II).

Here we find the following peculiarities :

- exposure commences in 15th year (twice),
- exposure not only to brake drum dust but also to dust from unused linings during grinding and turning (once), and
- differential diagnosis rendered difficult by findings combination II/IV (4 times).

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Discussion of Results - continued.

In another 5 men (9%) there are other disorders which restrict the functioning of lungs, heart and circulation. Details as to the distribution of diagnoses over the male and female workers in the three risk groups are shown in Table 9.

The prevalence of chronic-obstructive bronchitis as a non-suitability criterium is:

- 19.2% related to all 210 subjects,

- between 65 and 89% related to the 53 subjects with Type IV findings.

On the basis of our long years of occupational medical and epidemiological experience, we can state that these frequency figures are notably high in comparison with investigative results from other groups of subjects exposed to dusts. It should be pointed out here that measurements of respiratory capacity by Selikoff's working party found indications of obstructive ventilation disorders in 32 out of 87 motor vehicle mechanics, i.e. 37%.

In accordance with the epidemiological investigative results set forth here on the subject of health hazards through dusts emitted by brake linings containing asbestos, the following assessments of the material hypothesis, conclusions and recommendations would seem to be adequately covered, all due care being considered :

Assessment of Material Hypothesis

The material hypothesis must be assumed in the following form:
Long years of occupational exposure to dusts emitted by brake linings containing asbestos may, in employees in two of the three most important risk groups, and in individual cases, provoke detrimental repercussions on the pulmo-cardial system, and more particularly by way of specific, fibrogenous asbestos inhalation effects, such repercussions being demonstrable with a degree of probability acceptable in terms of specialist internal and occupational medicine.

SUMMARY (P. 65) 66)

Since 1973 the Federal Republic of Germany has had far-reaching regulations on the protection of persons exposed to asbestos. This raises the question of whether persons occupationally exposed to dusts emitted by brake linings containing asbestos should be generally considered as in danger from fibrogenous inhalation effects or not.

To investigate this workplace-related problem, a cross-sectional study of a selected group was carried out with retrospective considerations. This group consisted of 210 employed men and women each with at least 10 years' exposure to brake lining dust in 3 risk groups and from approx. 50 different firms. The data gathered for each subject resulted in

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Discussion of Results - continued

These findings are rivalled in each instance by an initial to moderate obstructive bronchitis with reasons for suspecting an initial fibrogenous inhalation effect. It is known that peribronchitic alterations in the X-ray picture can however lead to qualitatively similar, small, irregular and linear shadows as a nascent pulmonary asbestos fibrosis. Thus the importance of the Type II findings in 7.5% of the random sample is somewhat diminished, and the percentage of men in risk group c) with findings in the normal range (Type V = 64%) clearly exceeds those of the other three groups (45%, 51%, 48%, cf. Table 8).

In terms of occupational medicine, we should finally look at another result of this study in greater detail. This is the frequency and reasons for restricted suitability and/or unsuitability for work at risk from asbestos dust, which have been summarized here as rival findings of Type IV, as based on the non-suitability criteria as contained in Fig. 3.3 of principle G1*. The application of these criteria to all the 210 subjects with many years of exposure to brake lining dust in all three risk groups reveals in no fewer than 53 subjects (= 25.2%) medical doubts about the continuation of their former activity. Two diagnoses are by far the most significant reasons :

- the chronic-obstructive bronchitis of 41 of the 53 persons with Type IV findings (= 77%), and
- obesity in terms of excessive or extreme overweight (13%).

Table 9:
Absolute and relative frequancies of important diagnosis groups as reasons for restricted suitability and/or non-suitability for work at risk from asbestos dust for n = 53 employees exposed to brake lining dust, subdivided into risk groups and sex.

Diagnosis Group	Risk Group	Total
Chronic-obstructive bronchitis		
Obesity		
Other disorders		
Total		

G1* - Danger from mineral dust hazardous to health.

approx. 200 details - over 40,000 in all - both on their case histories, with special consideration of occupation and workplace, as well as on the findings. The subsequent detailed occupational medical and internal investigations made use of physical, clinical, ECG, X-ray and the latest pulmonary function analytical processes.

The occupational medical evaluation of the findings on a subject exposed to asbestos must today be carried out three-dimensionally. The comprehensive data material had to be reduced in terms of fibrogenous inhalation effects according to the quality of the findings to a few types with definite degrees of diagnostic certainty :

Type I ≙ probable effects; Type II ≙ possible effects (suspect findings); Type III ≙ no assumption of effects.
Rival and normal findings were grouped under Type IV and Type V respectively.

The risk assessment is primarily based on indings in terms of probable effects (Type I). Suspect findings in terms of initial effects (Type II) were not however disregarded. The prevalence of findings of Types I and I respectively were:

a) 5.9% and 15.7% for 51 men engaged in the industrial finishing of brake linings or processing them in the automotive industry (risk group a),

0.0% and 7.0% for 43 women in the same risk group a),

b) 3.2% and 15.9% for 63 men processing mainly used and unused brake linings in motor vehicle brake maintenance (risk group b),

c) 0.0% and 7.5% for 53 men flushing or brushing out brake drums in the brake maintenance trade (risk group c).

From this we can conclude that long years of occupational exposure to brake lining dust can causally lead to fibrogenous inhalation effects with the degree of probability decisive for the area of compulsory accident insurance. The risk of disease would appear to be somewhat higher for group a) than for group b), and is relatively lowest for risk group c).

A rival finding is the above-average prevalence in 19.2% of the 210 subjects examined of chronic-obstructive bronchitis as a non-suitability criterion for jobs at risk through asbestos.

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Discussion of Results - Conclusion.

The results obtained justify the realization of occupational medical prevention preferred for employees in risk groups a) and b). Details proposals shall be submitted on this. It is also recommended that ways be found to ensure in future that youths under the age of 18 years are not exposed to dusts emitted by brake linings containing asbestos in risk groups a), b) and c).

DISCUSSION OF RESULTS

In terms of carcinogenic properties there were distinct differences between the two dust samples. Sample AB I with a 45 % tumor incidence possesses unequivocal carcinogenic properties, for which the asbestos fibres contained in the dust sample should be primarily responsible. Compared with the results given in subject literature, this tumor rate must be regarded as relatively high.

It is more difficult to assess the results of the second test group AB II. A tumor rate of 11 % (n 22) is around the limit of a potential spontaneous frequency. In numerous dust control groups of investigations by Pott et al. the tumor rate was between 2 and 8 %, with a maximum of 10 %. We can conclude therefore that the occurrence of 11 % tumors with the given dust dose does not safely exclude the carcinogenic effect of the AB II dust. If we further remember that 40 animals had already died spontaneously by the appearance of the first tumors at the "9 months" test period, the tumor rate would increase to just 14%.

With regard to the fibrogenous properties there were distinct differences between the two dust samples. Sample AB I develops definite fibroblastic properties under the given test conditions, while AB II shows rare and also very minor coalescences with a single application of 50 mg per animal. Subject literature shows that tumors from fibrous dusts arise under concentrations that no longer exert any fibroblastic effects. Hence no indirect conclusions can be drawn from the extent of the coalescences with regard to the presence or absence of oncogenous properties of sample AB II.

RESULTS

Macroscopically, all animals showed distinct dust nodules on the omentum as well as on the liver, pancreas and other organs. In the group AB I growths in the upper abdominal cavity between omentum, liver, pancreas and stomach were quire marked in almost all animals, such that a fibrogenous effect must be ascribed to this dust. In Group AB II there were only minor growths in a few animals; no specific fibrogenous effect should be inherent in this dust.

In both groups (AB I and AB II) the first tumors appeared 9 months after the start of experiments. At that time 39 rats in Group AB I and 40 rats in Group AB II were dead. The tumors were either solid, sizeable (up to 5 cm) growths primarily on the stomach, liver or lower abdominal area or disseminated to matchstick-sized nodes spread throughout the entire peritoneal cavity. Haemorrhagic ascites with grit-like white grains were often exuded on opening the abdomen. Large, subcutaneous tumors were also found at various parts of the body. Histologically speaking, the abdominal tumors were mesotheliomae, sarcomae and carcinomae at various stages of development; transitional stages of the various types were frequently observed.

The cumulative appearance of tumors over a period of time is shown in Figure 1, which shows abdominal tumors of both test groups. Two additional graphs show the occurrence of tumors with haemorrhagic ascites. By the end of the experiments, 89 animals in Group AB I (=45%) and 22 in Group AB II (=11%) showed tumors of the abdomen, and in 30 cases (AB I) and 5 cases (AB II) this was accompanied by haemorrhagic ascites.

The occurrence of subcutaneous tumors is reflected in Figure 2. The differences in frequency are in the usual range of distribution.

CONCLUSIONS AND RECOMMENDATIONS

Page 100 to 102

It is a generally accepted fact in practice and science today that occupational exposure to asbestos dust can become a health hazard at the most varied kinds of workplaces. The Legislature have acknowledged scientifically proven findings and have taken account of both the fibrogenous risk as No. 4103 (asbestos dust pulmonary disorder) and the carcinogenic risks with No. 4104 (asbestos dust pulmonary disorders in conjunction with lung cancer) and No.4105 (asbestos-induced mesothelioma of the costal pluera and peritoneum) in the schedule of occupational disorders. Apart from other factors, the concentration and duration of inhalation of asbestos microdust are of vital importance. Particular difficulties arise in connection with an appraisal of the health risk for those occupational groups exposed to very slight dust concentrations or exposed to sporadic concentrations only. Those persons working in motor vehicle workshops on brake repairs are especially difficult to assess.

The following conclusions may be drawn from the investigations:

Group a:
<u>Industrial Machining and Processing of Brake Linings</u>

This group comprises persons handling brake linings in the finishing stages of manufacture (e.g. sawing, grinding, drilling, turning and milling) as well as those carrying out comparable work in the automative industry.

The average Chrysotile microdust concentrations found in these activities are in the range of 0.09 to 0.20 mg/m³. Thus the results of measurements are within the range of the current MRK value of 0.10 mg/m³.

In terms of occupational disorders, persons carrying out these activities, and especially three of the 94 examined cases, showed probable fibrogenous asbestos inhalation effects.

The experiments carried out on animals show that dust samples taken from this area possess both fibrogenous and carcinogenic properties.

All the results correspond in so far as they call for measures for technical and medical safety at work in the industrial machining and processing of brake linings.

We therefore recommend that

1. technical protection measures such as improved enclosure of the dust sources, increased air extraction etc. be implemented to keep the concentrations of Chrysotile microdust below the TRK value, and

./.

2. persons carrying out the afore-mentioned activities undergo occupational medical preventive examinations according to principle G1 of the industrial insurance and industrial safety corporations by way of

   - general basic examination
   - follow-up examinations at medium intervals (e.g. two years) and
   - detailed examinations at the usual intervals (five years).

Group b:
Hand machiningof Brake Linings

This group comprises persons handling unused and used brake linings in motor vehicle workshops. To a lesser degree of time (approx. 20%) brake drums are also blow-flushed or otherwise cleaned.

The concentrations of Chrysotile microdust founds in these activities are between 0.03 and 0.79 mg/m³. The results measured are thus distinctly above the current TRK value for Chrysotile. It must be remembered however that the proportion of these activities are often just one hour per shift or less than three hours per week.

Of the 63 persons examined in this group, two showed probable fibrogenous inhalation effects from asbestos.

The results indicate therefore that, with regard to the hand machining of brake linings, measures for technical and medical safety at work cannot be disregarded.

No animal experiments with group b dusts were carried out since these dusts are not essentially different from those in group a in terms of composition.

For the hand machining of used and unused brake linings, we therefore recommend that

1. technical measures such as enclosing dust sources and extraction of generated dusts be implemented to keep the concentrations of Chrysotile microdust under the TRK value, and that

2. persons carrying out the aforesaid activities undergo occupational medical preventive examination according to principle G1 of the industrial accident insurance and industrial safety corporations as follows:

   - general basic examination
   - follow-up examinations at extended intervals (three years)
   - detailed examinations at the usual intervals (five years).

For short-term exposure, the indications given in the description of the effects of asbestos dust should be observed.

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Group c:
Flushing of Brake Drums

This group comprises persons who air-flush or otherwise clean brake drums in motor vehicle workshops. Brake linings are also machined to a lesser time degree (less than 10%).

The concentrations measured during these activities show very high values avraging approx. 60 mg/m³ during the relatively brief flushing operation. However only sparsely scattered asbestos fibres were found. This does not indicate a zero risk, but the risk is substantially lower than in the hand machining of brake linings.

There are indeed indications that far greater concentrations of asbestos fibres are to be found in the flushing of American brake drums.

The medical cross-section showed that none of the 53 men carrying out this activity had fibrogenous inhalation effects that were demonstrable to any degree of probability. Only 4 subjects showed suspect findings.

Almost no fibrogenous effects were shown in this group by animal experiments. The results of animal studies into carcinogenic risks show that compared with dusts from establishments carrying out the industrial machining and processing of brake lining, the oncogenous properties are very slight. No definite statement can be made however, since the tumor rate was on the border of the anticipated spontaneous tumor rate.

The results indicate that the fibrogenous risk is slight. However on the basis of animal tests a minor carcinogenic effect cannot be ruled out at the present time. No assessment of the carcinogenic risk can be made by ascertaining the dust concentration at the workplace owing to a lack of MAK values for carcinogenic materials.

We recommend that

1. the high microdust concentrations sometimes caused by the cleaning of brake drums be minimized by technical precautions;
2. owing to the slight fibrogenous risk involved, no preventive examinations under principle G1 be carried out for the time being; this finding must be reviewed as and when new information on the carcinogenic risk is available;
3. to clarify outstanding questions,
   - the 53 persons in Group c cross-section be subject to continued medical surveillance, even after leaving their employment;
   - special investigations be carried out into the causes of the different asbestos contents in the brake drum dusts of German and American vehicles;
   - continued animal experiments be undertaken to assess the carginogenic risk inference of brake drum dust.

./.

When appraising the overall results it should be remembered that the findings of the cross-sectional examination only permit statements with regard to the fibrogenous risk. In the case of inhalation of concentrations of asbestos microdust at the workplace which leads to a fibrogenous risk, a carcinogenic risk must also be assumed.

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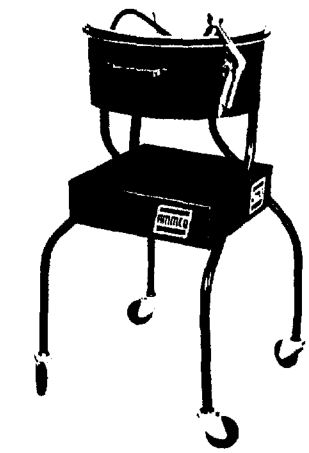

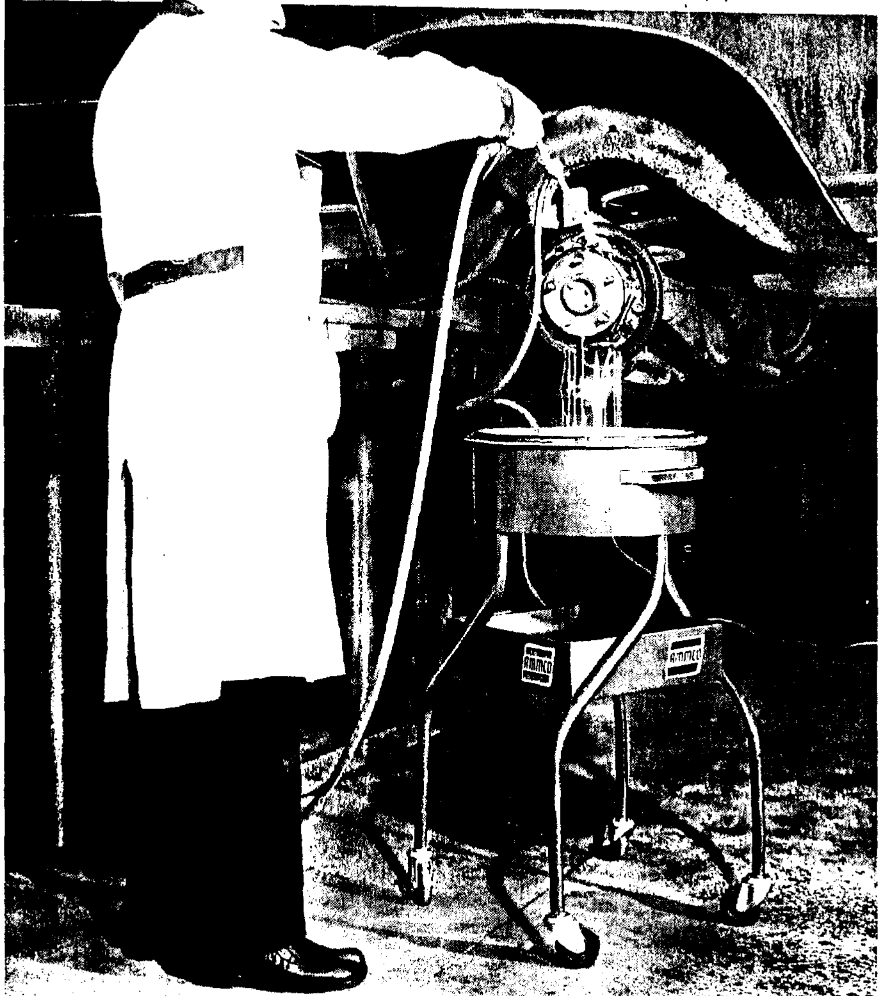

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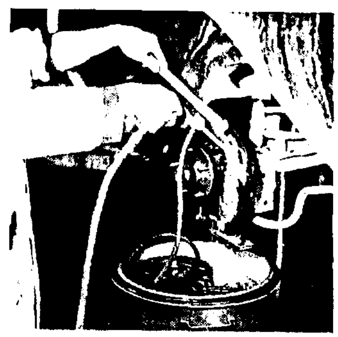

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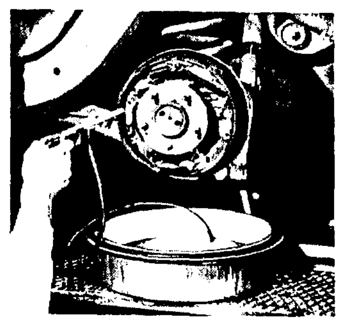

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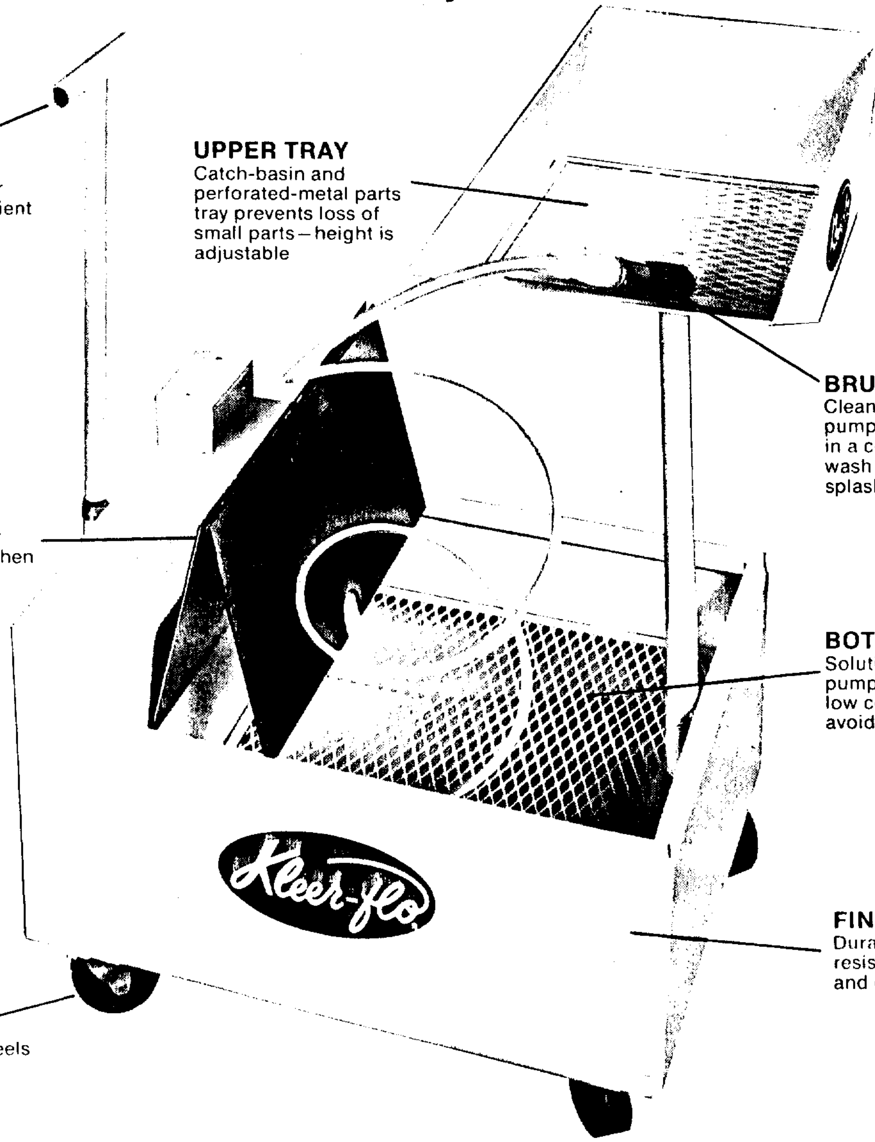

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BRUSH
Cleaning solution is pumped through brush in a controlled flow to wash thoroughly without splashing

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Cover closes over solution supply when not in use

BOTTOM TANK
Solution supply and pump are in the base – low center of gravity avoids tipping and spilling

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Durable epoxy finish resists scratching, rust and corrosion

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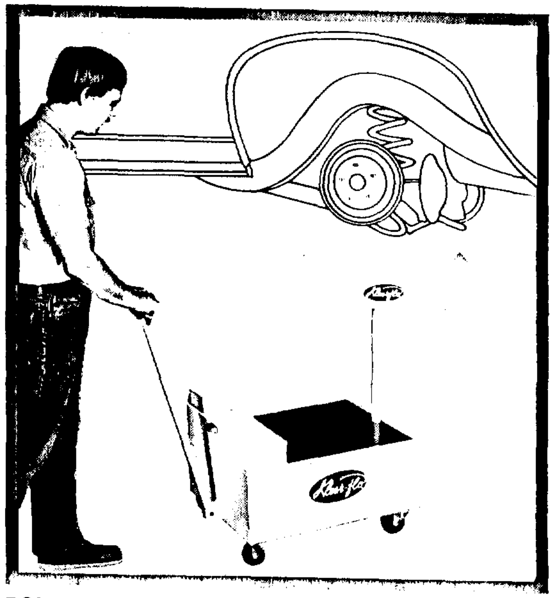
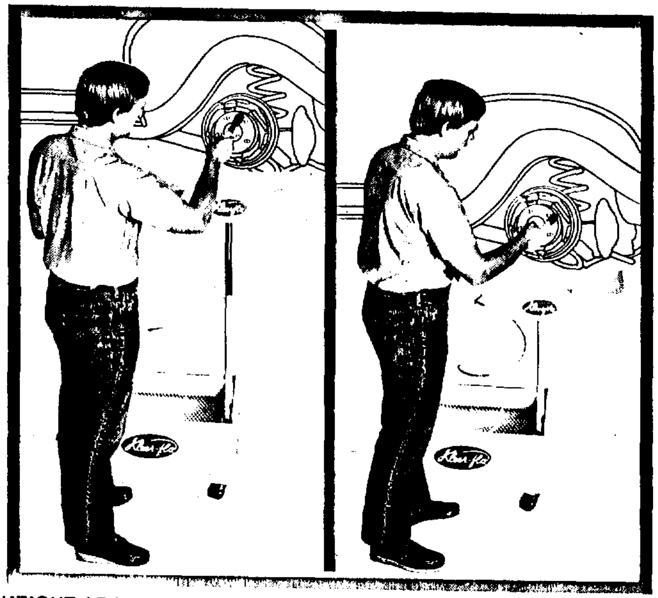
The Kleer-Flo Brake Washer removes asbestos fiber dust, grease and road dirt from brake assemblies. Kleer-Flo Greasoff™ No. 19 circulates through the brush to clean thoroughly – yet safely – eliminating the dangerous practice of blowing asbestos-laden dust into the air. Washing with the Kleer-Flo Brake Washer increases efficiency, too!

Each mechanic works at the most comfortable height for him. He works faster with clean parts and avoids delays because parts are held at the axle, where they're easiest to find. And the low center of gravity, caster wheels and T-handle move the unit easily from wheel to wheel. The solution passes through a barrier filter as it recirculates.

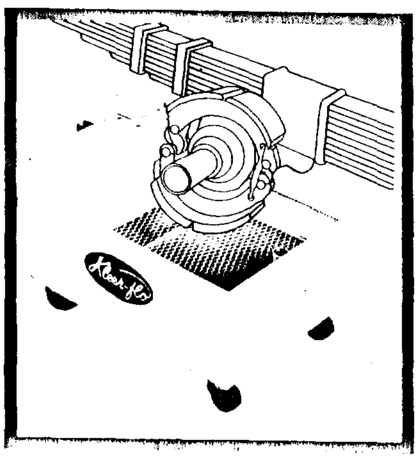
The Kleer-Flo Brake Washer helps you work faster and safer!



ROLLS INTO POSITION quickly, safely—thanks to the T-handle, caster wheels and low center of gravity.



HEIGHT ADJUSTS to enable each mechanic to work at best height for him. Reduces fatigue, prevents spilling and loss of small parts.



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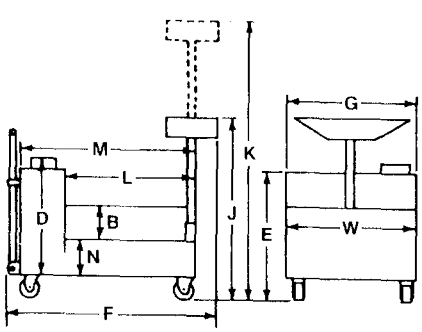

SPECIFICATIONS

MACHINE OVERALL		
Length	F	32"
Width	G	18"
Height	E	18"
Drain Pan Up (Max)	K	51"
Drain Pan Down	J	36"
MACHINE INSIDE		
Length	M	25½"
Width	W	18"
Depth	D	15½"
WORKING SPACE		
Length	L	19¾"
Width	W	18"
Depth	B	4½"
Reservoir Depth	N	5½"
ENGINEERING DATA		
Pump Motor H.P.	Fract.	
Elec. Requirements	110V., 60Hz., 1 Ph.	
Work Shelf Capacity Lbs.	100 Lbs.	
LIQUID CAPACITY		
(Machine) Gals.	6	
MISCELLANEOUS		
Tank Drain		
Swivel Casters		
Flow Thru Cleaning Brush		
Adjustable Drain Pan		
Shipping Weight, Lbs.	110 Lbs.	

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irregular or nodular interstitial opacities of limited extent and intensity on their films. Silica or asbestos exposure had occurred in 22% of the work force examined. Such exposures had occurred in various job categories in the titanium facility as well as in prior occupations. Eight of the 26 workers with abnormal X-rays had had silica or asbestos exposure. No clear pattern of restrictive disease in relation to X-ray findings could be seen.

Summary and Conclusions

Clinically significant or symptomatic pulmonary disease was infrequent in a survey of 207 currently employed production workers in a plant producing titanium dioxide from ilmenite ore. Evidence of airways obstruction was found in 47% of all workers (including 38% of workers who had never smoked regularly). This abnormality was not frequently accompanied by disabling shortness of breath. Despite the fact that approximately 90% of the group of workers examined had worked for 20 years or more, radiological changes consistent with pneumoconiosis were relatively few, and unrelated to the respiratory abnormalities observed.

We conclude (with the caveats inherent in a prevalence study in which only half of the eligible long-term workers were examined) that occupational exposure associated with titanium production by the sulphate process may commonly cause undesirable irritation of the upper and lower respiratory tract and functional abnormalities of the lung, but does not result in an important incidence of serious occupational lung disease. Individual workers may, however, suffer unwanted abnormalities. These findings, of course, do not speak to the presence or absence of increased risk of malignant pulmonary disease. This is being separately studied.

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Asbestos Content of Dust Encountered in Brake Maintenance and Repair

by A N Rohl PhD, A M Langer PhD, R Klimentidis BA, M S Wolff PhD and I J Selikoff MD
(*Environmental Sciences Laboratory, Mount Sinai School of Medicine of the City University of New York, New York, NY 10029*)

Asbestos in Brake Linings

The composition of automotive brake linings includes chrysotile asbestos fibre which comprises about 50% of the friction material. The exposure of garage workers to asbestos during brake lining maintenance and repair has recently been investigated (Rohl *et al.* 1976). This important issue was studied because a large labour force is potentially exposed (over one million people in the United States alone). Consequently it was thought essential to determine if chrysotile fibre survives braking, and to measure the amounts liberated as an aerosol during maintenance and repair operations.

Investigators in the past have expressed doubt as to whether chrysotile fibres can survive the high temperatures generated during braking (Lynch 1968, Hickish & Knight 1970, Hatch 1970). Chrysotile is alleged to be subjected to temperatures in excess of 800°C, which would cause its thermal transformation to forsterite or to an amorphous magnesium silicate phase. While 'hot spots' up to 1000°C may be attained (Carroll 1962), the heat distribution is nonuniform, and other processes, in addition to thermal wear, contribute to degradation of brake linings. For example, abrasion and macroshear may also cause physical breakdown (Burwell 1957, Mizutani *et al.* 1973). Accordingly, brake lining disintegration by these mechanisms may liberate partially altered or even unaltered chrysotile fibres.

Analysis of Brake Drum Dust

Initially, ten samples of automobile brake drum dusts from brake repair shops in New York City were collected and examined by optical microscopy, X-ray diffraction, transmission electron microscopy and energy dispersive X-ray spectroscopy, to determine the presence of chrysotile.

Optical microscopy: The detection of chrysotile in brake drum dust by optical microscopy is hindered by the nature of the debris matrix, consisting largely of opaque pyrolyzed phenolic-type resin binders and road dust. Chrysotile, particularly small fibres, has low optical relief and low birefringence, which further hinder its identification. Only in rare instances have large fibres, with optical

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(6)

Table 1

Chrysotile asbestos content of brake drum dusts

	No. of samples	X-ray diffraction (step-scan) No. positive	Weight percent Mean	Weight percent Range	Transmission electron microscopy No. positive
Great Britain	8	6●	1.8	0.7–2.3	8
West Germany	8	5●	2.4	0.5–3.2	8
France	1	1	2.5		1
United States of America	10	10	4.5	2.0–15.1	10
Finland	5	3	1.8	0.8–2.5	5
Western Australia	7	4	1.4	0.5–2.3	7
	39	29	$\bar{x}=2.4$ ± 1.1		39

● 1 sample possibly positive

properties consistent with chrysotile, been observed with this technique.

X-ray diffractometry: The ten brake dust samples were analysed by X-ray diffractometry, in both continuous and step-scan mode. The diagnostic reflection selected for chrysotile (3.66 Å; hkl=(004)) was step-scanned in the fixed-count mode. By comparison with external standards, the amount of chrysotile present can be determined. Chrysotile reflections were observed in all samples, with weight percentages estimated to range from 2 to 15 (average 4.5). Lead compounds, quartz, carbonate minerals, clays, halite (NaCl), graphite, micas and alpha-iron were also identified in various samples.

Twenty-nine additional brake drum dust samples were collected by colleagues in four European countries and Australia. The samples were obtained from areas representing variable circumstances, such as driving conditions, friction material composition, type of automobile and climate. The results of X-ray diffraction analyses are presented in Table 1. Of the 39 total samples analysed (including 10 United States samples) chrysotile was found in 29, or about three-fourths. The mean chrysotile content varied from 1.4% in the seven Australian samples to 4.5% in the New York City samples.

The thermal breakdown product of chrysotile, i.e., forsterite, which might be expected to form as a result of recrystallization, was not unambiguously detected in any sample.

Transmission electron microscopy (TEM): In order to verify the results of X-ray diffraction analysis, the brake dust samples were prepared for electron microscopic analysis by means of a technique which disperses the dust particles in a nitrocellulose film without altering particle sizes. Both free chrysotile fibre bundles and fibrils were observed in all 39 samples. Most of the chrysotile retained its characteristic morphology without significant alteration, and selected area electron diffraction patterns obtained on representative fibres demonstrated the preservation of crystal structure as well (Fig 1).

Fibre size distribution: In ten brake dusts sampled in New York City, free asbestos fibres were sized by TEM at magnification 42 000. The results showed that about 80% of chrysotile is in free fibril form and is shorter than 0.4 µm in length. Over 57% have lengths of about 0.2 µm. At magnification 40 000, such a fibre would be about 1 cm long. If lower magnification were used to scan for asbestos, significant numbers of fibres might not be detected.

It is obvious that most fibres are too small to be seen by optical microscopy. The Asbestos Standard adopted by the Occupational Safety and Health Administration (OSHA) of the US Department of Labour is limited to optical microscopy and neglects to count or control fibres less than 5 µm long. On the other hand, accumulating evidence suggests that such small asbestos fibres may produce disease (Holt *et al.* 1964, Davis 1965, Pott *et al.* 1972, Wagner *et al.* 1973, Hilscher *et al.* 1970, Bouhuys 1975).

Air sampling: Eight personal air samples taken during brake repair work were selected for electron microscopic analysis. This was done in order to positively identify chrysotile in the samples and to determine whether a systematic relationship existed between optically and submicroscopically visible fibres for this type of exposure. The membrane filters were ashed in plasma oxygen to eliminate organic materials and the residue was prepared for electron microscopy by a 'rubout' technique (Nicholson *et al.* 1971), which comminutes large chrysotile fibre bundles into individual fibres and fibrils. Large inorganic particles are likewise reduced in size, permitting all chrysotile to be seen and measured. Chrysotile was identified in the eight samples, in both fibre and fibril form (Fig 2). By measuring a large number of fibres at magnification 42 000 and converting the volumetric data into mass, a concentration per volume of air is determined. Comparison of optical microscopic fibre counts and the electron microscopic asbestos mass calculations indicates that a positive correlation exists between the two sets of data. These results show that the standard (OSHA) optical fibre counts may be only indicative of the total asbestos exposure.

Asbestos Exposure of Workmen

After the identification of chrysotile in the brake drum dusts, asbestos fibre exposure during maintenance and repair was determined by personal air sampling carried out at automobile repair shops, taxi fleet repair shops and a municipal truck repair shop in New York City. Air sampling and analytical methods for the determination of fibre concentrations were in accordance with the OSHA techniques (Bayer *et al.* 1975). Present regulations of OSHA prohibit asbestos concentrations of 5 fibres per millilitre (f/ml) or greater, longer than 5 µm as a time-weighted average, and concentrations above 2 f/ml will be illegal after July 1976. Peak concentrations or maximum excursions of 10 f/ml are permitted by the regulations.

In brake lining inspection and repair, the wheel

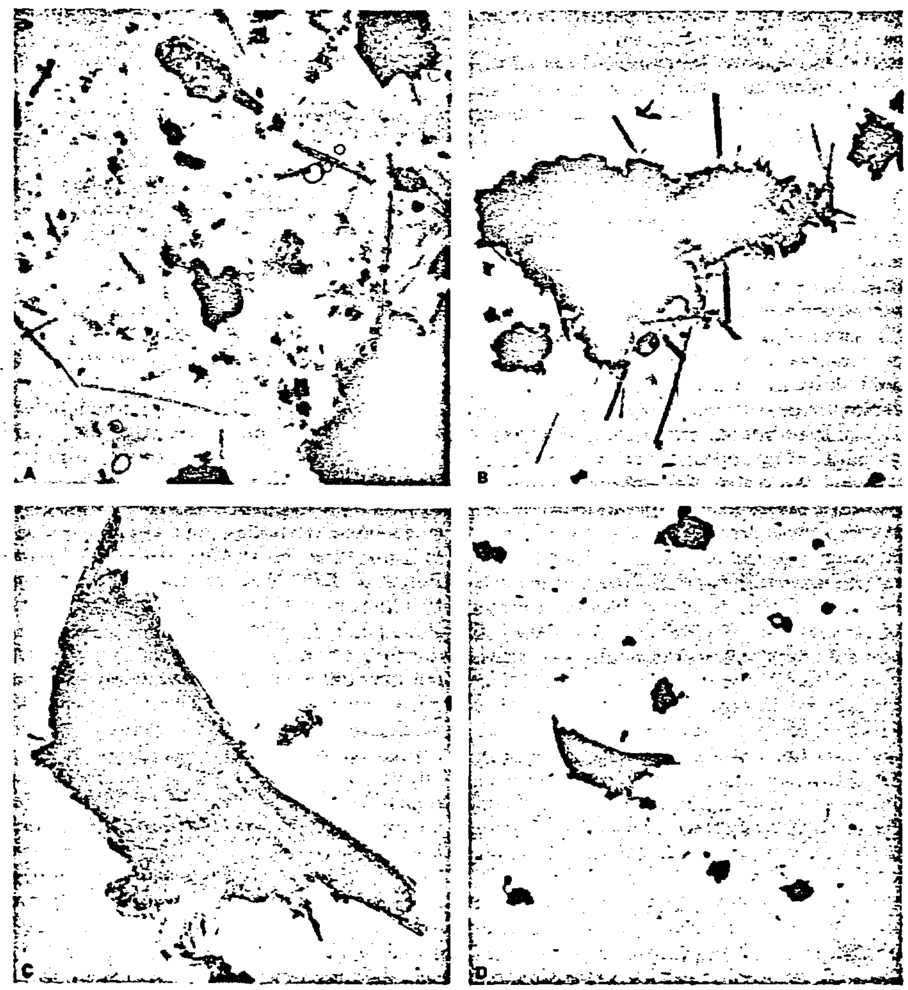

Fig 1 *Electron photomicrographs of brake drum dusts, taken at various magnifications.* A, *the numerous chrysotile fibrils have average lengths of 0.4 µm or less (× 30 000).* B, *large numbers of chrysotile fibres imbedded in, and protruding from, opaque particle, probably pyrolized phenolic resin binder (× 30 000).* C, *large chrysotile fibre bundle (× 45 000).* D, *large particle in left centre of photograph is the same as in* C, *but cannot be identified at low magnification (× 5400)*

FMSI 06056

is removed from the axle and loose dust is commonly removed from the drum and back plates by means of a jet of compressed air. A survey of 220 garages in Baltimore and Washington, DC has shown that this is the method of choice in 80% of the shops (Castleman *et al.* 1975). A similar situation exists in New York City. The data in Table 2 show that fibre concentrations are high in the breathing zone of the operator during compressed air blowing. An asbestos concentration gradient, diminishing with time and distance away from the operation, appears to occur. Persons up to 22 m from such activity are exposed to measurable concentrations of asbestos.

Personal air sampling was also conducted at New York City Department of Sanitation where truck brakes are repaired. Used linings are salvaged by machine grinding to remove dirt and grease from the surface. New linings are bevelled by grinding to reduce noise and improve break-in. Accordingly, these studies relate to levels of asbestos exposure which may be experienced by workers engaged in brake lining manufacturing. Table 2 shows that fibre concentrations experienced during grinding ranged from 1.7 to 7.0 f/ml of air in the breathing zone of the operator. The background or area samples for this operation ranged from 1.2 to 0.2 f/ml, with a general decrease

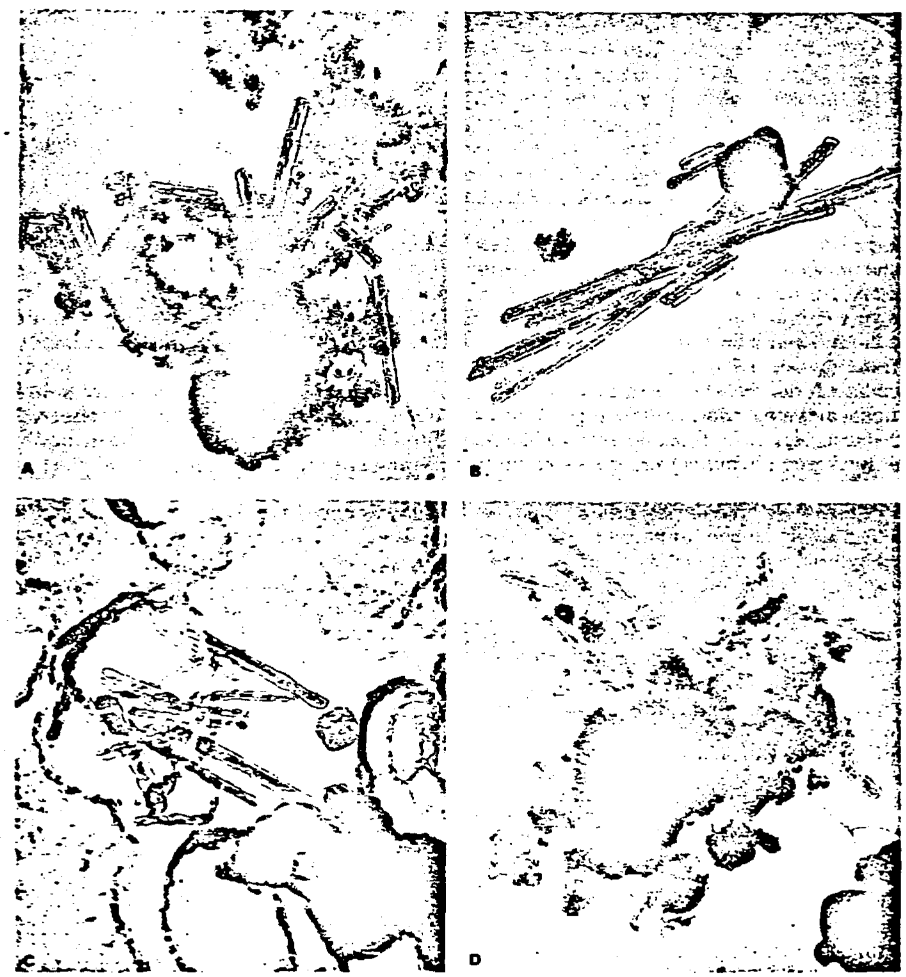

Fig 2 *Electron photomicrographs of personal air samples taken during brake repair work. Clumps of chrysotile are associated with opaque particles of road dust and resin binders.* A, B, × 60 000. C, D, × 72 000

Table 2

Personal air samples, automobile and truck brake repair

	No. of samples	Peak fibre concentration (fibres per ml) Mean	Range
Automobile brake repair			
Blowing dust from brake drums:			
Distance 1–1.5 m	4	15.0	6.6–29.4
Distance 1.5–3 m	3	3.3	2.0–4.2
Distance 3–6 m	2	1.6	0.3–4.8
Background (5 min after air jet blowing, distance 3.6–16 m)	2	0.2	0.1–0.2
Background (7–14 min after air jet blowing, distance 19.6–22.6 m)	2	0.1	0.1
	13		
Truck brake repair			
Renewing used linings by grinding (distance 1–1.5 m)	10	4.8	1.7–7.0
Background to grinding used linings:			
Distance 3.3 m	2	1.5	1.2–1.7
Distance 8.3 m	2	0.8	0.6–1.0
Distance 20.0 m	1		0.2
Bevelling new linings	4	37.3	23.7–72.0
Background to bevelling new linings:			
Distance 2.4 m	1		0.6
Distance 3.6 m	2	0.4	0.3–0.5
Distance 9.1 m	1		0.3
	23		

away from the operator. From six to ten other mechanics work within an area up to 20 m from this operation are exposed to asbestos as well. Since a person breathes about one cubic metre of air an hour, multiplication of the fibre concentrations by one million gives the number of fibres inhaled during this period. Fibre concentrations measured during bevelling of truck linings were as high as 72 f/ml and averaged about 37 f/ml. Background counts were measured up to 9.1 m away from this operation (0.3 f/ml). Fibre concentrations measured during drilling holes for rivets and grinding ranged from 0.3 to 29.2 f/ml, as reported by Boillat & Lob (1973). Four of the nine values exceeded 5 f/ml.

Conclusions

The existence of significant exposure during brake servicing operations necessitates the following measures:

(1) Implementation of industrial hygiene procedures to control exposure.
(2) Clinical studies of garage mechanics to determine evidence of asbestos-related disease.
(3) Epidemiological studies of the mortality experience of exposed workers.

In addition, the entire variety of dusts and other materials present in brake repair work should be characterized in order to determine its disease potential, especially silica and lead compounds.

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Neurotoxic Properties of Certain Aliphatic Hexacarbons

by Peter S Spencer PhD
and Herbert H Schaumburg MD
(*Departments of Pathology and Neuroscience, Saul R Korey Department of Neurology, Rose F Kennedy Center, Albert Einstein College of Medicine, Bronx, New York 10461, USA*)

During the summer of 1973 an outbreak of peripheral neuropathy developed among a large group of employees of a fabric manufacturing plant in Ohio, USA (Billmaier *et al.* 1974). The disease was characterized by distal weakness and sensory loss symmetrically in both the hands and the feet (Allen *et al.* 1975). The most severely affected individuals worked in the printing department where colouring inks, dissolved in volatile solvents, were applied to the surfaces of plastic coated fabrics. For several years the printing process required the use of a 9:1 solvent mixture containing methylethylketone (MEK) and methylisobutylketone (MIBK). Methyl-*n*-butylketone (MBK) was gradually introduced in the summer of 1972 to replace the MIBK. Methyl-*n*-butylketone was in its maximal use by December 1972 and the first case of peripheral neuropathy occurred shortly thereafter. The recent introduction of MBK into the printing department of the plant, coupled with other isolated outbreaks of neuropathy in individuals chronically exposed to MBK, suggested that this compound had neurotoxic properties. MBK produced peripheral neuropathy in several species of experimental animal (Duckett *et al.* 1974, Mendell *et al.* 1974, Spencer, Schaumburg, Raleigh & Terhaar 1975). These studies demonstrated that prolonged intoxication by inhalation or subcutaneous injection caused the insidious development of symmetrical weakness first in the hindlimbs and later in the forelimbs. The first signs of peripheral neuropathy developed after 4 to 12 weeks of continuous inhalation of 200–600 parts/10^6 of MBK, and after 12 to 16 weeks of intermittent inhalation of 1300 parts/10^6 of MBK. The onset of MBK neuropathy was associated with a reduction in the sciatic nerve conduction velocity (Mendell *et al.* 1974), an indication of nerve damage also found in rats and monkeys inhaling 1000 or 100 parts/10^6 MBK intermittently for periods of 3 and 8 months respectively (Johnson 1975), the figure of 100 parts/10^6 being the recommended Threshold Limit Value in the United States. Recent studies have suggested that concurrent exposure to MEK and MBK will produce neuropathy more rapidly than in animals exposed to MBK alone (Saida *et al.* 1976). Methylethylketone alone or MBK alone produce no neurotoxic effects (Spencer & Schaumburg 1976).

The purpose of the present paper is to emphasize the importance of chronic testing of potentially neurotoxic compounds in experimental animals, to describe the range of hexacarbon compounds which have been identified as neurotoxic agents and, finally, to characterize and illustrate the pathological basis for the onset of the nervous system disease. A total of seven hexacarbon compounds have been tested in this study (Table 1).

Table 1
Hexacarbon compounds tested

(1)	*n*-hexane $CH_3CH_2CH_2CH_2CH_2CH_3$
(2)	methyl-*n*-butylketone $CH_3COCH_2CH_2CH_2CH_3$
(3)	2,5-hexanedione $CH_3COCH_2CH_2COCH_3$
(4)	2,5-hexanediol $CH_3CHOH(CH_2)_2CHOHCH_3$
(5)	2,4-hexanedione $CH_3COCH_2COCH_2CH_3$
(6)	2,3-hexanedione $CH_3COCOCH_2CH_2CH_3$
(7)	1,6-hexanediol $HOCH_2CH_2CH_2CH_2CH_2CH_2OH$

The first compound, *n*-hexane, an important solvent and a minor component of petrol, was indicted in several reports as a possible neurotoxic agent (Herskowitz *et al.* 1971, Korobkin *et al.* 1975). Rats were exposed continuously to atmospheric levels of 400 to 600 parts/10^6 of *n*-hexane for up to five months, 500 parts/10^6 being the US Threshold Limit Value for *n*-hexane (*see also* Schaumburg & Spencer 1976). The second compound, methyl-*n*-butylketone, the solvent implicated in the outbreak of neuropathy, was administered to cats by subcutaneous injection of 150 mg/kg twice daily for periods up to six months (*see also* Spencer & Schaumburg 1976). The third compound, 2,5-

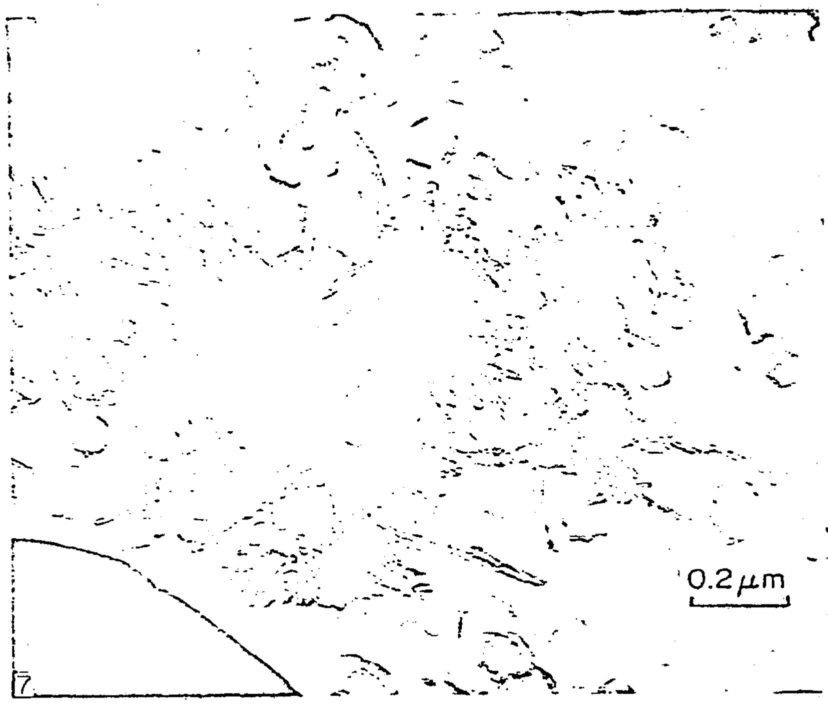

Fig. 7. Atmospheric sample collected 0.8 m above ground level at the exit of Tullamarine Freeway.

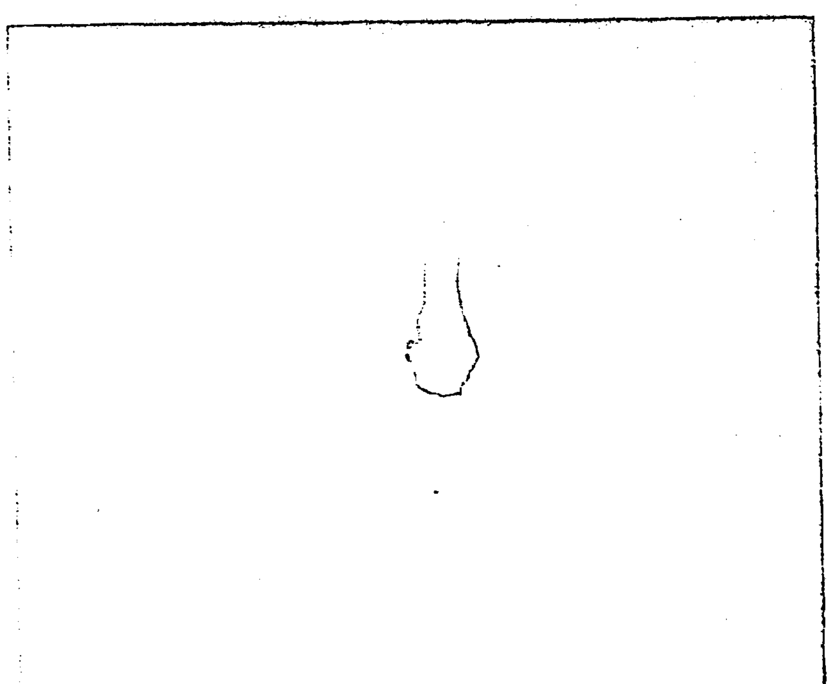

Fig. 8. Diffraction pattern from sample in Fig. 7.

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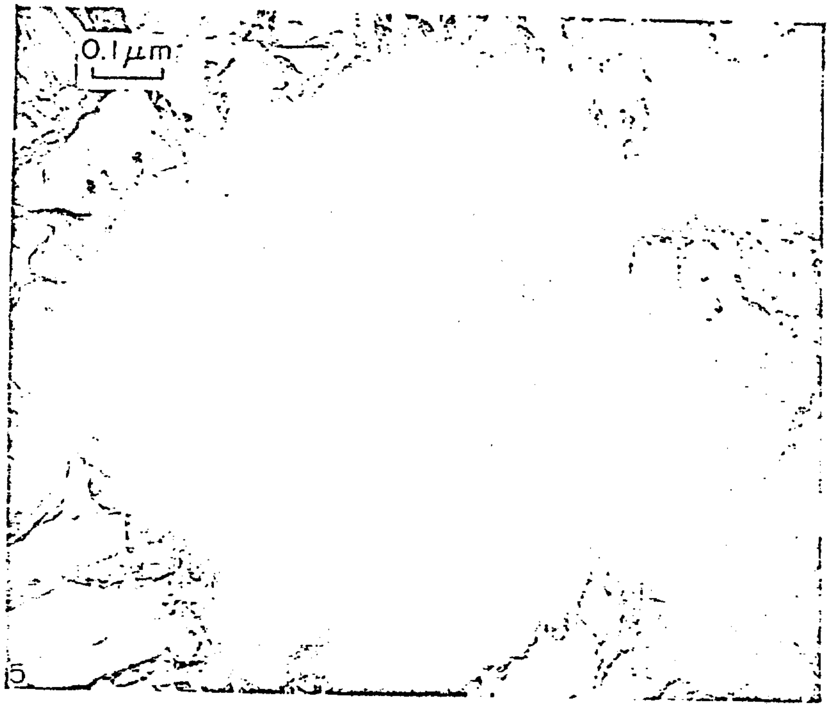

Fig. 5. Atmospheric sample collected 0.8 m above ground level at Melbourne University.

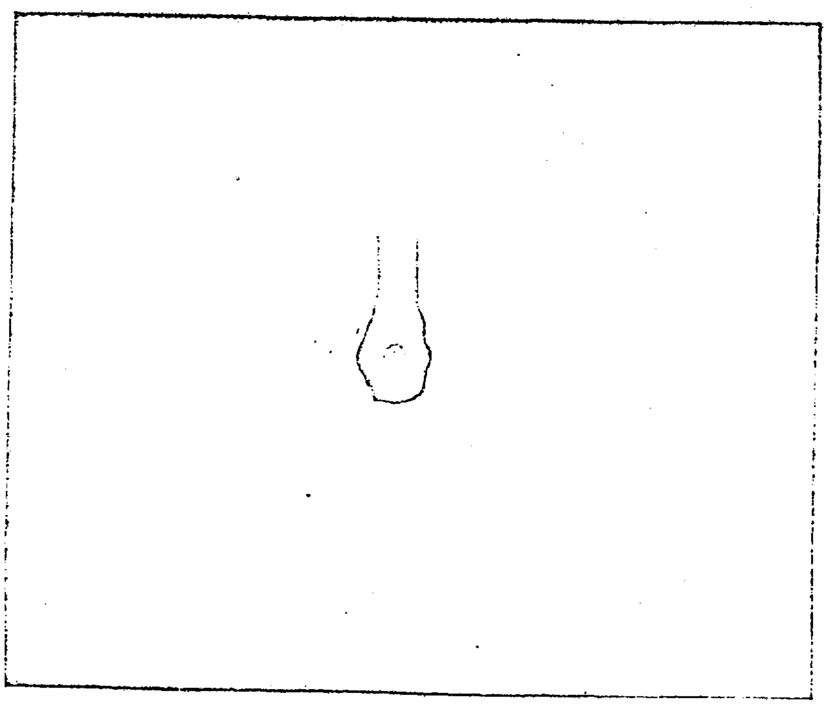

Fig. 6. Diffraction pattern from sample in Fig. 5

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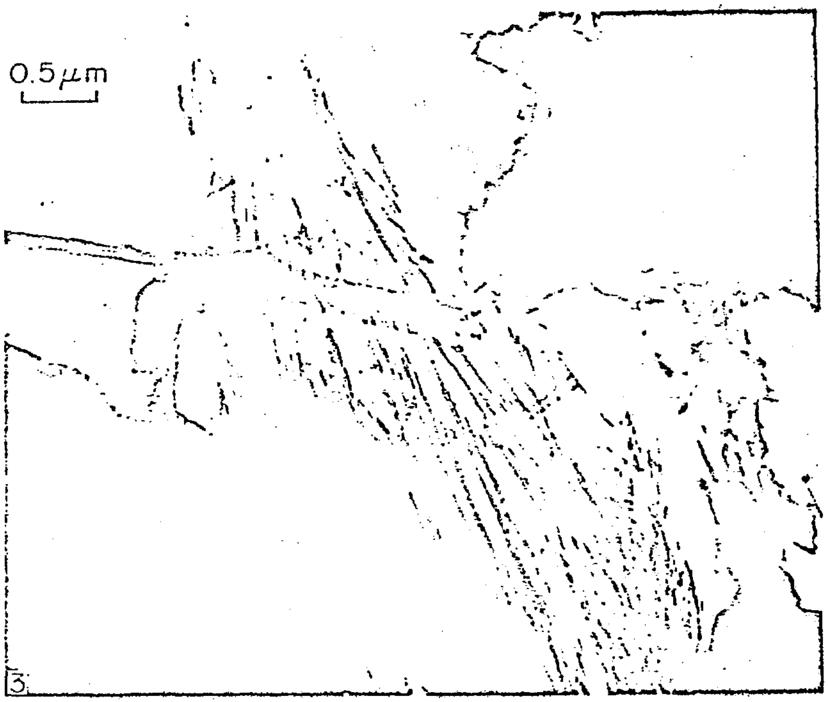

Fig. 3. Dust sample from worn brake lining.

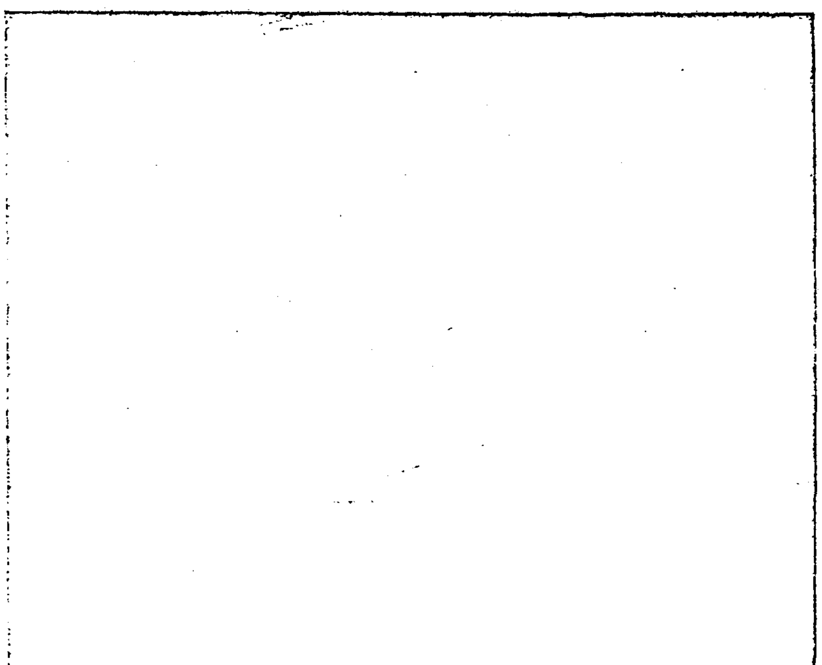

Fig. 4. Diffraction pattern from sample in Fig. 3.

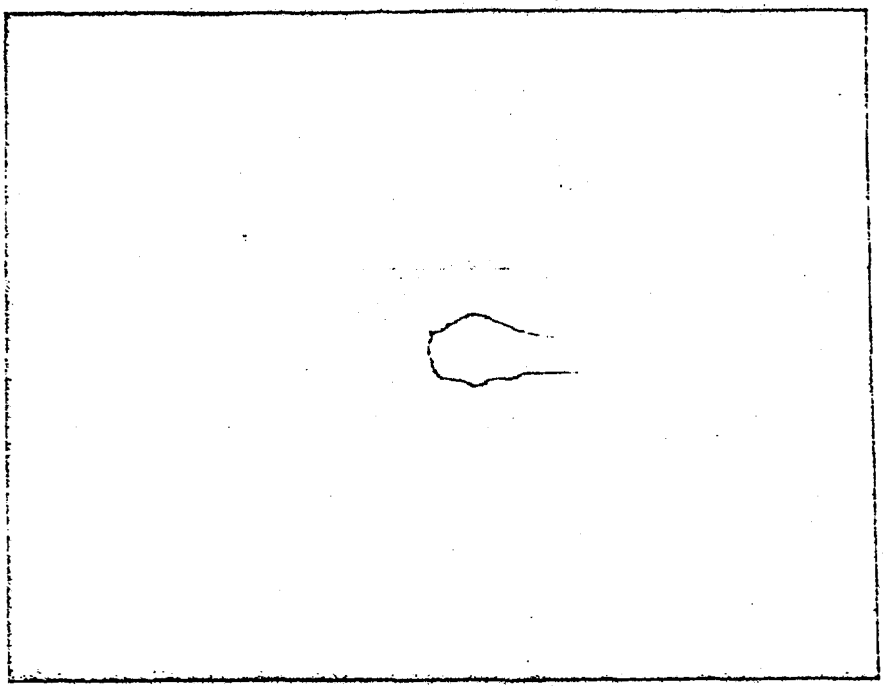

Fig. 2. Diffraction pattern from sample in Fig. 1

but would be expected to be very much lower under normal city driving. Chrysotile has been shown to maintain its crystal structure until temperatures in excess of 800 K are reached (Yada, 1971; Robock and Klosterkotter, 1973). The observations on the worn brake drums are then consistent with the likely temperatures reached and the known thermal behaviour of chrysotile. Yada (1967, 1971) has shown that electron bombardment inside the electron microscope can lead to production of amorphous material in the fibres and, therefore, excessive exposure during examination should be avoided.

Table 1. Values of $d(hkl)$ for chrysotile and brake linings, nm $\times$ 10^{-1}

Values for chrysotile (Yada, 1967, 1971)	Fresh brake lining	Worn brake lining	Plane (hkl)
7.30	7.30	7.21	(001)
4.60		4.60	(110)
4.50	4.48		(020)
3.65	3.62	3.67	(002)
2.70		2.67	(200)
2.60	2.62		(130)
2.51	2.52	2.56	(201)
2.43	2.45	2.47	(003)
2.30			(220)
2.25	2.24	2.26	(040)
2.15	2.13	2.10	(202)
1.82			(004)
1.80	1.79	1.75	(050)
1.53	1.54	1.55	(330)
1.46			(005)
1.35	1.32	1.33	(400)
1.21	1.21	1.19	(060)

Samples taken either on the roof or at ground level near the Department of Industrial Science contained very low concentrations of asbestos fibres (Fig. 5). Although the rings in the diffraction pattern (Fig. 6) are more diffuse than from fresh linings the interplanar spacings, shown in Table 2, again match both the values for fresh linings and Yada's values. Although the comparison in Table 2 enabled the presence of asbestos to be deduced, no attempt was made to estimate the atmospheric concentration because of its very low value.

Samples taken at the exit from the freeway, however, contained a much higher concentration of asbestos particles (Figs. 7 and 8) estimated at an average of 5×10^5 particles m^{-3} over the 9 h sampling period. The general appearance of the fibre clusters and the presence of other material is very similar to that observed for the worn brake lining dust. Again the diffraction patterns do not show significant amounts of amorphous material and match Yada's values (Table 2).

Table 2. Values of $d(hkl)$ for chrysotile and airborne asbestos, nm $\times$ 10^{-1}

Values for chrysotile (Yada, 1967, 1971) (hkl)	Dept. Industrial Science	Tullamarine freeway exit
3.65 (002)	3.65	3.60
2.15 (202)	2.20	2.15
1.80 (050)	1.80	1.75
1.21 (060)	1.28	1.18

EXPERIMENTAL

A number of methods have been proposed for the estimation of asbestos particles in the atmosphere (Keenan and Kupel, 1968; Lane *et al.*, 1968; Gadsden *et al.*, 1970) but at the present time the only method of sufficient sensitivity and selectivity for the very low concentrations involved is the electron microscopy of samples collected on suitable filters. Atmospheric samples were collected on a Millipore filter (VSWP 047, 0.025 μm pore dia.) at an average flow rate of 0.6 l min^{-1}. A High-Volume sampler was modified by placing an aluminium face-plate containing a small tube over the inlet to the sampler. A Millipore filter holder was connected by a plastic tube with a rotameter interposed to the small tube on the face plate. Samples were taken at three locations, (i) on the roof of the Department of Industrial Science, University of Melbourne, 10 m above street level and 30 m from the nearest traffic, (ii) outside the same building 0.8 m above street level, (iii) at the exit of the S.E. end of the Tullamarine freeway, 0.8 m above ground level. This last sampling point was 50 m from the position where brakes were applied to reduce the speed of vehicles from approx. 100 to 60 km h^{-1}. The total number of vehicles passing all three locations during the total sampling period was very similar and the major difference was the absence, locations (i and ii), or presence, Location (iii), of extensive braking. The sampling period was from 08:00–17:00 h during November 1973; the weather was fine with only light winds over this period. After the samples had been collected the Millipore filters were coated with a carbon film, approx. 20 nm thickness, and then five small pieces (1.5 × 1.5 mm) cut out at random. Each small section was placed on a copper grid, carbon film facing down, and the membrane material removed by dissolution in acetone. Electron micrographs and diffraction patterns were obtained from these specimens using a Phillips EM 200 microscope at 80 kV. The electron diffraction patterns were calibrated by evaporating aluminium on to the copper grid and by comparison interplanar spacings, *d*(*hkl*), could be determined. Samples of fresh and worn brake drum linings were obtained from an automobile repair shop and were crushed gently in a mortar and pestle with a few ml of chloroform. An electron microscope grid covered with a smooth film of evaporated carbon was then dipped into this suspension and the chloroform allowed to evaporate.

RESULTS AND DISCUSSION

Figures 1 and 2 show electron micrographs and diffraction patterns from a sample prepared from a fresh brake lining. The characteristic structure of chrysotile asbestos, long filaments each of which is a hollow cylinder (McCrone and Delly, 1973), is clearly visible in this micrograph. The electron diffraction patterns of chrysotile have been determined and indexed by Yada (1967, 1971). In Table 1 the interplanar spacings determined from the pattern of fresh brake linings are compared to Yada's values and the agreement is seen to be excellent.

Figures 3 and 4 show results for the dust from worn brake linings. The average length appears to be shorter than in the fresh lining but the hollow cylindrical structure is still obvious. The diffraction pattern still consists of well-defined rings and the interplanar spacings derived from these rings are in good agreement with Yada's values (see Table 1). There was no indication from the diffraction pattern of the presence of forsterite, the name given to thermally-degraded asbestos. It appears that for the wear this lining had received no significant changes in the crystal structure due to excessive heating had taken place. Temperatures within brake drums may reach 873 K under racing conditions with severe and repeated braking

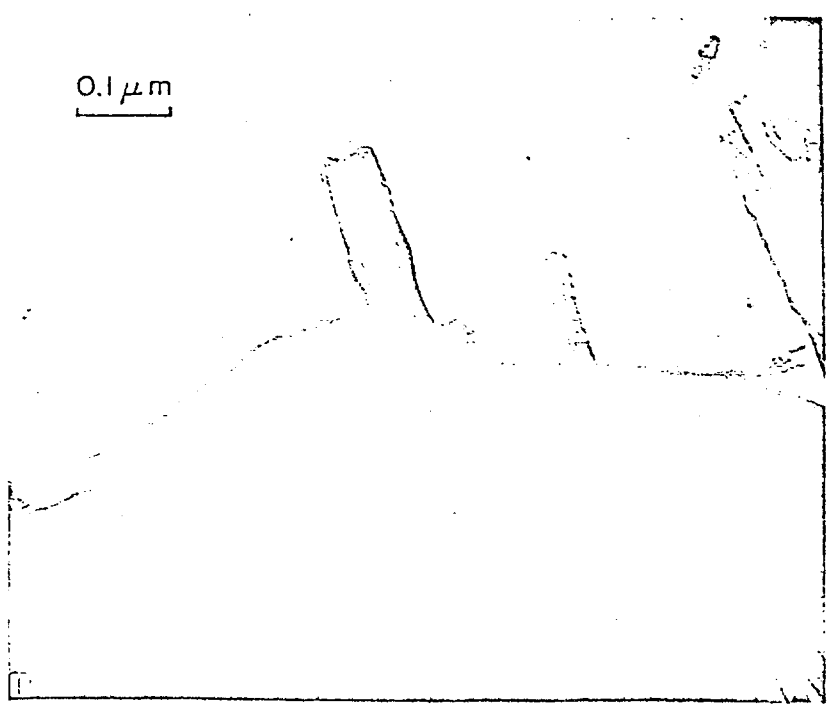

Fig. 1. Dust sample from crushed new brake linings.

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Atmospheric Environment Vol. 10, pp. 583–589. Pergamon Press 1976. Printed in Great Britain.

AIRBORNE ASBESTOS IN THE VICINITY OF A FREEWAY

J. ALSTE*, D. WATSON† and J. BAGG
Department of Industrial Science, University of Melbourne, Parkville, Victoria 3052, Australia

(*First received 22 December 1975 and in final form 16 February 1976*)

Abstract—Asbestos fibres taken from fresh or worn brake linings or collected from the atmosphere near a freeway were examined by electron microscopy and electron diffraction. The major effect of braking appears to be in separating bunches of fibres and reducing their average length but not in altering their crystal structure. The suggestion that gross changes in the crystal structure are brought about by heat generated during braking is not supported by this work. Airborne samples were collected at points where there was considerable braking and where there was only slight braking. At the point where slight braking took place the airborne concentration was very low and could not be satisfactorily measured. At the point where considerable braking occurred an estimate of 5×10^5 m^{-3} particles was determined, each particle consisting of a small bundle of fibres. The majority of particles had a maximum linear dimension $\leqslant 2$ μm.

INTRODUCTION

The concentration of asbestos fibres in the atmosphere may reach high levels in the immediate vicinity of mining the asbestos mineral or manufacturing asbestos products. It has been known for a long time that the inhalation of fibres at these concentrations is injurious to both man and animals (Merewether, 1930). A qualitative standard which has been proposed by the E.P.A. (*News Focus*, 1973) is that there should be no visible emissions during the handling and manufacture of asbestos products. One criterion for a recommended quantitative standard is that the concentration should not exceed 5×10^6 fibres m^{-3} of length $\leqslant 5$ μm for a 30 y exposure and that this standard should become more rigorous after July 1976 becoming 2×10^6 fibres m^{-3} (NIOSH, 1972; U.S. Dept. Labor, 1972). British and West German proposals agree with the more rigorous standard suggested above (Schatz and Woitowitz, 1973). Extensive work has been carried out on the health of workers exposed in the industries producing airborne asbestos. Much less work has been carried out on the presence of asbestos in the atmosphere far away from any such industry. Asbestos was found in all samples taken from the atmosphere of several cities in Europe which did have an asbestos industry (Holt and Young, 1973). The asbestos was present chiefly as single fibres but a small fraction occurred as agglomerates. No quantitative estimate of concentration was made but compared to other suspended particulates it was small. Preliminary results for New York city showed concentrations ranging from 11 to 60 ng m^{-3} with duplicate samples differing by a factor of 2–3 (Selikoff, 1972; Nicholson *et al.*, 1973). Asbestos was also found to be present in all 200 samples taken from the atmosphere of 49 cities in the U.S.A. (Selikoff, 1972).

The source of asbestos emissions in the absence of asbestos mining and industry is a matter of speculation but one strong possibility is from the brake linings of automobiles. These linings are subjected to considerable wear leading to the release of asbestos dust. In one careful study the release of asbestos was measured by surrounding the brake drum with a collector and capturing the total emission (Jacko *et al.*, 1973). A total emission of 17.8 μg km^{-1} for passenger vehicles and 54.8 μg km^{-1} travelled for light trucks were quoted as typical values. Not all this emission reached the atmosphere, some depositing upon the ground and some being retained by the brake drum. The fraction which became airborne was estimated to be 3.7% for passenger vehicles and 2.9% for trucks. This research also gave the expected result that heavy braking produced more emission than light braking. Although it is very difficult to convert these results into atmospheric concentrations clearly only very low concentrations would be anticipated.

Lynch (1968) examined the dust from brake linings and from the appearance of the fibres suggested that the crystal structure of the fibre was degraded by heat released during braking. Holt and Young (1973) found that fibres collected by them from the atmosphere showed very little evidence of loss of crystallinity, and therefore, following Lynch's suggestion, concluded that building materials were a more likely source than brake linings.

The aim of the work reported here was to examine more closely the possible contribution that brake linings could make to the asbestos concentration in the atmosphere.

*Present address: A.C.I. Environics, P.O. Box 8, Newport, Victoria, Australia.

† Present address: C.S.I.R.O., Division of Tribophysics, Melbourne, Australia.

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The particles consisted of small bundles of fibres together with other material which may have contained binder present in brake linings. Another possible source for this amorphous material consistent with a location where braking occurred is wear from tyres. Measurements by other workers (Pierson and Brachaczk 1975) have shown concentrations of airborne debris from tyre wear from 0.05 to 2.2 $\mu g\ m^{-3}$. The number of fibres in the bundle and their size varied considerably and no attempt was made to count individual number of fibres. The majority of bundles did have a maximum dimension $\leq 2\ \mu m$. Although these results are limited and of a preliminary nature the following points can be made:

(i) Electron diffraction has proved to be a method of great sensitivity in the identification of asbestos particles suitable for the low concentrations found in atmospheric samples.

(ii) Asbestos fibres from brake linings operated under normal conditions have the same crystal structure as asbestos from other sources. The absence of thermally-degraded material cannot, therefore, be taken as evidence that brakes have not contributed to a particular sample.

(iii) The results from the samples collected at the freeway exit suggest that emissions from brakes can become airborne. The concentrations reached are very low, below the recommended exposure standard (NIOSH, 1972; U.S. Dept. Labor, 1972), and consistent with the prediction by other workers that only a small fraction of the total dust formed becomes airborne (Jacko, *et al.*, 1973).

Acknowledgements—The authors would like to thank Dr. J. V. Sanders, C.S.I.R.O., Division of Tribophysics, University of Melbourne, for considerable assistance and use of electron microscope facilities. One of us, J. Alste, wishes to thank A.C.I. Fibreglass for support during this work.

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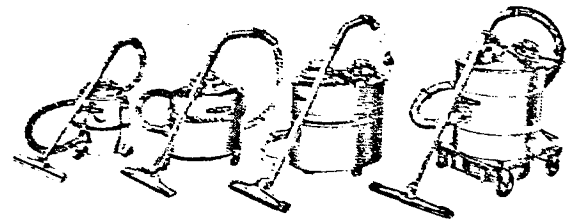

NILFISK
OF AMERICA, INC.

201 KING MANOR DRIVE, KING OF PRUSSIA, PA 19406 (215) 277-3900

April 20, 1979

Mr. I. H. Weaver
Corporate Director Envir. Control
RAYBESTOS-MANHATTAN
123 E. Stiegel St.
Manheim PA 17545

Dear Ike:

I thought you would be interested in the enclosed report from Dr. Arthur Rohl of Mt. Sinai Hospital Medical Center.

We have been anxiously awaiting the results of Dr. Rohl's tests and needless to say, are very pleased with the report and what he has to say about NILFISK'S ASBESTO-CLENE systems.

Sincerely,

NILFISK OF AMERICA, INC.

Bob Magdelain

Robert S. Magd~~e~~lain
President

RSM:ds

Enclosure

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NILFISK

THE MOUNT SINAI MEDICAL CENTER
ONE GUSTAVE L. LEVY PLACE • NEW YORK, N.Y. 10029

Mount Sinai School of Medicine • The Mount Sinai Hospital

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NILFISK OF AMERICA, INC.
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April 11, 1979

Mr. Robert S. Magdelain, President
Nilfisk of America, Inc.
201 King Manor Drive
King of Prussia, Pennsylvania 19406

Dear Mr. Magdelain:

This will report the results of air sampling tests conducted, in October 1978, to determine chrysotile asbestos concentrations during brake repair work.

Our major objective was to determine the efficiency of the Nilfisk Asbestos System utilizing HEPA filters, particularly with regard to submicroscopic asbestos fibers. Studies conducted in our Laboratory and elsewhere have demonstrated that free asbestos fibers present in brake drum dusts are predominantly shorter than 5μm in length. In particular, it was found that about 75% of the fibers in such dusts were less than 0.3μm in length, as determined by transmission electron microscopy. Thus, the optical microscopic technique used by OSHA for determining asbestos levels in workplaces (in which only fibers 5μm or longer are counted) would overlook a large number of asbestos fibers in air samples. That is, the total asbestos exposure in terms of fiber number, mass and surface area would be significantly greater than the levels determined using the OSHA fiber-counting method.

Therefore, it was of considerable interest to us to have an opportunity to test the efficiency of the Nilfisk Asbesto-Clene System. To do this personal air sampling was carried out on the exhaust of a HEPA-filtered vacuum dust collector and, simultaneously, on a garage mechanic cleaning a brake drum with the Nilfisk brake encapsulation cylinder. Three such tests were made. Background air samples, also using personal air pumps, were taken.

For each of the tests, a sample of settled dust was taken from the brake drum. The dusts were analyzed by x-ray diffraction in the step-scan mode to quantitatively determine asbestos contents, using a technique previously published. Asbestos was found in all three samples, ranging from 2.5% to 4.5% by weight.

The membrane filters were analyzed by both transmission electron microscopy (X25,000) and by the standard OSHA fiber-counting technique, employing phase contrast optical microscopy. The results are as follows:

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Sample	Description	Nanograms/cu meter (electron microscopy)	Fibers/milliliter (optical microscopy)
		TEST #1	
N-1	Background (70 feet from operator)	400	0
N-2	Operator (breathing zone - 6 ft. from dust collector)	0	0
N-3	Dust collector (HEPA-filtered vacuum)	0	0
		TEST #2	
N-4	Background (70 feet from operator)	615	0.12
N-5	Dust collector (HEPA-filtered vacuum)	0	0
N-6	Operator (breathing zone - 6 ft. from dust collector)	59,000	0.5
		TEST #3	
N-4	Background (same as in Test #2)	615	0.12
N-7	Operator (breathing zone - 6 ft. from dust collector)	0	0
N-8	Dust collector (HEPA-filtered vacuum)	0	0

Remarks and Conclusions:

The tests demonstrate that asbestos levels are virtually eliminated by the use of a system employing brake encapsulation device connected to a HEPA-filtered vacuum dust collector. Without the use of such equipment, fiber concentrations during compressed air jet-blowing of brake drums ranged from 6.6 to 29.8 fibers/milliliter. However, when the Asbesto-Clene System was used, fiber concentrations on both the mechanic and dust collector exhaust were not detected, as verified by transmission electron microscopy. An important exception to this is observed in Test #2, the sample taken on the operator. Prior to this test, this mechanic had worked on brake jobs without using the Asbesto-Clene System and without changing his work clothes. This exposure had resulted in contamination of his clothes, reflected in the high residual asbestos concentration of 59,000 nanograms/cubic meter and 0.5 fibers/milliliter. In contrast, the operator in Test #1 and Test #3 wore clean coveralls. This points up the need to adhere to the OSHA regulations concerning special clothing, change rooms, etc. to minimize contamination.

The background asbestos measurements, of 400 and 615 nanograms/cubic meter, are consistent with other background measurements taken during brake repair work. They are the result of residual contamination of the garage by asbestos.

This study has been unique and fortunate in two respects; first because of the great interest and importance of determining chrysotile asbestos levels in such circumstances. The data indicate that the Asbesto-Clene System represents an outstanding advancement in industrial hygiene procedures to control asbestos exposure. It has also been a pleasure to work with you in preparing and conducting these tests. If there are any questions regarding the results or conclusions in this report, please do not hesitate to contact me.

Sincerely,

Arthur N. Rohl, Ph.D.
Environmental Sciences Laboratory

ANR:jm

ROAD & TRACK 4/79

Technical Correspondence

Asbestos Health Hazards

There have been a lot of stories lately about the hazards of breathing airborne asbestos fibers. Is asbestos still used in brake linings? It is common practice to blow the brake dust out with compressed air to clean the brakes. Does this present a health hazard? Is there a risk to motorists from brake dust in the air near streets and highways?

Ken Bohn
Louisville, Kentucky

Asbestos is the name for a family of silicate minerals that occur in nature in the form of ultra-fine, brittle fibers. Asbestos has a high resistance to heat and is still commonly used as insulation or molded (with other materials) into clutch and brake linings. In molded form asbestos is safe but when the fibers are released (from wear or from cutting or sanding the molded material), they present an insidious health hazard. The fibers are so brittle that when they are broken, they tend to disintegrate into particles too small to be seen (an electron microscope is needed to see the smallest, most harmful particles). According to current medical research, usually there is no sign of asbestos-related disease for 10–35 years after the first exposure to asbestos particles. After this incubation period, the fibers can cause asbestosis, a disease characterized by severe scarring of the lung tissue, and mesothelioma, a cancer of the lining of the chest and abdomen. Asbestosis usually doesn't kill directly. Its victims generally succumb to related respiratory infections such as bronchitis or pneumonia. Exposure to asbestos fibers also greatly increases the risk of cancer of the lungs and esophagus, stomach, kidneys and larynx. Cases have been found where family members of workers exposed to asbestos fibers developed asbestos-related diseases just from exposure to asbestos fibers on the worker's shoes and clothing.

Motorists and pedestrians have little to fear from inhaling brake dust. There is some brake dust in the air near streets and highways, but the number of particles is very small and they tend to settle out of the air, so the overall risk is virtually nonexistent.

To reduce the risk of asbestos-related diseases, avoid contact with asbestos particles, especially airborne particles. It's usually a good practice to clean any component before reassembly, but with brakes and clutches, it's better to leave the brake or clutch dust in place, where it does no harm, rather than to use compressed air to blow it out and risk inhaling the asbestos fibers. If you must clean the parts, use a vacuum system or rinse the parts in solvent and wear disposable gloves. Clutch or brake linings shouldn't be allowed to soak in the solvent, as this can damage the lining material. Discard the used solvent and wash your hands immediately so you don't spread the particles around. To cut or sand clutch or brake linings, use a ventilation system designed to suck in the asbestos dust before it can be inhaled and wear a dust or paint mask. To clean brake dust from the wheels, use a detergent solution and rinse with a hose or use a high-pressure cleaner at a self-service car wash.

Information on health risks associated with asbestos exposure is available from NATIONAL CANCER INSTITUTE BETHESDA MD 20014.

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Bus fleet praised for fighting asbestos hazard

For its "excellent performance in protecting district mechanics from a cancer-causing substance, asbestos in fiber form," California's Health Dept. has commended the Golden Gate Bridge, Highway and Transportation District.

Golden Gate Transit, operating a fleet of 248 buses, was praised for protecting the 42 district mechanics who work with asbestos lining while performing brake and clutch maintenance and repairs on buses.

California is the first state to require employers to report workplace use of asbestos. Asbestos is the most widely used of 18 cancer-causing chemicals and substances regulated in California as part of a comprehensive program to prevent job-related cancer.

Excessive exposure to asbestos fibers can cause lung cancer, a rarer form of cancer known as mesothelioma, and a lung ailment called asbestosis.

State Health Director Jerome A. Lackner, M.D., said, "State industrial hygienists are discovering in inspections that asbestos in bus, truck and auto brake-repair shops is a significant potential health hazard to California workers, but one which safe work practices can control.

"An estimated 74,000 mechanics and other workers in 22,000 auto- and brake-repair shops serving the public are potentially exposed to asbestos through brake-repair work. Several thousand more workers doing brake repairs for transit systems, truck and bus lines and utility-vehicle fleets potentially risk similar exposure. Several citations for unsafe use of asbestos have been issued.

"So it is encouragingly good news when we learn that a large fleet operator such as Golden Gate Transit is effectively protecting its mechanics against exposure to asbestos fibers.

"The district's San Rafael brake repair facility is an outstanding example of safe asbestos use. It is well equipped to minimize dust. The district mechanics are using safe work practices."

The district mechanics are members of the International Association of Machinists & Aerospace Workers (IAM), Marin County Lodge No. 238. The Machinists union was represented, along with employer, government, and science representatives, on the State Health Dept. advisory committee, which early this year drafted the asbestos regulation now in effect.

Dr. Fred Ottoboni, Ph.D., head of the department's Occupational Cancer Control Unit, said the transit district followed these key procedures to maximize worker protection against asbestos fibers:

- New brake linings are "arced" (shaped to fit) with a low-speed lathe rather than a power sanding machine that could produce airborne fibers.
- Arcing is done in a room separate from other workers so that asbestos waste is isolated from other workers.
- The small amount of dust generated by this process is collected by an exhaust system.
- Waste material is put in labelled containers and disposed of in plastic bags.
- Cleanup of brakes prior to repair is done with a damp rag rather than with compressed air, thus eliminating a serious source of dust.

Anti-lock backflip stirs bus protest

The American Public Transit Assn., Washington, D.C., has protested the now-we're-against-it, now-we're-not moves of the DOT's Truck and Bus Safety Subcommittees on the anti-lock provision of FMVSS 121 (FO—11/77, p. 13).

APTA, whose members carry 90% of U.S. mass transport riders, wrote to William H. Marsh, executive secretary of NHTSA, protesting the subcommittee's reversal of a moratorium recommendation approved by a majority of members at a proper meeting.

APTA's executive director B.R. Stokes said, "It is unconscionable to attempt to reverse this action by the very questionable procedure employed. The safety of the public is too important to allow several individuals to sidestep usual democratic procedures.

"To reverse a carefully considered committee action (within one week) by a telephone/telegram ballot, without even a claim of change in circumstances, presentation of new evidence or the like, is a transparent ploy inconsistent with any procedure acceptable to our courts of law, our congressional representatives or our sense of justice."

Retrofitted bus takes wheelchairs

A 7-year-old Toledo (Ohio) transit bus has been retrofitted with an electric lift platform to accommodate disabled passengers (photo above). Inside the bus are six restraints to keep wheelchairs in place while the bus is moving. The platform, designed by City Machine & Tool Div. of Sheller-Globe, replaces the rear step well and also serves as a standard passenger step entrance. Modification was made with help of a grant from the Urban Mass Transit Authority.

Y-12

FMSI 06072

Dyna lane

top of the news

Find more work-related cancer

A government study estimates that at least 20% and possibly as many as 38% of the cancers that will occur in the U.S. over the next 30-35 years will be work-related. This conclusion represents a significant departure from conventional estimates, which have ranged from 1-5%.

Results of the study, prepared by the National Cancer Institute and the National Institute of Environmental Health Sciences (NIEHS), were disclosed last week by Joseph A. Califano, Jr., Secretary of Health, Education and Welfare. The complete report will be submitted as evidence to the Occupational Safety and Health Administration. The authors want it to be used as part of the data on which OSHA will base its policy for regulating carcinogens.

The HEW report represents a re-evaluation of available studies on occupationally-related cancers, particularly in the light of new evidence concerning the impact of asbestos-related cancer. It predicts that 2.15 million persons will suffer cancer attributable to asbestos over the next 30-35 years—an average of almost 67,000 cases/year. This would represent about 17% of all cancers detected annually in the U. S.

Commenting on the asbestos threat, David P. Rall, director of NIEHS and one of the authors, notes: "It is only in the last year or so that the full magnitude of the asbestos situation has been appreciated."

In addition, four other substances—arsenic; benzene; coal-tar pitch volatiles and coke oven emissions; and vinyl chloride—will result in 1-3% of cancers each year, the study says. Four other compounds—chromium; iron oxide; nickel; and petroleum distillates—will contribute to 3-18% of all cancers. Thus a 20% figure is a "conservative" estimate, Rall says.

NIEHS's RALL: Figures show "we're not in as good shape as we may have thought."

The figures do not include the potential effects of other unknown substances, Rall notes. But the study does carry a *caveat*—it notes that most cancers have multiple causes. Rall says a number of occupational groups, such as chemists and rubber workers, have been found to have an excess incidence of certain cancers but the specific causes are not known.

While Rall conceded that the estimates of the number of workers exposed to carcinogens are probably not accurate, he notes, "They are the best estimates we have," adding that they may in fact understate the situation. "The typical pattern is that the more you study an occupational group, the more relative risk you see," Rall observed. In his view, the message of the study is: "We really have to work much harder to make the workplace safe from chemical carcinogens. There may have been some feeling of complacency, but we're not in as good shape as we may have thought."

OSHA Administrator Eula Bingham underlined Rall's comments, noting that "the study came as no personal surprise" and labeling it as "a clear call to the nation for action." The study indicates that cancer is not necessarily "inevitable," Bingham says, adding that "we should launch an all-out assault to rid workplaces of cancer-causing exposures and turn out energies toward preventive rather than remedial programs."

Industry officials denounced the "premature" use of the HEW
Blair, Dow Chemical's vice president for Health and Environmental Sciences, noted that Califano's decision to release the results is "most unfortunate" and "uncalled for" because the report is in draft stage and so far "unsubstantiated" by data. Blair believes the estimates are another in a series of predictions that are periodically tossed out and not substantiated. "A better procedure would be for these people to have peer review of their study. Many scientific groups or technical people are all qualified to examine this."

Blair's sentiments were echoed by the American Industrial Health Council and the American Council on Science and Health. AIHC Executive Director Ronald A. Lang said the summary released by HEW did not clearly identify the scientific methods used, or the details of the study's results. "The summary Mr. Califano refers to tells us nothing," Lang notes, adding that any new data on cancer from occupational exposure "should be published and critiqued . . . before HEW alarms the public unnecessarily."

ACSH's Executive Director Elizabeth M. Whelan noted that the report "was seriously misleading in that it cited cancer mortality statistics among asbestos workers without even mentioning the contribution of the major lung carcinogen—cigarette smoke. Non-smoking asbestos workers have no more lung cancer than the general non-smoking population." AIHC's Lang added that asbestos exposure conditions that the study linked with 17% of all cancers "were cleaned up long ago."

Cancer link denied

Dow Chemical says that it will "vigorously contest" a $70-million lawsuit brought by a Vietnam veteran who claims that he developed a fatal cancer as a result of exposure to Agent Orange herbicide. Last week, Dow responded to the suit by petitioning to have it moved into U.S. District Court from New York State Supreme Court where it was originally filed late in July.

The suit by 28-year-old Paul Reutershan originally named Dow and five other companies thought to have supplied the defoliant—a blend of 2,4,5-T and 2,4-D herbicides—to the military. On Sept. 6 action was dropped against all but Dow.

In the complaint, Reutershan charges that his cancer was caused by exposure to Agent Orange while serving in Vietnam in 1967 and 1968. He discovered that he had cancer in October 1977. He claims that Dow was aware of the alleged harmful affects but failed to warn those exposed of the potential danger.

According to Dow, the move to federal court will give it greater freedom in examining expert witnesses called by Reutershan to prove his case. Dow maintains that there is no evidence that Agent Orange causes cancer.

Reutershan's attorneys say that this is the first case brought by a veteran over Agent Orange and that others may join the suit. However, a veterans' group called Citizen Soldier says that while a number of veterans seem to have symptoms consistent with dioxin—an inevitable contaminant of 2,4,5-T—proving the connection with cancer is difficult. The group says it is laying groundwork for an epidemiologic study of veterans exposed to Agent Orange.

Y-13

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July 1978
Volume 42
Number 7

Dpralane

Industrial Health Foundation
5231 Centre Avenue
Pittsburgh, Pennsylvania 15232

INDUSTRIAL HYGIENE DIGEST

NEWS ITEMS

663/78x Actions on the Threshold Limit Values of Chemical Agents.
American Conference of Governmental Industrial Hygienists, May 1978.

Notice of Changes Intended (For 1978)

Additions

Aspirin	5 mg/m^3
Amosite	0.5 fibers/cc
Chrysotile	2 fibers/cc
Crocidolite	0.2 fibers/cc
Cyanogen Chloride	0.25 ppm
Baytex	0.1 mg/m^3
1,3 Dichloropropene	1 ppm
Divinyl benzene	10 ppm
o-sec-Butylphenol	5 ppm-Skin
Chloroacetyl Chloride	50 ppb
Diethanolamine	3 ppm
2-Hydroxypropyl acrylate	0.5 ppm-Skin
Dalapon	1 ppm
m-Isopropylaniline	2 ppm-Skin
Propionic acid	10 ppm
Sodium bisulfite	5 mg/m^3
Tetrasodium pyrophosphate	5 mg/m^3
Trichloroacetic acid	1 mg/m^3

Deletions

140 Flash aliphatic solvent
N-Methyl -2- pyrrolidone

Y-14

FMSI 06074

TECHNOLOGY

Flash filling for front teeth

The time pressure is off on dental fillings with a composite developed by Imperial Chemical Industries in the United Kingdom. No longer must the dentist rush to fill a difficult cavity or build up a chipped tooth before the filling material hardens. According to a report in the May 8 CHEMICAL AND ENGINEERING NEWS, the new blend, called Fotofil, remains a paste until its catalyst is activated by light from a special source "gun." The paste then cures within a minute to an inert structure, which matches the enamel of neighboring teeth.

The active component of the paste is a resin made of urethane dimethacyclate, a member of the family of materials used to coat chemical tanks. A barium-containing glass filler makes up 80 percent of the paste formulation. The glass is ground to particles of 10 microns and coated with a silicon compound.

The dental material is soon to be marketed in the United States for restoration of front teeth. Molars, however, require a subtance highly resistant to abrasion. The developers are now investigating whether Fotofil or modifications with different glasses and resins are suitable for back teeth. Unlimited time for sculpturing molar work would be especially valuable because accurate shaping of molars prevents wear on the opposing teeth.

Sifting through the silicon

Finding a needle in a haystack is a difficult type of research problem, whether it involves trace impurities or basic constituents of chemical and biological systems. Researchers at Bell Telephone Laboratories report a new electron microscope technique for identifying and locating minute amounts of certain elements in diverse materials. So far, researchers have used it to identify a few hundred carbon atoms among several hundred billion silicon atoms, unwanted oxygen, nitrogen and carbon in integrated circuits and the storage site of the neurotransmitter serotonin in human blood platelets (reported in the May 5 SCIENCE).

The technique, called electron energy-loss spectroscopy, locates atoms of different elements by their interactions with a beam of electrons generated by the microscope. The beam electrons lose a characteristic amount of energy when they interact with each type of atom. David Joy and Dennis Maher then use a magnetic field to sort the beam atoms by amount of energy lost. In addition to detecting small amounts of elements, the technique allows scientists to measure distances between atoms to within a quarter of the diameter of one atom.

Roy Rogers to the delivery

Cows in labor may soon be calling cowboys, if the Federal Communications Commission approves a new device. A matchbook-size transmitter held in place by an adhesive signals when the cow's cervix dilates just before giving birth. The cowboy's receiver picks up the signal, which directs him to the bearing cow.

The reusable device, which has a range of 15 miles, was developed by Warren R. Jewett, Walter Evans and Lee Ingle of the University of Arizona. Bill Clevenger of Vita Vet, the company that plans to produce the detectors, estimates that 10 to 15 percent of unattended livestock births result in death to the newborn. Cattle and horses don't always take care of their new offspring or protect them from predators. The device will also be useful for zoo animals that often kill their newborns. Jewett's work on a birth signaling device began with an inquiry from the St. Louis Zoo. To save snow leopard cubs, zoo attendants need to be on hand to separate the cubs from their mother within 30 minutes of birth.

ENVIRONMENT

People pollution

Just breathing can make a room without ventilation that is also full of people pretty stuffy. How stuffy? Tsen C. Wang, a chemical engineer with Harbor Branch Foundation in Fort Pierce, Fla., rigged up a monitoring system to find out. Results, in the March CHEMTECH, showed elevated levels of carbon dioxide, carbon monoxide, alcohol, methane and acetone. Wang plotted accumulation and decay rates for CO_2 over time, and the steady-state contamination levels for each chemical based on the number of people in the room. Equations derived from the data permit fairly accurate predictions of necessary ventilation.

Asbestos pollution from auto brakes

Suspicion that automobile brakes release deformed "chrysotile" asbestos has been confirmed by Krishna Seshan, a materials science engineer at Lawrence Berkeley Laboratory in California. Most cars brake by grinding pads against a heat-resistant asbestos brake lining, Seshan says. His work shows that this deforms asbestos fibers, which are released as dust. And studies indicate that when asbestos is deformed, its surface electrical charge is altered, increasing its biological activity — and health risks, Seshan told SCIENCE NEWS. Asbestos has been linked with both lung disease and cancer in humans.

Deformed asbestos had been detected in air samples near highways, but scientists could not be sure where it originated. Seshan reasoned that highly deformed fibers probably came from autos, slightly deformed fibers from building-construction materials and undeformed fibers from natural rock. Since crystals "carry a memory" of their original structure despite later deformation, Seshan figured he might be able to correlate the degree of deformity with the fiber's source.

He examined brake-drum dust using dark field image electron microscopy (a way to observe small particles by looking at diffraction patterns of scattered electrons); the technique is common to microscopists, Seshan says, but relatively ignored by environmental scientists. Not only did he verify the presence of asbestos, but he also ascertained that fibers ranged from slightly to very deformed. He describes his work in the June ENVIRONMENTAL RESEARCH.

There is probably little risk to drivers because of the small amounts they would inhale, LBL says. Not so with mechanics; those who clean brakes using compressed air might inhale up to one million particles per cubic meter of air, LBL says.

Air pollution: More bad news

Results of a study conducted in Allegheny County, Pa., for the Environmental Protection Agency add weight to the theory that air pollution reduces life expectancy. Using statistical data for 1968 to 1972, John J. Gregor of Pennsylvania State University (now of Plymouth State College in New Hampshire) found that reducing total particulates one percent corresponded to a 0.23 to 0.89 percent reduction in pollution-related deaths. He cautions against extrapolating results to other regions, because it is not clear "whether the relatively large influence" of particulates on death rates is due to specific pollutants or to "inherent characteristics of particulate matter." For example, he found the correlation between sulfur dioxide — one of the particulate pollutants — and deaths was statistically insignificant.

The study, Intra-urban Mortality and Air Quality, also concludes that air pollution impacts increase with age, indicating either that the body's ability to counter effects decreases, or that pollutants have a cumulative effect. And although impact on both sexes is near equal after age 65, before 65 men show more adverse effects than women.

Y-15

FMSI 06075

Know and understand the law - OSHA will soon be around

. . . asbestos is a danger to your employees

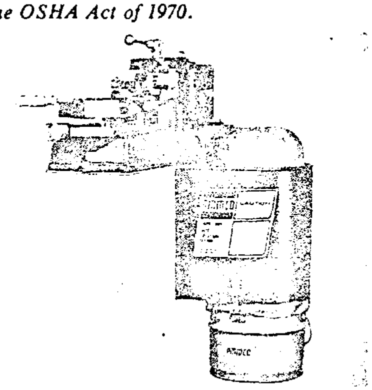
Last month, we introduced the proposed changes in the asbestos regulations and briefly outlined some of the standards your shop must meet to obey them. This month, we will take a closer look at some of the specific standards affecting your business, show how much danger is involved in handling asbestos and present some of the solutions parts and equipment manufacturers have developed.

When the 1974 asbestos inhalation law went into effect, most of the concern was for those employees involved in milling, fabrication and construction industries (the miners were under another law). Of the nearly one million tons of asbestos "consumed" in the United States in 1972, approximately 77% was used in the construction industry.

Use of the common sense NIOSH guidelines will mean greater shop safety and could help you pass OSHA industrial hygiene inspection.

However, further statistics reveal that only 500,000 workers are exposed to asbestos in mining, milling, fabrication and construction. Compare that number with the nearly *one million* American workers exposed to asbestos while installing and/or maintaining clutch and brake linings! A smaller percentage of the total asbestos is consumed but a larger percentage of America's work force is exposed.

A dust collection system designed for use with Ammco Tools, Inc.'s brake shoe grinders (Model 8925) efficiently collects, contains and disposes of asbestos dust ground off brake shoes, according to the company. No external power source is required, as a built-in suction fan pulls dust from the surface of the brake shoe and deposits it in a sealable disposable plastic bag. Once installed, the brake shoe grinder is said to meet or exceed Federal Clean Air Standards set by the OSHA Act of 1970.



But how serious is the exposure? A 1975 study done by Dr. W.J. Nicholson of Mt. Sinai Hospital detailed in a paper entitled "Asbestos Exposure During Brake Lining Maintenance and Repair" reveals some interesting statistics.

Before studies were undertaken, it was thought that the heat involved during the use of brakes caused a chemical breakdown, transforming the asbestos in the linings into a relatively harmless dust. The data presented in the paper indicates that workers engaged in car and truck brake service are exposed to potentially hazardous levels of airborne asbestos dust.

Specific brake servicing operations studied included blow-out of automobile brake assemblies, grinding of used truck brake linings and bevelling of new truck brake linings. Average peak asbestos air concentrations for these three activities based on personal samples taken within 10 feet of the operator were, respectively, 10.5, 3.75 and 37.3 fibers (greater than five microns in length) per cubic centimeter, up to 19 times worse than the recommended limit.

The study concluded that "during brake lining maintenance and repair, workmen in garages, service stations and brake repair shops are exposed to asbestos and thus may be subject to serious cancer risk. Others, at some distance from the repair work, (including those who are within 75 feet) are perhaps subject to the same hazard."

This study, and others that have been undertaken, has established in the scientific community a basis for studying the extent of asbestos-related disease in brake servicing personnel. A recent review of scientific literature, quoted in an ASIA news bulletin, states that "the association between asbestos exposure and [tumors of the chest and abdominal membranes] has revealed at least four cases of these rare tumors in persons who were employed in jobs involving automobile brake servicing." (Researchers have just begun to pinpoint this industry. Other related cases are expected to be found.)

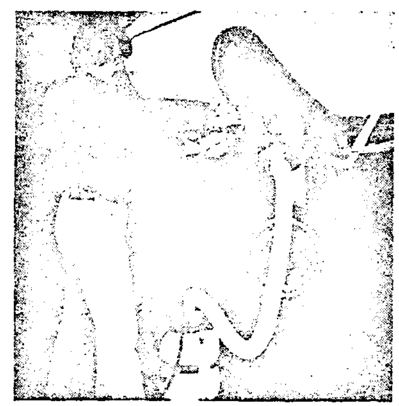
Now that the scientific community and the federal government are convinced of the risk involved in brake servicing, it is time for the individual shop owner to comply with the standards established by the Dept. of HEW and stated in the Airborne Asbestos regulations.

The law states that airborne asbestos fibers must be below a certain count per cubic centimeter. Specifically, the Federal Register states "The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than five micron, per cubic centimeter of air."

The measurement is done by using a membrane filter method with an electronic microscope costing between $500-$1,000. Obviously, this is too costly for most brake shops. Some insurance companies will undertake this measurement for their accounts, providing the insurance company has an industrial hygiene division. Also, some state OSHA offices will help.

Regardless who does it, the employer is responsible for taking the measurement. An explanation of the membrane filter method (which is the only acceptable method according to OSHA) can be found in the Asbestos Information

The Brake-O-Vac brake assembly cleaner has been redesigned by Per-Lux, Inc., to meet OSHA requirements by attaching the unit to an approved shop vacuum. When attached to a standard air hose, dust, asbestos and other foreign matter can be vacuumed off brake assemblies in seconds. Automatic or manual models, plus quick-change adapters from 9 in. to 12 in., are available.



FMSI 06076

Y-10 (2)

Association's "Recommended Work Practices: Fabrication and Use of Asbestos Friction Materials." It takes 11 complicated pages to explain the procedure.

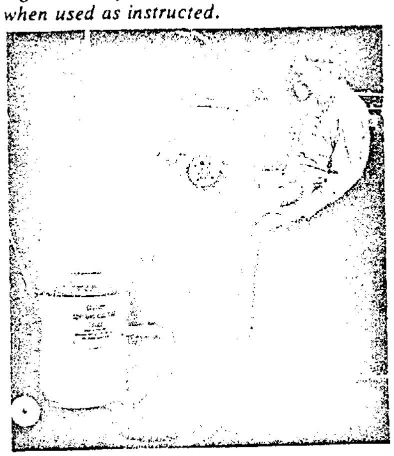
A toll-free call to OSHA's Chicago office revealed that the industrial hygiene inspectors will look favorably on indications of voluntary compliance. (The Chicago office is quite willing to answer any questions on this and any other OSHA regulations. The toll-free number is: 1-800-621-0523).

The National Institute for Occupational Safety and Health has suggested the following procedures for asbestos brake and clutch servicing in order to reduce exposures:

Model 1250 brake assembly washer introduced by Ammco permits solvent washing of brake assemblies and eliminates the practice of air-blasting asbestos particles and dust around the shop. The specially designed gun, which requires shop air pressure, delivers a properly atomized stream of solvent without misting or waste. The solvent returns to the sump through the perforated parts pan for recirculation. As parts are removed from the brake assembly, they are allowed to drop into the perforated parts pan where they are retained until reused or discarded.

- If possible, an area should be designated for all brake and clutch repairs. Entrances should be posted with warning sign saying: "Asbestos dust hazard. Avoid breathing dust. Wear assigned protective equipment. Do not remain in area unless your work requires it. Breathing asbestos dust may cause asbestosis and cancer."
- During brake servicing, an air purifying respirator, either single use or with replaceable particulate filter(s), as approved by the Mining Enforcement and Safety Administration of NIOSH, will be worn during all procedures starting with the removal of the wheels and including reassembly. Such a respirator should also be worn during all clutch procedures from removal to installation of a new assembly.

Tempo Products Co. offers this brake/clutch service vacuum (Model AB-7515) for dry recovery of asbestos fibers. The vacuum is equipped with a four-stage filtration system with secondary fail-safe protection that is said to assure maximum asbestos filter entrapment. Each unit includes complete instructions and all elements necessary for the safe collection and disposal of asbestos fibers. According to the manufacturer, it has been certified to comply with current regulations by an environmental laboratory when used as instructed.



- Dust should first be cleaned from brake drums, brake backing plates, brake assemblies and clutch assemblies using an industrial type vacuum cleaner equipped with a high efficiency filter system. After vacuum cleaning, any remaining dust shall be removed using a rag soaked in water and wrung until nearly dry. Under no circumstances should compressed air or dry brushing be used for cleaning.
- During arcing and riveting operations, respirator should also be worn. Grinding (arcing) machines should be provided with local exhaust ventilation such that worker exposures maintained at least below the 1976 asbestos standard.
- Industrial vacuum cleaner bags containing asbestos dust and cloths used for wiping brake and clutch assemblies should be sealed in plastic bags and labeled with the following warning label printed in letters of sufficient size and contrast to be readily visible and legible, "Caution, contains asbestos fibers. Avoid breathing dust. Breathing asbestos dust may cause asbestosis and cancer."
- All floor cleaning in areas where brakes and clutches are repaired should be done with a high efficiency industrial vacuum cleaner.
- Although adherance to the above procedures should minimize any contamination of work clothing, appropriate portions of the OSHA asbestos regulations concerning special clothing, change rooms, etc. should be followed.

Compliance to this law will mean not only a safer shop for your employees but it will mean a cleaner and neater shop. Also, be sure your employees understand the severity of this problem so that compliance procedures become standard operating methods in your shop.

Exclusive! Beware of Brake Dust!

By Bob Cerullo

MOST MECHANICS GO ABOUT the task of cleaning brake and clutch dust knowing that while doing the job they are inhaling some of this dust. It has been general knowledge that linings and pads are made on the average of 50 to 60 percent asbestos. However, past studies have led us to believe that the asbestos fiber was locked into other materials in the lining and that a change due to the high heat of friction took place during braking or clutch application. This transformed the asbestos fiber into a non-toxic, non-fibrous material called forsterite. The conclusion then was that the dust was harmless.

Studies conducted by the Mt. Sinai School of Medicine in New York City indicate that brake dust may actually contain an average of 3 to 6 percent asbestos with some tests showing concentrations as high as 15 percent. Samples of air were taken under actual working conditions in a taxi-fleet garage and a N.Y. Dept. of Sanitation truck repairshop. These samples were analyzed by electron microscopy and revealed levels of airborne asbestos considerably higher than those permitted by federal law. It should be noted that during the testing in the truck repairshop grinding of brake shoes was carried out.

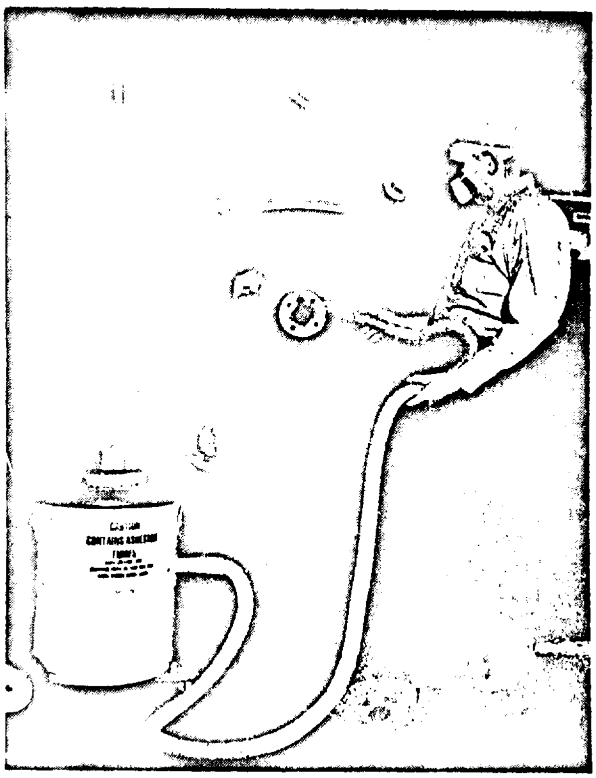


Fig. 1. REMOVE BRAKE DUST with high-efficiency filtered industrial vacuum cleaner. Wear air-purifying respirator.

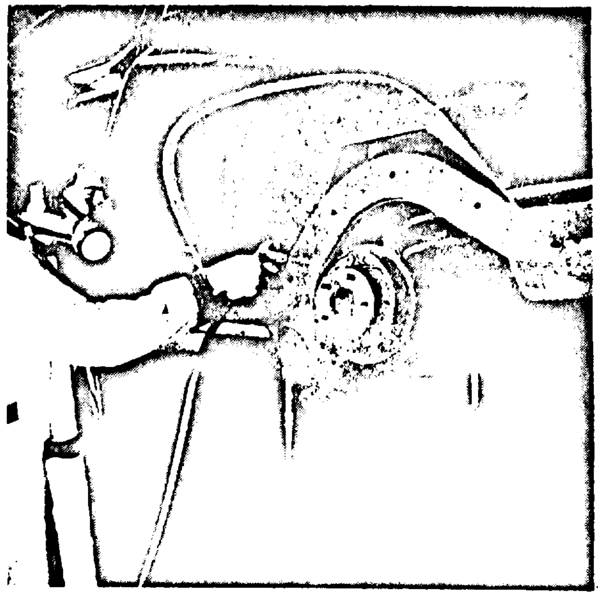


Fig. 2. NEVER BLOW OFF dirt from a brake assembly with an air gun. After vacuuming, use a nearly-dry damp rag.

The work of the researchers at Mt. Sinai was discussed at a meeting of the National Institute for Occupational Safety and Health (NIOSH) where the results of physical examinations given to 90 men who had been working as automobile and truck-brake repairmen for a period of 10 years were examined. Of this small group the doctors stated that X-ray examinations showed that over one-quarter had signs of abnormalities consistent with asbestosis disease; the same tests revealed that one quarter had also restricted pulmonary (lung) functions. This evidence prompted NIOSH to issue an alert to the automotive repair industry indicating that while the full extent of asbestos-related disease in brake-service personnel is not known because this occupational group has not been systematically studied up to now, enough scientific data has been accumulated to point out the need to start immediate control measures so that the health hazard of asbestos can be minimized.

There is no doubt that a health hazard exists and that exposure to asbestos fibers can increase the risk

continued on page 7

FMSI 06078

Y-11 (3)

continued from page 74

of developing four diseases: asbestosis—a non-malignant scarring lung condition; cancer of the lung; cancer of the digestive tract and mesothelioma—a cancer of the lining of the chest or abdominal cavities.

There are some authorities and other studies that place the percentage of asbestos in brake dust at a much lower level than those reported by the Mt. Sinai group and disagree with its findings. All authorities agree that no matter how small the concentration of asbestos in brake and clutch dust, there is an immediate need to initiate work practices in every shop that will eliminate any risk to the health of mechanics.

The danger is associated with drilling, grinding and cutting of brake linings. The dust generated during these operations must be collected in a vacuum-recovery system that has a high-efficiency filter. Many older grinders either have no recovery system or are equipped with vacuums that allow tiny particles of asbestos fiber to be blown into the air. Buying pre-ground shoes will minimize the need for grinding.

Where possible, a separate area should be set aside for brake and clutch work and a sign posted at the entrance that reads:

ASBESTOS
DUST HAZARD.
AVOID BREATHING DUST.
WEAR ASSIGNED PROTECTIVE EQUIPMENT.
DO NOT REMAIN IN AREA UNLESS YOUR WORK REQUIRES IT.
BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH.

Dust should never be removed from a brake or clutch assembly with an air blowgun or by brushing. The only way to safely clean dust containing asbestos is with an industrial-type vacuum with a high efficiency filtering system (Fig. 1). Don't use one of your wife's old vacuum cleaners because it probably will do more harm than good. The fine particles of asbestos will pass through most vacuum cleaners and you will end up with a higher concentration of asbestos than you would have if you hadn't used the vacuum at all. The vacuum you buy should have a 99-percent efficiency for 0.3 micrometers diameter aerosols. If there is any remaining dust that was not removed by vacuuming, wash it off using a slightly damp rag. Under no circumstances should you use an air gun or dry brush (Fig. 2).

There is no point in being careful about vacuuming the dust if, when you empty the vacuum cleaner bag, the dust blows all around you and the shop. Brake and clutch dust should be disposed of in a special plastic bag marked as follows:

CAUTION:
CONTAINS ASBESTOS FIBERS.
AVOID BREATHING DUST.
BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM.

Even using a high-efficiency industrial vacuum cleaner will not prevent a small amount of dust from reaching some noses and mouths which will inhale it. To prevent this, you should wear an air-purifying respirator of either the throwaway type like those used in body shops or one with a replaceable particulate filter. Before you buy either type, be sure that it is approved by NIOSH or the Mining Enforcement and Safety Administration. Wear the respirator while you are operating a grinder, drill or when emptying the dust collection bags on your vacuum cleaner.

There is bound to be some brake and clutch dust that falls to the floor while you are working, so be sure to use an industrial vacuum cleaner to pick it up. Don't sweep this part of the shop with a broom. A broom has the tendency to flick the asbestos particles up into the air and that is where they are dangerous. The rest is common sense: If your shop has heavy accumulations of dust on lockers, parts shelves, overhead door channels, beams and on window sills there is a good chance that dust contains some asbestos. Wear your respirator and use your vacuum cleaner to go over all those hidden places carefully and clean up the dust. Change your work clothes regularly and don't bring them home. Have them washed by an industrial laundry. Wash your hands thoroughly before eating and avoid eating in the area where you do brake and clutch work.

Every shop, large or small, is responsible for meeting the requirements of the federal law which calls for industrial hygiene inspections carried out by OSHA represen[illegible]. Under this law the level of asbestos shall [illegible]ed 2 fibers longer than 5 micrometers per [illegible] meter of air. (For a list of these firms send [illegible] addressed stamped postcard in an envelope [illegible] Asbestos, MOTOR, 1790 Broadway, New York [illegible]019.)

Research has deter[illegible] that smoking increases the rate of lung can[illegible] among people exposed to asbestos dust. In sho[illegible] you have been working around brakes and [illegible] for several years, it would be wise to give up smoking.

continued on page 85

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continued from page 76

It is gratifying to note that a great deal of money and time is being spent by brake and clutch lining manufacturers to deal with the problem. In addition to OSHA's specific requirements label, one firm has included useful extra p... on the warning label on every box of brake ... clutch facings it sells. This same firm ... mended procedures for reducing asb... during brake service in their service manu... training film.

In the final analysis you are the only one who can protect yourself from the potential dangers of exposure to asbestos dust. If you wear a respirator or mask, use an approved brake vacuum cleaner, dispose of the dust in the prescribed manner, vacuum the floors and use good common sense about house cleaning, there is little to fear from the presence of asbestos dust. The few extra precautions involved could prevent you from contracting a very painful if not fatal disease. Start tomorrow to clean up your act . . . you owe it to yourself, your family and your fellow workers.

How to Promote Your Service Department

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the clinic will be favorably impressed and may become customers in the future. A clinic of this type invariably uncovers the need for much service work, and the dealer should get a substantial share of this work.

The best promotion won't be effective unless the service department can deliver what it promises. Among the most frequent customer complaints are: work not done when promised, cars not repaired properly and high cost of repairs. Most dealerships will make good on a job if the work is performed improperly or a part is defective. These "warranties" are usually informal in nature, but some dealers have plans that are specific and widely advertised.

Your shop equipment can also be an important merchandising tool. An optical wheel alignment machine, for example, projects a "picture" of the front-end setup of a customer's car. ... owners understand the pattern of a... most are impressed by the dealer'... est in such sophisticated equipme... echnicians in its operation.

Finally, never forget tha... erchandisers are your shop person... not be high-pressure salesmen. It ... ss the customer with their courtesy ... sincerity and back up that impressi... performance. Your investment in me... ment and promotional plans will pay off.

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Bus fleet praised for fighting asbestos hazard

For its "excellent performance in protecting district mechanics from a cancer-causing substance, asbestos in fiber form," California's Health Dept. has commended the Golden Gate Bridge, Highway and Transportation District.

Golden Gate Transit, operating a fleet of 248 buses, was praised for protecting the 42 district mechanics who work with asbestos lining while performing brake and clutch maintenance and repairs on buses.

California is the first state to require employers to report workplace use of asbestos. Asbestos is the most widely used of 18 cancer-causing chemicals and substances regulated in California as part of a comprehensive program to prevent job-related cancer.

Excessive exposure to asbestos fibers can cause lung cancer, a rarer form of cancer known as mesothelioma, and a lung ailment called asbestosis.

State Health Director Jerome A. Lackner, M.D., said, "State industrial hygienists are discovering in inspections that asbestos in bus, truck and auto brake-repair shops is a significant potential health hazard to California workers, but one which safe work practices can control.

"An estimated 74,000 mechanics and other workers in 22,000 auto- and brake-repair shops serving the public are potentially exposed to asbestos through brake-repair work. Several thousand more workers doing brake repairs for transit systems, truck and bus lines and utility-vehicle fleets potentially risk similar exposure. Several citations for unsafe use of asbestos have been issued.

"So it is encouragingly good news when we learn that a large fleet operator such as Golden Gate Transit is effectively protecting its mechanics against exposure to asbestos fibers.

"The district's San Rafael brake repair facility is an outstanding example of safe asbestos use. It is well equipped to minimize dust. The district mechanics are using safe work practices."

The district mechanics are members of the International Association of Machinists & Aerospace Workers (IAM), Marin County Lodge No. 238. The Machinists union was represented, along with employer, government, and science representatives, on the State Health Dept. advisory committee, which early this year drafted the asbestos regulation now in effect.

Dr. Fred Ottoboni, Ph.D., head of the department's Occupational Cancer Control Unit, said the transit district followed these key procedures to maximize worker protection against asbestos fibers:

- ☐ New brake linings are "arced" (shaped to fit) with a low-speed lathe rather than a power sanding machine that could produce airborne fibers.
- ☐ Arcing is done in a room separate from other workers so that asbestos waste is isolated from other workers.
- ☐ The small amount of dust generated by this process is collected by an exhaust system.
- ☐ Waste material is put in labelled containers and disposed of in plastic bags.
- ☐ Cleanup of brakes prior to repair is done with a damp rag rather than with compressed air, thus eliminating a serious source of dust.

Anti-lock backflip stirs bus protest

The American Public Transit Assn., Washington, D.C., has protested the now-we're-against-it, now-we're-not moves of the DOT's Truck and Bus Safety Subcommittees on the anti-lock provision of FMVSS 121 (FO—11/77, p. 13).

APTA, whose members carry 90% of U.S. mass transport riders, wrote to William H. Marsh, executive secretary of NHTSA, protesting the subcommittee's reversal of a moratorium recommendation approved by a majority of members at a proper meeting.

APTA's executive director B.R. Stokes said, "It is unconscionable to attempt to reverse this action by the very questionable procedure employed. The safety of the public is too important to allow several individuals to sidestep usual democratic procedures.

"To reverse a carefully considered committee action (within one week) by a telephone/telegram ballot, without even a claim of change in circumstances, presentation of new evidence or the like, is a transparent ploy inconsistent with any procedure acceptable to our courts of law, our congressional representatives or our sense of justice."

Retrofitted bus takes wheelchairs

A 7-year-old Toledo (Ohio) transit bus has been retrofitted with an electric lift platform to accommodate disabled passengers (photo above). Inside the bus are six restraints to keep wheelchairs in place while the bus is moving. The platform, designed by City Machine & Tool Div. of Sheller-Globe, replaces the rear step well and also serves as a standard passenger step entrance. Modification was made with help of a grant from the Urban Mass Transit Authority.

Find more work-related cancer

A government study estimates that at least 20% and possibly as many as 38% of the cancers that will occur in the U.S. over the next 30-35 years will be work-related. This conclusion represents a significant departure from conventional estimates, which have ranged from 1-5%.

Results of the study, prepared by the National Cancer Institute and the National Institute of Environmental Health Sciences (NIEHS), were disclosed last week by Joseph A. Califano, Jr., Secretary of Health, Education and Welfare. The complete report will be submitted as evidence to the Occupational Safety and Health Administration. The authors want it to be used as part of the data on which OSHA will base its policy for regulating carcinogens.

The HEW report represents a re-evaluation of available studies on occupationally-related cancers, particularly in the light of new evidence concerning the impact of asbestos-related cancer. It predicts that 2.15 million persons will suffer cancer attributable to asbestos over the next 30-35 years—an average of almost 67,000 cases/year. This would represent about 17% of all cancers detected annually in the U.S.

Commenting on the asbestos threat, David P. Rall, director of NIEHS and one of the authors, notes: "It is only in the last year or so that the full magnitude of the asbestos situation has been appreciated."

In addition, four other substances—arsenic; benzene; coal-tar pitch volatiles and coke oven emissions; and vinyl chloride—will result in 1-3% of cancers each year, the study says. Four other compounds—chromium; iron oxide; nickel; and petroleum distillates—will contribute to 3-18% of all cancers. Thus a 20% figure is a "conservative" estimate, Rall says.

NIEHS's RALL: Figures show "we're not in as good shape as we may have thought."

The figures do not include the potential effects of other unknown substances, Rall notes. But the study does carry a *caveat*—it notes that most cancers have multiple causes. Rall says a number of occupational groups, such as chemists and rubber workers, have been found to have an excess incidence of certain cancers but the specific causes are not known.

While Rall conceded that the estimates of the number of workers exposed to carcinogens are probably not accurate, he notes, "They are the best estimates we have," adding that they may in fact understate the situation. "The typical pattern is that the more you study an occupational group, the more relative risk you see," Rall observed. In his view, the message of the study is: "We really have to work much harder to make the workplace safe from chemical carcinogens. There may have been some feeling of complacency, but we're not in as good shape as we may have thought."

OSHA Administrator Eula Bingham underlined Rall's comments, noting that "the study came as no personal surprise" and labeling it as "a clear call to the nation for action." The study indicates that cancer is not necessarily "inevitable," Bingham says, adding that "we should launch an all-out assault to rid workplaces of cancer-causing exposures and turn out energies toward preventive rather than remedial programs."

Industry officials denounced the "premature" use of the HEW
Blair, Dow Chemical's vice president for Health and Environmental Sciences, noted that Califano's decision to release the results is "most unfortunate" and "uncalled for" because the report is in draft stage and so far "unsubstantiated" by data. Blair believes the estimates are another in a series of predictions that are periodically tossed out and not substantiated. "A better procedure would be for these people to have peer review of their study. Many scientific groups or technical people are all qualified to examine this."

Blair's sentiments were echoed by the American Industrial Health Council and the American Council on Science and Health. AIHC Executive Director Ronald A. Lang said the summary released by HEW did not clearly identify the scientific methods used, or the details of the study's results. "The summary Mr. Califano refers to tells us nothing," Lang notes, adding that any new data on cancer from occupational exposure "should be published and critiqued . . . before HEW alarms the public unnecessarily."

ACSH's Executive Director Elizabeth M. Whelan noted that the report "was seriously misleading in that it cited cancer mortality statistics among asbestos workers without even mentioning the contribution of the major lung carcinogen—cigarette smoke. Non-smoking asbestos workers have no more lung cancer than the general non-smoking population." AIHC's Lang added that asbestos exposure conditions that the study linked with 17% of all cancers "were cleaned up long ago."

Cancer link denied

Dow Chemical says that it will "vigorously contest" a $70-million lawsuit brought by a Vietnam veteran who claims that he developed a fatal cancer as a result of exposure to Agent Orange herbicide. Last week, Dow responded to the suit by petitioning to have it moved into U.S. District Court from New York State Supreme Court where it was originally filed late in July.

The suit by 28-year-old Paul Reutershan originally named Dow and five other companies thought to have supplied the defoliant—a blend of 2,4,5-T and 2,4-D herbicides—to the military. On Sept. 6 action was dropped against all but Dow.

In the complaint, Reutershan charges that his cancer was caused by exposure to Agent Orange while serving in Vietnam in 1967 and 1968. He discovered that he had cancer in October 1977. He claims that Dow was aware of the alleged harmful affects but failed to warn those exposed of the potential danger.

According to Dow, the move to federal court will give it greater freedom in examining expert witnesses called by Reutershan to prove his case. Dow maintains that there is no evidence that Agent Orange causes cancer.

Reutershan's attorneys say that this is the first case brought by a veteran over Agent Orange and that others may join the suit. However, a veterans' group called Citizen Soldier says that while a number of veterans seem to have symptoms consistent with dioxin—an inevitable contaminant of 2,4,5-T—proving the connection with cancer is difficult. The group says it is laying groundwork for an epidemiologic study of veterans exposed to Agent Orange.

Y-13

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Number 7

Industrial Health Foundation
5231 Centre Avenue
Pittsburgh, Pennsylvania 15232

INDUSTRIAL HYGIENE DIGEST

NEWS ITEMS

663/78x Actions on the Threshold Limit Values of Chemical Agents.
American Conference of Governmental Industrial Hygienists, May 1978.

Notice of Changes Intended (For 1978)

Additions

Aspirin	5 mg/m^3
Amosite	0.5 fibers/cc
Chrysotile	2 fibers/cc
Crocidolite	0.2 fibers/cc
Cyanogen Chloride	0.25 ppm
Baytex	0.1 mg/m^3
1,3 Dichloropropene	1 ppm
Divinyl benzene	10 ppm
o-sec-Butylphenol	5 ppm-Skin
Chloroacetyl Chloride	50 ppb
Diethanolamine	3 ppm
2-Hydroxypropyl acrylate	0.5 ppm-Skin
Dalapon	1 ppm
m-Isopropylaniline	2 ppm-Skin
Propionic acid	10 ppm
Sodium bisulfite	5 mg/m^3
Tetrasodium pyrophosphate	5 mg/m^3
Trichloroacetic acid	1 mg/m^3

Deletions

140 Flash aliphatic solvent
N-Methyl -2- pyrrolidone.

Y-14

TECHNOLOGY

Flash filling for front teeth

The time pressure is off on dental fillings with a composite developed by Imperial Chemical Industries in the United Kingdom. No longer must the dentist rush to fill a difficult cavity or build up a chipped tooth before the filling material hardens. According to a report in the May 8 CHEMICAL AND ENGINEERING NEWS, the new blend, called Fotofil, remains a paste until its catalyst is activated by light from a special source "gun." The paste then cures within a minute to an inert structure, which matches the enamel of neighboring teeth.

The active component of the paste is a resin made of urethane dimethacyclate, a member of the family of materials used to coat chemical tanks. A barium-containing glass filler makes up 80 percent of the paste formulation. The glass is ground to particles of 10 microns and coated with a silicon compound.

The dental material is soon to be marketed in the United States for restoration of front teeth. Molars, however, require a subtance highly resistant to abrasion. The developers are now investigating whether Fotofil or modifications with different glasses and resins are suitable for back teeth. Unlimited time for sculpturing molar work would be especially valuable because accurate shaping of molars prevents wear on the opposing teeth.

Sifting through the silicon

Finding a needle in a haystack is a difficult type of research problem, whether it involves trace impurities or basic constituents of chemical and biological systems. Researchers at Bell Telephone Laboratories report a new electron microscope technique for identifying and locating minute amounts of certain elements in diverse materials. So far, researchers have used it to identify a few hundred carbon atoms among several hundred billion silicon atoms, unwanted oxygen, nitrogen and carbon in integrated circuits and the storage site of the neurotransmitter serotonin in human blood platelets (reported in the May 5 SCIENCE).

The technique, called electron energy-loss spectroscopy, locates atoms of different elements by their interactions with a beam of electrons generated by the microscope. The beam electrons lose a characteristic amount of energy when they interact with each type of atom. David Joy and Dennis Maher then use a magnetic field to sort the beam atoms by amount of energy lost. In addition to detecting small amounts of elements, the technique allows scientists to measure distances between atoms to within a quarter of the diameter of one atom.

Roy Rogers to the delivery

Cows in labor may soon be calling cowboys, if the Federal Communications Commission approves a new device. A matchbook-size transmitter held in place by an adhesive signals when the cow's cervix dilates just before giving birth. The cowboy's receiver picks up the signal, which directs him to the bearing cow.

The reusable device, which has a range of 15 miles, was developed by Warren R. Jewett, Walter Evans and Lee Ingle of the University of Arizona. Bill Clevenger of Vita Vet, the company that plans to produce the detectors, estimates that 10 to 15 percent of unattended livestock births result in death to the newborn. Cattle and horses don't always take care of their new offspring or protect them from predators. The device will also be useful for zoo animals that often kill their newborns. Jewett's work on a birth signaling device began with an inquiry from the St. Louis Zoo. To save snow leopard cubs, zoo attendants need to be on hand to separate the cubs from their mother within 30 minutes of birth.

ENVIRONMENT

People pollution

Just breathing can make a room without ventilation that is also full of people pretty stuffy. How stuffy? Tsen C. Wang, a chemical engineer with Harbor Branch Foundation in Fort Pierce, Fla., rigged up a monitoring system to find out. Results, in the March CHEMTECH, showed elevated levels of carbon dioxide, carbon monoxide, alcohol, methane and acetone. Wang plotted accumulation and decay rates for CO_2 over time, and the steady-state contamination levels for each chemical based on the number of people in the room. Equations derived from the data permit fairly accurate predictions of necessary ventilation.

Asbestos pollution from auto brakes

Suspicion that automobile brakes release deformed "chrysotile" asbestos has been confirmed by Krishna Seshan, a materials science engineer at Lawrence Berkeley Laboratory in California. Most cars brake by grinding pads against a heat-resistant asbestos brake lining, Seshan says. His work shows that this deforms asbestos fibers, which are released as dust. And studies indicate that when asbestos is deformed, its surface electrical charge is altered, increasing its biological activity — and health risks, Seshan told SCIENCE NEWS. Asbestos has been linked with both lung disease and cancer in humans.

Deformed asbestos had been detected in air samples near highways, but scientists could not be sure where it originated. Seshan reasoned that highly deformed fibers probably came from autos, slightly deformed fibers from building-construction materials and undeformed fibers from natural rock. Since crystals "carry a memory" of their original structure despite later deformation, Seshan figured he might be able to correlate the degree of deformity with the fiber's source.

He examined brake-drum dust using dark field image electron microscopy (a way to observe small particles by looking at diffraction patterns of scattered electrons); the technique is common to microscopists, Seshan says, but relatively ignored by environmental scientists. Not only did he verify the presence of asbestos, but he also ascertained that fibers ranged from slightly to very deformed. He describes his work in the June ENVIRONMENTAL RESEARCH.

There is probably little risk to drivers because of the small amounts they would inhale, LBL says. Not so with mechanics; those who clean brakes using compressed air might inhale up to one million particles per cubic meter of air, LBL says.

Air pollution: More bad news

Results of a study conducted in Allegheny County, Pa., for the Environmental Protection Agency add weight to the theory that air pollution reduces life expectancy. Using statistical data for 1968 to 1972, John J. Gregor of Pennsylvania State University (now of Plymouth State College in New Hampshire) found that reducing total particulates one percent corresponded to a 0.23 to 0.89 percent reduction in pollution-related deaths. He cautions against extrapolating results to other regions, because it is not clear "whether the relatively large influence" of particulates on death rates is due to specific pollutants or to "inherent characteristics of particulate matter." For example, he found the correlation between sulfur dioxide — one of the particulate pollutants — and deaths was statistically insignificant.

The study, Intra-urban Mortality and Air Quality, also concludes that air pollution impacts increase with age, indicating either that the body's ability to counter effects decreases, or that pollutants have a cumulative effect. And although impact on both sexes is near equal after age 65, before 65 men show more adverse effects than women.

Y-15

Asbestos exposure during brake-lining maintenance and repair

Problem:

Brake-linings may contain as much as 50% chrysotile asbestos, and the disintegration of the lining during braking releases fibers, some of which become constituents of brake drum dust. Other fibers are released into the general environment. An investigation was made to obtain information concerning asbestos exposure of automobile and truck maintenance workmen, particularly those responsible for brake-lining work.

Personal air sampling was carried out at various auto repair shops, fleet repair shops and several municipal truck repair shops. It is estimated that there are about 124,000 men in this work in New York City alone.

The exposure of workers during brake-lining maintainance and repair is of interest as a background to investigation of their health experience. This, in turn, has considerable significance in determining whether brake-lining dust is pathogenic. If it is not, we would have little concern regarding brake-lining dust as a source of general environmental exposure to asbestos. On the other hand, if workers exposed to this dust are found to have asbestos disease, then the effects of exposure of the general population to the same dust, albeit at much lower levels, would have to be further evaluated.

Materials and methods:

Personal air samples were taken during brake-lining maintenance work. Air samples were also taken at adjacent sites, including customer waiting areas and automobile showrooms. The standard techniques for filter processing and fiber counting which have been adopted by the Occupational Safety and Health Administration of the Department of Labor. Both optical and electron microscopic methods were employed, the latter because the great majority of asbestos fibers were too fine to be detected by optical microscopy. X-ray powder diffraction and microchemical scanning electron microscopic analyses were also utilized to identify chrysotile asbestos in brake drum samples.

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FMSI 06085

Results to date:

Table I shows the levels of asbestos found during the most common operation of brake-lining maintenance. When a brake lining is brought into a repair shop for inspection or replacement, the wheel is removed and all loose dust is removed from the drums and back plates by means of a compressed air jet. The cloud that is produced is visible, and remains so for minutes afterward. There is minimal, if any, effort to control dust in most garages and workmen very rarely wear respirators. Table I shows that fiber counts are high in the operator's area, and that there are moderately high concentrations at least 20 feet away. Background sampling during the same operation shows that immediately after jet air blowing and for at least 14 minutes afterward, there are measurable concentrations. These measurements were taken at varying distances from the operator (from 10 to 75 feet) and show that other people within that perimeter are exposed, including mechanics, shop management, salesmen and customers.

Ten samples of brake drum dust were processed for electron micropsopic examination without changing the size distribution, and asbestos fibers present in the dust were measured. The results are shown in Table II. It was found that most fibers are too small to be seen by optical microscopy; almost all of them were shorter than 0.4μ in length. Virtually all were of respirable size.

Prior to this study, it had been generally accepted, on the basis of limited data, that asbestos brake-linings are thermally altered to an inert, presumably harmless dust, during braking action. Our observations show that asbestos fibers do survive. This has been found in every brake drum dust sample analyzed by x-ray diffraction, electron microscopy and microchemical scanning electron microscopy.

Table III and IV present data collected during brake lining maintenance operations at the New York City Department of Sanitation truck repair shop. Two important operations are performed in this large shop for reasons of economy-grinding and bevelling of linings, otherwise generally performed during manufacture. Accordingly, these studies relate to levels of asbestos exposure experienced by workers engaged in manufacturing. New linings are ground to remove imperfections on the surface and used linings are salvaged by grinding the surface to remove grease and dirt fiber concentrations experienced during grinding ranged from approximately 2.0 to 7.0 large (optically visible) fibers/ml of air ($2x10^6$ - $7x10^6$ $/m^3$). The background or area samples for this operation ranged from 1.2 to 0.2 fibers/ml (1.2 - 0.2 x 10^6 $/m^3$) with a general decrease with increasing distance away from the operator. From six to ten other mechanics would thus be exposed to perhaps about one fiber/ml. A concentration of even one fiber/ml is equivalent to inhaling 8 million large fibers per working day, those longer than 5μ. Much larger numbers of shorter fibers would simultaneously be inhaled.

Table IV shows fiber concentrations measured during bevelling of new truck brake-linings. The lining edge is bevelled on a grinding wheel, so that the brake will grip properly. Concentrations were very high, ranging from 32 to 72 fibers/ml, and background counts were measurable up to 30 feet away.

Significance:

The data indicate that, during brake-lining maintenance and repair, workmen in garages, service stations and brake repair shops are exposed to asbestos and thus may be subject to serious cancer risk. Others, at some distance from the repair work, are perhaps subject to the same hazard. These environmental measurements will be of value in considering the health experience of brake-lining repair workers, as a background to evaluation of the importance of asbestos from brake-linings as a factor in general community asbestos air pollution.

Publications:

To be published.

Investigators:

A. M. Langer, Ph.D., A. Rohl, Ph.D., Mary S. Wolff, Ph.D.

Support:

Health Research Council: U-1272.

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Period:

1973

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Table I

PERSONAL SAMPLES - AUTOMOBILE BRAKE SERVICE

Operation	Distance	Concentration (fibers/ml.) *
Blowing dust out of drum brakes	3-5 ft.	13.8
" " " " " "	"	29.4
" " " " " "	"	6.6
" " " " " "	"	13.6
" " " " " "	5-10ft.	3.8
" " " " " "	"	2.0
" " " " " "	"	4.2
" " " " " "	10-20ft.	0.4
" " " " " "	"	4.8

BACKGROUND SAMPLES - AUTOMOBILE BRAKE SERVICE

Operation	Distance from Operation	Time Lapse	Concentration (fibers/ml.)
Blowing dust out of drum brakes	10 ft.	0 min.	0.3
" " " " " "	20 ft.	0 min.	0.8
" " " " " "	12 ft.	5 min.	0.2
" " " " " "	50 ft.	5 min.	0.1
" " " " " "	65 ft.	7 min.	0.1
" " " " " "	75 ft.	14 min.	0.1

* Only fibers longer than 5μ were counted, by phase microscopy at 400x.

Table II

SIZE DISTRIBUTION OF CHRYSOTILE FIBERS IN BRAKE DRUM DUST

Fibers counted and sized at 42,000 X

(all fibers have diameters from 250Å to 500Å)

Sample	750-1500Å	1500-2250Å	2250-3000Å	3000-3750Å	Total
1	40%	34%	11%	11%	96%
2	32	23	32	-	87
3	20	25	25	-	70
4	26	37	26	7	96
5	57	17	4	-	78
6	23	9	12	12	56
7	50	26	21	2	99
8	29	30	21	17	97
9	6	41	18	10	75
10	11	6	31	31	79

Table III

PERSONAL SAMPLES - TRUCK BRAKE SERVICE

Operation	Concentration (fibers/ml.)
Renewing used linings by grinding	2.7
" " " " "	7.0
" " " " "	2.2
" " " " "	4.1
" " " " "	5.0
" " " " "	4.7
" " " " "	5.6
" " " " "	1.7
" " " " "	2.5
" " " " "	2.0

BACKGROUND SAMPLES - TRUCK BRAKE SERVICE

Operation	Distance	Concentration (fibers/ml.)
Background to grinding used linings	10 ft.	1.2
" " " " "	10 ft.	1.7
" " " " "	25 ft.	1.0
" " " " "	25 ft.	0.6
" " " " "	60 ft.	0.2

Table IV

PERSONAL SAMPLES - TRUCK BRAKE SERVICE

Operation	Concentration (fibers/ml.)
Bevelling new linings	31.7
" " "	23.7
" " "	32.7
" " "	72.0
" " "	26.3

BACKGROUND SAMPLES - TRUCK BRAKE SERVICE

Operation	Distance	Concentration (fibers/ml.)
Background to bevelling linings	8 ft.	0.6
" " " "	12 ft.	0.5
" " " "	12 ft.	0.3
" " " "	30 ft.	0.3

PERSONAL SAMPLES - TRUCK BRAKE SERVICE

Operation	Concentration (fibers/ml.)
Punching rivets into brake lining	1.9
" " " " "	2.0
Chipping rust off used brake drums	2.4
Sweeping floor around grinder	3.6
Background taken 15 ft. away during sweeping	3.1

RECOMMENDED (INTERIM) PROCEDURES FOR
ASBESTOS BRAKE AND CLUTCH SERVICING

The National Institute for Occupational Safety and Health (NIOSH) has research underway concerning dust exposures during brake and clutch servicing. Due to preliminary data demonstrating significant asbestos exposures during presently used brake and clutch servicing techniques, NIOSH has reviewed alternate techniques whereby asbestos exposures are reduced. The following are interim procedures recommended by NIOSH to minimize dust exposures.

1. If possible, an area shall be designated for all brake and clutch repairs. Entrances into this area shall be posted with an asbestos exposure warning sign as follows:

Asbestos
Dust Hazard
Avoid Breathing Dust
Wear Assigned Protective Equipment
Do Not Remain in Area Unless Your Work Requires It
Breathing Asbestos Dust May Cause Asbestosis and Cancer

2. During brake servicing, an air purifying respirator, either single use or with replaceable particulate filter(s), as approved by the Mining Enforcement and Safety Administration (formerly Bureau of Mines) or NIOSH, shall be worn during all procedures starting with the removal of the wheels and including reassembly. During manual clutch servicing, such a respirator shall be worn during removal and cleaning of the clutch, pressure plate and housing assembly and during installation of the new clutch assembly.

3. Dust shall first be cleaned from brake drums, brake backing plates, brake assemblies and clutch assemblies using an industrial type vacuum cleaner equipped with a high efficiency filter system (>99% efficiency for 0.3 μm diameter aerosols). After vacuum cleaning, any remaining dust shall be removed using a rag soaked in water and wrung until nearly dry. Under no circumstances shall compressed air or dry brushing be used for cleaning.

4. During arcing and riveting operations, an approved respirator, as described in (2) above, shall be worn. Grinding (arcing) machines shall be provided with local exhaust ventilation such that worker exposures are maintained at least below the 1976 OSHA asbestos standard (29 CFR 1910.1001).* At a minimum, the dust bag of the arcing machine shall be removed and replaced with the hose of the high efficiency industrial vacuum described in (3) above.

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(2)

5. Industrial vacuum cleaner bags containing asbestos dust and cloths used for wiping brake and clutch assemblies shall be sealed in plastic bags and labeled with the following warning label printed in letters of sufficient size and contrast to be readily visible and legible;

Caution
Contains Asbestos Fibers
Avoid Breathing Dust
Breathing Asbestos Dust May Cause Asbestosis and Cancer

All asbestos waste shall be disposed of in accordance with the OSHA asbestos regulation, 29 CFR 1910.1001(h). During removal of vacuum bags, an approved respirator, as described in (2) above, shall be worn.

6. All floor cleaning in areas where brakes and clutches are repaired shall be done with the high efficiency industrial vacuum cleaner as described in (3) above. Grinding (arcing) machines shall also be cleaned with such a vacuum cleaner and any remaining dust wiped with a damp cloth. An approved respirator, as described in (2) above, shall be used during this cleaning.

7. Although adherence to the above procedures should minimize any contamination of work clothing, it is required that the appropriate portions of the OSHA regulations on asbestos (29 CFR 1910.1001(d), (3 and 4)) concerning special clothing, change rooms, etc. be followed.

NOTE: Strict adherence to the above procedures should minimize exposures to mechanics during brake and clutch servicing. These are interim recommendations and are subject to revision pending results of ongoing NIOSH research.

* Section 1910.1001 of the Code of Federal Regulations was formerly Section 1910.93a. This change was noted in the Federal Register, May 28, 1975.

Prepared By
Division of Field Studies and Clinical Investigations
National Institute for Occupational Safety and Health
Cincinnati, Ohio

MOTOR

1790 Broadway, New York, N. Y. 10019

ROBERT J. CERULLO
CONTRIBUTING TECHNICAL EDITOR

1851-60TH STREET, BROOKLYN, NEW YORK 11204

March 30, 1977

To; E.W.Drislane

Your in good company E.W. since as you will see on the attached sheet the National Institute for Occupational Safety and Health uses the word breathing in their Recommended Procedures for Asbestos Brake and Clutch Servicing.

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FMSI 06096

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ASBESTOS BRAKE AND CLUTCH SERVICING

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August 6, 1975

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