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McGILL UNIVERSITY

March 6, 1975

Mr. John H. Marsh
Director of Environmental Affairs
Raybestos-Manhattan, Inc.
100 Oakview Drive
Trumbell Connecticut
USA 06611

Dear John;

Thank you for your letter which arrived while I was out of the country. I enclose a copy of the final manuscript submitted to the Annals of Occupational Hygiene. I changed the first paragraph for style and made one or two minor additional comments (i.e. concerning asbestos left on workers clothes and on the weight of the cloth at plant 2) following our conversation with John Magenheimer. I will keep you informed of its progress.

Yours sincerely,

G.W. Gibbs, MSc,PhD
Assistant Professor

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EXHIBIT
P-649

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FIBRE RELEASE FROM ASBESTOS GARMENTS

G. W. Gibbs

Abstract

The concentrations of airborne fibres (≥ 5 μm) in the breathing zones of workers wearing asbestos safety garments were measured using the membrane filter method. At plant 1 where men wore asbestos coats, hoods and mittens, concentrations of fibres ranged 0.3 - 5.0 fibres/cc and the 8 hour time-weighted concentrations were 0.1 - 1.1 fibres/cc. At plant 2 where hoods, coats, mittens and leggings were worn, concentrations of airborne fibre ranged 9.9 - 26.2 fibres/cc and the 8 hour time-weighted average concentration was 4.7 fibres/cc. Counts of fibres collected on nucleopore filters and examined by scanning electron microscopy showed that the concentrations of fibres ≥ 5 μm in length represented 2.3 - 32% of the total airborne fibre. The difference between the quantities of fibre released from the garments at the different plants was probably related to the methods or materials used in garment manufacture. The results showed that there is a need to identify and to reduce the release of fibre from asbestos safety garments currently supplied to protect persons working in hot environments.

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Fibre release from asbestos garments

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Introduction

Tests of industrial type asbestos aprons and gauntlets in the laboratory[1] have shown that concentrations of asbestos near the breathing zone of a worker can exceed the current British[2] and proposed US standard[3] of 2 fibres/cc. Fibre concentrations associated with the wearing of new unlined asbestos cloth fire-fighting helmets have also been shown to exceed 2 fibres/cc[4]. The concentrations of asbestos to which industrial workers wearing asbestos safety garments at their place of work are exposed and hence the potential hazard for such workers have not been previously reported. The objective of the present study was to provide such information.

Materials and Methods

Population for Study

The study involved men employed at two ore reduction plants where asbestos safety garments were worn routinely. The first survey was conducted in the blast furnace section of a large steel plant (Plant 1) where ore for reduction was fed continuously to four furnaces. Five men were normally assigned to each furnace and all workers on two neighbouring furnaces were chosen for study. As the work on each furnace was fundamentally the same, neighbouring furnaces were chosen for convenience. The men working on these furnaces prepared channels along which molten iron flowed, tapped the furnaces and kept channels clear of slag during casting. Castings were held at approximately 4-hour intervals and lasted ½ to 1½ hours. Men generally wore asbestos safety coats for the duration of a casting but hoods and

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gloves were worn for varying periods as necessary.

The second survey was conducted at a small plant manufacturing elemental phosphorus (Plant 2). Four men were responsible for two furnaces which operated continuously. Slagging operations (i.e. tapping the furnace) were performed at approximately 1 to 1½-hour intervals and lasted 15-45 minutes. The work was similar to that at the steel works. Asbestos safety coats and leggings were worn throughout the slagging operations but hoods and gloves were worn only when necessary. Men employed on two shifts were studied.

Asbestos Garments

The asbestos garments worn by men in this study, as far as could be ascertained, were from three sources. Information and properties of the cloths from which garments were manufactured are summarized in Table I. In spite of extensive inquiries, it was not possible to obtain full details of the cloths from which garments were manufactured in all cases. This was due to the fact that manufacturers bought cloth from more than one supplier and it was not always possible to identify the individual coats used by the companies. Estimates of the age of the garments were obtained from each man tested.

Collection of Airborne Fibre Samples

Airborne samples of dust were collected using calibrated personal monitors which were attached to the employee in such a way as not to interfere with his work. The open faced filter was located in the employee's breathing zone, outside the asbestos coat but under the hood when worn. Samples for optical fibre counts were collected on Millipore 37 mm (type AA, pore size 0.8 μm) and a number of samples for scanning electron microscopic examination were collected on

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Nucleopore (type GE-40 pore size 0.4 μm) filters. Sampling rates were approximately 2 litres per minute. The sampling period was the total time from the start to finish of a slagging operation. It was not possible to collect samples of ambient air in the work areas as safety regulations at both plants did not permit persons other than the employees in the work area during a cast. However, we were assured by management and research departments that there was no other sources of fibrous dusts.

Counting of Airborne Fibre Samples

(a) Optical Counts

Millipore membrane filters were mounted and counted using the method of the British Occupational Hygiene Society[2]. Fibres greater than or equal to 5 μm in length and with length:breadth ratios greater or equal to 3:1 were counted on a Zeiss WL Standard Research Microscope at a magnification of 400x using phase contrast. At least 20 fields were counted on each filter and the same observer counted each sample twice.

(b) Scanning Electron Microscopy

Airborne samples of dust collected on nucleopore filters were examined by Scanning Electron Microscopy as follows. Circular segments (13 mm in diameter) were cut with radii touching the centre of the 37 mm filter and were attached by adhesive tape to standard 13 mm SEM mounts. Samples were coated with 150 Å layers of Au-Pd and scanned at a magnification of approximately 6,000x on a Cambridge Stereoscan type 96113 Mark 2A scanning microscope. Scans were performed across the diameter of the specimen and photographs of random fields were taken. The field area ranged 257 to 265 μm^2. Both the total number

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Discussion

The mean concentration of airborne asbestos fibre measured in the breathing zones of workers wearing asbestos safety garments at Plant 1 were similar to those reported by Lumley[4] for men wearing new firefighting helmets with unlined asbestos cloth covers (2.3 fibres/cc) but lower than those reported by Bamber and Butterworth[1] (mean 3.5 fibres/cc) who tested an undefined type of protective clothing in a laboratory study. In this present study, it was not possible to determine whether the airborne fibres originated from the coat, gloves, or hood, as hoods were worn only intermittently. In all but one case, the concentrations of fibres in the breathing zones of men wearing coats from sources A and B were below the threshold limit value of 5 fibres/cc, currently adopted in the U.S.A.[3], but one third of the tests exceeded the standard of the British Occupational Hygiene Society (2 fibres/cc)[2]. The time-weighted average concentrations to which men were exposed for the particular operations studied at Plant 1 were all less than 2 fibres/cc.

The concentrations of fibre in the breathing zones of men employed at Plant 2 were high, exceeding the excursion level of 10 fibres/cc permitted in the U.S. Standard[3]. The reason for the difference between the quantities of fibre released from these garments compared with those at Plant 1 is not known. However, both coats and mittens at Plant 2 were untreated and leggings were also worn. The coats were observed to leave asbestos on the men's clothes when removed. It would seem advisable that garments which release fibres readily should not be used until a method of reducing their fibre release has been found.

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Conclusion

In conclusion, there is a need to identify and decrease the fibre release from asbestos garments to prevent exposure of workmen to concentrations which may be considered hazardous to health or exceed present and likely future standards. This should be done by developing new processes for manufacturing and treating (or coating) asbestos cloths and by testing garments for fibre release before distribution for sale to industry. Such tests should take into consideration the release of submicroscopic fibre.

Acknowledgements

I acknowledge with thanks the assistance of Messrs. H. Hui, M.Sc., A. Corsillo and F. Schafer, who conducted the field surveys and performed the fibre counts and Mr. C.Y. Hwang, M.Sc., who was responsible for the electron microscopic studies, the companies who provided access to their plants to conduct the study and the workers who participated. This research was supported by a grant from Raybestos Manhattan Inc.

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Table I

Materials used for manufacture of asbestos garments

		Plant 1 Garments - Source A	Plant 1 Garments - Source B	Plant 2 Garments - Sourc
Coats	Weight	2.5 lb/sq.yd.	2.5 lbs/sq.yd.	2.25-2.50 lb/sq.
	Grade	Underwriters*	Underwriters	Underwriters
	Weave	Plain	Plain	Plain and Herrin
	Treatment	Nil	½% Acrylic base on weight of cloth	Nil
Hoods	Weight	1.2 lbs/sq.yd.	1.2 lbs/sq.yd.	2.25 lbs/sq.yd.
	Grade	Underwriters	Underwriters	Underwriters
	Weave	Herringbone	Herringbone	Basket
	Treatment	Aluminized outside	Aluminized outside	Dust suppressed* Aluminized outsi
Mittens	Weight	2.50 lb/sq.yd.	2.50 lb/sq.yd.	2.25-2.50 lb/sq.
	Grade	Commercial	Underwriters	Underwriters
	Weave	Plain	Plain	Plain and Herrin
	Treatment	Nil	½% Acrylic base on weight of cloth	Nil
	Comments	Knit flame proof cuff, chrom leather, green tanning - palm and thumb		
Leggings	Weight	Not worn	Not worn	2.50 lb/sq.yd.
	Grade			Underwriters
	Weave			Basket
	Treatment			Dust suppressed

*Underwriters - 80-85% Asbestos
**These hoods were manufactured from heavier cloth than normally encountered in industry and the aluminized layer had a different appearance.

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Table II Measured concentrations and time-weighted concentrations of airborne fibres to which men wearing asbestos safety garments at plant 1 were exposed.

Source of Garment	Age of garments weeks	Mean exposure period (mins) for slagging operation	Number of samples	Measured Concentration in fibres/cc		Daily exposure period (mins)		8-hour weighted concentration in fibres/cc	
				Mean	Range	Mean	Range	Mean	Range
A	New (< 1 week)	49	3	1.1	0.7-1.3	98	82-114	0.3	0.1-0.3
	1 - 4 weeks	52	15	1.7	0.5-3.7	104	50-144	0.3	0.1-0.8
	4 weeks	51	5	2.0	0.6-2.6	102	70-130	0.4	0.1-0.6
B	New (< 2 days)	54	16	2.4	0.3-5.0	108	62-128	0.5	0.1-1.1
Total		52	39	2.0	0.3-5.0	103	50-144	0.4	0.1-1.1

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TABLE III

Concentrations of airborne asbestos fibres in the breathing zones of men wearing asbestos garments by occupation

Occupation	Number of Samples	Concentration fibres/cc Mean	Range
Keeper	9	1.7	0.5-5.0
Hot Blastman	3	2.7	0.5-4.6
First Helper	5	2.2	0.3-3.7
Second Helper	7	2.5	0.7-4.0
Third Helper	6	1.9	0.8-3.5
Miscellaneous	9	1.6	0.5-3.7
Total	39	2.0	0.3-5.0

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Table IV

Concentrations of airborne asbestos fibres measured in the breathing zones of men wearing asbestos safety garments at Plant 2

Source of Garments	Age of Garments in weeks	Mean Exposure period in mins	Number of Samples	Concentration in fibres/cc Mean	Range
C	< 1 week	39	2	12.8	10.6-15.1
	1-4 weeks	28	2	18.1	9.9-26.2
	>4 weeks	38	2	12.3	10.6-14.0
Total		35	6	14.1	9.9-26.2

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Table V

Concentration of airborne asbestos fibre as determined by scanning electronmicroscopic examination of nucleopore membrane filters (N) at 6000x magn. and optical examination of millipore membrane filters (H) at 400x.

Source of Garment	Age (weeks)	Airborne fibre concentrations (fibre/cc)			
		S.E.M. count on Nucleopore filter (N)		Optical count on Millipore filter (H)	
		Total fibre	Fibres ⩾ 5 μm length	Fibres ⩾ 5 μm	
A	8	100	32	4.0	
A	1	109	18	-*	
A	3	869	20	0.5	2.5
B	New	230	61	2.9	4.7
C	8	341	96	10.6	11.0
C	Coat 3 Hood 8	216	51	26.2	51.0

*Sample for Comparison lost.

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