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HISTORICAL RESEARCH REPORT

Research Report TM/70/02
1970

An investigation of the hazard of stripping asbestos laggings from boilers

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UDC: 679.867.6:613.6

NOT FOR PUBLICATION

Report No. TM/70/2

RESTRICTED

AN INVESTIGATION OF THE HAZARD OF STRIPPING
ASBESTOS LAGGINGS FROM BOILERS

by

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March 1970

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INSTITUTE OF OCCUPATIONAL MEDICINEAn Investigation of the Hazard of Stripping
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1. PURPOSE OF INVESTIGATION

At the request of Dr. J. Lockie of the South of Scotland Electricity Board, a dust sampling investigation was performed at Clyde's Mill Power Station, Cambuslang, on 26th January 1970. The objectives of the investigation were to examine in the light of the Asbestos Regulations (1969):-

- (i) the suitability of various sampling instruments for assessing the asbestos hazard caused by stripping boiler laggings.
- (ii) the effectiveness of a wet method of stripping asbestos lagging from boilers in comparison with a dry method.
- (iii) whether the asbestos concentrations at a "barrier" position some 50 feet away from the lagging operations were within the allowable limits while the operations were in progress.

2. DUST MEASUREMENT

The instrument selected for routine measurements must be capable of assessing the asbestos hazard accurately in low or high asbestos concentrations during short or long periods of exposure in mixed dusts. In addition it should be portable, easy to use in boiler plant conditions and, ideally, the results of the evaluation should be available immediately at the sampling point or, alternatively, subsequent analysis should be relatively simple. Addingley (1966) has discussed the usefulness of various dust sampling instruments in the asbestos industry. The Standard Thermal Precipitator (S.T.P.), membrane filter and Royco samplers have been successfully and widely used. The membrane filter method was preferred to the S.T.P. on the grounds of its greater convenience and versatility, namely:

- (i) Variation in flow rate between 10 and 500 cm³/min does not affect the results. Thus, either long or short period samples may be taken with the membrane filters, the flow rate being adjusted to give the required particle density for microscope analysis. Conversely, the S.T.P. is an inflexible instrument of low, fixed flow rate (7 cm³/min) and small area of deposition. Long periods of sampling are necessary in low dust concentrations and many samples are needed to cover whole shift sampling in high dust concentrations, so increasing the evaluation effort.
- (ii) The apparatus is simple, robust and low in cost.
- (iii) The pumps may be operated by hand, battery driven or powered by mains electricity as convenient.

- (iv) The S.T.P. requires constant attention by a technician but the membrane filter instrument can be used in a fixed position with little supervision or as a personal sampler carried by a workman.

As an alternative, the Royco Photo-electric Counter gives an immediate digital display or print out record of total dust concentration in a pre-determined size range. Counts greater than $4 \mu\text{m}$ with this instrument have been shown to correlate satisfactorily with the membrane filter method in chrysotile dusts (Addingley 1966). It is, however, expensive (c. £3,000), not very portable and the proportion of total count due to asbestos requires standardising against a membrane filter instrument. This would appear to severely limit its usefulness in mixed dusts.

The British Occupational Hygiene Society (1968) have also reviewed the choice of sampling methods for asbestos measurements and have recommended the membrane filter technique as the standard method.

The instruments selected for comparison at Clyde's Mill were based on these recommendations and are listed in Table 1. The Royco Counter was not used partly for the reasons given but also because none was readily available. In addition to the S.T.P. and membrane filter, two instruments designed to sample respirable dust - the Long Running Thermal Precipitator (L.R.T.P.) and the M.R.E. Gravimetric Sampler - were included so that respirable dust measurements could be compared with those measured by the non-selective samplers. The Konimeter was included to assess the usefulness of the immediate, on site, spot measurements which are possible with this instrument. X

3. OPERATIONS INVESTIGATED

The trial was conducted in 'A' boilerhouse where arrangements had been made to strip chrysotile/magnesite lagging from the drum ends of two similar sets of boilers. The general layout is shown in Figure 1. The boilers had been out of commission for a considerable period and the lagging was naturally damp and not necessarily typical of plant in current use.

All three boiler ends at Site 1 were soaked with water from sprays for about half an hour prior to removing the lagging. P.V.C. sheeting was erected beneath and on the sides of the catwalk (but not above) to stop debris falling to the ground. During dry stripping at Site 2, an attempt was made to contain the dust within a totally enclosed area. The latter was again made with P.V.C. sheeting sealed to the boiler faces. An air extraction system was used to ventilate the enclosure. The workmen used an M.S.A. Dustfoe respirator for personal protection during both operations.

The wet and dry stripping operations were performed separately by one workman, wet stripping being started first. The dust levels were monitored throughout each operation at Sites 1 and 2 by the four instruments A, C, D and E described in Table 1. Both operations were/

were of short duration, the wet stripping lasting for 33 minutes and dry stripping taking only 14 minutes.

During each operation simultaneous samples were taken with similar instruments (B, C, D) at Site 3, the S.T.P. being omitted and the membrane filter sampler B being preferred to Type A since its higher sampling rate was better suited to the low dust concentrations anticipated at the barrier position.

Additionally, several short period samples were taken at Sites 1 and 2 during the stripping operations using the Dräger pump version of the membrane filter instrument, F, and the Konimeter, G.

After the stripping operations were completed, the P.V.C. sheets were removed and the floor swept clear of the remains of the lagging which was then shovelled into barrows and removed. Additional samples were taken with the S.T.P. and the Dräger membrane filter sampler, F, during the latter part of this work, covering sweeping and shovelling only.

4. RESULTS AND DISCUSSION

All the samples taken with the membrane filter instrument were "fixed" to the filter surfaces immediately after sampling by spraying with a cytological fixative (The Asbestos Research Council 1969). Each filter sample was evaluated by a procedure essentially similar to that described by the British Occupational Hygiene Society (1968). Interference microscope techniques were used in preference to phase contrast microscopy and at a magnification of approximately 600 X. Opposite sectors cut from each filter were rendered transparent with an optically dispersive fluid of refractive index $n_d = 1.561$ (orthophthalic acid dibutyl ester and cinnamic aldehyde) and a sufficient number of random fields were scanned on each to give a statistically significant count. Total dust counts were made in the size range $> 1 \mu\text{m}$ projected diameter and fibres were counted which were $> 5 \mu\text{m}$ in length and with a length to breadth ratio equal or greater than 3 : 1.

This method was also used to evaluate the membrane filter deposits obtained with the gravimetric sampler since there was insufficient dust for weighing. The S.T.P. samples were counted directly with the interference microscope. Dust deposits were not discernible on the L.R.T.P. samples. The low sampling rate and relatively large area of deposit of this instrument are unsuitable for short duration and for low dust level operations.

The dust concentrations measured with the various instruments are given in Table 2. In the case of the Konimeter samples, which were counted with the built-in light microscope system, it was not possible to distinguish any fibrous particles from the other particulate matter present. Accordingly, only total dust concentrations are reported. In principle, the fibre concentrations could be estimated from the latter if the proportion of fibres in the dust is known. The fibre concentrations have been expressed as a percentage of total dust in Table 2 for this purpose. These show appreciable variation according to the instrument used and site sampled so that conversion of the Konimeter results cannot be performed with confidence. Nevertheless, it is evident that the Konimeter gives crude agreement with the other measurements at Site 2 but considerably exceeds them at Site 1.

With the exception of the Konimeter samples, the experimental results show that the asbestos concentrations were within the

recommended limit of 2 fibres per cm^3 during wet stripping at Site 1 and also at the barrier position (Site 3) during both stripping operations. Dry stripping, on the other hand, produced excessive concentrations of fibres within the enclosed area and respirator protection is clearly essential for workmen employed in this operation. The short period sample F/3 suggests that the hazard in this area diminished rapidly after work ceased.

The samples taken during sweeping up illustrate the marked spatial variation that can occur, especially in virtually still air conditions, and point to the need for the use of personal samplers for accurate assessment of the hazard. In this case, the S.T.P. sample was taken at a fixed position near the work while the membrane filter sample covered the general environment of the workman.

Insufficient information is available from this trial to permit a rigorous comparison of the various instruments. The S.T.P. results agree reasonably well with the corresponding simultaneous membrane filter measurements. Within the limitations of the trial, the membrane filter instrument proved to be the most suitable for routine measurements. Relatively lower respirable concentrations were obtained with the gravimetric sampler (D), this being most marked at Site 2 during dusty work and least evident at the barrier position. The performance of the size selector in fibrous dusts has not previously been studied and these results point to the need for further work before using instruments of this type for routine measurements of asbestos.

5. CONCLUSIONS

- (i) The membrane filter instrument, preferably used as a personal sampler, would be a suitable control instrument; with the S.T.P. as a possible alternative.
- (ii) Asbestos dust concentrations were within the proposed limits (< 2 fibres/ cm^3) during wet stripping but considerably in excess of the limit during dry stripping.
- (iii) Asbestos dust concentrations were within the proposed limit at the barrier position during both wet and dry stripping.

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June 1969. 8p. [The Measurement of Airborne Asbestos Dust
by the Membrane Filter Method].

TABLE 1
CHARACTERISTICS OF INSTRUMENTS USED

	Instruments	Category	Manufacturer	Flow Rate	Method of Sample Collection/Evaluation	Remarks
A	Membrane Filter (Portable battery driven pump)	Long Period --- Samples total dust	Institute Workshop	0 - 100 cm^3/min .	Membrane filter - microscopy (interference contrast)	Design based on B.O.H.S. recommendations using 1" Gelman filter holders (FVC) and Melinex washers
B	Membrane Filter (Austen Dymax EE.II pump)	Long Period --- Samples total dust	Institute Workshop	10 - 400 cm^3/min	Membrane filter - microscopy (interference contrast)	See 'A' above
C	Long Running Thermal Precipitator Type 112A	Long Period --- Samples Respirable dust	C.F. Casella & Co. Ltd.	$2\text{cm}^5/\text{min}$	Cover glass - microscopy (interference contrast)	
D	N.C.B./M.R.E. Gravimetric Dust Sampler Type 113A	Long Period --- Samples Respirable dust	C.F. Casella & Co. Ltd.	2.5 litre/min	Membrane filter - normally by weighing	The samples obtained were not heavy enough for weighing but were counted by interference microscopy
E	Standard Thermal Precipitator	Short Period --- Samples total dust	C.F. Casella & Co. Ltd.	$7\text{cm}^3/\text{min}$	Cover glass - microscopy (interference contrast)	
F	Membrane Filter (Dragger hand pump)	Short Period or Spot Sampler --- Samples total dust	Dragger-Norwalk Ltd. (adapted at Institute)	$100\text{cm}^3/\text{per stroke}$	Membrane filter - microscopy (interference contrast)	See 'A' above
G	Konimeter	Spot Sampler --- Samples total dust	W. Watson & Sons	$10\text{cm}^3/\text{per stroke}$	Glass slide coated with vaseline. - microscopy - (built-in)	

TABLE 2

RESULTS OF ASBESTOS AND TOTAL DUST MEASUREMENTS AT CLYDE'S MILL POWER STATION

Operation	Duration (mins.)	Site	Dust Concentrations measured by:- (*Total > 1µm/cm ³ ; fibres > 5µm/cm ³)									
			Membrane Filter		Gravimetric Sampler		S.T.P.		Membrane (Drüger Pump)		Kminicor	
			Sample No.	Fibres (Total)	Sample No.	Fibres (Total)	Sample No.	Fibres (Total)	Sample No.	Fibres (Total)	Sample No.	Fibres (Total)
Wet Stripping	33	On Catwalk Site 1	A/102	1.1 (19) * 5.8%	D/4	0.3 (5.4) * 8.8%	E/1	2.5 ^(a) (20) * 12.9%	F/1	0.8 (11.2) * 7.1%	G1 G2 G3 G4 G5	(70) (92) (31) (145) (176)
		At Barrier Position Site 3	B/101	0.2 (3.7) * 5.1%	D/3	0.1 (2.8) * 3.9%						
Dry Stripping	14	On Catwalk Site 2	A/103	66 (620) * 10.6%	D/5	11 (100) * 16.7%	E2	83 (697) * 11.9%	F/2 F/3	49 (315) * 15.6% 4.5 ^(b) (31) * 14.1%	G6 G7 G8 G9 G10 G11 G12 G13	(> 300) (240) (241) (240) (241) (240) (240) (240)
		At Barrier Position Site 3	B/104	0.3 (5.8) * 6.9%	D/6	0.3 (4.2) * 7.1%						
Sweeping up after stripping	30	On floor below Sites 1 & 2					D/3	11 ^(c) (54) * 20.1%	F/4	0.7 ^(d) (5.1) * 13.7%		

* The figures in brackets refer to total dust concentrations.

* Fibre concentrations expressed as a percentage of the total dust concentration.

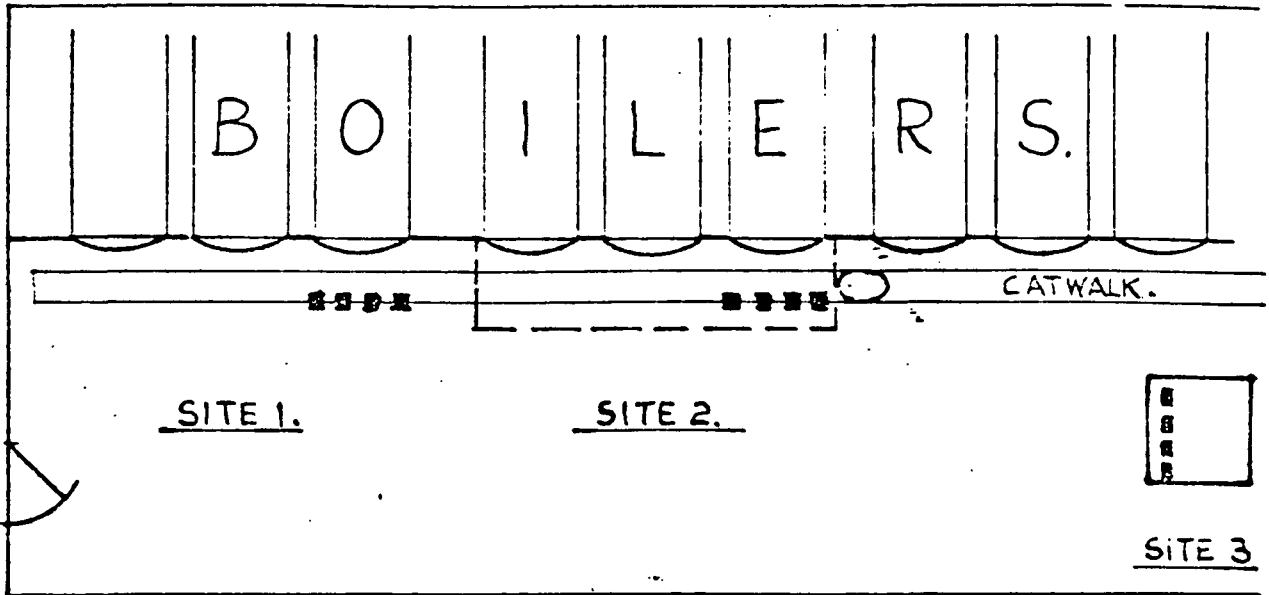
(a) Sparse deposit.

(b) Sampled 5-10 mins after the end of the stripping operation.

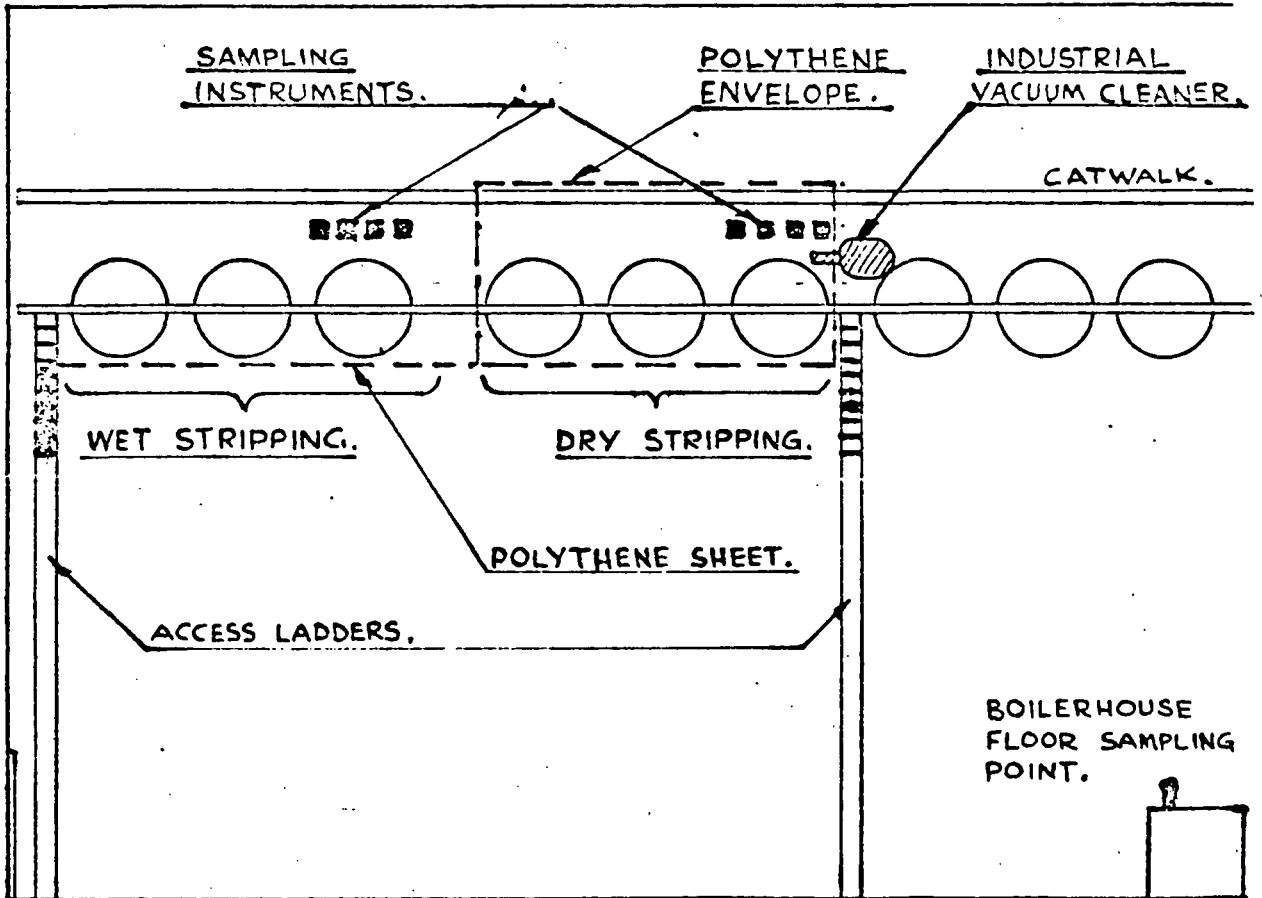
(c) Sampled at a fixed position near the operation.

(d) Sampled in the general environment near the workman.

FIGURE 1.



PLAN.



ELEVATION.

SITE OF SAMPLING DURING ASBESTOS STRIPPING
AT CLYDE'S MILL POWER STATION.

FIGURE 1.

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