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# MONITORING AN ASBESTOS SPRAY PROCESS

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**Abstract**—An assessment has been made of the hazard of the fibre clouds associated with an asbestos spray process which incorporated a pre-damping stage. Spraying produced only low concentrations of asbestos fibres, but the subsequent clean-up operations were inadequate. There were potential hazards for building operatives from debris and deposits left by the spray team.

## INTRODUCTION

THE HAZARDS associated with the inhalation of asbestos fibres include lung fibrosis and malignancy. Whilst there is evidence that the inhalation of a substantial amount of asbestos is required to produce significant fibrosis, carcinogenesis may require a very much smaller dosage (NEWHOUSE, 1973). Obviously those industries using the product in quantity, e.g. ship builders and insulation industries, will cause their workers to be exposed to a greater extent than other groups, but the increased number of cases of mesotheliomas now being reported indicate that workers in the building construction industry, plumbers and others apparently more trivially exposed, can be at risk. A specific potential hazard in the construction industry is the use of asbestos cement spray in the fire-proofing of structural steel. In the event of a serious fire the fire-proofing delays distortion of the steel structure for a sufficient length of time to allow evacuation of all personnel. Criticism of this process has been expressed because of the potential dust contamination of operatives, of other workers on the construction site and, if the process is carried out in the open, the liability to cause widespread dispersal of asbestos dust thereby adding to urban contamination. Very little information has been available on the dust clouds produced by asbestos cement spraying. Concentrations of up to 300 fibres/cm$^3$ when ships' bulkheads were being sprayed with crocidolite have been quoted (HARRIES, 1971) and concentrations of more than 1000 parts/cm$^3$ have been reported for other asbestos spray operations (MÜGLICH and SCHULZ, 1970).

The Asbestosis Research Council (A.R.C., 1972) has published a Guide to assist asbestos spray contractors to comply with the Asbestos Regulations (1969). It strongly recommends the incorporation in the spraying procedure of a pre-damping process, which the Department of Employment and Productivity (D.E.P., 1970) report to have dramatically reduced the concentration of fibres released into the atmosphere. An opportunity to collect relevant data presented itself when a maternity unit was to be constructed in the grounds of the City Hospital, Nottingham. The unit was to be built in the South West corner of the hospital grounds and since the prevailing wind is West/South Westerly the majority of potential dust "fall out" would be over the remainder of the grounds.

*City Hospital, Nottingham.

Asbestos spraying took place when there was only a small labour force on site and almost the entire shell of the building was complete (Fig. 1). Polythene sheets were put over those windows where the glass was not present if spraying was carried out in the vicinity.

## THE ASBESTOS CEMENT SPRAY PROCESS

A mixture of asbestos, cement and water is sprayed directly under pressure on the steel girders which form the structural frame of the building. The mixture adheres to the steel and sets, thus giving a fire-protective casing to the steel.

Amosite was used exclusively in this operation.

*Details of process*

1. The dry asbestos-cement mixture was brought in sealed paper bags with an inner plastic lining.
2. A bag was opened and a hod filled by hand. This measured quantity was put into a revolving drum which, after water had been added, was rotated for several minutes.
3. The dampened mix was then emptied into a second hod from which the spray machine was fed.
4. The spray mix was ejected under pressure from a hose nozzle directly on the structural steel work (Fig. 2).
5. Following the spraying, the adherent material had a shaggy surface. This was pressed flat with a wooden board to give a compressed, but rough finish.

Each spray team consisted of two men. Both were supplied with synthetic fibre overalls although it was noted that on some days ordinary cotton overalls were being worn. No special arrangements were made for changing out of the overalls into street clothing. Laundering of the overalls was arranged by the company. Baxter "Pneu-seal" respirators, which appeared to fit well to the face, were worn by both operatives. In addition to the spray machinery the team brought an industrial vacuum cleaner and polythene sheeting which was used as a screen round the spraying zone and also as a floor cover under the machinery and spraying platform. A portable water sprayer was used to wet any asbestos which fell on this sheeting before sweeping it up. This waste was placed in plastic bags which were subsequently removed from the site by the spray operatives.

## DUST CLOUD MEASUREMENTS

The objectives of the investigation were to measure the concentration of the asbestos fibre cloud at the point of application and to determine its change with distance.

All samples were obtained on membrane filters (Millipore type VC, 0·1 μm pore size). Casella personal samplers, sampling rate 150 ml/min., were used to obtain samples in the breathing zones of the asbestos spray operatives during the various stages of the process, and similar samplers were positioned at points distant from the sprayer. At sampling points outside the building, where the mains electric supply was easily available, a Dymax pump provided the suction (2 l./min.) through the membrane filter. Evaluation of the samples followed the recommended method of the Asbestosis Research Council (A.R.C., 1971), which entailed microscopic

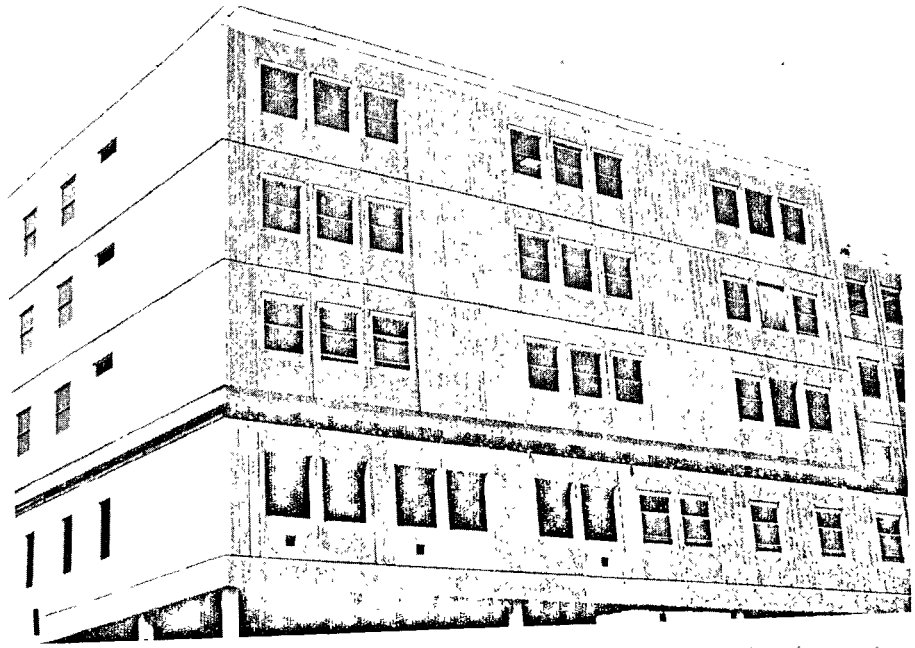




FIG. 1. Construction stage at which asbestos spraying took place.

FIG. 2. Asbestos spraying of steel framework.

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examination of the sample under phase contrast illumination and counting the number of fibres in the appropriate size range at magnification of ×450. Using the method described by LARNER (1964) a portion of each membrane filter sample was evaluated by electron microscopy.

The fibre preparation was a cyclic operation, each stage taking only a few minutes, and to obtain adequate samples, cumulative samples of each stage on a number of cycles were obtained. Samples near the spray operator were obtained only during the spraying period, the sampler was stopped during periods of smoothing and moving the spraying platform. At positions distant from the spray operator the samplers ran continuously for several hours and were stopped only during morning and lunch breaks. Samplers were placed 15 and 30 ft from the spray operator and since the concrete beam floors had a number of holes in them, samplers were also placed on the floors above and below adjacent to the spraying zone. To detect fibres which escaped from the building under construction, samplers were placed in elevated positions on buildings 60 and 500 yd away in the direction of the prevailing wind, or 60 yd away on the opposite side when the wind was in that direction.

## RESULTS

A sample of the amosite used was taken from the bag, and the length and diameter distributions of the fibres were determined by optical and electron microscopy to assess their potential hazard. The distributions, given in Tables 1 and 2, show that if

TABLE 1. AMOSITE FIBRE LENGTH DISTRIBUTION

| Length (μm) | Percent |
|---|---|
| 1 - 5 | 17 |
| 5 - 10 | 25 |
| 10 - 15 | 15 |
| 15 - 20 | 12 |
| 20 - 25 | 8 |
| 25 - 30 | 4 |
| 30 - 40 | 5.5 |
| 40 - 50 | 4.5 |
| 50 - 70 | 6 |
| 70 - 100 | 2.5 |
| > 100 | 0.5 |
| | 100.0 |

TABLE 2. AMOSITE FIBRE DIAMETER DISTRIBUTION

| Diameter (μm) | Percent |
|---|---|
| < 0.07 | 1.7 |
| 0.07 - 0.2 | 22.9 |
| 0.2 - 0.4 | 35.3 |
| 0.4 - 0.6 | 20.2 |
| 0.6 - 0.8 | 8.1 |
| 0.8 - 1.0 | 7.0 |
| 1.0 - 1.3 | 3.0 |
| 1.3 - 2.6 | 1.7 |
| 2.6 | 0.1 |
| | 100.0 |

well dispersed in the process the fibres would be highly respirable, as more than 99 per cent of the fibres had diameters less than 1 μm, and lengths less than 100 μm.

Samples were obtained on site on three separate occasions and in Table 3 the concentrations of fibres having lengths between 5 μm and 100 μm, as seen with phase contrast microscopy, are tabulated. All the fibres had diameters smaller than 1 μm.

The highest concentration was found, as expected, in the breathing zone of the spray operator emphasizing the importance of his wearing an adequate respirator (DEPARTMENT OF EMPLOYMENT, 1969). In the preparatory part of the process respiratory protection is also essential, particularly in the first stage when the amosite is

TABLE 3. AIRBORNE FIBRE CONCENTRATIONS; FIBRES, LENGTH 5–100μm

| Operation or Position | Fibres/cm³ | | | |
|---|---|---|---|---|
| | Day 1 | Day 2 | Day 3 | Mean |
| Transferring amosite from bag to hod* | 2.5 | 2.7 | 2.5 | 2.6 |
| Emptying hod into pre-damping drum* | 1.1 | 1.2 | 1.4 | 1.2 |
| Loading spray machine with damped fibre* | 0.8 | 0.7 | 0.8 | 0.8 |
| Spraying* | 4.5 | 8.5 | 7.5 | 7.0 |
| 15 ft from spraying | 0.02 | 0.03 | 0.03 | 0.03 |
| 30 ft from spraying | 0.01 | 0.01 | 0.01 | 0.01 |
| Floor above | 0.02 | 0.02 | 0.03 | 0.02 |
| Floor below | 0.01 | 0.01 | 0.01 | 0.01 |

*Breathing zone of operative.

being handled in a dry state. At points 15 and 30 ft away from the spray operator the concentration had fallen to a low level.

Fibres of length 5–100 μm are considered to be the most appropriate in assessing the risk of asbestosis, but the size of fibre involved in carcinogenesis is not yet known. The concentration of all fibres longer than 1 μm was determined and these are tabulated in Table 4. Extending the range increased the count only marginally.

TABLE 4. AIRBORNE FIBRE CONCENTRATIONS; FIBRES LONGER THAN 1 μm

| Operation or Position | Fibres/cm³ |
|---|---|
| | Mean |
| Transferring amosite from bag to hod | 3.0 |
| Emptying hod into pre-damping drum | 1.6 |
| Loading spray machine with damped fibre | 1.0 |
| Spraying* | 7.4 |
| 15 ft from spraying | 0.04 |
| 30 ft from spraying | 0.01 |
| Floor above | 0.03 |
| Floor below | 0.01 |

## DISTANT "FALL OUT"

A total of 19 samples were collected for periods between 4 and 24 hr at the points beyond the building construction site. All samples were thoroughly examined and only a single amosite fibre was observed.

## RESIDUAL DEBRIS

A few days after the spray team had left, a tour of inspection of the building was made and several disconcerting features were observed. Asbestos which had fallen on the floor during and subsequent to the spraying operation in a number of places had not been removed. Clumps of asbestos were observed on the floor. This material was being swept up, in a dry state, by a workman prior to a screed being laid. Samplers were not available on site at the time to measure the fibre concentration

but in a test sweeping made subsequently a cloud of over 2 fibres/cm³ was found in the breathing zone of the sweeper whilst clearing an area of just 4 yd². Elsewhere we have found that sweeping asbestos debris may generate clouds in excess of 20 fibres/cm³ in the breathing zone of the sweeper. The workman had no respiratory protection. Asbestos was also observed on piles of sawn timber and building implements and when these were moved a cloud of asbestos fibres would again be generated. In a number of places conduit work uncompleted before spraying commenced, which approached or ran alongside sprayed beams, had not been adequately cleared of the asbestos inadvertently sprayed on it. In addition to these hazards left by the spray operatives it was noted that where the coating on beams had been disturbed by fitters, for example, to bolt partition supports to them, the asbestos had been dropped to the floor to be subsequently swept up. Casual evidence that fibre had been drifting in the air was provided by small bolls of fine fibre on the surface of floors screeded after the spray team had left the site. After completion and handover of the building, several 24 hr samples were obtained in various parts of the building. No fibres were detected on any of these samples.

## DISCUSSION

The concentrations of the fibre clouds associated with the asbestos spray process incorporating the pre-damping feature have been found to be remarkably low compared to those previously reported. Whilst adequate respiratory protection was necessary for the spray operatives, the probability of a significant number of fibres reaching building operatives outside the spray area was minimal. It was observed that a small number of fibres did escape through interconnecting holes in the structure to the floors above and below the spraying zone. This could easily have been prevented by use of the polythene sheeting provided. The hazard associated with the operation lay in the inadequacy of the cleaning operation following the spraying of the steel structure, although the spray team was provided with the equipment to do this safely. There was a lack of appreciation of the need to remove and dispose of the asbestos as carefully and quickly as possible after the main spraying process was completed. Where asbestos had been removed for subsequent work, ragged edges had been left and the asbestos fragments had dropped on the floor, to be swept up later. Clearly, more adequate supervision at this stage is required if the subsequent exposure of unprotected building operatives is to be avoided.

It should be emphasized that many different tradesmen—joiners, partition fitters, electricians, etc.—and especially men engaged in sweeping up the dry concrete floor, would be unaware of the particular dust hazards. They were, in fact, more liable to respiratory exposure than the original spray team because they had no respiratory protection.

## SUMMARY

This report makes a specific assessment of the potential hazards in the use of sprayed asbestos cement.

The results show that during the time of the asbestos spray operation the technique used on this project generated cloud concentrations ranging from about 1 to 8 fibres/cm³ near the operatives, and proper respiratory protection was necessary.

There was no significant health hazard to other workmen on the building site provided they remained clear of the spraying area, and provided adequate screening of the spray area was carried out. No "fall out" of stray asbestos dust was observed outside the building construction area.

However, following the completion of the spraying operation the following inadequacies were noted :

1. All waste material had not been removed; asbestos cement was to be found on fittings and materials which would be handled later.
2. In subsequent operations requiring the removal of small areas of asbestos cement the waste material had been dropped on the floor.

Both of these factors caused dried asbestos cement fragments to be scattered around the construction site. The subsequent sweeping up of this dry material caused clouds of asbestos dust to be generated, resulting in a possible hazard to the health of personnel in the building during the next phase of building. More attention to cleaning up after the spraying operation is completed could greatly reduce this risk.

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