

THE ESTABLISHMENT OF A MEDICAL SURVEILLANCE PROGRAM IN AN ASBESTOS FACTORY

A COLLABORATIVE EFFORT BY MANAGEMENT,
COMPANY PHYSICIANS, CHEST PHYSICIANS AND RADIOLOGISTS

PLAINTIFF'S EXHIBIT

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ABSTRACT

The current Occupational Safety & Health Administration (OSHA) Standard for Exposure to Asbestos Dust was published in 1972. It requires medical examinations for preplacement purposes, annually thereafter and on work termination or retirement. Medical records must be maintained and kept by the employer for at least 20 years. Medical surveillance must be provided for all persons in an occupation exposed to airborne concentrations of asbestos fibers. The medical examination, as a minimum, has to include a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at one second (FEV_{1.0}). The format for the medical records is not stipulated, standardization of the techniques to be used in obtaining chest roentgenograms of performing tests of lung function is not required, and no guidance is given as to the methods to be used in the interpretation and reporting of results.

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The legal obligation to provide medical examinations and a need to update the medical services at a friction materials plant in Pennsylvania provided an ideal opportunity to attempt to correct some of the deficiencies in the medical examination requirements of the OSHA Standard for Exposure to Asbestos Dust.

This paper describes the implementation of a medical surveillance program which required the medical records to be redesigned, reporting procedures to be established for employers and employees, redefinition of the plant medical director's duties and the re-organization of the plant medical department. A standardized medical questionnaire has been introduced based upon the Medical Research Council's Respiratory Symptoms Questionnaire, the lung function equipment has been replaced by a new instrument and the nurses have been trained in their use.

Chest radiographs, taken by the nurses at the plant, are interpreted by a consultant who uses a reporting system specially devised for the plant which will be illustrated in this paper. Guidelines have been prepared for the use of the plant physician when reporting the results to employers and employees.

The annual physical examination is conducted by a chest physician (JDE or an associate) using a standardized form for recording the findings. At the time of the physical examination the completed questionnaire, lung function test results and x-ray findings are available (as well as the entire x-ray series) and the results of the preliminary examination by the nurses which includes blood pressure readings, urine analysis and haematocrit. Occupational histories form part of the medical record and we hope to enter the average annual exposure levels on the medical examination record.

The decision as to whether an employee is being adversely affected by his work environment is not an easy one to make, but hopefully, utilizing the approach outlined, we now have a better chance of arriving at an answer.

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Finally, we believe the OSHA requirements have been met and improved upon to the benefit of the employee, the employer and the physicians who have to attend to the needs of both of them.

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mentioned earlier (*Arch. Envir. Hlth.*, 1972, v. 24, 189). The subjects were divided into 6 groups on the basis of the dust index and smokers and non-smokers were grouped separately. Multiple linear regression coefficients for each dust exposure group, taking into account age, height and weight, were calculated and the average overall multiple linear regression for the whole sample was calculated by weighting the contribution from each group by the information contained in it. The resultant value was used to standardize the mean function test results for the different dust exposure groups to common dimensions. Group mean values so standardized were compared with those of the adjacent dust exposure group.

The results are presented in a series of tables which show that there is an increase in age and a decline in weight with increasing dust index. The lower two dust exposure groups could be distinguished by several of the lung function tests. Thus inspiratory capacity, forced vital capacity and forced expiratory volume in 0.75 second and in 1 second were all affected, although in smokers they were somewhat less sensitive as tests. However, it is interesting to note that non-smokers with low dust exposure had the best lung function of any group. Any of the tests mentioned seemed to be suitable for health surveillance of asbestos-exposed workers, whatever their smoking habits.

G. F. Keatinge

3252. PILAT, L., RAFAILA, E., CRACIUN, O., TECULESCU, D., GEORGESCU, A. M., & APOSTOLESU, R. Contribution à l'étude des corrélations entre les aspects radiologiques, cliniques et fonctionnels respiratoires de l'asbestose. [A contribution to the study of the correlation between radiological, clinical and respiratory function aspects in asbestosis.] *Medica Lav.*, 1972, v. 62, No. 11, 495-504. English summary (9 lines). 1

The 79 subjects studied in this investigation were employed in a factory producing various kinds of asbestos appliances, including brake linings and jointings and filters for the chemical industry. The manufacturing processes gave rise to much dust up to 3 years ago, when measures to control it greatly reduced the dust concentrations. However, the authors do not quote figures because they were not satisfied that the techniques used for the estimations were adequate for the purpose.

The investigation reported therefore is limited to physical examination of the workers, which included radiography of the chest and a comprehensive series of lung function tests as well as a clinical examination

and a careful anamnesis. Asbestosis was classified into 3 stages—minimal, moderately advanced and fairly well advanced—based on the radiological appearances.

The results are presented in a series of tables. In 1965-66, as a result of radiography of the chest, 30 patients were recognized as suffering from asbestosis. 18 of these were subjected to further radiography of the chest in 1969 and showed evidence of progression. Pleural calcification, which was rather extensive, was seen in 1 patient who had an exposure period of 39 years. Dyspnoea on effort and productive cough were present in more than half the workers examined and as the radiological category increased, shortness of breath and cough were more noticeable. An obstructive ventilatory defect was closely related to radiological progression and to deterioration in respiratory symptoms. A genuine alteration in pulmonary diffusion, far from making an early and constant appearance in asbestosis as is commonly believed, in fact rarely occurs. Smoking did not seem to have a significant effect on the results of the lung function tests. Clinical signs were few and clubbing of the fingers was noted in only 2 patients and basal crepitations were heard in 1 single subject.

G. F. Keatinge

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3253. LEWINSOHN, H. C. The medical surveillance of asbestos workers. *R. Soc. Hlth J.*, 1972, v. 92, No. 2, 69-71.

The author reviews the historical background to the present knowledge of asbestos-related disease and the development of current legislation. He describes the methods of medical surveillance in his own factory, the Rochdale factory of Turner Brothers Asbestos Company. Here there are over 900 employees working in asbestos-scheduled areas and a further 374 maintenance, quality control and laboratory workers who are also exposed to asbestos. Medical arrangements for their protection start with an induction course and a training scheme for safe methods of working and the issue of a booklet outlining the need for the Asbestos Regulations and giving details of the diseases associated with exposure. Preemployment screening is used to identify employees unsuitable for work with asbestos. Periodic medical examinations are undertaken by the Pneumoconiosis Panel, alternating with those of the Factory Medical Officer. Annual examinations are recommended for workers exposed for 20 years or longer. The chest is examined by X-ray within 3 months of starting work and there-

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after annually. The FEV1 is part of the initial medical examination, and a full battery of pulmonary function tests including estimation of the gas transfer factor is undertaken at 6 months, 3, 5 and 19 years and thereafter annually. The most striking finding is that after 20 years exposure more than half of the workers have abnormal radiographs, including evidence of pleural thickening, and more than 30% have radiological evidence of pleural fibrosis. The transfer factor is also reduced in a high proportion of workers, but this is also found in non-exposed new starters.

The author emphasizes the importance of enlightened management, an educated labour force and sound industrial hygiene methods for the successful medical surveillance of asbestos factory workers.

This is a description of a most comprehensive scheme of medical surveillance which must be commended. It is a sobering thought that the survey by MEREWETHER and PRICE in 1930 (*Bull. Hyg.*, 1930, v. 5, 562) showed evidence of pulmonary fibrosis among 30% of asbestos workers, and though the criteria for the diagnosis of this condition have changed, X-ray evidence of fibrosis is still present in 30% of workers in 1970. *M. L. Newhouse*

- 3254 BOTHAM, S. K. & HOLT, P. F. Development of asbestos bodies on amosite, chrysotile and crocidolite fibres in guinea-pig lungs. *J. Path.*, 1971, v. 105, No. 3, 159-67.

Guineapigs were exposed to chrysotile, crocidolite and amosite asbestos for a short period at the beginning of each experiment so that on death the length of time which the fibres had been in the lung was accurately known. Anthophyllite asbestos had been studied in previous experiments [*Abstr. Hyg.*, 1969, v. 44, abstr. 621].

On inhalation of all types of asbestos the fibres were distributed throughout the lungs. Some fibres of all types were ingested by macrophages and Perl-positive material derived from red cells was deposited on them, but some intracellular fibres remained uncoated during the year after dusting. After a further 6 months uncoated chrysotile fibres were not found, but a few anthophyllite and rather more crocidolite fibres remained uncoated while uncoated amosite fibres were common.

The morphological development of asbestos-body coating followed the following sequence: smooth, corrugated, partially beaded and fully beaded. The development and fragmentation of a chrysotile

asbestos body were faster than with the other types of asbestos. *Muriel L. Newhouse*

- 3255 SMITH, B. A. & DAVIS, J. M. G. The association of phagocytosed asbestos dust with lysosomal enzymes. *J. Path.*, 1971, v. 105, No. 3, 153-7.

Granulomas were produced by the intrapleural injection of chrysotile asbestos dust (25 mg) into the right lower thoracic cavity of guineapigs. Animals were killed at 2 and 4 weeks after injection. Pieces of the granulomas were fixed and sectioned for electron microscopic examination, histochemical methods being used to stain for acid phosphatase. The Gomori technique reveals the presence of acid phosphatase as deposits of lead phosphate.

Acid phosphatase was demonstrated only in the lysosome series of organelles but not all of these structures gave a positive reaction. Usually less than 50% of the lysosomes in the macrophages and giant cells gave a positive reaction and often fewer than 10% of the phagocytosed dust particles were in structures that gave a positive reaction. The few fibroblasts in the granulomas usually contained a small amount of chrysotile dust and then both primary lysosomes and dust-containing phagosomes usually contained acid phosphatase. There was no satisfactory evidence for the rupture of phagosomes and subsequent liberation of the lysosomal enzymes into the cell cytoplasm. *P. F. Holt*

- 3256 MINISTRY OF AGRICULTURE, FISHERIES AND FOOD. Working Party on the Monitoring of Foodstuffs for Heavy Metals. Second Report. Survey of lead in food. 31 pp. 1972. London: H.M. Stationery Office. [21p]

- 3257 VASKOV, L., BATOLSKA, A. & DITCHEVA, T. Néphrographie radio-isotopique chez des travailleurs exposés à un risque d'intoxication professionnelle par métaux lourds. [Radio-isotopic nephrography in workers at risk of occupational poisoning by heavy metals.] *Arch. Mal. Prof. Méd. Trav.*, 1972, v. 33, No. 3, 107-12. English summary.

The authors present the results of a study of 58 workers at the occupational diseases institute in Sofia in which they considered the possibilities afforded by a radioisotope technique of demonstrating if or how renal function was affected by work with heavy metals. The method (to which references in the literature are given) of registering tracings of radio-nephrograms after the intravenous injection of sodium

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Lewinsohn, 1967

ASBESTOS - A REVIEW OF HEALTH SAFEGUARDS. by H.C. Lewinsohn.

Talk to the Institution of Industrial Safety Officers on 12.9.67

It has been stated that Asbestos has been in use for at least 2,500 years. It was said to have been woven into the wicks of the 'perpetual lamps' of the Vestal Virgins, and the linen vivum used by the ancient Romans for cremation cloths was made of asbestos. Marco Polo came upon asbestos mines which were probably those known to have been operating in the Russia of Peter the Great, and in the 15th century there was an account of asbestos being used during the siege of Rouen in 1420.

Until the end of the 17th century asbestos was mainly an object of superstition and curiosity. In the mid-nineteenth century, with the discovery of serpentine asbestos (or chrysotile) in Canada, the emphasis was placed on conservation of heat by lagging rather than resistance to fire.

All known deposits of the mineral were of the chrysotile variety until a German geologist named Lichtenstein discovered a mass of heavy asbestos of lavender blue colour near Frieska in the North-West Cape Province of South Africa; this is the famous Cape blue variety, which was first exploited in 1891. South Africa is the main source of blue asbestos (crocidolite), although deposits also exist in Australia, and elsewhere, and have recently been reported in the iron formations of the 'Labrador troughs' of Canada.

Amosite, a fawn coloured asbestos, was subsequently discovered in the Transvaal, and these deposits are thought to be unique in the World.

Anthophyllite, a magnesium silicate which differs from chrysotile in being less soluble, is of less commercial interest than the other three types, but of considerable medical interest. It is mined principally in Finland and Italy.

Table 1. in Gileon's Wyers Memorial Lecture (1965) summarises quite adequately the statistics relating to world production of the various types of asbestos and their composition.

The dangers of asbestos to man have been in the news - both in the medical journals and in the lay press. A brief review of the present situation in the light of this interest would not be untimely now.

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In 1930 Merewether and Price published their "Report on Effects of Asbestos Dust on the lungs and Dust Suppression in the Asbestos Industry" at the instigation of the Factory Department of the Home Office. The first case recorded "about whom there was expert opinion that the inhalation of asbestos dust had at least contributed to, if not caused, the fatal outcome" occurred in 1900 and is now referred to as the "Montague Murray case". Dr. Montague Murray gave evidence in 1906 before the Departmental Committee on Compensation for Industrial Disease. In this case post-mortem examinations confirmed the clinical diagnosis of extensive non-tubercular pulmonary fibrosis. The second (Cooke's case) occurred in 1924. Here there was a contribution of "a progressive dust fibrosis together with a chronic tuberculous infection". Following the discovery in February 1928 of a "case of non-tubercular fibrosis of the lungs in an asbestos worker, of sufficient severity to necessitate treatment in hospital (Seiler's case)" an inquiry was commenced by Merewether and Price. In their words "When, therefore, investigation of Seiler's case showed that other industrial and infective causes of fibrosis could be definitely excluded, the necessity of deciding whether the supervention of this disease in an asbestos worker was an exceptional occurrence, or evidence of a grave health risk in the industry", was apparent and the investigation referred to was undertaken.

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Merewether and Price examined 363 asbestos workers. They limited their investigations to those processes in which there was exposure to pure asbestos or asbestos mixed with a very small percentage of cotton or other vegetable fibre. Processes involving an exposure to mixed dusts including asbestos were not investigated, since it was felt that it was not possible "to evaluate the effect on the lungs of mixed dust, of which asbestos dust is only one component, until the action of asbestos dust itself was determined." The workers examined were from the textile branch of the industry, manufacturing insulating materials from practically pure asbestos.

This inquiry led to the conclusion that "the inhalation of asbestos dust over a period of years results in the development of a serious type of fibrosis of the lungs". They found that 95 of the 363 workers (26.2%) showed a definite fibrosis due to asbestos dust. Of the 133 who were X-rayed 62 presented radiological signs of a diffuse fibrosis and in a further 25 there were suggestive radiological changes not definitely diffuse fibrosis. Merewether found that one in four of the sample of 363 workers examined had evidence of pulmonary fibrosis attributable to asbestos dust and he calculated that on the sample, one in eight of all workers in the industry would be found to have evidence of fibrosis. The findings with regard to the incidence of fibrosis in relation to length of employment were most significant and the results are given. Here it is demonstrated that length of employment and not age was the major factor in the production of fibrosis. The report contained 12 recommendations listed as follows :

1. Application of efficient localised exhaust ventilation and dust producing points.
2. Substitution of enclosed mechanical methods for hand conveyance, and for dust hand work generally.
3. Effective enclosure of dust producing machines and plant.
4. Substitution of wet methods for dry.
5. Elimination of certain dust producing appliances.
6. Abandonment of settling chambers in manufacturing processes to the utmost extent.
7. Effectual separation of processes to prevent unnecessary exposure to dust.
8. Wide spacing of dust producing machines in new factories and as far as practicable in existing works.
9. Use of sacks of loose texture material for internal work.
10. Efficient cleaning system with wide use of vacuum methods.
11. Storage of asbestos and other goods to be outside workrooms.
12. Exclusion of young persons from specially dusty work.

Legislation followed in 1931 and regulations were made for the control of the hazard during manufacturing processes which were embodied in the Statutory Rules and Orders, 1931, No. 1140. The parts of factories to which the Asbestos Industry Regulations 1921 (S.R. and O. 1931 No. 1140) apply were scheduled in the official document and are now generally termed 'scheduled areas'. They comprise areas for the operations of crushing and opening, textile processes, insulation fabrication, mattress making or repairing and all sawing and grinding. In addition cleaning of chambers or appliances for asbestos dust collection were included. Under section 79 of the Factory and Workshops Act 1901 the Secretary of State issued a certificate to the effect that "the manipulation of asbestos and the manufacture and repair of articles composed wholly or partly of asbestos and processes incidental thereto are dangerous". The section in the Workmen's Compensation Act of 1925, which provided for the application of that Act to workmen suffering from silicosis, was extended to certain processes involving exposure to asbestos dust, and in 1931 "Asbestosis" became a compensatable disease. For the better care of the workers in 'Scheduled Areas' they were subject to initial and periodic examination, annual at first, by Medical Panels employed by the Home Office. Workers found to be suffering from asbestos fibrosis were suspended from further work in the industry and compensation payments were made to those found suffering from the disease. There was no appeal (on the question of diagnosis) from the decision of the Medical Examining Board. Coroners in Great Britain were instructed to enquire

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into the deaths of asbestos workers in cases where they had been suspended from work on account of pulmonary disability or when their length of service rendered it likely that their occupation was a contributory cause of death. In all suspended cases, and in most of the others, necropsies were performed and pathological material was thus provided for study.

In 1935, Lynch and Smith in the United States, suggested that patients with asbestosis might be exposed to an increased risk of lung cancer; and by 1955 Doll in this Country had demonstrated a tenfold excess of lung cancer in a group of asbestos textile workers (T.B.A. Rochdale) with 20 years exposure or more. In this factory chrysotile was predominately used, but some exposure to crocidolite may also have occurred. In a subsequent report in 1964, Knox, Doll and Hill presenting a follow-up of this same population and those entering the same factory after 1933 when the Regulations came into effect, now show that the vigorous action taken then, and later, to reduce dust levels, has been largely successful in eliminating the hazard, though a further period of observation is necessary before complete success can be claimed.

The Annual Report of H.M. Chief Inspector of Factories on Industrial Health 1966 brings up to date the evidence (obtained from death certificates recording asbestosis) of the association of pulmonary tumours with asbestosis. The 1964 report notes, that "It is possible however that the percentage of death certificates recording lung cancer is exaggerated by the current acceptance of an association even where the asbestosis present is minimal. A former asbestos worker dying from lung cancer may have asbestosis diagnosed for the first time at autopsy".

The current interest in asbestos stems from the growing evidence of an association between asbestos exposure and the occurrence of the relatively rare tumour known as mesothelioma, which may occur in either pleura or peritoneum. Doll in his Rock Carling Fellowship (1967) monograph on "Prevention of Cancer" notes that, "This condition is normally so rare that even a small absolute risk can be rapidly detected once it has been envisaged". Approximately 300 cases have now been described, the great majority in South Africa and the United Kingdom. In some cases, both in South Africa and Britain this exposure has been environmental and not occupational and asbestosis has seldom been present. The answer is not clear as to why it occurs in people who might have had only slight exposure many years before. Some cases may have occurred and not been recognised; but the more important reason would appear to be the long induction period of approximately forty years that characterizes the condition. Few of those who were heavily exposed prior to the introduction of preventive measures can have survived long enough to develop it.

Certain authorities, mainly in the United States of America, related mesothelioma to chrysotile exposure alone, but it is now believed by most reliable investigators that a pure exposure cannot be proven and many of the cases of alleged pure chrysotile exposure had in fact been exposed to mixed asbestos varieties including crocidolite. In South Africa the experience of Wagner has been that large numbers of cases have been described only in relation to blue asbestos. In the N.W. Cape Province, 110 cases have been described from the crocidolite area, none in the amosite mining area of the Transvaal and none in the chrysotile mining areas in Swaziland. Whether lung cancer is also produced more easily by crocidolite remains to be shown. The difficulty in this case is that the risk of lung cancer has been demonstrated in relation to the use of asbestos and not to its mining, and asbestos workers have seldom been exposed to one type of asbestos alone. It is clear however from British experience, that a high risk of lung cancer can occur when the asbestos used has been almost wholly chrysotile. (Doll 1955).

In order to assess the risk of mesothelioma, epidemiological studies will have to be undertaken to investigate populations, either industrial or residential, exposed only to one type of fibre. Such exposures are almost entirely limited to those engaged in mining and milling of fibre, which is done in the countries where the different types of asbestos are found. The International Union Against Cancer (U.I.C.C.) has given an important lead in this work with its report of an international working party, and the

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Union has set up an international committee to help implement the recommendations of the working party, and to bring together workers in many countries at the planning stage of their research.

What are the measures which the industry adopt to improve conditions, and why, in spite of these measures, has the incidence of asbestosis increased steadily rather than declined? If lung cancer is a risk can this be controlled by the measures adopted? Is the incidence of mesothelioma controllable as well?

The industry has unfortunately not been covered as a whole by the Asbestos Industry Regulations. Merewether & Price did not cast their net widely enough, and it was not really appreciated until recently that users of asbestos products were as much at risk as asbestos workers themselves of the safety precautions recommended by the Asbestos Industry Regulations and the Codes of Practice prepared by the Asbestos Industry were not adhered to. The insulation industry which is concerned with lagging, with asbestos cement products, with asbestos spraying and the use of numerous products incorporating asbestos is not governed by the 1931 Regulations. No regulations have yet been introduced for the handling of asbestos products for thermal insulation, although it is accepted that to eliminate the risk of asbestosis all practical steps should be taken to minimise the inhalation of asbestos dust. The Asbestosis Research Council has produced Codes of Practice for working various types of asbestos products used in thermal insulation (e.g. loose lagging, pre-formed materials and sprayed insulation), for stripping materials containing asbestos, the use and care of respirators and the medical supervision of workers. Another code covers the handling, working and fixing of asbestos and asbestos-cement products in the building and construction industries.

Since it has been suggested that mesothelioma can be caused in certain cases by quite limited exposure to asbestos (possibly even non-occupational) and there is evidence that the main risk is associated with blue asbestos (crocidolite) it is important to take all possible precautions to reduce this risk. Of the three main types of asbestos imported into Britain last year, 83% was white asbestos (chrysotile), 14% was amosite and 2% was blue asbestos (crocidolite). Blue asbestos is mainly used because of its acid properties and is not used any longer in asbestos cement products or sprayed asbestos insulation work.

The safety of the worker can be best provided for if the procedures in the A.R.C. Codes of Practice are adopted when ever asbestos products are used.

The employer may do all in his power to ensure the workers safety, but the ultimate success of the effort depends upon the attitude of the man at risk and his willingness to work within the safety regulations. It therefore falls upon the employer to monitor the working environment, to rectify dust producing processes and to provide the most modern and up-to-date methods for dealing rapidly with dangerously high dust counts should they arise. There is as yet no universally accepted maximal allowable concentration of asbestos dust, and engineers, doctors and research workers are striving to determine from the incomplete information available what level of dustiness can be considered safe. The only information they have had to rely upon in this country is what has been provided to the British Occupational Hygiene Society by a large asbestos textile factory where the relating of dust concentrations to morbidity has shown that in certain areas with counts below a certain level the incidence of asbestosis diagnosed clinically with the stethoscope has steadily decreased as dust counts improved. It is hoped that a recommendation by the B.O.H.S. based on these findings will shortly be published and that this will become the M.A.C. The present MAC which is given as 5 million particles per cubic foot or 187 particles per c.c. is based on American findings using the Greenburg-Smith impinger tests which are not standard practice in Britain.

It is not my intention to discuss dust counting methods or instruments except in the simplest terms as I am not an authority on these matters. Addingley (1966) and Holmes (1965) have described in their respective publications

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just these details. Most of the standard types of instrument have been used with asbestos and are listed below :

1. Owens jet counter - This is of value in taking snap samples. Insufficient.
2. Konimeter - Designed for snap sampling.
3. Thermal precipitator - efficiency falls off for long asbestos particles.
4. Greenburg-Smith impinger - provides only a "poor" indication of exposure.
5. Membrane filter methods.
6. Gravimetric methods.
7. Tyndallometric methods.

In the factories I work in, the membrane filter method and a tyndallometric method using the Royco photo-electric particle counter are used together. The Royco instrument enables much more efficient routine testing to be carried out than has been possible previously. The membrane filter provides a valuable check and is also useful for mixed dusts. The limitations of the Royco are that it counts all particles which pass through it, provided they are big enough to give a signal. In the range from 10 upwards any error due to normal atmospheric pollution is important, and in the 40 upwards size range is negligible. The Royco is therefore suitable for dust tests in any ordinary asbestos textile operation. In some operations, however, such as automobile brake lining manufacture other organic and mineral dusts are present along with asbestos, and under such circumstances the Royco will record the total dust count only, and other methods must be used to estimate the asbestos.

Merewether said : "While it seems necessary for the production of generalized fibrosis of the lungs that a definite minimal quantity of dust must be inhaled, the lower the concentration of dust in the air breathed, the larger the lapse of time before fibrosis is fully developed, and within a certain limit the higher the concentration of dust, the sooner the fibrosis becomes fully developed and the more intense the involvement of the lung tissue. If this hypothesis is correct, and the evidence points to it, the practical inferences are of very great importance, since it follows that the application of measures resulting in the reduction of the concentration of dust in the air in neighbourhood of dusty processes will cause, firstly, a great increase in the length of time before workers develop a disabling fibrosis, and secondly the almost total disappearance of the disease, as the measures for the suppression of dust are perfected". Nearly 40 years later these words need careful consideration once again in the light of the increased incidence of asbestosis and its complications in workers not protected by the 1931 Regulations. New Asbestos Regulations are being formulated at this very moment and the advice of the Factory Inspectorate, the various interested medical bodies, the industry as a whole and the trade unions has been sought to aid in their preparation. It is hoped that the new Regulations will include not only controls to be instituted by manufacturers of asbestos products, but also safeguards for users. The 1931 regulations do not take into account the different varieties of asbestiform materials and the evidence to suggest different biological effects for each. The Regulations do not suggest a maximum allowable concentration for asbestos dust in the working environment and make no mention of medical arrangements for selection and follow-up of scheduled workers. If in 40 years time we are going to have to admit once again a lack of comprehensive control, then these deficiencies will have to be corrected in any new regulations.

The New Draft Regulations lay much stress upon the use of respirators for various purposes. Merewether stated that respirators provide only partial protection and "there is a real danger that the use of them may give a sense of false security". Respirators cannot be said to be valueless but can only be regarded as a second line of defence and an admission of defeat of dust control precautions. Under very exceptional circumstances there may be scope for the use of the efficient type of breathing apparatus comprising a mask or helmet with a fresh air supply. The air supply may be by air line from a compressed air source providing filtered air or it may be from the environment passed to a face mask by means of a powerful fan and under positive pressure, thus enabling the mask fitting to be looser because

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leakage does not matter. The power pack can be worn on the workers back and does away with the need for fresh air hoses which in themselves constitute a danger on building sites etc. The Manufacturers concerned are at present developing a Positive Pressure Fresh Air Respirator and this has been welcomed by the Factory Department, the workers and the industry.

The Asbestosis Research Council has issued brief recommendations on the "Use and Care of Respirators".

- Respirators should be worn by all employees at all times when :
1. Spraying asbestos and feeding hoppers on sprayed asbestos work. Respirators should be worn by both operator and attendant during the full period that work is being carried out and by any employee remaining in the dusty atmosphere for a limited period after spraying operations have terminated.
 2. Carrying out the following operations which, wherever possible, should be carried out in open spaces where there is a free circulation of air :-
 - a) The dry mixing of any material containing asbestos (this operation must be carried out in segregated areas if possible)
 - b) The mixing of compositions and self-setting cements which have an asbestos content.
 - c) The cleaning and emptying of sacks or other containers which contain asbestos or an admixture of asbestos.Where the above operations are being carried out in confined spaces adequate arrangements must be made for ventilation.
 3. Carrying out the following operations :-
 - a) The cutting of all insulation materials containing asbestos or an admixture of asbestos by hand in confined spaces.
 - b) The cutting of materials containing asbestos or an admixture of asbestos by portable or other power-driven saws or similar tools.
 - c) The breaking down for removal of lagging containing asbestos or an admixture of asbestos.

The approved respirator should be carefully maintained, and adequate servicing arrangements should be made to ensure that this is done and that employees are not without respirators during maintenance.

The Medical Supervision of workers in scheduled areas is at present the prerogative of the Pneumoconiosis Medical Panels of the Ministry of Social Security under the Silicosis and Asbestosis (Medical Arrangements) Scheme 1931. There is little doubt that this scheme has failed to use the results of the medical examinations system and dust assessments from industrial processes to keep a watch on the asbestos industry as a whole. In his Wyens Memorial Lecture Dr. J.C. Gilson asks for a properly integrated scheme in which information about groups of individuals and their dust exposure is analysed to provide a continuing check on changing conditions in the industry.

The Asbestosis Research Council recommend the following scheme for the Medical Supervision of Workers :

1. All employees should be examined clinically and radiologically before employment or as soon as possible afterwards, certainly within three months to avoid the employment of who may be particularly susceptible to the hazard.
2. Periodic examination should be made thereafter, annually if possible
3. Notes on the Medical examination of Workers in the Asbestos Industry are available as a guide to doctors concerned.
4. New employees should be advised of the precautions necessary in the industry.
5. A system of recording the employment history of workers entering the Thermal Insulation Industry or who have been employed in the insulation contracting industry would be beneficial.
6. To the above I would add a sixth recommendation :
Examination of any personnel whose regular duties bring them in daily contact with asbestos workers handling asbestos materials e.g. joiners working in the proximity of sprayers, electricians working where ladders are using asbestos, etc. etc. These "non-asbestos workers" should observe all the precautions recommended for scheduled workers.

The diagnosis of asbestosis is at present made by the P.M.P. who have the power to suspend a man from his job. The early diagnosis of asbestosis is more frequently made by the industrial medical officer. The P.M.P. only see worker

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every 2 years and their periodic medical examinations do not include routine X-rays or lung function tests. There is good evidence to suggest that asbestos induced changes in X-rays and lung function tests may precede other diagnostic criteria and it is for this reason that efforts are being concentrated upon these two fields to enable standards for early diagnosis to be established on an international level. Hunt of Clackheaton believes that asbestos workers with lung function deterioration detected at an early stage should be immediately removed from exposure. He believes that the course of the disease in man may be arrested, even regress slightly, and certainly progress much more slowly.

Many questions remain to be answered and much more effort will be required on the part of all concerned to make it as safe to work with asbestos as it is to work with radio-active materials. Engineers have a great part to play in designing plant which does not permit the escape of asbestos dust into the working environment or into the general atmosphere. Epidemiologists and statisticians have yet to determine the threshold limit value for asbestos. Medicine has to fathom the cellular and intra-cellular reactions to asbestos and to determine what controls the processes of fibrosis, malignancy, and immunity. There is certainly an immunological factor as many workers never contract the disease whilst others do so readily.

Last but not least it is to the Safety Officers and Industrial Hygienists that the task of supervising the processes and enforcing safety regulations falls.

"Hercules himself must yield to odds :
And many strokes, though with a little axe,
Hews down and falls the hardest timber'd oak.

King Henry VI. part. 3. Act. 2, Sc. 1.
William Shakespeare.

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