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PRACTICAL METHODS FOR PROTECTION OF MEN WORKING WITH ASBESTOS MATERIALS IN SHIPYARDS

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Abstract

The Asbestosis Research Council was set up by leading asbestos companies in the United Kingdom in 1957 to carry out and sponsor research into the nature, cause and prevention of disease related to the inhalation of asbestos dust. In addition to its medical and scientific research projects, it has established an Environmental Control Committee to investigate and develop methods of practical control and safety in all those situations where materials containing asbestos could be used in a manner likely to produce potentially harmful quantities of dust. A report is given of the results of a particular study made of those situations where special difficulties occur through the space limitations of the working area. The aim of the study was to identify the type of product and the work patterns and situations where these difficulties mainly occurred, to collect information as to practical methods of control which have been devised, and to check on the effectiveness of such methods in reducing the exposure of operatives to acceptable standards.

Introduction

The Asbestosis Research Council was formed in 1957 by the three major asbestos companies in the United Kingdom as a co-operative research organisation to prosecute a programme of research into the causation and prevention of asbestosis.

Chairman, Environmental Control Committee, Asbestosis Research Council, United Kingdom.

The Environmental Control Committee of the ARC, through its various Working Groups, attempts to establish and recommend safe working methods appropriate to different types of materials and different areas of use. In the case of ship construction, the circumstances are highly specialised and in some respects exceptional. There is evidence that the incidence of asbestos-related disease among ship workers is higher than in most other areas of use.

We have tried in the first instance to identify the environmental conditions which have given rise to this situation in the United Kingdom. We have then sought out the practical experience of users in this industry in the development of methods of working which have effectively reduced the level of exposure, and we have considered to what extent experience in the asbestos industry itself and of users of asbestos products in other sectors may be applied to the benefit of workers in ship construction and repair. It is hoped in due course to assemble information about these practices in the form of one of the ARC's series of Control and Safety Guides.

Special environmental conditions

Cases of disease reported so far are likely to have had their origin in operating conditions before the early 1950s, and, in the case of mesotheliomas, in even earlier periods - perhaps 40 years ago. It is necessary, therefore, to consider the kind of materials which were being used during those years and the way in which work was carried out.

In early years these materials were, particularly for naval vessels, mainly mattresses made of crocidolite (blue) asbestos cloth filled with crocidolite fibre. Pre-formed sectional insulation containing amosite or chrysotile was increasingly used from the late 1950s until the early 1960s. Sprayed asbestos - mainly crocidolite - was increasingly used from the middle 1940s.

In the past ten years, half of the new cases of asbestosis in the UK have come from the insulation side of the industry. Application of sprayed asbestos and of pre-formed insulation in the very restricted areas of ships' quarters resulted in the build-up of high concentrations of dust, though nothing like the levels experienced in stripping.

The conditions occurring in shipyards, especially naval dockyards, can be seen to have been made exceptionally hazardous by an unfortunate combination of several adverse factors. These are, first, the need to work in often extremely confined and restricted situations where many of the services used in factories for dust reduction or control are not available; second, the prevalence hitherto of particularly friable materials; third, operations, such as stripping, which create excessive dust; fourth, extensive use of a particular type of asbestos - crocidolite - believed to be especially associated with mesothelioma. All of these factors appear to have combined to create an exceptional and persistent hazard even affecting workers not directly involved in the manipulation of asbestos materials.

The situation today

Non-asbestos materials are now used for thermal insulation, and sprayed asbestos is rarely used, at least in British shipyards, unless predamping is employed. Nevertheless, as long as ships are in service in which these materials have been used in the past, stripping will occur, with its attendant dust problem.

The materials which continue to be used do not pose such difficult problems of control. In the United Kingdom, control by exhaust ventilation or the provision of personal protection is required if the asbestos dust level exceeds 2 fibres/ml (or 0.2 fibres/ml in the case of crocidolite). Many asbestos-containing materials in regular use do not come into this category and are regarded as "non-dusty". Some others, under certain conditions, can give rise to dust above this level; in many of these cases it has been found possible to devise methods of working or to devise equipment which adequately controls the dust level (see table 1).

Control and safety measures

Stripping. The operation presenting the most difficult problem for dust control is stripping off old insulation, whether this consists of sprayed asbestos or pre-formed insulation. Techniques developed in the British naval dockyards and by major users and contractors on industrial installations have relied on three basic methods, namely, enclosure; suppression by wetting; and personal protection.

The effect of wetting has been reported to reduce concentrations in the working area, but this technique has been abandoned in British naval yards as creating too many other problems, except in the control of waste during disposal.

Enclosure of the area, for example with polythene sheeting, combined with a ventilation system creating negative pressure can limit the contaminated area. One manufacturer is hopeful of developing a wet stripping machine incorporating a dust-proof debris receptacle. To date, however, operatives engaged in stripping must be equipped with positive-pressure respirators conforming to British Standard 4275, or air-line breathing apparatus, and with protective clothing completely covering the body from ankle to neck, as well as head covering. A hood incorporating the face-piece of the respirator or breathing apparatus has been found to be comfortable to wear and acceptable for men working in restricted areas over quite long work periods.

Strict standards of hygiene must be observed, particularly in clearing up stripped material during and upon completion of the work, and for disposal of the collected waste in impermeable containers such as heavy plastic bags.

Sprayed asbestos coatings. The application of sprayed asbestos coatings has been classified as an operation producing heavy concentrations, not only in the operator's breathing zone but also in adjacent areas. Concentrations of as much as 1,500 fibres/ml have been reported, though a level of 200-300 fibres/ml is more

Table 1

USE OF ASBESTOS MATERIALS IN SHIP CONSTRUCTION – DUST LEVELS OBSERVED IN TYPICAL OPERATIONS

Operation	Asbestos dust concentration (fibres/ml)		
	A	B*	C*
	Mean (1) Max		
Stripping			
Sweeping and bagging debris	555 3 815		
Removal of sprayed coatings	248 1 906		
Adjacent areas	83		
Removal of lagging (100% asbestos)	159	62	
Spraying	Range		
Undamped	173 to 322		150–1 500
Predamped	–	Range 1.7 to 4.7	1–4
Application of pipe lagging			
15% asbestos	11.2 61	48 60	–
Incombustible board			
Cutting (without exhaust)	–	– 100	–
Cutting (portable exhaust)		1.1 to 4.5	
Drilling (without exhaust)	–	1.0 to 1.9	–
Drilling (portable exhaust)		0.7 to 0.9	
Asbestos cloth			
Various operations			
Conventional	–	5 to 10	
Dust-suppressed	–	1 to 3	
New process	–	0.2 to 1.5	

* Not necessarily observed in a marine situation.

A. P.G. Harries: (1) 1967, remainder 1971.

B. ARC.

C. Government hygienists.

normal. The development of predamping techniques, whereby the asbestos fibre is wetted before being introduced to the feed tank of the spray-gun, has been demonstrated to reduce the amount of dust dramatically. In the United Kingdom, the Factory Inspectorate see no problem in the application of sprayed asbestos, providing that the fibre is predamped and that only chrysotile or amosite fibre is used (see table 2).

Table 2

APPLICATION OF SPRAYED ASBESTOS COATINGS - COMPARISON OF PREDAMPED WITH DRY FIBRE FEED

Position of sample	Asbestos fibre concentration (fibres/ml)		
	Without predamping	With predamped fibre	
		Official test	ARC test
Spray operative's shoulder	1 500	4	4.2
Feeding machine	150		1.9
Feeding damping drum	-		4.7
1st distance from sprayer	(9m) 19-37	(4.5m) 1	(6m) 3.0
2nd distance from sprayer	(18m) 12	(12m) 1	(10m) 1.9

Asbestos cloth and thermal insulation. The main source of dust from insulation lies in the primary lagging, and therefore, where operating conditions permit, non-asbestos materials such as calcium silicate and mineral wool have been introduced. Although the asbestos cloth covering on pipes and in mattresses has never been considered to contribute other than minimally to the hazard, the asbestos industry has developed improved textile materials to reduce still further the possibility of dust emission. Such improvements have taken the form either of conventionally produced asbestos cloth with a dust suppression treatment, or of a cloth made by an entirely new process and also subject to a dust suppression treatment.

Even with non-asbestos primary lagging, stripping will produce considerable quantities of dust which, although not asbestos, make protection desirable. The amount of dust from the asbestos covering cloth, which is usually painted or treated with a covering compound, is not likely to be significant. Table 3 indicates the effect of the introduction of various measures to reduce the asbestos dust level. It can be seen that, having eliminated asbestos from the primary lagging, with presently available asbestos covering materials the asbestos dust is reduced to a level generally considered to be non-hazardous.

Table 3

ASBESTOS DUST LEVELS IN VARIOUS INSULATION PROCESSES INVOLVING THE USE OF ASBESTOS CLOTH

Operation	Asbestos dust concentration (fibres/ml)	
	With conventional asbestos cloth	With (a) dust-suppressed or (b) new process asbestos cloth
Fitting asbestos cloth over primary lagging containing 15% asbestos	up to 61 (average of 50 tests 10.5)	
Fitting asbestos cloth over non-asbestos primary lagging	5–10	(a) 1–3 (b) 0.2–1.5
Stripping insulation consisting of 100% asbestos primary lagging covered with asbestos cloth	up to 3 021 (average of 211 tests 150)	
Stripping insulation consisting of non-asbestos primary lagging covered with asbestos cloth		(b) 0.5–1.2
Making mattresses with asbestos filling	up to 126 (average of 23 tests 14.4)	
Making mattresses with mineral wool filling		(b) 0.2–1.5
Ripping cloth	6.6	>1

* P.G. Harries

** S. Holmes

Fire-resisting board materials. These materials nowadays probably constitute the main asbestos product used in ship construction and are of special significance in view of their value for the protection of life at sea. They usually contain 25 to 40 per cent of asbestos and may be used for bulkheads in board form, or, with special finishes of veneer or plastic sheeting, to form the decorated wall panels of cabins and accommodation quarters generally. When these materials are cut or drilled with power tools, relatively high concentrations of dust can be produced. Manufacturers of these

materials in the United Kingdom have introduced methods of surface sealing, but while these have resulted in some reduction in dust arising from handling the boards, they have not effected an improvement in the dust levels from cutting and drilling. It has been shown, however, that by the development of suitably designed tools equipped with local exhaust ventilation, the level of dust in the operator's breathing zone can be controlled to a considerable extent.

Ideally, panels should be cut to the sizes and shapes required ready for fitting with the minimum of adjustment on the vessel under construction. If materials cannot be obtained from the manufacturers ready cut, then a workshop should be set up on shore suitably equipped with dust extraction equipment. Such equipment, when properly designed and operated, will reduce dust levels to the extent that personal protection is not necessary.

Even when these arrangements are made, it is not always possible to avoid some final cutting to fit. Occasional hand cutting or drilling will only produce moderate amounts of dust. Nevertheless it is recommended that respirators should be worn when this work has to be done in confined spaces. Suitably shrouded tools for cutting and drilling have been designed which can be connected to portable dust extraction equipment. Such equipment is capable of controlling the dust to levels where respiratory protection is no longer required. Tests carried out by official assessors have confirmed that levels lower than 5 fibres/ml may be expected when performing cutting and drilling with these tools. The equipment can also be used for vacuum cleaning purposes and is relatively inexpensive (see table 4).

One of the larger British shipyards has established a special on-shore cutting shop equipped with saws, sanders and routering equipment and with an exhaust ventilation installation guaranteed to control the concentrations of asbestos dust at not more than 2 fibres/ml. The same yard has also established standard working practices for joiners fitting non-combustible asbestos boards on ships under construction. These practices provide for the use of portable vacuum cleaners for cleaning working areas, for de-dusting clothing of workmen at the end of the working period, and for providing local exhaust ventilation when occasional cutting has to be done. The arrangements also include the provision of a segregated area on the ship at a point convenient for the joinery work. This is simply done by the erection of screens made up of battens and PVC sheeting. It provides in effect an on-ship workshop equipped with a power saw fitted with a dust extraction device as well as vacuum equipment for collecting spilt sawdust and chippings.

It has been found that by the use of properly designed dust extraction devices, the carefully planned supply of materials involving minimum on-site fabrication, and the maintenance of good standards of industrial hygiene, incombustible board materials can be worked without creating hazardous quantities of dust. It has also been found that, in carrying out these measures, the amount of labour involved in shipboard work has been considerably reduced. This saving can more than compensate for the cost of such relatively inexpensive equipment as has been described.

Table 4

VARIOUS OPERATIONS WITH INCOMBUSTIBLE BOARDS OR PANELS

Operation	Asbestos dust concentrations (fibres/ml.			
	A test room investigation		Other reported cou.	
	without dust extraction	with dust extraction	without dust extraction	with d extra.
Hand sawing				
Unveneered	31.4	3.4	13.8 to 44.8	-
Veneered	58.4	1.1	-	-
Power hand saw				
Unveneered	>200	1.6	87	1.5
Veneered	-	-	63 to 109	1.7
Bench saw				
Unveneered	>100	4.5	109 to 186	1.5
Veneered	-	-	-	1.1
Power drill				
Unveneered	1.9	0.9	-	-
Veneered	1.0	0.7	5.4	-

These counts have been reported by various investigators under varying conditions, but the ARC's membrane sampling method has been used in all cases.

Conclusion

More work must be done in the development of tools which do produce dust or which are equipped with efficient dust extractio devices. There is scope for further improvement in the develop of dust-suppressed materials. Possibly one of the most importa areas for improvement is in the raising of standards of hygiene and in the education of all those concerned - both management an workers - in adhering to the working procedures and safety stan devised for their protection. It will not be easy to maintain a consistent level, particularly since neglect produces no immedia penalty. Only by continual vigilance and a sustained educationa effort will the desired standard be achieved.

We believe that the methods of control we have reviewed and recommend are practicable and that time will show these to have effective, so that the important part played by asbestos materi in ship construction, particularly for the safety of those who

to sea, may continue to be enjoyed at no risk to those who build the ships.

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