THE ASBESTOSIS RESEARCH COUNCIL

PLAINTIFF'S EXHIBIT UR-615
PENGAD-Bayonne, N.J.

The Control of Dust by Exhaust Ventilation when Working with Asbestos

CONTROL AND SAFETY GUIDE—No. 7

50030085

Note

These Guides are the recommendations of the Environmental Control Committee (ECC) of the Asbestosis Research Council (ARC) concerning steps necessary to fulfil the requirements of the Asbestos Regulations 1969.

In the preparation of this Guide the Committee has had the benefit of advice from the Engineering Branch of H.M. Factory Inspectorate and from Mr. P. Swift, Chairman of the Dust Collector Manufacturers Technical Committee of HEVAC.

50030086

THE ASBESTOSIS RESEARCH COUNCIL

CONTROL AND SAFETY GUIDE—No. 7

The Control of Dust by Exhaust Ventilation when Working with Asbestos

Contents

		Page
Introduction		2
1	Definition of Asbestos Dust	3
2	Typical Dust Control Systems	3
	Hooding	4
	Ducting	4
	Dust Collectors (Incorporating Filters)	5
	Fans and Motors	6
3	Low Volume—High Velocity Exhaust Systems	7
4	Commissioning	7
5	Statutory Inspection and Examination	9
	Appendix A—Assessment of Air Requirements	10
	Appendix B—Approximate Cost of Exhaust Ventilation Equipment	12
	Appendix C—Ducting	13
	Appendix D—Weekly Inspection Check List	14
	Appendix E Yearly (or 14 Monthly) Examination and Testing Check List	14

50030087

Introduction

Under the new Asbestos Regulations, in force from May 1970, the protection of workers from industrial disease which might arise from the inhalation of asbestos dust becomes a statutory obligation wherever asbestos materials are used in such a way as to give rise to the emission of dust dangerous to the health of employed persons.

The Asbestosis Research Council and the major companies of the U.K. asbestos manufacturing industry have had considerable experience in devising safer methods of production and processing of asbestos materials, as the record of improvement in their own factories testifies.

For the assistance of those who will now be similarly concerned with the control of working conductions in accordance with the Asbestos Regulations 1969, the Environmental Control Committee have prepared a series of Guides, based on the experience of its members in many different sections of the asbestos industry.

The purpose of these notes on exhaust ventilation is to provide guidance to those individuals or companies not having previous experience of such equipment, and to help them to comply with the requirements of the Regulations to provide, maintain and use dust extraction equipment.

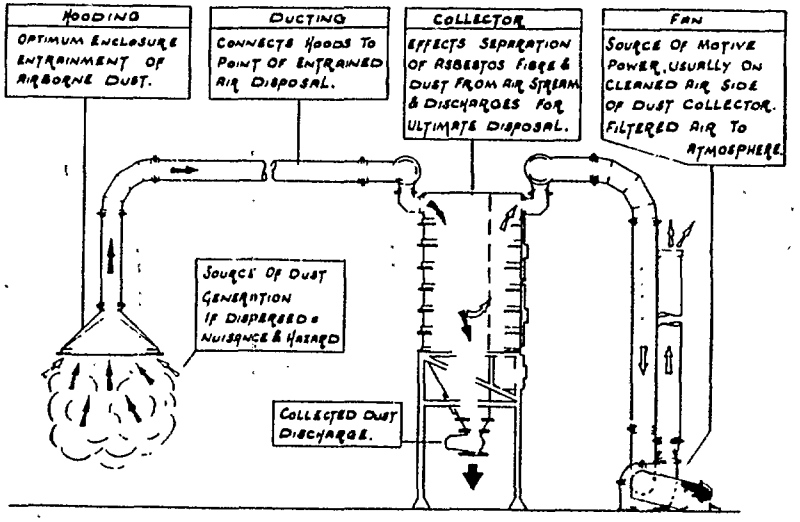
59030088

1 Definition of Asbestos Dust

Asbestos dust is defined in the Regulations as dust consisting of or containing asbestos to such an extent as is liable to cause danger to the health of employed persons, and in the case of chrysotile or amosite asbestos this is understood to mean in excess of 2 fibres/cc. Wherever possible, processes should be developed or modified so that asbestos dust, as defined, is not created. Where this is not possible then Regulation 7 requires that exhaust ventilation equipment is provided and used.

2 Typical Dust Control Systems

Assuming that there is no way of preventing the dust from being created at all, by modifications to the process, or preventing its dispersion by complete enclosure, control of airborne dust is exercised by entraining the dust-laden air into a dust control system.



Typical Dust Control System

2.1 Dust control systems normally consist of:-

Hooding - the optimum enclosure and entrainment of airborne dust.

Ducting - connects the hood or hoods with the dust collector.

Dust Collector - effects separation of particles and dust from the air stream.

Fan - moves the dust laden air.

59030089

2.2 **Hooding**

The importance of locating and determining the source and free path of the emitted dust and the design of the hood to entrain such dust cannot be over-stated. The use of a high intensity light beam * to locate and examine the path of dust is effective and helpful in this matter of hood design. All operations should be studied in detail before deciding upon a final design of hood, which will usually fall into one of two categories:

(a) 'Capture' type of hood which is commonly used to entrain the dust from a localised dust source into the system through which it is finally collected.

(b) 'Enclosure' or 'booth' type, inside which the dust produced is contained as it is generated and so designed as to prevent the dust escaping into the workplace. Enclosures are often used for such operations as feeding, bagging or bench work where dust is generated over an area rather than from a localised source.

The speed of air entering the hood should be such as (a) for the capture type, to create sufficient air flow to draw in or entrain the dust into the system, (b) for the enclosure type, to create negative pressure within the enclosure so that dust cannot 'leak' out into the workplace. Hoods of either kind should be designed so that the openings are no larger than necessary since excess entry area will increase the volume of air to be handled. This will naturally increase the size and therefore the cost and operating expense of the plant without increasing its effectiveness.

Where specially designed hoods have been developed which effectively control the dust they should be used.

2.3 **Ducting**

Ducting is necessary in any dust control installation where the collector and fan are located away from the dust source and where plants with more than one dust source are served by one collector and fan.

While detailed advice is listed in Appendix C, the following general principles should be observed:

(a) Ducting of circular section wherever possible should be of such size as to provide an adequate carrying velocity throughout the system.

(b) The interior of the ducting should be smooth and all bends of generous radius.

(c) Connections to a main duct should be made from above or one side; a series of upward rising connections breaking into the bottom of a main duct is bad practice.

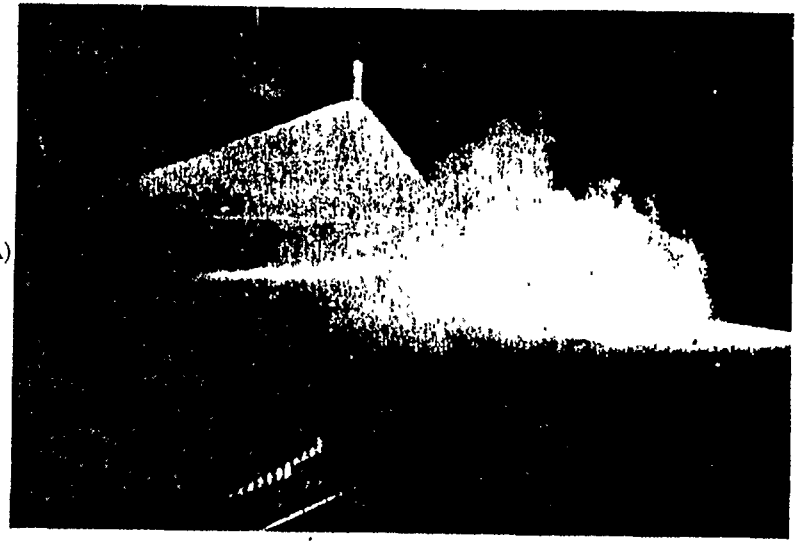
(d) Access doors should be provided at intervals and adjacent to bends where build-up may occur. Test points should be provided.

(e) Ducting must be adequately supported.

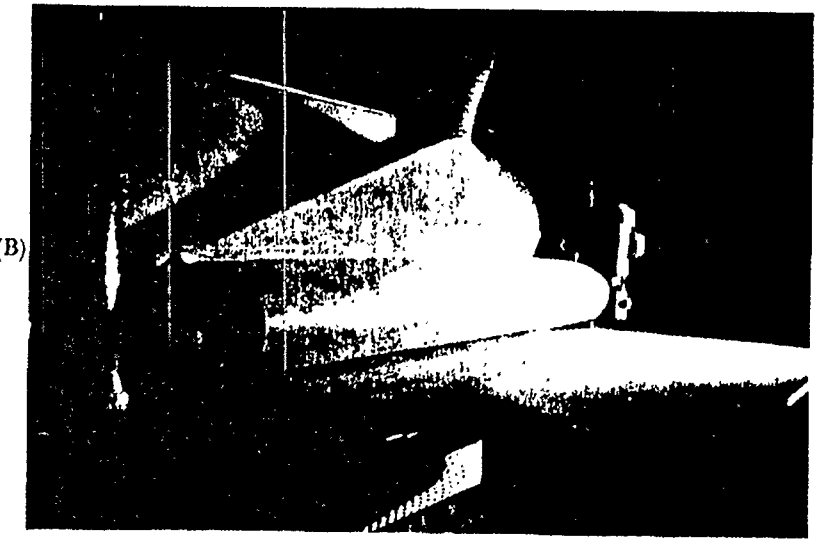
**See "Accidents" No. 79, April, 1969, page 7. Published by H.M.S.O. Price 2s. nett.*

S6030090

(A)



(B)



Dust Extraction fitted to a triple drum sander photographed in the light of a high intensity beam.

Picture A *without dust exhaust.*

Picture B *with dust exhaust: complete and effective removal of dust is clearly demonstrated.*

S6030091

2.4 Dust collectors

Three types only need be considered in this context:—

Cyclones
Wet Dedusters
Fabric Filters

2.4.1 ***Cyclones*** are of relatively poor efficiency as dust separators and for this reason should not be used as sole collectors of asbestos dust. They can, however, sometimes be used before a fabric filter to take out heavy material and particles from the air stream and this lightens the load on the filter. Indeed, wherever there is a risk of heavy material getting into the air-stream from the point of entrainment, it is recommended that arrangements be made for the removal of such material before the filter stage.

2.4.2 ***Wet Dedusters,*** as their name implies, use water in various ways to assist in the separation of the solid matter from the air stream. Their application is generally a specialised one and a natural choice when wet processes are carried out. The presence of water in such circumstances makes dry fabric filters unsuitable. The collection efficiency of a wet deduster is not as high as that of a fabric filter.

2.4.3 ***Fabric Filter Collectors.*** Experience with this form of dust collector has shown it to be the most suitable method for asbestos working. There are two main types of such collectors, the choice of which will depend upon the working conditions to be controlled. They are:—

(a) *Intermittent*—used when the pattern of work allows the system to be closed down for cleaning (e.g. at meal breaks or shift changes) and where the dust load between cleaning times is within the capacity of the filters. This type of unit is simple and cheap and would be expected to be satisfactory for a wide range of users.

(b) *Continuous* - a more sophisticated design and usually arranged in sections, allowing one section at a time to be automatically isolated from the fan system for a few minutes for cleaning, while the remainder of the filter sections continue with their normal function. The filters are cleaned either by shaking the sleeves or applying reverse air through them. The air supply to such reverse jets must be clean, dry and at the stipulated pressure. The continuous operation filter is usually considered in cases where duty has to be non-stop, or where the dust load is so high as to call for the removal of the collected dust from the filter element at more frequent intervals than the work routine permits.

2.4.4 ***Filter Materials.*** The material used for the filter may be either felt or woven cloth. The felt material has a better permeability and a higher collection efficiency; the woven material generally has greater strength and flexibility.

59030092

2.4.5 ***Filter Capacity.*** The volume of air to be handled determines the area of filter material needed and consequently the size of the filter collector. In calculating filter capacity, maxima of 5 feet per minute for woven cloth filter and 10 feet per minute for felt filter are recommended.



A large filter collector showing multiple filter sleeves

59030093

2.4.6 ***Filter Collectors—General.*** Many types of filter collectors are commercially available, from large installations serving multiple dust points with the filter suitably housed outside the factory building, to small units complete with integral fan and motor located near the machine being served. These unit filters allow rapid and inexpensive provision of dust control facilities to a single machine or a group of limited size. As with all filters, the siting should be such as to give easy access for all forms of maintenance and cleaning. Hopper design should be carefully considered to avoid 'bridging' (blocking by the arching of fibres) of the waste material.

For disposal of filter waste see ARC Code of Practice for the Handling and Disposal of Asbestos Waste Materials.

2.5 Fans and Motors

These are vital components of the system and should be capable of continuous and efficient operation throughout the year. Fan design is a specialised subject in itself, so these notes will be limited to general advice regarding their selection and application.

All reputable fans have a known 'characteristic curve' and it is prudent to select the fan so that it is not working at the extreme limit of its performance. Direct drive between fan and motor may suggest savings in first cost, but the vee belt arrangement allows for simple speed alteration and the correction of application errors. On many asbestos dust control plants, where proprietary fabric filters are used, the fan will be located after the filter, i.e. on the 'clean air' side. In these cases, the costlier but more efficient full-aerofoil fans more than justify the extra cost by a saving in power used. Where the fan is located on the 'dirty' side and is pushing air through the filter, the lower cost fans with simpler impellors are used. Wet dedusters are better served by semi-aerofoil fans which are not so sensitive to the carry-over of water.

The recommended practice is for the fan to be installed after the filter. This ensures that the system is a 'negative' one so that, should any leak occur, ambient air will be drawn into the system and contaminated air will not be blown out. It is prudent, when calculating the plant required, to allow 10% additional air entrainment to cater for leakages which may occur during the life of the installation or for small increases in extraction found necessary at commissioning. Since propellor fans are designed to handle air against virtually no pressure, they should not be used in ducted exhaust systems.

Fans can sometimes be noisy. They should therefore be selected and sited with care to avoid possible nuisance. Unavoidable noise can be reduced by additional sound attenuation equipment.

2.6 General

The addition of extensions to an existing dust exhaust system without increasing the total air extracted should be avoided. Such ad hoc extensions can result not only in the extension being ineffective, but in impairing the efficiency of the original installation.

50030094

3 Low Volume—High Velocity Exhaust Systems

The exhaust systems described in previous paragraphs are of the conventional High Volume—Low Velocity type, but mention must be made of Low Volume—High Velocity Exhaust Systems (LV/HV) which have found application in recent years, particularly to hand tools and machining operations. Control is achieved by exhausting the air directly from the point of dust generation, using close-fitting, custom-made hoods and nozzles. Capturing velocities are high (10,000 to 12,000 feet per minute), but the volume of air used is low (10 to 250 c.f.m.) because of close proximity of the nozzle to the dust source. For flexibility, small-bore plastic hose can be used as a connection to the tool with the remainder of the system utilising fixed steam piping and fittings. This method, wherever it can be applied, provides local exhaust ventilation with effective control at the dust source and in situations where conventional High Volume —Low Velocity systems would be too cumbersome to be practicable.

The dust is conveyed at high speed through the flexible piping and, with the high entering velocities involved, exhaust needs to be provided not by a conventional fan, but by a multi-stage centrifugal exhauster, capable of providing static pressures of about 5 in. mercury at the nozzle opening. These systems require the same careful design as the more conventional ones and since there is less data available for design use, firms who are interested in the possible application of this LV/HV system are advised to consult H.M. Factory Inspectorate, who have made a special study of this method of dust extraction, or the Environmental Control Committee which can provide information about specific applications of LV/HV systems to particular items of equipment. Suitable industrial vacuum cleaners may sometimes be adapted to provide this type of localised extraction.



Portable cutting equipment incorporating dust exhaust unit — designed for cutting asbestos insulation board

50030095

4 Commissioning

The contractor should formally commission the plant on completion of erection and, at that time, pass to the purchaser operating and maintenance instructions together with a list of recommended spares.

After one month's satisfactory operation, the contractor should survey and test the installation and provide the purchaser with a copy of the test figures obtained. It is recommended that the test readings be permanently marked in paint at the measuring points. It is advisable that the purchaser reaches clear understanding with the contractor regarding the contractor's responsibilities concerning commissioning before any order is placed.

Consideration can also be given at this time to the future employment of the contractor to undertake the statutory examination and testing referred to in the following section.

5 Statutory Inspection and Examination of Exhaust Ventilation Equipment

5.1 Regulation 7, paragraphs (3) and (4), of the Asbestos Regulations 1969 requires that

> "(3) Exhaust ventilation equipment provided in accordance with this Regulation shall be inspected at least once in every seven days and shall be thoroughly examined and tested by a competent person at least once in every period of fourteen months, and a report of the results of every such examination and test containing approved particulars and signed by the person making or responsible for the carrying out of the examination and test shall be made within fourteen days after the examination and test.
>
> "(4) Every such report as aforesaid shall be attached to the general register and be preserved and kept available for inspection by any inspector for a period of two years after it is made."

5.2 For the inspection "at least once in every seven days" it is recommended that a departmental foreman or chargehand should undertake this task. The purpose of this weekly check is to see that the plant is being handled correctly and to ensure by regular scrutiny that any noticeable deterioration is checked by prompt action. See Appendix D for specimen check list.

5.3 The fuller and more detailed examination and testing at least once every fourteen months calls for a more detailed technical approach. The competent person referred to would either be an employee of the user (suitably experienced and capable of carrying out the checks listed), or such work could be placed on contract with a firm of specialists. A specimen check list for this examination and test will be found at Appendix D. The requirement for a signed record of this inspection to be filed with the general register should be noted.

A new register is being produced by H.M. Factory Inspectorate which includes a column for static pressure readings.

5C030096

April 1970

The Asbestosis Research Council

Secretary to the Council,
Dr. S. Holmes,
P.O. Box 40,
Rochdale, Lancashire
Tel: Rochdale 47422

Environmental Control Committee,
Secretary,
114 Park Street,
London, W1Y 4AB.
Tel: (01) 499 6022

5C030097

Appendix A

ASSESSMENT OF AIR REQUIREMENTS

The quantity of air needed at any point is determined by the design of the hood and its proximity to the source of the dust. Thereafter the sum of the volumes of air taken by each hood in a system determines the size of collectors, fans etc, and the total investment required.

Conventional broad indications of the air volumes used for some machines are given below. These nominal specifications should not be accepted without careful scrutiny. It is important that the air velocity at the point of origin of the dust be sufficient to capture it. In consequence, hoods must be carefully designed and close fitting, if the following typical rates are to be effective.

Typical Exhaust Rates for Conventional Low Velocity Systems

1.	*Power Circular Saw:*	10" to 12" dia.	Top Connection	300 cfm
			Bottom Connection	350 cfm
		16" to 18" dia.	Top Connection	350 cfm
			Bottom Connection	450 cfm
2.	*Bandsaw:*	Up to 36" dia. pulleys	Top Connection	300 cfm
			Bottom Connection	350 cfm
3.	*Sanding:*	Double disc 30" dia.	per disc	350 cfm
		Bobbin Sander		450 cfm

4. *Routing:*
Routing machines are difficult to provide with a standard hood form due to the wide range of operations performed on them. For small repetitive work, a close-proximity hood fitted with a 'bristle curtain' may be applied. The open area face velocity should be not less than 600 ft./min. For large and varied operations, a 'booth enclosure' on the machine table and around the cutter is recommended with a face velocity not less than 250 ft./min.

5. *Drilling:*
Fixed pedestal drills are best served when fitted with a small hood having high velocity in excess of 2,000 ft./min. Suggested air volume per spindle 120 cfm.

6. *Milling and Turning*:
Close proximity hood forms with face velocities of 2,000 ft./min. should be used where possible. However, the nature of the machining operation will often prevent this and it may be necessary to supplement or replace the local exhaust points with a booth form around the machining area. Booth face velocity to be 350 to 500 ft./min.

NOTE:
Operator acceptance of booth forms may be more easily won by the use of transparent and hinged panels. It is also suggested that in such instances a 'built-in' flexible connection for use as a vacuum cleaner to clean the machine table at intervals would be valuable.

5003098

Enclosed Dust Points

In order to ensure that dust remains inside the designed enclosure, velocity of the air entering the enclosure through the arranged aperture should not be below 150 ft./min.

Low Volume—High Velocity Systems

These systems are quite different from conventional systems and generally use 10-250 cfm at velocities of 10,000 to 20,000 feet per minute. Experimental work is strongly advised in order to ascertain more closely nozzle design, air quantity and air speed and in such instances an industrial vacuum cleaner may be useful for this exploratory work.

5003099

Appendix B

APPROXIMATE COSTS OF EXHAUST VENTILATION EQUIPMENT

It will be appreciated that the cost of exhaust ventilation equipment will vary considerably according to many local factors and site conditions. The brief table below is provided, however, as a general indication of the scale of costs which might be expected for the supply, installation and commissioning of typical systems including hoods, ducting, collecting/filter units, fans and motors. They do not include provision for housing the equipment. In comparing costs of the various systems the relatively low volume of air per point required by the low volume/high velocity system should be taken into account.

Type of System	*Estimated Cost on 1,000 cfm of Air Handled*	*Estimated Cost on Minimum Installations*
Small self-contained unit serving one or two machines	£700-800	1,000 cfm £700
Fabric filter, multiple point, intermittent operation	£440-550	2,500 cfm £1,100
Fabric filter, multiple point, continuous operation	£500-700	7,500 cfm £4,000
Wet deduster, multiple system	£300-400	2,000 cfm £800
Low volume/high velocity system —multiple point	n.a.	200 cfm £300

5003016

Appendix C

DUCTING

Conventional System

All ducting should be circular in section wherever possible and manufactured from mild steel. Interiors should be smooth and free of obstructions.

Gauge Sizes

The following gauge sizes should be regarded as a minimum.

Up to 12" dia.	20 swg
12" to 30" dia.	18 swg
30" to 40" dia.	16 swg
40" dia. and above	14 swg

Finish

Ducting should have a suitable external protective finish.

Joints

Ducting up to 16" diameter should have rivetted and taped slip joints; 16" diameter and above flanged and gasketted joints are recommended.

Bends

All bends should have a mean radius of three times the diameter of the duct whenever possible.

Connections

Branch connections should enter the side of the main duct on an expanding taper and at an angle of not more than 30° to the main.

Balancing

Where system balancing is necessary, the design volume can be obtained by the fitting of balancing cones or slide dampers. Balancing cones have the advantage of not being subject to unauthorised alteration, but require the provision of access doors for their adjustment. Slide dampers, being adjustable from outside the ducting, can be tampered with; if used they should be locked after initial adjustment.

Access Doors and Panels

When balancing cones are fitted, adjacent access panels will be required. Inspection doors for duct maintenance should be sited at intervals in horizontal main ducting and adjacent to bends.

Instrument Test Holes

Test holes of ½" diameter should be provided for checking air flows throughout the system, covered when not in use.

Low Volume/High Velocity System

As referred to in the text, this system does not use conventional sheet metal ducting, but makes use of commercial steam piping and fittings.
Bends should be of the 'long sweep' type and kept to the least possible number.

5003016

Appendix D

WEEKLY INSPECTION CHECK LIST

The weekly visual inspection should include the following checks:

1. That the condition of the hoods and nozzles is being maintained and that they are correctly positioned.
2. That the filter hoppers are not overfilled and the emptying routine is being regularly carried out.
3. That there are no obvious system leaks.
4. That none of the filter elements are leaking dust.
5. That the filter shaking gear or cleaning equipment is functioning properly.
6. Where gauges are fitted, that the designed pressures are being maintained. The normal or expected gauge reading should be clearly marked on or near the gauge.

Appendix E

YEARLY (OR 14 MONTHLY) EXAMINATION AND TESTING CHECK LIST

1. All hoods and ducting are in position and in good order.
2. There are no air leaks to any part of the system.
3. The condition of all filter elements is good.
4. There is no unacceptable wear of component parts of the filter shaking or cleaning gear.
5. All lubrication points are charged.
6. The fan and drive to the fan are in good condition and correctly adjusted.
7. The air flow in each part of the system and the fan inlet pressure are to the designed specification.

While the above are listed as suggested items to be checked and recorded formally in accordance with the statutory requirements, it is recommended from experience that Items (4), (5) and (6) be also checked every three months.

5003102

5003103

PUBLICATIONS BY THE ASBESTOSIS RESEARCH COUNCIL

Codes of Practice —For Handling Consignments of Asbestos Fibre in British Ports

—For Handling and Disposal of Asbestos Waste Materials

Technical Note —No. 1: The Measurement of Airborne Asbestos Dust by the Membrane Filter Method

Control and Safety Guides—

No. 1: Protective Equipment in the Asbestos Industry (Respiratory Equipment and Protective Clothing)

No. 2: The Application of Sprayed Asbestos Coatings

No. 3: Stripping and Fitting of Asbestos-containing Thermal Insulation

No. 4: Asbestos Textile Products, CAF/Asbestos Beater Jointings and Asbestos Millboard

No. 5: Asbestos-based Materials for the Building and Shipbuilding Industries and Electrical and Engineering Insulation

No. 6: Handling, Storage, Transportation and Discharging of Asbestos Fibre into Manufacturing Processes

No. 7: Control of Dust by Exhaust Ventilation when working with Asbestos

No. 8: Friction Materials (in preparation)

5003104