Department of the Environment

Asbestos materials in Buildings

London Her Majesty's Stationery Office

First published 1983

ISBN 0 11 751713 5

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1 Introduction

1.1 Asbestos has been used in building materials for many years and there is a large tonnage of these materials in existing buildings. The use of asbestos in new building materials has been sharply reduced in recent years but a significant tonnage is still used, mainly in the manufacture of asbestos-cement. A considerable volume of information and advice on asbestos in buildings is available in a variety of books, reports, advice notes and other publications. The purpose of this booklet is to present in a single publication a description of the main past and present uses of asbestos in buildings and to give general advice on the precautions which should be taken when dealing with asbestos materials. Sources of more detailed information and advice are also listed.

1.2 The advice is aimed at local authority officers responsible for public and private buildings, building maintenance engineers, environmental health officers and officers called upon to advise the general public. Local Authorities have general responsibilities under public health legislation where premises are prejudicial to health, and are also responsible for building control and asbestos waste disposal. As employers they have responsibilities under health and safety legislation and are also responsible for enforcing the Health and Safety at Work etc Act 1974 in premises such as offices, shops and communal homes. As housing authorities they have responsibilities to ensure the safety of their tenants and may be called upon to advise private householders. They also provide and maintain a wide range of buildings for their various services.

1.3 This booklet does not cover specialised technical uses of asbestos in factories, power stations or production plant. Nor is it intended to give detailed advice on the protection of construction, demolition or maintenance workers exposed to asbestos. It is important that the correct safety precautions are taken when working with asbestos materials and all such work is subject to the Health and Safety at Work etc Act 1974 and associated legislative requirements. Detailed information and advice can be obtained from the Health and Safety Executive's area offices.

The nature of asbestos

1.4 Asbestos is a fibrous mineral which occurs in many parts of the world; the main sites of commercial production are in Canada, the Soviet Union and Southern Africa. It is mechanically strong and highly resistant to heat and chemical attack, and because of its fibrous nature, can be woven into fabrics and used as a reinforcement for cement and plastics. The three main types of asbestos produced commercially are:

Crocidolite — blue asbestos
Amosite — brown asbestos
Chrysotile — white asbestos

The import of crocidolite into the UK ceased in 1970 and the quantity of amosite imported is very small and declining rapidly. Approximately 80,000 tonnes of chrysotile asbestos were imported in 1981, about half of the quantity imported in the peak year of 1973.

1.5 Apart from its uses in building materials, described in this booklet, the other main uses of asbestos are in friction materials, asbestos-cement pipes, plastics reinforcement and various jointing, packing and filling materials used mainly in industry.

The Advisory Committee on Asbestos

1.6 In 1976 the Government appointed an expert advisory committee (The Advisory Committee on Asbestos — ACA) to look into risks to the health of workers and the general public arising from exposure to asbestos. The Committee reported in 1979 (1) making a number of recommendations for further action to reduce exposure to asbestos. On asbestos in buildings the Committee said:

> 'Firm conclusions about asbestos dust levels in buildings cannot be drawn from the present data. However ..... the number of people at risk is probably small.'

and:

> 'Our evidence of the non-occupational risk is not such as to prompt us to recommend the general removal of asbestos from buildings. Present evidence suggests that dangers from asbestos in buildings are likely to arise only when asbestos fibres are released into the air when products containing asbestos are damaged, either accidentally or during maintenance and repair.'

1.7 The Committee recommended that further monitoring of the levels of airborne asbestos should be carried out. Preliminary results of this work are now available and are discussed in the following section of this booklet. They support the Committee's conclusions on asbestos in buildings.

1.8 The ACA also made a number of other recommendations about asbestos used in building materials. These are detailed below.

Crocidolite. No crocidolite has been imported into the UK since 1970 but the ACA recommended a formal ban on its import. The Government has accepted this recommendation and regulations are to be made under the Health and Safety at Work etc Act 1974.

Thermal and acoustic insulation. The ACA recommended a ban on the use of asbestos in these materials and specifically on sprayed asbestos coatings. The Health and Safety Commission (HSC) published a consultative document and draft regulations on these proposals in 1981 (2). In practice sprayed asbestos has not been used since 1974 and the use of asbestos in insulation materials has also been phased out.

Licensing. The ACA recommended that work with asbestos insulation or coatings should be carried out only under licence. The HSC published a consultative document in 1982, and draft regulations were published in 1983 (3).

Code of Practice. The ACA recommended that the HSC should produce a code of practice on work with asbestos insulation and coatings and this was published in 1981 and revised in 1983 (4).

2 Health Effects

2.1 Most of the information on health effects of exposure to asbestos has been derived from studies of workers occupationally exposed to asbestos fibres at concentrations many times higher than those encountered by the general public. Estimates of the risk of low level exposure therefore have to be based on extrapolation from occupational exposure levels.

Asbestos-related diseases

2.2 The principal diseases known to be caused by exposure to asbestos are asbestosis, lung cancer and malignant mesothelioma. Asbestosis is a fibrosis or scarring of the lung in which the tissue becomes less elastic, making breathing progressively more difficult. It is irreversible and may progress even after cessation of exposure to asbestos. People occupationally exposed to asbestos have an increased risk of developing lung cancer. The increase in risk depends on the degree of exposure and is very much greater for smokers than for non smokers. Mesothelioma is a cancer of the inner lining of the chest wall or of the abdominal wall. Its incidence in the general population is extremely low; the estimated risk for heavily exposed asbestos workers is very much greater. It is not known to be associated with smoking.

Latency and degree of exposure

2.3 There is commonly a lag or latency period of 10–20 years between first exposure and onset of symptoms for asbestos-related diseases. In the case of cancer, the period of latency may be up to 40 years or more. All three main diseases are thought to be related to the cumulative dose to which an individual has been exposed and the time since exposure. There is evidence that inhalation of high concentrations for short periods of time may be as harmful as prolonged exposure to low concentrations, at least as far as cancer is concerned. An increased risk of lung cancer and mesothelioma has been found where known occupational exposure to asbestos was of short duration but at a high concentration.

2.4 The HSC introduced new control limits for occupational exposure to asbestos (5) in January 1983. The control limit for airborne chrysotile fibres was reduced to 1 fibre/millilitre (f/ml) and for amosite to 0.5 f/ml; the control limit for crocidolite remained at 0.2 f/ml. There is a measureable risk of contracting an asbestos-related disease after prolonged exposure at these levels.

Type and size of fibre

2.5 All three main types of fibre have been associated with the development of asbestosis, and the ACA concluded that evidence for a difference in risk of asbestosis with fibre type was slight. The relative risk of lung cancer is increased with exposure to any of the three types of fibre; crocidolite and amosite are thought to be more dangerous than chrysotile. For mesothelioma, there is strong evidence that crocidolite is more dangerous than chrysotile; the position of amosite may be intermediate.

2.6 Fibre size is thought to be an important variable. Fibres of length greater than 200 μm (1 μm = one millionth of a metre) are generally cleared from the nasal passages and do not enter the lungs; shorter fibres with a diameter of less than 3 μm may penetrate deep into the lungs. Animal experiments have shown that fibres with diameters less than 2.5 μm and lengths between 10 and 80 μm are the most likely to cause cancer. Fibres encountered in the general environment are usually very much shorter than this, but there is no reliable evidence on the relative risk of these very small fibres. It is not known whether these very small fibres can cause cancer, and they may have different surface properties which could alter their biological activity.

The public health risk

2.7 Asbestos fibres are widely distributed in the environment and have been found in the lungs and urine of up to half of people examined in the general population, albeit in much smaller numbers than in the occupationally exposed. The ACA concluded in 1979 that the presence in the general environment of chrysotile containing small quantities of amosite or crocidolite was unlikely to have produced any material increase in the risk of lung cancer or mesothelioma in the general population. On general environmental exposure to crocidolite and amosite, the ACA concluded that an excess risk of lung cancer could not be completely excluded although the number of cases, if any, would be small, and that an important area of uncertainty remained about mesothelioma. The ACA also drew attention to

the possibility that children might be more at risk than adults; they have more chance of being affected by carcinogens with long latencies, and the susceptibility to cancer may be increased in the very young.

2.8 Attempts have been made to estimate risks to the general public from airborne asbestos fibres by extrapolation from occupational data. There is no convincing evidence of the existence of a safe, threshold dose of asbestos below which no risk of disease or death is incurred, and data for occupational exposures indicate a linear relationship between exposure and risk. On this basis, if the linear exposure-risk relationship remains valid at very low exposures, the risks to the general public are likely to be extremely small. Nevertheless, as there is no known safe level for exposure to asbestos, it is inappropriate to attempt to set a precise limit for non-occupational exposure. Instead, it is advisable to reduce exposure to the minimum that is reasonably practicable. In cases where there is potential daily, 24 hours exposure, as in homes, or where children may be exposed, particular effort should be made to ensure that levels are as low as possible.

Asbestos in buildings

2.9 The ACA recommended that a programme of work should be prepared to evaluate asbestos exposure in the non-occupational environment. Measurements have been made in a number of buildings, including houses, schools and public buildings, in which asbestos materials were present and preliminary results have been published (6). In no case was the measured level above the limit of detection of the sensitive electron microscopy method used (the limit is 10 ng/m^3, ie one hundred millionth of a gram per cubic metre). This level cannot be directly compared with the occupational control limit which is measured in fibres per unit volume, but 10 ng/m^3 is roughly equivalent in mass terms to one five thousandth of the control limit of 1 f/ml for chrysotile asbestos. There have been a number of reports from other countries of higher concentrations measured in buildings containing sprayed asbestos. Further measurements are being made in this country in buildings where high dust concentrations might be found.

Ingestion of absestos

2.10 Exposure to asbestos also occurs through drinking water, food and beverages. There is no firm evidence that ingestion, as opposed to inhalation, of fibres is hazardous. Some, but not all, epidemiological studies of asbestos workers have shown a significant excess of cancers of the gastro-intestinal

tract, which some epidemiologists have attributed to the swallowing of asbestos fibres cleared from the lungs by mucociliary action. Investigations of cancer incidence in parts of the world with high asbestos levels in drinking water are inconclusive, but there is no evidence that the levels of asbestos found in water in the UK are a risk to health.

3 Asbestos Materials and Substitutes in New Building Works

3.1 The main remaining use of asbestos in construction materials is in asbestos-cement; there are also a number of small-scale uses in sealants, felts, tapes, mastics, adhesives, paints and plasters. The ACA recommended that asbestos should be replaced by safer materials wherever possible, and a wide range of asbestos-free products is now available. Appropriate uses of the remaining asbestos-containing materials and the substitute materials available are described in this section.

Asbestos-cement

3.2 Asbestos-cement (AC) products generally contain 10–15% of white asbestos fibre bound in a matrix of hydrated Portland Cement; they may be compressed into flat or corrugated sheets or moulded into a wide range of components (Table 1). The degree of compression of sheet materials is variable. Semi-compressed sheets have a density of about 1200 kg/m^3 and one smooth face. Uncoated sheets are light grey in colour. AC sheet is widely used in agricultural and sectional buildings. Corrugated sheet is widely used for roofing and wall cladding. Fully-compressed sheets have a density of about 1600 kg/m^3 and can have a factory-applied surface coating. The sheets have had a wide range of uses, including weather boarding, chalkboards, counter and bench tops, infill panels, facing of composite wall panels and tiles for cladding, decking and roofing. Some older AC components, especially pressure pipes, may contain crocidolite. Low density AC boards containing a higher proportion of asbestos (known as wallboard) are sometimes used in place of conventional insulating board (paragraphs 4.4 to 4.7).

Table 1 Moulded AC Components

Cable trough and conduit	Guttering and rainwater pipes
Cisterns and tanks	Ventilators and ducts
Drain and pressure pipes	Fencing
Vent and flue pipes	Plant tubs and boxes

3.3 The asbestos fibres in AC are firmly bound in the cement matrix and will be released only if the material is mechanically damaged or deteriorates with age. AC, particularly when coated, is relatively resistant to light abrasion and impact. The lower fibre content and well bound matrix make AC products much less likely to generate dust during their normal operational life than other asbestos products. When used externally, AC components will slowly weather, but, the rate of fibre release is so low that it presents no significant hazard. If AC is used inside buildings, dust released by wear, maintenance or repair, may accumulate. AC components should therefore not be used internally where they are likely to be subject to damage or abrasion or where they will need to be cut or drilled after installation. The use of coated AC components where possible is recommended. Alternatively, AC may be painted on both sides to seal it completely, to prevent warping or cracking and to reduce surface deterioration (paragraphs 5.16 to 5.21).

3.4 Asbestos dust can be released when working with AC materials and Health and Safety Executive (HSE) guidance on working with asbestos-cement (7) should be consulted when planning such work. Small jobs carried out by a householder do not come within the scope of the health and safety at work legislation, but nevertheless the general safety precautions recommended by the HSE should be followed, and these are summarised below.

3.5 When the work does not involve cutting, abrading or breaking the material and dust is not likely to be released, relatively simple precautions are sufficient:

(i) precautions should be taken to prevent any dust generation, for example by damping the material;

(ii) any waste material should be collected and disposed of safely (paragraphs 5.28 to 5.31);

(iii) any dust that is released should be removed with an industrial vacuum cleaner with a high efficiency filter (not a domestic cleaner), or alternatively a damp cloth can be used to remove dust; the cloth should be sealed in a plastic bag while still damp, and safely disposed of.

3.6 When AC materials are cut or drilled dust may be released and additional precautions are needed:

(iv) only people engaged in the work should go into the working area;

(v) protective clothing and a dust mask suitable for asbestos should be worn;

(vi) a plastic sheet should be used to collect any dust;

(vii) hand tools rather than power tools should be used;

(viii) work should be done outside if possible and working overhead should be avoided;

(ix) the material should be wetted to minimise dust release;

(x) protective clothing should be cleaned or disposed of safely, and those engaged in the work should wash carefully.

3.7 Work which is liable to generate more dust (for instance work with power tools, building demolition or removal of old disintegrating material) should be carried out professionally and may fall within the requirements of the Asbestos Regulations 1969; the safety measures set out in the HSE guidance (4,8) must be complied with fully. Any work with crocidolite falling within the scope of the regulations must be notified to the HSE before the work starts.

3.8 After several years AC used externally may become covered with lichens, algae and mosses. These growths can release acids which attack the alkaline cement matrix leading to accelerated deterioration. Dry scrubbing or cleaning with high pressure water jets can release loose fibrous materials and are better avoided. Low pressure water and brushing can be used in conjunction with a biocide (9), but the material removed should be collected and disposed of safely.

Other asbestos-containing materials

3.9 Asbestos may be found in some textured paints or plasters, roofing felts and various mastics and sealants used in building works. Flooring materials containing asbestos are covered in paragraphs 6.12 and 6.13.

3.10 Textured paints and plasters are available for both interior and exterior decoration. Both dry-mix and ready-mixed asbestos-free makes are currently available and the packaging will generally indicate if the material contains asbestos. A number of makes supplied in powder form contain asbestos, together with pigments, plastic resins and fillers. Care should be taken when mixing the powder with water to avoid creating dust clouds. Mixing should preferably be done outdoors and by tipping the powder carefully into the water and stirring. Once mixed, fibres are unlikely to be released during application. Textured paint containing asbestos should never be sanded down. If it must be removed, it should be thoroughly wetted to soften it and damp down any dust, then scraped off.

3.11 In mastics, weatherproofing sealants, putties and adhesives small quantities of asbestos may be included to impart anti-slumping characteristics, to improve covering power and prevent cracking and crazing. In these products, the fibres are bonded into the materials as sold and will not present any hazard during application. The only possible hazard is from subsequent sanding down of hardened material. Some are thermoplastic and cannot be sanded but there could be occasion to sand down others, eg vehicle underseals or tile adhesive. Sanding down with power tools should be avoided.

3.12 Some roofing felts, flashing tapes and damp-proof courses contain asbestos fibre in a bitumen matrix, but these materials are not likely to present a hazard during normal installation work. It is possible that they could become brittle or break up with age and they should then be removed carefully, any adhering material should be removed manually (not by power grinding) and the waste material should be disposed of safely, not by burning (paragraphs 5.28 to 5.31).

3.13 Asbestos reinforced PVC contains 50–70% chrysotile asbestos and has been used to make cladding and panels. It is unlikely to release fibres after installation, but cutting with high-speed power tools should be avoided.

3.14 Asbestos mixed with bitumen has been used since the 1920s as a coating for corrugated steel sheet. The material has been used as a roofing and cladding for buildings such as warehouses or factories. The asbestos is firmly bound into the material, but could be released if the bitumen burns in a fire. The protective coating should not be burned off scrap sheet.

Asbestos substitutes

3.15 Asbestos-free substitutes are now available for many building materials which used to be made with asbestos and the manufacturers claim that equivalent performance can be obtained in most cases. The characteristics of some substitute materials are described below, but this is not intended to be a comprehensive catalogue of alternatives to asbestos. New materials are introduced frequently. Manufacturers should be consulted for full technical performance details.

3.16 Asbestos materials were often used because they were non-combustible or had good fire resistance. When they are replaced the fire properties of the substitute should be considered, especially in the case of insulation. Where a specified period of fire resistance is required the substitute material must be able to meet the specification.

3.17 *Sprayed fire protection.* Mineral fibre sprayed materials are available for a range of maximum temperatures up to 650°C and for fire protection of up to 4 hours depending on thickness. A high temperature sprayed material of ceramic fibres in an inorganic dry binder is available for temperatures up to 1200°C. There are also a number of hard-set sprays based on vermiculite for use in thermal insulation and fire protection.

3.18 *Thermal insulation and lagging.* Substitutes for asbestos in pre-formed pipe lagging include glass fibre, rockwool and slagwool which may be faced with aluminium foil, PVC or canvas. Other insulating materials include polyurethane, polyisocyanurate and polyphenolic foams, calcium silicate, foamed glass, and cellulose fibre. These materials are available in a variety of slab or preformed shapes with a range of insulating properties. Many plastic foam insulation materials used for lagging are combustible and may burn freely, producing smoke and fumes; cellulose fibre also burns unless it contains added flame retardants. Before a material is chosen, the fire performance required and consequences of using combustible material should be considered.

3.19 *Insulating board.* Asbestos-free insulating boards were developed in the 1970s and the use of asbestos in boards manufactured in the UK was phased ut completely by 1980. Boards are now available made of a variety of rganic, inorganic and man-made fibres with matrices of Portland Cement, alcium silicate, vermiculite or perlite, together with fillers and density nodifiers. The Building Research Establishment is evaluating the characteristics and durability of the main types of non-asbestos insulating boards. Ceiling tiles based on mineral fibres have been available for many years.

3.20 *Fibre reinforced composites.* There is as yet no one material which can completely replace asbestos-cement (AC), but there are several partial substitutes. Cement can be reinforced with glass, steel, carbon or polymer fibres instead of asbestos, and glass-reinforced gypsum or plastic are also possible replacement materials. Glass-reinforced cement (GRC) is made with an alkali-resistant glass fibre. It is very strong initially but its properties deteriorate with time at a rate dependent on exposure conditions and it performs best in dry conditions (reference 10 should be consulted for suitable applications). Improved second generation materials are now becoming available and are expected to have considerably better durability. GRC is non combustible. Glass reinforced gypsum is made from a cheaper glass fibre and a non-alkaline gypsum binder. It has high impact strength and is fire resistant, but is not suitable for exterior use. Glass reinforced plastic may be used for some applications where resistance to combustion is not needed. However, it

has poor scratch resistance and can burn at high temperatures producing smoke and noxious fumes. The fire propagation properties of glass reinforced plastics can vary widely depending upon composition, and must be taken into account when they are used. Coated steel or aluminium can replace AC in some uses and there are a variety of alternatives for products such as tiles and slates. Research into substitutes for AC is continuing.

3.21 *Heat-resistant textiles, rope and packings.* Flame or heat-resistant textiles are made using glass, ceramic and various polymer filaments and are available for a wide range of temperatures. Flame-resistant wool, leather or nylon may be suitable at low temperatures. Glass fibre rope is available as a replacement for asbestos rope. In jointing and packing materials polytetrafluoroethylene (PTFE) can be used at low temperatures and ceramic, glass or carbon fibre are suitable for higher temperatures.

Safety of substitute materials

3.22 Mineral fibre substitutes are in general much safer than asbestos, but there is some evidence of a health risk from these materials, and a Health and Safety Commission working party on man-made mineral fibres (11) made the following recommendations on non-occupational exposure:

> 'Non-occupational exposures to man-made mineral fibre are likely to be of short duration and carry no significant risk to health. Nevertheless, householders insulating their own lofts would be well advised to follow the general advice on precautions set out in this report and included in a guidance leaflet available to purchasers of insulation wools at the point of sale. Use of a simple dust mask is recommended.
>
> Care should be taken in the design of plant and insulation in buildings to prevent the distribution of fibres through ducted air distribution systems.'

4 Asbestos Materials in Existing Buildings

4.1 Current uses of asbestos in building materials are described in Section 3 of this booklet and these materials will also be found in existing installations. But a number of asbestos materials which are no longer used may still be found in older buildings. This section gives brief descriptions of the most common of these materials and the action required to make them safe.

Sprayed asbestos

4.2 This is a mixture of hydrated asbestos-cement applied by spray techniques, containing up to 85% asbestos fibre. Crocidolite (blue asbestos) was extensively used in sprayed asbestos until its import was stopped in 1970, and stocks may have been used in later installations. The use of sprayed asbestos ceased in 1974. Sprayed asbestos was used to provide fire protection for structural steelwork and for thermal and acoustic insulation and condensation control. It is unlikely to be found in houses of normal construction. It is a friable material and likely to release fibres especially if disturbed during repair and maintenance work. As it ages sprayed asbestos may release more fibres and asbestos dust may accumulate in adjacent areas. Sprayed asbestos should be regularly inspected for damage or deterioration and if there is any evidence of dust release it should be effectively sealed, enclosed or removed as described in Section 5. If sprayed asbestos is left in place its location should be marked on building records or plans, and warning notices attached nearby.

Lagging

4.3 Lagging is a term which covers a wide range of materials including pipe sections, slab, rope, tape, corrugated asbestos paper, quilts, felts, blankets and plastered cement. Asbestos has also been used as a surface coating on felt and cork insulation. Asbestos lagging may have a protective covering of cloth, tape, paper or metal, or a surface coating of cement. The asbestos

content of lagging depends on the type of material and can be high. A common form of pipe and boiler lagging consists of 85% magnesia and 15% asbestos with an asbestos surface coat. Asbestos based lagging has been used in public buildings, factories and hospitals; it has been found in houses, although rarely, and in some flats with early central heating systems. The likelihood of fibre release depends on the material composition, and its friability and state of repair, but lagging is particularly susceptible to damage or disturbance during maintenance work, or because of leaks from pipes or boilers. Small damaged areas may be repaired with tape or plastered with a non asbestos material, taking the appropriate precautions (4). In general it is essential to ensure that asbestos lagging is either effectively sealed and labelled as containing asbestos, or is removed and replaced with a non-asbestos material.

Insulating boards

4.4 These are low density — approximately 700 kg/m^3 — boards containing 25–40% asbestos (usually amosite) mixed with hydrated Portland Cement or calcium silicate. Asbestos insulating board is semi-compressed and because of its softness and high fibre content gives heat and sound insulation and fire protection. It is found in all types of industrial, commercial, public and private buildings including houses and flats. Asbestos insulating board was mainly used to provide structural fire protection and heat resistance, as a non combustible core or lining for other products, and, because of its resistance to moisture movement, as a general building board. It may be found in ducting, ceilings, partitions, fire places, steel work casings, panels, door facings and wall and roof linings, including external canopies, porch linings and linings of other humid areas. Composite materials containing a core or lining of asbestos insulating board have been used in similar places to the ordinary board and as boiler casings, oven linings, and in suspended floor systems. Insulating board containing asbestos has not been made in the UK since 1980.

4.5 Shipboards are a rigid composite of amosite asbestos, hydrated lime and silica with a density of 500–700 kg/m^3. They have been used for glazing channels and, suitably coated, for sealing gaps in panels, screens and doors. Thick shipboard has been used for internal insulation and fire protection.

4.6 Asbestos insulating board ceiling tiles, intended for fire protection, were made of board cut into squares and given bevelled edges. The tiles were introduced in the early 1950s and were used in large numbers until the mid 1960s when their use started to decline. The tiles were widely used in schools, hospitals and shops. A small proportion of tiles were made with a perforated surface for acoustic absorption.

4.7 Insulating board has a higher fibre content and is softer than asbestos-cement, and is therefore more likely to release fibres. If it is damaged or deteriorates it should be replaced, and it should be removed from places where it is likely to be subject to impact or abrasion (12).

Millboard and paper

4.8 These materials have an asbestos content approaching 100% and have been used for insulation of electrical equipment, for thermal insulation and as a fire-proof facing on wood fibre board. Since their fibre content is high there could be a hazard when handling them especially when large quantities are moved after storage. These materials are not highly bonded and should not be used where they might be subject to abrasion or wear.

Yarns, ropes and textiles

4.9 Asbestos yarns, often reinforced with other yarns or filaments, were used in jointing and packing materials, gaskets and caulking for brickwork. Asbestos ropes have been widely used for thermal insulation of pipes and as a firestop where pipes pass through walls. Plaited asbestos tubing was commonly used as flexible insulation for electric wire and cable. Asbestos cloth was used in fire protective clothing such as overalls, gloves and aprons, and in fire blankets and curtains, and was sometimes aluminized to reflect radiant heat. These articles are used in foundries, laboratories, kitchens or other places where there are very hot substances. The risk of fibre release depends on the structure of the material — a bonded gasket material is unlikely to release asbestos, but an unbonded woven material could release fibres in use especially if it is damaged or worn.

5 Procedure for Existing Asbestos Installations

5.1 It is not possible to give detailed instructions on how to deal with all the many different uses of asbestos materials which may be found in buildings, but this section describes a general procedure which is summarised in Figure 1. The guiding principle is to avoid the release of asbestos-containing dust, especially in occupied areas. The airborne concentration of asbestos should always be reduced to the lowest reasonably practicable level taking into account the use and occupancy of the building.

Identification

5.2 Asbestos has been used in many building materials and these materials have been used for a variety of purposes. The first step in dealing with a suspected asbestos problem is therefore to check whether asbestos is present, and if so what type and approximately how much.

5.3 Unless the material carries an asbestos label (paragraphs 6.16 and 6.17) or some other warning notice, a simple visual examination may not be enough to determine whether it contains asbestos. A check of the original building plans may show that asbestos-based materials were specified; the type and quantity of asbestos can then be checked with the original supplier if known. If this information is not available it will be necessary to take samples of the material for analysis, but sampling itself can give rise to risks of exposure, and the other means of identification should be tried first. Samples should always be handled as if they contain asbestos until the results of analyses prove otherwise.

5.4 Sampling and analysis can be done by many well-equipped analytical laboratories, and detailed procedures can be found in works of reference (13). Some asbestos-based materials such as insulating board or asbestos-cement are relatively uniform and a small number of samples should be sufficient. Lagging and spray may be less uniform, as separate mixtures may have been used in different areas and layers. Material may also have been removed,

repaired or patched at various times in the past; the number of samples should be large enough to cover these variations in composition.

5.5 It will not usually be necessary to carry out an accurate quantitative analysis; an indication of the presence of asbestos and its type will probably be sufficient. Examination of the sample by polarised light microscopy will usually be adequate to give this information, but there are several more complex techniques available if identification is difficult. It should be borne in mind that asbestos materials might be concealed, for example in heater units, inside ducting or behind a false ceiling.

Inspection

5.6 If the presence of asbestos is confirmed the installation should be examined to determine whether asbestos-containing dust may be released. There are a number of means by which dust can be released from asbestos materials:

(i) any work which involves the use of power tools, breaking of the material or abrasion (eg maintenance, replacement or repair);

(ii) impact damage or abrasion caused by vehicles, people or movement of objects;

(iii) damage or disturbance by birds, rodents, vandalism or weathering. If friable material falls onto floors it may rapidly become broken up and dispersed;

(iv) vibration or mechanical movement of a surface, especially if the asbestos material is on the underside (eg internal insulation);

(v) strong air currents can scour fibres from soft materials such as lagging and sprayed coatings. Air movement caused by natural draughts or by forced air can release fibres and particular care must be taken to avoid blowing air over damaged surfaces.

5.7 Many of these mechanisms for dust release will occur only intermittently or transiently and may not be observed during a brief inspection. Once respirable fibres are released into the air they can remain suspended for long periods, but will be diluted and further dispersed by normal air movements. In areas with little natural air movement, such as ceiling recesses, accumulations of dust may gather.

5.8 If asbestos-containing material is loose and friable or damaged, or old and deteriorating, it is reasonable to suspect that fibres are being released and deposits of dust may be found. Undamaged bonded materials such as insulating board and asbestos-cement, especially if coated, are much less likely to release dust in normal use, but transient conditions such as those described above should also be investigated. Inspection of the material and assessment of possible causes of dust release will often provide sufficient information for a decision to be made on what action to take. If the extent of any dust release is uncertain it may be helpful to measure the airborne asbestos concentration in the building.

Measurement

5.9 Sampling and analysis of airborne asbestos can help in assessing risk when it is suspected that fibres are released regularly or where a background concentration of asbestos has built up. It will not be useful if the main mechanisms of fibre emission are transient and infrequent, unless the sampling period coincides with a period of fibre release. At the very low concentrations which are normally found in buildings it is difficult to sample and analyse airborne asbestos accurately and an experienced analysis service should be used.

5.10 The method normally used is based on the membrane filter method used to measure occupational exposure (14) and the samples are examined by phase contrast optical microscopy. Because of the lower concentrations found a larger volume sample is needed to give a statistically significant fibre count. In general it is necessary to take a sample of 0.5–2.0m^3 volume, and at least four fibres must be counted for the result to be statistically significant. The lower limit of measurement by this method is about 0.01 fibres/ml. The limit of resolution of the phase contrast optical microscope restricts the size of fibre which can be seen; the standard occupational measuring method specifies fibres having a length greater than 5 μ m, a diameter less than 3 μ m and a length:diameter ratio greater than 3:1. Many of the fibres found in buildings are very small with a diameter below the limit of visibility of phase contrast microscopy. But the longer fibres which are believed to be the most dangerous will frequently be wide enough to be counted.

5.11 There are many sources of airborne dust in buildings, some of it fibrous (eg gypsum, carpet fibres), and there can be serious problems in identifying asbestos fibres amongst the other material on the filter. Phase contrast microscopy cannot positively distinguish between asbestos and other organic or inorganic fibres, and a technique such as polarised light microscopy or

electron microscopy with energy dispersive X-ray analysis is needed to identify fibres with certainty. If the fibre count by the standard method gives cause for concern it will be necessary, for a full interpretation of the results, to identify the fibres using a more complex and expensive analysis method.

Assessment

5.12 The assessment of the risk due to asbestos dust release requires:

(i) identification of the asbestos material;

(ii) inspection of the material to assess dust release;

(iii) evaluation of the significance of any dust release.

The inspection process will reveal sources of asbestos and associated mechanisms for dust generation. The more violent generation mechanisms are likely to produce the highest dust levels, but these are also likely to be the most transient. It is therefore possible that atmospheric sampling will not give an accurate assessment of peak dust levels. It is equally important to identify transient conditions which might generate dust, and avoid them. Undisturbed materials have been found to release very little dust.

5.13 In general, if asbestos materials are sound and undamaged, and there is no evidence of dust release, they may be left in place. Precautions should be taken to alert maintenance workers to the existence of asbestos materials, and the presence of asbestos should be marked on records or plans for future reference. A sealing coat can be applied as an added precaution (paragraphs 5.16 to 5.21).

5.14 If there is evidence of dust release, either from inspection or from dust measurement, it will be necessary to take further action to seal or remove the material. The main factors which need to be taken into account in deciding on a course of action are:

(i) the type and condition of the material;

(ii) the frequency of disturbance or damage to the material;

(iii) the amount of dust released;

(iv) the use of the building;

(v) the difficulty and cost of sealing or removal;

(vi) the cost of replacement, if required.

5.15 A control strategy, including both remedial and preventative measures, will need to be developed for each case, based on an individual assessment of these factors. In general priority should be given to cases where there is clear evidence of dust release or where the risk of release is high, and where people, especially children, are likely to be exposed for long periods. If the action taken is likely to lead to an increase in airborne asbestos dust the work area should be sealed off (4) or the building emptied while the work is carried out and, after completion, the airborne asbestos concentration should be measured before the area is re-occupied.

Sealing

5.16 Rigid asbestos materials such as insulating board or asbestos-cement (AC) may be sealed by painting. The surface should be prepared and damaged material repaired, but asbestos materials should not be sanded or wire-brushed. Dusty surfaces can be cleaned with an industrial vacuum cleaner fitted with a high efficiency filter (not a domestic cleaner) or wiped with a damp cloth which is disposed of in a sealed bag while still damp. AC used externally may need treatment with a biocide (paragraph 3.8) before painting.

5.17 Insulating board can be painted with an initial coat of diluted PVA emulsion followed by one or more full strength coats. AC is alkaline and should be primed with an alkali-resistant primer or a chlorinated rubber or oleo-resinous paint followed by one or more top coats. Where possible both sides should be painted. The general safety instructions in paragraphs 3.4 to 3.7 should be followed.

5.18 When a higher degree of protection from damage is required a number of other sealing systems are available:

(i) flexible or semiflexible polymeric or bitumen coating;

(ii) inorganic cement type coating;

(iii) preformed sheet or panels.

The choice of sealing system depends on the nature of the asbestos material, the degree of damage protection required and any surface flammability requirements.

5.19 Friable materials, such as sprayed asbestos and lagging, can be sealed with sprayed or brushed polymeric or bituminous coatings or with a hard setting cement type coating supported, if necessary, by a metal mesh. The sealing coat must adhere firmly, and the asbestos material itself should be

checked to ensure that it is sound and firmly attached to the underlying surface. Alternatively asbestos surfaces can be boxed-in with sheet material suitably sealed at corners and edges, provided adequate resistance to fire spread can be maintained. The enclosed area between the covering and the asbestos material should be sealed and adequate cavity fire barriers constructed. Precautions must be taken to protect the people doing the work from exposure to asbestos dust (4).

5.20 Where asbestos insulation is being used for fire protection it is important that the fire hazard is not increased by the use of combustible sealants. The sealed materials must meet the standard for spread of flame specified in the Building Regulations (as defined in BS476). Normal paints may not achieve this standard and specially formulated sealants are available (15).

5.21 Arrangements should be made to alert maintenance workers to the existence of asbestos materials. The presence of asbestos should be marked on building records or plans, and as an additional precaution warning notices may be attached at places where the material might be disturbed during maintenance work. In the case of housing occupants should be made aware of the location of any asbestos materials and advised of appropriate precautions. Sealed asbestos should be checked regularly to ensure that the sealing is intact.

Removal

5.22 When it is not possible to seal an asbestos material effectively or it is subject to frequent disturbance and likely to release dust, it may be decided to remove it completely. However it should be recognised that removal will often lead to higher short-term dust levels than sealing the material in place, and appropriate precautions must be taken.

5.23 Removal of asbestos materials, especially sprayed asbestos or lagging, should in general be carried out by a specialist contractor or trained staff. The Health and Safety Commission (HSC) has published draft regulations on the licensing of work with asbestos insulation and coating (3), and Codes of Practice on work with asbestos materials (4,7,12) have been published or are in preparation.

5.24 The HSC regulations are not intended to cover occasional removal of small quantities of asbestos material by an individual householder, and small quantities of asbestos-cement or insulating board can be safely removed

provided the precautions outlined in paragraphs 3.4 to 3.7 are followed. Removal of any loose or friable material should be left to a specialist contractor.

5.25 When friable materials are removed it will usually be necessary to empty the building or seal off the working area. This may not be necessary when non-friable materials such as asbestos-cement or insulating board are removed, but people not engaged in the work should be kept out of the working area. The whole area should be thoroughly cleaned up afterwards, and after large-scale removal work the airborne fibre concentration should be measured before the area is re-occupied.

5.26 When asbestos-cement or insulating board is removed it should be wetted to suppress dust and the sheets should be removed whole and not be broken up. The material removed and any dust or debris should be carefully collected and any smaller pieces or dust should be dampened and sealed in strong plastic bags marked 'asbestos'. The working area should be thoroughly cleaned after removal using a dustless method (paragraph 3.5).

5.27 When asbestos fire protection material is removed it must be immediately replaced with materials having an equivalent fire performance. When sprayed asbestos or lagging is removed, particularly from a substrate with a rough surface, it may not be possible to remove all traces of asbestos, and in this case a sealing coat should be applied after removal.

Disposal

5.28 Asbestos materials are classed as controlled wastes and must be disposed of at sites licensed by a Waste Disposal Authority under the Control of Pollution Act 1974. The Waste Disposal Authorities are the metropolitan and non metropolitan county councils and the Greater London Council in England, and the district (or island) councils in Wales, Scotland and Northern Ireland.

5.29 Hazardous wastes which are particularly dangerous are classified as 'special wastes' (16) and include:

(i) any measureable quantity of crocidolite (blue asbestos);

(ii) any other form of asbestos containing at least 1% by weight of free fibres or dust.

The Special Waste Regulations (17) are additional to the waste disposal site licensing provisions and provide for control of the transport of the waste from

the point of arising to the proper disposal site. The conveyance and disposal of asbestos wastes are often carried out by specialist hazardous waste disposal contractors.

5.30 Fibrous or dusty waste should be sealed in strong plastic bags, and if blue asbestos is present the bags should be labelled 'Blue asbestos — do not inhale dust'. Most asbestos waste is disposed of by landfill, and the bags should be covered with at least 20 cm of consolidated earth immediately on receipt at the site. It is not so important for asbestos-cement or other bonded asbestos wastes to be covered immediately but they should be covered by the end of each working day. A Waste Management Paper (18) published by the Department of the Environment includes a full code of practice on the disposal of asbestos waste.

5.31 Advice on the disposal of small quantities of asbestos waste arising in the home is given in the booklet 'Disposal of awkward household wastes' (19). Small quantities of waste can be disposed of, after dampening any dust, by sealing in a plastic bag and placing in the dustbin. Where more significant amounts of waste are involved the booklet advises that it should be sealed in a marked bag and arrangements made with the local authority for collection and disposal. The public does not usually have access to hazardous waste disposal sites, but civic amenity sites are available in many areas and small amounts of asbestos waste can be disposed of by the public at these sites provided it is properly sealed in a bag. Larger sheets of asbestos-cement should not be broken up for disposal; if they are taken to civic amenity sites they need not be sealed in bags but should be kept clear of other wastes.

Figure 1 Dealing with asbestos materials in buildings

1	IDENTIFICATION	Does the material contain asbestos; if so, how much and what type?
2	INSPECTION	Is the material friable and likely to release dust; is there any loose dust? Is the material damaged or deteriorated; could dust be released when the material is disturbed?
3	MEASUREMENT	Airborne asbestos concentrations can be measured using a membrane filter method; if significant numbers of fibres are detected, identify the fibrous material.
4	ASSESSMENT	If there is a possibility of asbestos dust release take further action to seal or remove the material.
5	SEALING	Paint, seal or enclose the material to prevent dust release; record the presence of asbestos.
6	REMOVAL	Alternatively the material may be removed following approved safety procedures.
7	DISPOSAL	Asbestos waste must be disposed of safely as a controlled or special waste.

The aim is to reduce exposure to airborne asbestos to the lowest reasonably practicable level.

6 Domestic appliances, household goods and DIY work

6.1 Asbestos has a variety of domestic applications. In addition to its uses in building construction it is found in some domestic appliances, household goods and DIY materials. It may also be present in the fixtures and fittings of the home, such as fireplace surrounds, lagging on old central heating systems, asbestos-cement flue pipes for central heating boilers, and asbestos millboard covers for fuse boxes. For the majority of applications in the home, the likelihood of fibre release from undamaged, asbestos-containing products in situ is very small. The background level of free asbestos found in houses is, in general, extremely low and poses negligible risk to the occupants. However, it is important to minimise the release of asbestos dust in the home since people can be exposed for long periods. The mere presence of asbestos-containing materials in the home does not necessarily constitute a hazard, and removing undamaged material may create more hazard from dust than would leaving it in place. It is only when asbestos materials are in a damaged or friable condition, or during their installation, modification, removal or demolition that there is the possibility of significant fibre release.

Domestic appliances

6.2 Asbestos has been used in domestic appliances for its thermal or electrical insulating properties, as a friction material, and in gaskets and seals. UK manufacturers no longer use asbestos in hair driers, fan-heaters, irons, toasters, washing machines, tumble driers, spin driers, dish-washers, refrigerators or freezers, except for small amounts in some appliances in the form of gaskets or braking pads which are usually completely sealed within the appliance and are unlikely to release free fibres to the atmosphere.

6.3 Asbestos may be present in some older types of cooker in the lining of ovens and in oven door seals. These are not likely to present a hazard to the user unless they are damaged or become friable, in which case they should be replaced. Any dust released should be wiped out with a damp cloth which

should then be disposed of safely. Use of asbestos materials in cookers is being phased out.

Household goods

6.4 Asbestos textiles are no longer used in oven gloves manufactured in the UK, although some imports may still contain asbestos. Simmering mats made from asbestos millboard or asbestos paper are widely available. They are a potential source of exposure if they flake with ageing. Mats showing signs of deterioration should be disposed of safely.

6.5 Older types of ironing board may have iron rests made of asbestos millboard or paper. These are also liable to wear with age and should be replaced if they show signs of damage or wear. In recent years, iron rests have been made of asbestos-cement, which is much more hard-wearing than millboard or paper and contains a smaller percentage of asbestos. It is resistant to abrasion and the fibres are bonded into the material. Unless damaged by impact it is unlikely to present any hazard to the consumer.

Heaters

6.6 Some types of catalytic gas heater, fuelled by liquefied petroleum gas, contain loosely compressed asbestos fibre panels. Catalytic heaters are the type which 'burn without a flame'. Gas passes over a panel of asbestos or man-made mineral fibre containing platinum catalyst. Asbestos panels may contain up to 0.5kg of chrysotile asbestos. The panels may crumble as they age and asbestos fibres can be released into the air. Deterioration of the panel may be apparent on visual inspection as bald patches or as a dusty deposit on the surfaces below it. Earlier types of panel are held in place by wire mesh only. Later types are covered by another woven material, but this does not necessarily seal the asbestos in. The Department of Trade has issued a public warning about these heaters (20), and detailed advice has been issued to environmental health departments. Members of the public in any doubt about the condition of such a heater should contact their local authority environmental health department for advice.

6.7 Asbestos materials have been used in some impelled (fanned) warm air heating systems. Some heater units have asbestos insulation around the fan or heat exchanger, and asbestos materials have been used to line the air ducts. Asbestos insulating board has also been used for fire protection in cupboards housing impelled warm air heating units. There is a risk of fibre release if the

insulation is damaged (during installation, running or maintenance) or weakened by age. British Gas Regions or Electricity Boards may be able to advise whether a particular impelled warm air heating system contains asbestos material and whether it can be inspected without dismantling the unit. If it does contain asbestos, the condition of the material should be checked where this is practicable. If there are any signs of deterioration or dust release, or if it is not practicable to carry out adequate inspection, the substitution for this material of an asbestos free material with equivalent fire performance (approved by the manufacturers) should be considered.

Alternatively it may be more economic or practical to replace the entire unit, especially if it is approaching the end of its useful life.

6.8 Asbestos insulating board or other asbestos-based material may sometimes have been used for fire protection in cupboards, stores and doors housing heater units, and in the case of warm air units any loose fibres could be distributed through the heating system. Insulation used in such circumstances should be checked and if necessary sealed as described in paragraphs 5.16 to 5.21, or it may be replaced with an asbestos-free substitute material with equivalent fire resistance. An advice note concerning some types of impelled air heaters has been issued to local authorities by the Health and Safety Commission, outlining remedial measures which can be taken where action is necessary (21).

DIY work

6.9 Do-it-yourself (DIY) applications for asbestos span a wide range of products. Some of these are listed in Table 2 but it should be emphasised that many manufacturers of the products listed do not use asbestos and that products containing asbestos are now the exception rather than the rule. The asbestos content of individual products varies enormously, eg from 0.5–2.0% in putties up to 90% in damp-proof courses, as does their potential to release fibres during DIY work. Once in place and during normal wear, these products present very little hazard in the home; in most cases, the fibres are bonded in the material and cannot be released unless the material is disturbed or damaged. However, during DIY work with some of these products it is possible for some fibre release to occur, and precautions should be taken to avoid inhaling any dust (see paragraphs 3.4 to 3.7 and 5.22 to 5.27). Waste material and dust must be safely disposed of as described in paragraphs 5.28 to 5.31.

Table 2 DIY Products

Wall plugging compounds	Floor tile cement
Textured paints	Vinyl floor tiles
Flashing tape	Cushion flooring
Mastics	Roofing felt
Bitumen sealants	Damp-proof courses
Putties	Asbestos rope/string
Asphalt tile adhesive	

6.10 Wall plugging compounds and dry-mix textured paints may contain loose asbestos, which is bonded into the material only when water is added to the mix just before use. Wall plugging compounds comprise asbestos dust, long cotton fibres and plaster or cement. They are generally used in small quantities and for short periods of time, so any intake of dust should be small. Care should be taken to follow the manufacturer's safety instructions and to avoid leaving containers open. Other types of filler used to repair damage to plaster do not now contain asbestos, though some have in the past. (For information on textured paints and other DIY materials see paragraphs 3.9 to 3.12).

6.11 Asbestos rope or string is available from specialist shops serving the plumbing and heating trade. It is used for caulking, packing, jointings and occasionally thermal insulation. It is generally sold as 'dust suppressed'. This diminishes but does not eliminate the possibility of fibre release. In the home, it is likely to be present or used only in small quantities and asbestos-free substitutes are now available.

Flooring materials

6.12 Asbestos is added to the mix of certain PVC and thermoplastic floor tiles and sheet materials to give improved strength and stability, and some types of PVC cushion flooring have an asbestos paper backing. Fibres bonded into flooring will be released as the material wears, but the rate of release is likely to be very low except under conditions of heavy wear in commercial or industrial buildings. It is recommended that worn flooring should be replaced. Asbestos-free replacement flooring materials are becoming increasingly available.

6.13 When flooring containing asbestos is being removed it should be lifted carefully and any residue left behind should not be removed by power sanding. It is preferable to cover or skim the uneven surface. Cushion flooring with an asbestos-paper backing should be cut and laid carefully and should

not be stuck down. When removing this material it should be lifted carefully and any loose dust dampened and collected; any backing sticking to the floor should be carefully removed while damp. It must not be removed with a power sander. Waste material should be disposed of as described in paragraphs 5.28 to 5.31. It should not be burned. Asbestos is currently being phased out of flooring materials made in the UK.

Asbestos-cement water storage cisterns

6.14 Cold water storage cisterns are sometimes made from asbestos-cement (AC). They are generally durable and not easily damaged by moderate freezing conditions. The asbestos fibres are found within the cement and can be released only by abrasion, drilling of holes or by dissolution of the cement surface by very corrosive water. Most public water supplies are now treated to prevent corrosion of the materials with which they come into contact. It is only very soft highly acidic waters which could attack the surface of AC significantly, and where such waters are supplied it is likely that AC tanks will have been lined with a suitable bituminous coating.

6.15 Water for drinking and cooking should — for reasons of hygiene unconnected with asbestos — be drawn only from the kitchen tap supplied directly from the main. It should not be drawn from any storage tanks in a roof space or from hot water systems fed via storage. Studies on water which has been passed through AC pipes have indicated that there is no significant increase in asbestos fibre count in the water and any increase from AC cisterns is likely to be even less. Therefore unless an AC storage tank is corroded internally there is no reason to consider its immediate replacement. But if it has an AC cover, this could be corroded on its underside by condensation (which is soft and aggressive) and should be replaced with a close fitting lid of another waterproof material.

Labelling of asbestos products

6.16 A voluntary labelling scheme for asbestos-based products was introduced in the UK in 1976. The purpose of the scheme is to enable anybody who has to work with these products to be able to identify them immediately and be aware of the need to take adequate precautions. Informing consumers which products contain asbestos also enables them to take this into account when deciding which products to purchase. The scheme applies to all asbestos-containing products which could constitute a possible danger to health through release of asbestos dust, whether at work or through use in the

home, including DIY activities. A list of products known to meet these criteria is available from the Asbestos Information Centre (22). It includes building materials, thermal insulation materials, domestic goods, asbestos textiles, millboard, paper, fibre waste intended for sale, asbestos based friction materials, asbestos-reinforced plastics and processed asbestos fibre. The list is not intended to be exhaustive and any products which clearly meet the criteria set out above should be labelled. Labelling is not required where asbestos fibre has been modified by a bonding agent, coating, binder or other material so that the likelihood of free fibres being released during any foreseeable use is negligible. This exception does not apply to domestic goods.

6.17 The label takes the form of a standard warning 'Take care with asbestos. Warning. Breathing asbestos dust can damage health. Observe the safety rules', together with a large letter 'a'. The information on the label should be supplemented by safety advice.

6.18 A recently agreed European Community Directive will, when implemented, require all asbestos containing products sold in member states to carry a standard label and safety warning either on the product itself or on its packaging.

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Printed in England for Her Majesty's Stationery Office by Robendene Ltd., Amersham, Bucks
Dd 736562 C46 8/83