Department of the Environment
Industry Profile

Timber products manufacturing works

Industry Profile sponsored by
Contaminated Land and
Liabilities Division

Industry Profiles, together with the Contaminated Land Research Report series, are financed under the Department of the Environment's contaminated land research programme.

The purpose of these publications is to provide regulators, developers and other interested parties with authoritative and researched advice on how best to identify, assess and tackle the problems associated with land contamination. The publications cannot address the specific circumstances of each site, since every site is unique. Anyone using the information in a publication must, therefore, make appropriate and specific assessments of any particular site or group of sites. Neither the Department or the contractor it employs can accept liabilities resulting from the use or interpretation of the contents of the publications.

The Department's Contaminated Land Research Report series deals with information needed to assess risks; procedures for categorising and assessing risks; and evaluation and selection of remedial measures.

General guidance on assessing contaminated land and developing remedial solutions which is complementary to the Department's publications is provided by the Construction Industry Research and Information Association (CIRIA).

ISBN 1 85112 308 3

Acknowledgements

The Department of the Environment is grateful to the members of the Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL), and the following individuals and organisations for assistance in the compilation of this profile:

Mr R Allcorn (TRADA Technology Limited)
Mr D L Barry (WS Atkins Environment)
Mr S D Margolis (British Woodworking Federation)
Mr S Page (Crosby Sarek Limited)
Mr J M Shipman (Research and Technology, Furniture Industry Research Association)
Mr R P J Swannell (AEA Technology, Harwell)

DOE Industry Profile

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This profile is based on work by Dames and Moore International and was prepared for publication by the Building Research Establishment.

Preface

DOE Industry Profiles provide developers, local authorities and anyone else interested in contaminated land, with information on the processes, materials and wastes associated with individual industries. They are not definitive studies but they introduce some of the technical considerations that need to be borne in mind at the start of an investigation for possible contamination.

Every site is unique. Investigation of a site should begin with documentary research to establish past uses. Information on the site's history helps to focus a more detailed investigation. This knowledge needs to be supplemented by information on the type of contamination that may be present and where on site it may be found. Profiles give information on the contamination which might be associated with specific industries, factors that affect the likely presence of contamination, the effect of mobility of contaminants and guidance on potential contaminants.

The date when industrial practices first commenced on a site and its location are important clues in establishing the types of operations that may have taken place, so each profile provides a summary of the history of the industry and its likely geographical spread within the United Kingdom.

Profiles should be read with the following reservations in mind:

- individual sites will not necessarily have all of the characteristics described in the profile of that industry;
- practices can vary between sites and change over time;
- as practices change, problems of possible contamination may also change;
- the profile may refer to practices which are no longer followed, and may omit current practices which avoid contamination.

The risks presented by contaminated sites depend on the nature of the contaminants, the targets to which they are a potential threat (such as humans or groundwater) and the routes or pathways by which they reach these targets. The current or proposed use of a site and its environmental setting are crucial in deciding whether treatment is necessary and if so, the methods to be used. Some sites may not need treatment.

The information in profiles may help in carrying out Control of Substances Hazardous to Health (COSHH) assessments for work on contaminated land - see Health and Safety Guidance Note HS(G) 66 *Protection of workers and the general public during the development of contaminated land,* Health and Safety Executive, 1991, and *A guide to safe working practices for contaminated sites,* Construction Industry Research and Information Association, 1995.

Note: the chemical names given to substances in this profile are often not the modern chemical nomenclature, but the names used historically for those substances.

Timber products manufacturing works

1. Background

This profile deals with the manufacture of solid wood and wood-based panel products. It also includes the finishing of wood products with surface coatings such as varnishes and paints at their place of manufacture. It does not include the off-site preservative treatment of timber, which is dealt with in a separate Industry Profile (see Section 4).

1.1 Solid timber products

The solid timber products manufacturing industry can be broadly divided into three categories:

construction timber (trussed rafters and beams)
joinery (window frames, doors and staircases)
furniture.

The construction industry is the largest consumer of timber products in the United Kingdom, the second largest being the furniture industry.

Timber products have been made wherever small centres of population have grown up, and timber products manufacturers have become established throughout the country, with no particular regional bias. Historically, the home of furniture making was High Wycombe, although large quantities were also manufactured in East London, Leeds, Manchester, Bristol and East Anglia.

Census of Production data suggest that the maximum number of establishments (including sawmills) was just over 21 000 in 1930. The number decreased to some 8500 facilities in the late 1960s, but an expansion in the industry in the 1980s showed an increase up to about 15 000. In 1993, there were some 12 650 establishments operating in the United Kingdom.

The majority of manufacturing works in 1935, 1968 and 1993 were small scale operations, ie about 80% of establishments employed less than 25 people. Large scale operations employing more than 500 people represented less than 1% of the total number of works, and these were restricted to furniture manufacturing works and sawmills.

1.2 Wood-based panel products

Wood-based panel products increase the use of raw wood by using a higher proportion of the felled tree. They also have advantages over solid wood; large sheets can be produced and the major defects and differences in properties along and across the grain, characteristic of solid timber, can be avoided. Wood-based panel products fall into three main groups:

fibre building boards
particleboard (mainly chipboard)
plywood.

There are four main types of fibre building boards: softboard (including a bitumen-impregnated product), mediumboard, hardboard and medium density fibreboard (MDF).

The first fibre building boards were produced in 1898 and the industry expanded rapidly in the 1920s and 1930s. Medium density fibreboard is a modern product, manufactured over the last two decades. Its production is increasing rapidly, since it is replacing chipboard in many applications and is being used in totally new areas. There are currently three manufacturers of fibre building board in the United Kingdom: Caberboard Limited, Kronospan and Sundeala Board Company.

Plywood, made from thin veneers of solid wood, was first manufactured in the mid-19th Century. The industry was well established by 1890. Improvements in the bonding resins used in plywood manufacture greatly improved board construction and use in the 1970s and 1980s. However, the plywood industry has declined in the face of foreign competition and speciality boards are now manufactured at only two plants.

The United Kingdom particleboard manufacturing industry grew up near to sources of indigenous softwoods, for example the forests of Scotland, Wales, Lincolnshire and East Anglia. The most common particleboard, chipboard (made from wood chips), was first manufactured in the 1940s. Improvements in board technology, developed for plywood manufacture in the 1970s and 1980s, were also applied to chipboard. There is an expanding chipboard industry in the United Kingdom, manufacturing boards mainly from indigenous softwoods. More modern particleboards which have been manufactured over the last two decades include waferboard, oriented strand board (OSB) and cement-bonded particleboard.

2 Processes

2.1 Raw materials and methods of delivery

The chemicals required for the manufacture and subsequent on-site treatment of timber and timber products are generally received as powdered solids or liquids.

2.1.1 Adhesives

Two types of adhesive are used. The major synthetic resins, used in the manufacture of panel products and some solid wood products, are formed by the reaction of formaldehyde with urea, melamine, a mixture of urea and melamine, or phenol. A hardener is added to the resin before application. Adhesives based on polyvinyl acetate (PVAc) are only suitable for non-loadbearing applications and are used in solid wood products, particularly furniture and joinery.

Formaldehyde resins

Aqueous solutions of the various formaldehyde resin compounds are used. Generally, relatively high volumes of these resins are required and so the solutions are usually transported by bulk road tanker and are off-loaded and transferred to storage facilities on site. Powdered phenolic formaldehyde resin is typically delivered and stored on site in one tonne bags.

American isocyanate resin technology for both chipboard and MDF is being actively promoted in the United Kingdom. Trials have been undertaken at United Kingdom sites with a view to introducing this type of resin.

Small quantities of resin hardeners are used, typically various ammonium compounds and maleic acid. The materials are generally delivered to site in kegs, drums and bags and then mixed and stored as aqueous solutions. The use of chloride-based resin hardeners is decreasing because dioxins/furans may be formed during incineration of the process wastes. Substitution with sulphate-based resin hardeners is now common practice.

Polyvinyl acetate
These are one- or two-part emulsions. Two-part PVAc adhesives are strengthened by the addition of an isocyanate hardener before application and are therefore more durable than one-part types. PVAc adhesives are generally transported in drums or kegs.

2.1.2 Surface coatings
Coatings consist of fine pigments, dispersed in a binder and dissolved in a solvent, which may be an organic type (eg toluene, xylene, white spirit or glycol) or water. There may be additives to prevent deterioration of the coating in the drum, to improve properties such as viscosity, flow or drying rate, or to inhibit the growth of micro-organisms (see the profile on Chemical works: coatings (paints and printing inks) manufacturing works, Section 4).

Surface coatings are usually delivered in drums.

2.1.3 Other materials
These include sizing agents (for example, anionic, cationic and non-ionic wax emulsions, and chromium complexes of long chain fatty acids), wood preservatives and fire retardants, alum and bitumen. For more information on wood preservatives, see the profile on timber treatment works (see Section 4).

2.2 Handling and transfer of materials

Transfer from bulk tankers to the storage area is normally undertaken by coupling tankers to receiving pipework and pumping or blowing out the chemicals. Once bulk liquids are in storage tanks, no manual handling occurs except at periods of maintenance or when unforeseen problems occur. Transfer from the product storage area to the process units is generally by pump.

Small kegs and bags of chemicals may be handled manually. Larger drums or tonne bags are normally transferred from the storage area to the mixing or application area using fork-lift trucks. Liquid materials stored in individual kegs or drums are transferred on site for mixing or application as required. Bagged materials are often cut with a knife and poured into the mixing vessel. Although the current trend in the industry is for mandatory containment bunds, less rigorous controls will have been usual in the past.

2.3 Manufacturing processes

2.3.1 Solid timber products

The manufacturing process varies depending upon the nature of the finished product. The timber is generally brought into the plant in log or plank form, either from a United Kingdom sawmill or from the docks where it has been imported. If the finished product is likely to be at risk from fungal decay, then the timber may be treated with a wood preservative. Sawn timber is treated at the sawmill or in a preservative pre-treatment works, before manufacture of the timber components. Alternatively, machined timber components can be treated before assembly, or the final product treated after assembly and gluing; again, treatment may be carried out at a separate facility on the same site or off site at a specialist timber treatment works (see the profile on timber treatment works for information, Section 4). The timber is dried, usually in a kiln, to a moisture content appropriate to its intended use. Surface coatings such as paints, stains and varnishes are often applied in-house.

2.3.2 Fibre building boards

These are based upon ligno-cellulosic fibres derived from woody structures such as sugar cane fibre and forest thinnings. One of the three plants currently operating in the United Kingdom manufactures its board solely from old newsprint.

The first stage of manufacture is the reduction of the woody raw material to chips. The chips are treated by steam under pressure to soften the lignin and then reduced to fibre, either by mechanical action, or by ejection from the steam-heated pressure vessel, which causes them to explode.

Hardboard, mediumboard, and softboard are produced by a wet process. The fibres are added to water to produce a slurry with a 3-5% fibre content. At this stage, additives such as water-repellent size, a solution of alum, wood preservatives, flame retardants or bitumen emulsion may be added to the pulp.

The slurry is then passed to a forming machine, where it is felted and mechanically de-watered. Felting and interfibre bonding resulting from the natural resin present in the wood raw material produce the strength of the board. A small amount of synthetic resin may be added to increase strength. The resulting board is cut into strips and transferred to drying ovens.

Medium density fibreboard differs from the other three board types in that it is produced using a dry process. The wood fibres are dried before they are formed into a mat for pressing. In the absence of water, and at lower pressing temperatures compared with those used for other fibre building boards, interfibre bonding is not effective. Instead, the high strength of medium density fibreboard is achieved by the addition of synthetic resin, giving it a major advantage over normal mediumboard.

2.3.3 Particleboard

Chipboard is manufactured from a combination of both scrap and mechanically produced wood chips, the grades of which are selected in order to meet the required physical characteristics of the particular finished board. Wood chips are dried and sprayed with an emulsion of resin, hardener and surfactant before being transported in an air stream to a forming station, where a mat of chips is formed on a stainless steel caul or platen. The platen is fed into a heater press where it is compressed and the resin is cured at high temperatures. After curing, the board is cooled, cut to size, and sanded to produce a smoother finish.

Waferboard was constructed from large wafers of wood, up to about 75 mm square and 0.5 mm thick, bonded together with powdered phenol formaldehyde resin under pressure and heat. Waferboard has now been replaced by OSB which is of similar construction to waferboard but the wood particles used in its manufacture are rectangular, with the width characteristically about half the length. There is some alignment of the particles (strands) to create a three-ply or, more rarely, five-ply structure.

Cement-bonded particleboard, as its name implies, uses cement as a bonding agent.

2.3.4 Plywood

Plywood comprises an assembly of thin veneers of solid wood bonded together by an adhesive, with the direction of the grain in alternate plies usually at right angles.

Manufacture begins with the production of a continuous sheet of veneer from a full log. This is fed through a continuous dryer to ensure that the moisture is evenly distributed throughout the ply. The dried veneer is graded by appearance and narrower widths are joined to form standard widths. The plies are glued together using mechanical glue spreaders. The assembled packs of veneers are finally loaded into heated presses for pressing and curing. After the board has been cured, it is sanded to the required thickness and trimmed to size.

2.3.5 Surface finishing

Surface coatings are usually applied as several coats, generally a basecoat or primer followed by one or more top coats. Some products may be finished with a basecoat or primer only, with topcoats being applied where the products are to be used. Other products may leave the manufacturing works fully-finished.

There is an increasing trend for a laminate to be produced and applied on site to wood-based panel products. The laminate consists of a paper layer impregnated with urea, formaldehyde or melamine, to produce an aesthetic and durable finish.

2.4 Ancillary activities

Most sites operate, service and repair a fleet of vehicles and have large on-site engineering and electrical departments. In addition, some sites may have their own electrical sub-stations, with equipment possibly containing polychlorinated biphenyls (PCBs). PCBs may also occur in other electrical equipment across the site.

2.5 Waste management

Most wood waste, including off-cuts, work dust, sander dust, trimmings and rejected final product, is used as fuel. This waste continues to be burned on site to provide steam, or for general heating, although it is now combusted under controlled and regulated conditions. Those substances not suitable for burning, and the ash resulting from burning, are disposed of to licensed landfills. Dioxins and furans may be present in areas where waste wood products were incinerated in the past, or where ash from burning was disposed of on site.

Waste management policies have advanced significantly since the mid-1970s.

Some wood waste is recycled for a variety of uses, such as for wood chips or sawdust, or for reprocessing eg for paper or board production. Bark is normally converted to a mulch for horticultural dressing or used as a surface dressing at racehorse tracks.

Medium density fibreboard production and on-site formalin manufacture create large volumes of wastewater which require treatment prior to discharge. Surface run-off from sites has a high biological oxygen demand (BOD) and a high concentration of suspended solids. The laminate process produces significant volumes of resin slurry containing a high paper fibre burden. Currently this waste is landfilled, although at some sites there is a trend towards blending it with work dust and sander dust and incinerating the mixture. In the past, wastewaters were normally discharged to local authority sewers, subject to discharge consents.

3. Contamination

The contaminants on a site will largely depend on the history of the site and on the range of materials produced there. Potential contaminants are listed in the Annex and the probable locations on site of the main groups of contaminants are shown in Table 1. It is most unlikely that any one site will contain all of the contaminants listed. It is recommended that an appropriate site investigation be carried out to determine the exact nature of the contamination associated with individual sites.

3.1 Factors affecting contamination

Sites may have been occupied by the industry over a considerable period, and older sites will predate the introduction of good housekeeping practices.

Ground contamination may relate to the drainage system, including sumps and soakaways, which may have been used to collect or dispose of any spillage and leakages. Some of the chemicals were originally in solid form, but during the various processes may have been dissolved in water or organic solvents. In addition, many slurries have been produced in the panel products manufacturing industry.

Storage tanks and delivery lines, particularly those underground, may be significant sources of ground contamination as there may have been undetected leakages for long periods. The lack of bunding around above-ground chemical storage areas, including those for hydrocarbon fuels, may have resulted in widespread contamination.

Hydraulic presses may have, in the past, used polychlorinated biphenyls (PCBs) because of their low flammability characteristics. PCBs may also have been used as dielectric fluids in transformers or capacitors and contamination may have occurred during refilling or dismantling of these.

Asbestos may have been used in building materials, such as cladding and roofing, and as fire protection and insulation of structural steel and pipelines.

Fires, especially in chemical storage areas, may have caused spillage. Contaminated fire-fighting water may enhance migration.

Both timber products and chemicals may have been disposed of on site and areas where this has taken place are likely to be contaminated. Waste disposal areas could also be the source of hazardous gases such as methane, carbon dioxide and hydrogen sulphide, generated biologically, as well as vapours of volatile organic compounds.

Dioxins and furans may be formed by the incineration of wastes containing chlorine-based resin hardeners.

3.2 Migration and persistence of contaminants

The transport and fate of both organic and inorganic compounds within the soil depends on physical, chemical and biological factors. The higher the organic matter and clay content within the soil, the greater the degree of adsorption of contaminants and the lower their mobility. The greatest mobility will occur in coarse-grained sands and gravels with low organic content. The less soluble organic compounds which become adsorbed on to clay or organic matter will provide on-going sources of water pollution long after the source has been removed, by continuing to desorb into soil-water.

Many of the organic solvents liable to be encountered have moderate to high vapour pressures. Close to the soil surface some will be lost directly to the atmosphere by evaporation. Lateral movement through the soil either in the dissolved or vapour phase may also contaminate surface water.

Organic solvents and hydrocarbons of low water solubility tend to migrate to the water-table, although migration is dependent upon soil characteristics. In most cases, such compounds are less dense than water and float on the surface of the water-table. Those more dense than water sink to the bottom of aquifers and their migration may not be consistent with the general groundwater flow. Although the solubility of some of the other organic compounds (eg the wood preservative pentachlorophenol and some of the organophosphorus compounds) is relatively low, their dissolved concentrations may be several orders of magnitude greater than water quality standards permit.

The more water-soluble organic solvents used in timber production, such as the ketones and glycols, dissolve and readily migrate through the soil system and eventually to groundwater. Formaldehyde is particularly mobile and may migrate considerable distances from its source. Many of the inorganic finishes used, such as the compounds containing boron, together with those used as hardeners, for example the ammonium compounds, are soluble and have significant potential to migrate.

Significant spillages of organic solvents into the soil may accelerate the migration of other compounds that have low water solubility but which are readily soluble in organic solvents. This will increase the potential for groundwater contamination by compounds such as organic dye materials, metals from pigments, preservatives and possibly even some of the resin-associated materials.

Biodegradation processes in soils can be influenced by a number of factors, namely moisture content, oxygen concentration and pH, acting separately or in combination. For example low moisture content reduces microbiological activity, while high moisture content can reduce oxygen penetration and possibly lead to anaerobic soil conditions. Such conditions enhance the biodegradation of some materials, eg chlorinated compounds, while aerobic conditions are needed to biodegrade many oils. Also, low pHs tend to reduce the bacterial population and encourage fungal activity; at pHs lower than 5 microbiological activity is much reduced. The presence of heavy metals also inhibits micro-organisms. As a result of these factors, at high concentrations in soil, even relatively non-persistent compounds may not biodegrade readily.

Owing to their low water solubility and low volatility, PCBs do not generally present a major threat to groundwater but their tendancy to bio-accumulate in the fatty tissue of organisms and subsequently transfer along the food chain means that even very low concentrations may present a hazard to ecosytems.

Soil pH may have a significant effect on contaminant mobility, particularly for heavy metals. Metal mobility may in most cases be enhanced under more acidic conditions, although the relationship is often complex.

Widespread contamination of the site may occur through wind-blown dispersion of suface waste deposits containing asbestos. Asbestos is neither soluble nor biodegradable and persists in the soil.

4. Sources of further information

4.1 Organisations

For information concerning timber products manufacturing works in the United Kingdom the following organisations should be consulted:

British Woodworking Federation
82 New Cavendish Street
London
W1M 8AD

Building Research Establishment (Timber Division)
Garston
Watford
WD2 7JR

Furniture Industry Research Association (FIRA)
Maxwell Road
Stevenage
Hertfordshire
SH1 2EW

Timber Trade Federation
26-27 Oxendon Street
London
SW1Y 4EL

TRADA Technology Limited
Stocking Lane
Hughenden Valley
High Wycome
Buckinghamshire
HP14 4ND

Wood Panel Products Federation
1 Hanworth Road
Feltham
Middlesex
TW13 5AF

4.2 Sources of information concerning the activities described in this profile

Dragun J. *The soil chemistry of hazardous materials.* Hazardous materials control research institute, Silver Spring, MD, USA. 1988.

Kempe's Engineers Year-book. Benn Business Information Services Ltd, Tonbridge. Published annually.

Case study including information relevant to this Industry Profile:

Paul V. *Bibliography of case studies on contaminated land: investigation remediation and redevelopment.* Garston, Building Research Establishment, 1995.

Estimates of the size and geographical distribution of the timber products manufacturing works can be obtained from the Central Government statistics, held principally by the Guildhall Library, Aldermanbury, London and the Business Library, 1 Brewers Hall Garden, London:

Census of Production Reports, Board of Trade, HMSO (from 1924 to 1969).

Business Monitor Series: Annual Census of Production Reports, Central Statistical Office, HMSO (from 1970 to date).

Information on researching the history of sites may be found in:

Department of the Environment. *Documentary research on industrial sites.* DOE, 1994.

4.3 Related DOE Industry Profiles

Chemical works: coatings (paints and printing inks) manufacturing works
Timber treatment works
Waste recycling, treatment and disposal sites: landfills and other waste treatment or waste disposal sites

4.4 Health, safety and environmental risks

The Notes issued by the Chief Inspector of Her Majesty's Inspectorate of Pollution (HMIP) provide guidance for the processes prescribed for integrated pollution control in Regulations made under the Environmental Protection Act 1990. Of particular relevance are:

Her Majesty's Inspectorate of Pollution. *Combustion processes. Combustion of solid fuel which is manufactured from or comprised of wood waste or straw in appliances.* Chief Inspector's Guide to Inspectors. Process Guidance Note IPR 1/8. London, HMSO, 1992.

Her Majesty's Inspectorate of Pollution. *Timber preservation processes.* Chief Inspector's Guidance to Inspectors, Process Guidance Note IPR 6/3. London, HMSO, 1995.

Her Majesty's Inspectorate of Pollution. *Adhesive coating.* Chief Inspector's Guide to Inspectors, Process Guidance Note IPR 6/32. London, HMSO, 1992.

Her Majesty's Inspectorate of Pollution. *Wood coating.* Chief Inspector's Guide to Inspectors, Process Guidance Note IPR 6/33. London, HMSO, 1992.

Her Majesty's Inspectorate of Pollution. *Secretary of State's guidance. Processes prescribed for air pollution control by Local Authorities.*

Also of relevance are the following Department of the Environment Process Guidance Notes:

Department of the Environment. *Manufacture of timber and wood-based products.* Process Guidance Note PG 6/2. London, HMSO, 1991.

Department of the Environment. *Chemical treatment of timber and wood-based products.* Process Guidance Note PG 6/3. London, HMSO, 1991.

Department of the Environment. *Processes for the manufacture of particleboard and fibreboard.* Process Guidance Note PG 6/4. London, HMSO, 1991.

The Control of Substances Hazardous to Health (COSHH) Regulations 1994 and the Management of Health and Safety at Work Regulations 1992 are available from HMSO. Information on relevant health and safety legislation and approved codes of practice published by HSE publications are available from Health and Safety Executive Books, PO Box 1999, Sudbury, Suffolk, CO10 6FS (telephone 01787 881165), as well as HMSO and other retailers.

Information on the health, safety and environmental hazards associated with individual contaminants mentioned in this profile may be obtained from the following sources:

Gibson D T. *Microbial degradation of organic compounds.* Marcel Dekker, New York, 1984.

Hill I R and Wright S J L (Editors). *Pesticide microbiology.* Academic Press, London, 1978.

Howard P H. *Handbook of environmental fate and exposure data for organic chemicals.* Vols I and II. USA, Lewis Publishers, 1990.

Sax N and Lewis R. *Hazardous chemicals desk reference.* New York, Van Nostrand Reinhold Company, 1987.

Verschueren K. *Handbook of environmental data on organic chemicals.* 2nd Edition. New York, Van Nostrand Reinhold Company, 1983.

4.5 Waste disposal and remediation options

Useful information may be obtained from the Department of the Environment series of Waste Management Papers, which contain details of the nature of industrial waste arisings, their treatment and disposal. A current list of titles in this series is available from HMSO Publications Centre, PO Box 276, London, SW8 5DT. Of particular relevance is:

> **Department of the Environment.** *Special Wastes: a technical memorandum providing guidance on their definition.* Waste Management Paper No. 23. London, HMSO, 1981. New edition in preparation.

Publications containing information on the treatment options available for the remediation of contaminated land sites, prepared with the support of the Department of the Environment's Research Programme, can be obtained from National Environmental Technology Centre Library, F6, Culham, Abingdon, Oxfordshire, OX14 3DB.

A full list of current titles of Government publications on all aspects of contaminated land can be obtained from CLL Division, Room A323, Department of the Environment, Romney House, 43 Marsham Street, London, SW1P 3PY.

Advice on the assessment and remediation of contaminated land is contained in guidance published by the Construction Industry Research and Information Association (CIRIA), 6 Storey's Gate, Westminster, London, SW1P 3AU.

Annex Potential contaminants

The chemical compounds and other materials listed below generally reflect those associated with the industry and which have the potential to contaminate the ground. The list is not exhaustive; neither does it imply that all these chemicals might be present nor that they have caused contamination.

Resins/adhesives	polyvinyl acetate urea formaldehyde (aqueous) urea-melamine formaldehyde (aqueous)* resorcinol formaldehyde (aqueous)* phenol formaldehyde (powder or aqueous)*
Resin hardeners*	ammonium chloride (aqueous) ammonium sulphate (aqueous) ammonium hydroxide (aqueous) hexamethylenetetramine maleic acid
Catalysts*	molybdenum oxide
Sizing agents*	chromium complexes of long chain fatty acids eg stearic acid myristic acid
Other materials*	aluminium sulphate bitumen which may contain a wide range of hydrocarbons including polycyclic aromatic hydrocarbons (PAHs)
Surface coatings	
inorganic pigments	aluminium cadmium copper lead zinc
organic pigments	anthraquinones phthalocyanine
dyes	
binders	complex hydrocarbons acrylic eg polymethyl methacrylate alkyd eg polyester-saturated/unsaturated oil/fatty acids cellulose esters eg cellulose nitrate cellulose acetate butyrate vinyl eg polyvinyl acetate

organic solvents	aliphatic hydrocarbons eg hexane octane aromatic hydrocarbons eg toluene xylene naphthalene alcohols and glycols eg ethanol triethylene glycol ketones esters
additives	plasticisers driers antifreeze in-can preservatives
Preservative treatments	copper-chrome-arsenic compounds organochlorine compounds metal carboxylates pentachlorophenol tributyltin oxide sodium borate boric acid

General contaminants

Fuels/mineral oils	
Asbestos	
Polychlorinated biphenyls (PCBs)	
Dioxins and furans	
Gases	methane carbon dioxide hydrogen sulphide

* potential contaminants at only wood-based panel products manufacturing works

Table 1 Main groups of contaminants and their probable locations

Timber products manufacturing works

Main groups of contaminants	Location								
	Raw materials delivery/storage/transfer	Process plant		Products storage	Drainage system including soakaways	Fuel storage/boilers/power generation	Waste disposal/incineration	Water treatment areas	Electricity transformer areas
		Panel products	Solid timber						
Metals and metalloids									
Inorganic compounds									
Acids/alkalis									
Asbestos		1	1			1			
Organic solvents eg white spirit, kerosene									
Preservatives									
Polychlorinated biphenyls (PCBs)		2							
Dioxins and furans									
Fuels									

1 In building materials cladding and pipe insulation for example
2 In hydraulic presses (older plants only)

Shaded boxes indicate areas where contamination is most likely to occur

DOE Industry Profiles

Airports
Animal and animal products processing works
Asbestos manufacturing works
Ceramics, cement and asphalt manufacturing works
Chemical works: coatings (paints and printing inks) manufacturing works
Chemical works: cosmetics and toiletries manufacturing works
Chemical works: disinfectants manufacturing works
Chemical works: explosives, propellants and pyrotechnics manufacturing works
Chemical works: fertiliser manufacturing works
Chemical works: fine chemicals manufacturing works
Chemical works: inorganic chemicals manufacturing works
Chemical works: linoleum, vinyl and bitumen-based floor covering manufacturing works
Chemical works: mastics, sealants, adhesives and roofing felt manufacturing works
Chemical works: organic chemicals manufacturing works
Chemical works: pesticides manufacturing works
Chemical works: pharmaceuticals manufacturing works
Chemical works: rubber processing works (including works manufacturing tyres or other rubber products)
Chemical works: soap and detergent manufacturing works
Dockyards and dockland
Engineering works: aircraft manufacturing works
Engineering works: electrical and electronic equipment manufacturing works (including works manufacturing equipment containing PCBs)
Engineering works: mechanical engineering and ordnance works
Engineering works: railway engineering works
Engineering works: shipbuilding, repair and shipbreaking (including naval shipyards)
Engineering works: vehicle manufacturing works
Gas works, coke works and other coal carbonisation plants
Metal manufacturing, refining and finishing works: electroplating and other metal finishing works
Metal manufacturing, refining and finishing works: iron and steelworks
Metal manufacturing, refining and finishing works: lead works
Metal manufacturing, refining and finishing works: non-ferrous metal works (excluding lead works)
Metal manufacturing, refining and finishing works: precious metal recovery works
Oil refineries and bulk storage of crude oil and petroleum products
Power stations (excluding nuclear power stations)
Pulp and paper manufacturing works
Railway land
Road vehicle fuelling, service and repair: garages and filling stations
Road vehicle fuelling, service and repair: transport and haulage centres
Sewage works and sewage farms
Textile works and dye works
Timber products manufacturing works
Timber treatment works
Waste recycling, treatment and disposal sites: drum and tank cleaning and recycling plants
Waste recycling, treatment and disposal sites: hazardous waste treatment plants
Waste recycling, treatment and disposal sites: landfills and other waste treatment or waste disposal sites
Waste recycling, treatment and disposal sites: metal recycling sites
Waste recycling, treatment and disposal sites: solvent recovery works
Profile of miscellaneous industries incorporating:
- Charcoal works
- Dry-cleaners
- Fibreglass and fibreglass resins manufacturing works
- Glass manufacturing works
- Photographic processing industry
- Printing and bookbinding works

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