Department of the Environment
Industry Profile

Chemical works

coatings (paints and printing inks) manufacturing works

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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).

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DOE Industry Profile

Chemical works: coatings (paints and printing inks) manufacturing works

This profile has been compiled by the Finishes Section, Building Research Establishment, and follows earlier work undertaken by Dames and Moore International. It 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.

Chemical works: coatings (paints and printing inks) manufacturing works

1. Background

'Coatings' is a generic term used to describe an extremely diverse range of products designed to decorate and/or protect surfaces. Coatings can be sub-divided into two separate groups.

Non-curing coatings
A misnomer for coatings which harden by 'natural' chemical reactions once applied to a surface eg linseed oil. As only a very small minority of the coatings produced are of this sort, this profile does not deal with their manufacture.

Curing coatings
These coatings contain a solvent, binder and possibly solids. The curing process involves the solvent evaporating, allowing the binder (a resin) to harden to a solid. This type of coating is preferred because the resultant film is tougher, there are fewer problems with re-application and the product can be varied to achieve a certain performance level.

The choice of solvent is determined by its ability to dissolve the binder and evaporate at a suitable rate. The binder or resin is chosen to give the desired properties eg hardness, flexibility, chemical resistance. Some curing coatings may contain just a solvent and binder, but many contain finely divided solid particles which affect the strength of the coating. Solid particles which impart colour and/or opacity into the coating are known as pigments. Coatings containing pigments are commonly referred to as paints.

The products of the industry can generally be classified into two broad sectors, namely industrial coatings (including printing inks) and decorative paints. This distinction is made on the basis of the 'target' market for the product; there are similarities between the different sectors of the industry. Therefore, specific reference to ink works is only made in this profile where there are important differences in technology which could have a significant impact on potential site contamination. In this profile 'coatings' should be taken as referring to the generic product unless otherwise stated.

1.1 Industrial coatings

Industrial coatings include all products used or applied in manufacturing processes and by certain professional painters in the course of maintenance, refurbishment and construction activities.

1.2 Printing inks

Printing inks are a specialised surface coating designed to 'mark' a substrate. These coatings contain a high proportion of pigment and are applied as very thin

films to a wide variety of substrates. Substrates include paper, board, plastics, celluloid films, aluminium foil, steel, tin plate and aluminium containers.

1.3 Decorative paints

These are a sub-set of the industry's products aimed specifically at the domestic market. Decorative paints include all clear and pigmented coatings supplied for use on interior and exterior surfaces for decorative and/or protective purposes. Application is by brush, roller or spray.

1.4 History and location

The paint industry originated as a craft industry which pre-dated the Industrial Revolution. The paint industry was well developed by the mid-19th Century, with over 250 factories in Britain. Census of Production data indicate that by 1924 there were over 600 manufacturing works. The greatest number of works recorded was almost 800 in the late 1920s and early 1930s. There are now about 600 establishments. About half of the works in the early part of this century had less than 10 employees. Large works have dominated the paint industry since the 1940s.

The early paint industry was largely concentrated in London and the South East. The industry was also well established in cities such as Bristol, Liverpool, Manchester and Birmingham, which were major manufacturing centres with large populations to ensure a ready workforce. They had good communications for the movement of raw materials and finished goods by road, rail and water. By the middle of this century, the paint industry was still located in the same areas, but there had been a relative increase in the number of plants in Northern England and Scotland.

The printing ink industry has always been much smaller in size than the paint industry. Historically printing ink manufacturers were often situated near to major centres of the printing industry.

2. Materials and processes

Coatings are composed of fine particulate materials dispersed in a polymeric binder (resin), which in turn is dissolved or dispersed in a liquid carrier phase (solvent). These constituents form the bulk of the composition, although minor additives may be present to control and modify the properties of the resultant product. Coating powders do not require a liquid carrier phase in their manufacture.

2.1 Raw materials

A wide range of coatings for the domestic and industrial markets may have been produced at any coatings manufacturing works. The industry is probably unique in the range and diversity of organic and inorganic-based materials which it can use to manufacture its products. Many of the raw materials used are obtained from, or based on, naturally-occurring materials but complex chemicals synthesised from coal and, more recently, petroleum are also used. An exhaustive list of raw

materials used over the years by the industry as a whole would run into tens of thousands. However, the number used at any one manufacturing works would be more restricted and depend on the range of coatings a company chose to market.

2.1.1 Pigments, dyes and extenders

A pigment is a solid material, in the form of small discrete particles, which remains insoluble in the resin and solvent constituents of the coating. Pigments can be either organic or inorganic compounds. Pigments are added to impart colour and/or to protect the substrate against corrosion or degradation. Materials which impart colour and are soluble in the solvent phase are termed dyes or dyestuffs. Dyes are of organic composition. Extenders modify the paint properties, for example, by improving corrosion protection or water resistance, but add little or no colour. Extenders are inorganic in origin.

Examples of pigments, extenders and dyes which may have been used for coatings manufacture are provided in the Annex. Today, manufacturers buy in ready-prepared pigments and extenders from specialist producers. In the past, some manufactured their own pigments, usually on a separate site.

2.1.2 Binders

Binders are polymeric complexes which provide integrity to the dried film and bond it to the surface to which it is applied. A wide variety of mostly organic resins has been used in the manufacture of paints. Combinations of natural oils and resins, widely referred to as 'varnishes', were the main type of binder for paints, but their use has declined greatly since the Second World War. Modern synthetic binders are manufactured from a wide range of materials.

Examples of the major categories of binders are given in the Annex, but the variety of combinations of components is such that only a brief indication of composition is possible.

In the past, a number of coatings manufacturers produced some or all of their resin requirements on site, thus necessitating storage and handling of precursor chemicals. However, while on-site resin manufacture is still common, much is now purchased from commercial resin manufacturers.

Lithographic and letter press printing inks traditionally used vegetable oils and varnishes as binder media. During the last 50 years, there has been a major growth in alternative printing processes such as photogravure, flexography and screen printing. As a consequence, more than half the volume of ink currently manufactured contains organic solvents. A wide variety of resins are now used as binders, many of which are very similar to those used in paint manufacture.

2.1.3 Solvents

Organic solvents are low viscosity, volatile liquids, which dissolve or carry the resins. They provide the necessary conditions for pigment dispersion, stabilise the product during storage, control application characteristics and aid film formation. The solvent content of coatings ranges from zero to 90%, depending on the particular product. Organic solvents are purchased from commercial producers or suppliers. A list of common solvents used in the manufacture of coatings is given in the Annex.

Water finds uses as a solvent or carrier in certain paints and inks, either alone or in combination with organic solvents. Water may be drawn directly from the mains supply, or demineralised before use.

2.1.4 Additives

Many additives are used in paints to control or modify properties such as viscosity, flow, drying time and to inhibit biological growths. These additives are often used in low concentrations relative to the main formulation ingredients described above and are invariably obtained from suppliers of specialist chemicals. The range of additives used in coatings is extremely large; an indication of the types of chemicals that have been used as additives since the 1950s is given in the Annex. More recently, additives may have included active ingredients to inhibit the growth of moulds on painted surfaces (see the profile on pesticides manufacturing works, Section 4).

2.2 Manufacture

2.2.1 Raw materials handling and storage

A wide range of raw materials is received, stored and issued as required.

Liquids, primarily the resins and solvents, are delivered in drums and/or in bulk containers and tankers. Liquid additives are delivered in small carboys and metal or plastic containers. Liquids in drums are off-loaded either by vehicle off-loader, pick-up hoist or fork-lift truck, or manually by rolling the drums down skids or 'bumping-off' onto buffers. Manual methods are unlikely nowadays owing to considerations of health and safety. Bulk liquids are off-loaded by gravity discharge, self-contained pumps, pumps on vehicles, or as detachable tanks.

Solids such as pigments, extenders, dyes and some resins, arrive in sacks, paper bags, barrels or kegs of wood or metal, and also in bulk. The solids are handled with sack barrows, stillage trucks, fork-lift trucks, lifts, hoists, cranes, elevating platforms and conveyors.

Raw material stores are generally laid out in a manner to prevent cross-contamination of materials and to facilitate easy accessibility for input and output of stock. There are also isolated and separated 'high risk' storage areas, containing flammable materials such as solvents and cellulose nitrate.

2.2.2 Processes

The manufacture of paints and inks can be considered as a flow process. Raw materials are received into the works, stored and issued as required to the manufacturing unit. They are then compounded, packaged, and the finished product is transferred to a warehouse ready for despatch. The layout of a factory depends on the type and variety of products produced, the size of output and whether the product is made in a batch or continuous process. Most manufacturing is carried out in a batch process.

Paint and ink manufacture is a complex operation. A pigmented system requires pre-mixing of pigment/extender into the resin solution or dispersion to break down the agglomerates. The pre-mix is then milled to produce a finely dispersed pigment. This is followed by relatively simple blending operations to incorporate liquid and/or solids. The pigment dispersion operation is the most important stage in the manufacturing process. Many diverse types of equipment have been used in

the past to disperse pigments. Traditionally, pug mills, edge runners, single or triple-roller mills and ball mills and, more recently, attrition mills, high speed dispersers and sand mills have been used.

The main manufacturing plant is often housed in a multi-storey building so that gravity can aid the flow of materials through the various production stages. The operation involves raw materials being introduced from the top floor, processing on floors below, and final packaging on the ground floor. The modern practice is to install horizontal flow processes.

For practical and operational reasons, any on-site facility for the manufacture of resins is invariably housed separately from the coatings manufacturing unit. Finished resins are delivered either directly to the manufacturing unit, or placed into the central raw material store.

Quality control testing is performed at all stages of manufacture. This function is carried out in a laboratory, where new products are also developed and tested. The laboratory might be within the main body of the processing works but more often it is located separately.

2.2.3 Product storage and handling

The finished coating is packaged into various sized containers and stored in a warehouse or outside in covered racks ready for transport to the customer. Paint works warehouses traditionally held large reserve stocks of the popular types of products. In more modern works, stock is placed on pallets and stored on high-rise racks until required. Handling of stock involves the use of fork-lift trucks. Older works would have used lower level storage systems more appropriate to manual handling. There are sites with no manufacturing facilities, used exclusively for the storage and distribution of coatings.

Ink manufacturers have traditionally needed to match supply to demand very closely. As a result, they would not necessarily have carried the same large stocks of finished products as paint manufacturers, although the range may be greater.

Today, both paint and ink manufacturers maintain the smallest stocks possible, to match the usual demands of the business.

2.2.4 Other activities

Power generation for manufacturing and space heating is the main non-production requirement in coating works. In the past, this would have required the delivery, storage and handling of coal or coke. Fuel oil or gas are now used. Some plants may have effluent treatment facilities to ensure compliance with discharge consents.

In addition to carrying small stocks of raw materials, development laboratories may also have small quantities of novel materials to be evaluated for future bulk use. They also have a full range of chemicals required for normal analytical work.

Waste material is not generated to any great extent during the manufacture of coatings. However, waste which might be recycled could, for example, be a faulty batch not meeting the required specification.

3. Contamination

The contaminants on a site will largely depend on the history of the site, the particular manufacturing, material and product handling processes, 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

Ground contamination may occur as a consequence of accidental spillage of raw materials during delivery, storage or use. Contamination is most likely in areas associated with transfer/storage of solvents and other liquids, but could occur from spillage or leakage of dry powder stores. In these areas, some spillages and leakages were almost inevitable during the lifetime of a plant, especially before the introduction of more rigorous environmental management procedures.

The greatest potential for soil contamination is associated with storage tanks (particularly underground tanks), drum storage areas, pipework and tanker off-loading areas. Older or upgraded plants may have redundant underground tanks or pipelines containing residues of raw materials, products or wastes. Surface water soakaways on any site with a long history of industrial use may be prime areas of potential contamination. The decommissioning, demolition or restructuring of plant may also affect ground contamination due to spillages from tanks and pipework.

Fine powders are easily transported by wind and may have caused near-surface contamination across the site.

Contamination may also have resulted from on-site disposal of, for example, faulty products, hopper sludges, or residues generated by washing down of process plant. Old wastes might have been moved during plant development phases and may therefore be found in places not expected from the layout of the site.

Soil contamination from fuel supplies, especially petroleum-based oils, could also occur, with the greatest risk in the vicinity of boiler houses and fuel storage tanks and fuel lines. Delivery of fuels could also give rise to ground contamination resulting from accidental spillage.

The presence of laboratories on site may have increased the range of potential contaminants present, although their scale of use would be relatively modest.

Fires in storage or other areas can result in contamination through spillages and run-off of fire-fighting water.

Older plants may have had asbestos materials used in pipe insulation, or in building materials such as roofing.

Large plants with electricity sub-stations may have used polychlorinated biphenyls (PCBs) as dielectrics in transformers or capacitors.

Chemicals may have been used for treating effluents or wastewater.

3.2 Migration and persistence of contaminants

3.2.1 Organic compounds

The transport and fate of organic compounds within the soil will be dependent on a combination of physical, chemical and biological factors.

Many of the organic solvents likely to be encountered are volatile with moderate to high vapour pressures. They will readily partition from the liquid phase to the vapour phase resulting in high concentrations in the soil pore space above the unsaturated zone. Close to the soil surface, some will be lost directly to the atmosphere by evaporation. Free phase product consisting of some of the other less soluble solvents, for example, toluene, may migrate to the water-table. In most cases, such compounds are less dense than water and will therefore float on the water-table surface. However, chlorinated solvents are denser than water and tend to migrate to the bottom of aquifers. Their migration may not be consistent with the general groundwater flow. They are persistent chemicals and at low concentrations can render groundwater unsuitable for public supply.

The more soluble organic solvents including the alcohols, for example methanol, will dissolve in water and readily migrate through the soil and eventually to the groundwater. The occurrence of widespread contamination by solvents may increase the mobility of particular organic compounds which, though of low aqueous solubility, may dissolve readily in organic solvents. The potential for groundwater contamination by organic compounds of low aqueous solubility may therefore be increased.

Resins and solvents can also present flammability risks and, under certain soil conditions, resins can biodegrade to produce methane gas.

The higher the natural organic matter and clay content of the soil, the greater the degree of adsorption of the organic contaminants and the greater the reduction in contaminant migration. Thus, the greatest degree of mobility will occur in coarse-grained sands and gravels with little natural organic matter. The less soluble compounds, which become adsorbed onto clay or organic matter may be sources of water pollution long after the source has been removed, by continuing to desorb into the soil-water.

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. 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. Consequently, at high concentrations in soil, even relatively non-persistent compounds may not biodegrade readily.

3.2.2 Metals

The movement of metals through the soil is also significantly retarded by the presence of clay minerals and organic matter. The solubility of some metals (eg copper, zinc and lead) may increase under acidic conditions. In other cases the relationship is more complex. For example, trivalent chromium is more soluble under acidic conditions, whereas the solubility of hexavalent chromium is increased under both acidic and alkaline conditions and arsenic may become more soluble at higher pHs.

Heavy metals, such as lead, cadmium and mercury, and the organotin and organomercury compounds, which are or were used as biocides, can enter food chains and are known to be toxic.

3.2.3 Other factors

Asbestos is neither soluble nor biodegradable and persists in soil. Widespread contamination of a site may occur through wind-blown dispersion of surface deposits containing loose asbestos fibres.

PCBs may have been used in transformers or capacitors on site. PCBs are generally insoluble in water, but accumulate in the fatty tissues of organisms and may subsequently enter the food chain.

4. Sources of further information

4.1 Organisations

For information concerning the coatings, paints and printing ink manufacturing industry the following organisations should be consulted:

The British Coatings Federation
James House
Bridge Street
Leatherhead
ET22 7EP

The European Resin Manufacturers' Association
Queensway House
2 Queensway
Redhill
Surrey
RH1 1QS

The Oil and Colour Chemists' Association
Priory House
967 Harrow Road
Wembley
Middlesex
HA0 2SF

The Paint Research Association
8 Waldegrave Road
Teddington
Middlesex
TW11 8LD

4.2 Sources of information concerning the activities described in this profile

Boxall J and von Fraunhofer J A. *Concise paint technology.* Paul Elek, London, 1977.

Heaton N. *Outlines of paint technology.* Three editions published between 1928 and 1947 are useful for historical perspective on raw material usage. Charles Griffen, London.

Nylen P and Sunderland E. *Modern surface coatings.* Interscience, London, 1965.

Sittig M. *Hazardous and toxic effects of industrial chemicals.* Noyes Data Corporation, New Jersey, 1979.

Turner G P A. *Introduction to paint chemistry and principles of paint technology* 2nd Edition. The Oil and Colour Chemists' Association, Chapman and Hall, 1980.

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 chemical works can be obtained from the following Central Government statistics, held principally by the Guildhall Library, Aldermanbury, London and the City 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: inorganic chemicals manufacturing works
Chemical works: pesticides manufacturing works

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 is:

> **Her Majesty's Inspectorate of Pollution.** *Toluene and di-isocyanate use and flame bonding of polyurethanes.* Chief Inspector's Guidance to Inspectors, Process Guidance Note IPR 6/5. London, HMSO, 1995.

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:

> **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.

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.

Pigments, dyes, extenders and binders

Inorganic pigments	aluminium powder antimony oxide cadmium compounds carbon chromium oxide copper/zinc bronze powder iron oxides lead compounds nickel titanate strontium chromate zinc compounds
Organic pigments	anthraquinones arylides
Organic dyes	azo dyes triphenyl methanes
Extenders	asbestos barium sulphate (barytes/blanc fixe)
Binders	hydrocarbon resins oils phenol formaldehyde amino compounds alkyds

Organic solvents

Aliphatic hydrocarbons	cyclohexane hexane heptane octane white spirit
Aromatic hydrocarbons	toluene ethylbenzene xylene styrene naphthalene

Chlorinated hydrocarbons	dichloromethane 1,1,1-trichloroethane trichloroethylene tetrachloroethylene
Alcohols and glycol ethers	methanol ethanol isopropanol butanol ethylene, diethylene and triethylene glycols propylene glycols ether derivatives of glycols
Ketones	acetone methyl ethyl ketone methyl isobutyl ketone cyclohexanone n-methyl-2-pyrrolidone
Esters	ethyl acetate propyl acetate butyl acetate esters of glycol ethers
Miscellaneous	dimethylformamide 1-nitropropane

Additives

The following are some examples used since the 1950s.

Plasticisers	dialkyl phthalates chlorinated paraffins alkyl esters phosphates epoxidised oils
Lubricants/slip aids	fatty acid amides halogenated hydrocarbons
Driers	metal fatty acid salts eg octoates, tallates, naphthenates or resinates of lead, cobalt, manganese, calcium or zinc
Catalysts	lead oxide organotin compounds organic peroxides sulphuric acid p-toluene sulphonic acid

Anti-oxidants	hydroquinone methyl ethyl ketoxime butyl hydroxy toluene
Chelating agents	ethylene diamine tetraacetic acid (EDTA)
Surfactants	aryl alkyl sulphonates metal fatty acids quaternary ammonium sulphates polyethoxylated phenols
Pigment wetting agents	silicone oils
Rheology modifiers	urethanes acrylics
pH adjusters	alkalis eg ammonia potassium hydroxide acids eg acetic sulphuric amines eg dimethylaminoethanol triethylamine
Defoamers	hydrocarbon solvents
Substrate wetting agents	silicone oils
In-can preservatives	formaldehyde organomercury compounds sodium benzoate
Anti-gassing agents	zinc aluminium
Anti-freeze	ethylene glycol

General contaminants

Asbestos

Polychlorinated biphenyls (PCBs)

Fuels	coke, coal fuel oil

Effluent treatment chemicals

Table 1 Main groups of contaminants and their probable locations

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Main groups of contaminants	Location									
	Raw materials delivery/storage transfer	Process buildings	Product storage	Waste/ rejects storage	Waste disposal	Process pipework/ pumps	Drainage system/ soakaways	Effluent treatment areas	Fuel storage/ pipework/ plant	Electrical transformer areas
Metals and metalloids	■	■	■	■	■	■	■	■		
Inorganic compounds	■	■	■	■	■		■	■		
Acids/bases	■	■		■	■	■	■	■		
Asbestos		[1]			■	[2]				
Organic compounds eg aliphatic/aromatic hydrocarbons, halogenated solvents	■	■	■	■	■	■	■	■		
Fuels	■				■	■	■		■	
Polychlorinated biphenyls (PCBs)										■
Effluent treatment chemicals					■			■		

[1] building fabric
[2] steam mains

Shaded boxes indicate areas where contamination is most likely to occur

Recycled paper

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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