

Engineering works

railway engineering works

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

Engineering works: railway engineering works

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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.

Engineering works: railway engineering works

1. Background

This profile covers the processes and activities carried out at railway engineering works. These processes include the manufacture, maintenance and repair of engines, carriages and rolling stock. The works covered by this profile are generally referred to as heavy maintenance depots. This profile also includes the processes and activities carried out at refuelling yards.

In the early days of the railway era most of the separate railway companies could not afford to maintain their own workshops. They relied on private industry for the construction and major maintenance of locomotives and rolling stock.

With the amalgamation of companies in 1923, London Midland Scottish Railway (LMSR), London and North Eastern Railway (LNER), Southern Railway (SR) and Great Western Railway (GWR) built about 50% of their own locomotives and rolling stock. They all tended to concentrate specific manufacturing processes at single works and generally concentrated output at those works with the best facilities. Some of the smaller repair works were closed as stock decreased in variety.

The Census of Production data indicate that there were over 900 establishments involved in the manufacture/repair of locomotives, carriages and other railway equipment in 1935. About 550 of these were owned by the railway companies.

At the time of nationalisation (1948), British Rail inherited the following:

	Works building new locomotives	Heavy repairs and rebuilding
LMSR region	Crewe, Derby, Horwich	Kilmarnock, St. Rollox, Bow, Barrow, Inverness
LNER region	Doncaster, Darlington, Gorton, Stratford	Cowlairs, Inverurie, Gateshead
GWR region	Swindon	Wolverhampton, Caerphilly, Newton Abbot, Oswestry, Barry
SR region	Eastleigh, Brighton, Ashford	
London Transport region		Neasden

Subsidiary repairs were carried out at other works, for example at Rugby, Leeds and Bristol. British Rail also inherited a total of 666 steam motive power depots (engine sheds) where routine locomotive maintenance work was carried out.

Carriage and wagon works activities were carried out at a considerable number of locations including Doncaster, Derby, Eastleigh, Caerphilly, Cowlairs, Temple Mills, York, Shildon, Faverdale, Wolverton, Earlestown, Bromsgrove, St. Rollox, Barassie, Gormiston and Lancing. In addition, there were 90 out-station wagon repair shops.

The Census of Production data for 1948 indicate that there were about another 540 works in the private sector associated with the manufacture and repair of locomotives and carriages. Some of these facilities undertook the manufacture of other railway equipment such as turntables, signals and brake gear.

The most notable post-war change in the railway engineering industry was the replacement of steam locomotives with diesel and electric locomotives. These were manufactured both by British Rail at some of the existing works and by private companies. This transition accelerated following the modernisation proposals of the 1950s. Large numbers of maintenance works were decommissioned and became derelict following further rationalisation during the 1950s to 1970s.

Between 1948 and 1970, there was a significant reduction in the number of private sector companies involved in manufacturing and repairing railway equipment. In 1970, British Rail Engineering Limited (BREL), consisting of 14 main works, was established. At this time, there were almost 100 locomotive and carriage manufacturers and repairers in the United Kingdom, some of which were also involved in manufacturing other railway equipment. Further rationalisation took place with the closure of manufacturing centres. BREL was privatised in 1989, which comprised the works at Crewe, Derby Loco, Derby Carriage and York. The company changed its name to ABB Transportation in 1992. British Rail reorganised its heavy maintenance works in 1987 creating BRML; rationalisation of capacity has taken place since then. The six remaining BRML works were sold to the private sector in June 1995. The Trainload Freight companies, which were vested on 1 April 1995 in preparation for privatisation, own depots which undertake all but the heaviest maintenance work.

Railway Group Standards are mandatory technical documents that set out what is required to ensure safe working by all participants on the restructured railway. They increasingly cover environmental matters, and will minimise any contamination of railway properties in the future.

2. Activities

2.1 Range of activities

Railway works have been involved in the manufacture and repair of locomotives, carriages and rolling stock. The buildings range in size from small engine sheds, where only minimal maintenance is undertaken, to large-scale manufacturing works, where construction of engines, carriages and rolling stock and a full range of maintenance operations takes place.

2.2 Manufacturing works

2.2.1 Raw materials

The major materials used at manufacturing works are steel, aluminium, timber, insulating materials (including polyurethane), plastics, fibreglass materials and various prefabricated components. Other materials include diesel oil, degreasing agents, paints, solvents and lubricants. Formerly, asbestos was used for insulating purposes and coal was used as fuel.

In the past, materials were delivered by rail and road. Nowadays, most deliveries are made by road. Diesel fuel is mostly delivered by road tanker.

Bulkier materials are lifted by overhead cranes and, at some shunting sites, transported in a local rail trucks system with a shunting locomotive. Most of the smaller containers and materials within a manufacturing works are transported on pallets or by forklift trucks, with some manual handling. Diesel oil is pumped into storage tanks either above or below ground. Solvents, lubricants etc are nowadays stored on hardstanding or in bunded areas.

Suitable protective measures are taken at sites to minimise the risk of there being any unanticipated release of substances to the environment as a result of storage and handling. Some of the issues are dealt with in the Railway Group Standard entitled 'Management of Safety - Surveillance Check'.

2.2.2 Steam locomotive manufacture

The most prominent feature of the steam locomotive was the boiler. This was constructed from plates of acid-open-hearth steel strengthened by passage through rollers. The edges were then planed and trimmed and the plates were formed into a cylindrical shape by passage through sets of bending rollers. Hydraulic riveters were used to rivet the boiler shell after the joints were cleaned. The firebox was constructed of steel and copper. After various mountings and fire tubes were fitted to the boiler, it underwent a hydraulic test, followed by a steam test.

A large number of the small parts required on the locomotive were produced by stamping shops, using a large steam-driven hammer known as a drop stamp. The copper and tin smith's shops were responsible for work related to pipe details and lamps. In the wheel shop, axles were hydraulically pressed into the bosses of the cast steel wheel centres and wheels were balanced.

Assembly of the locomotive in the erecting shop involved lowering the boiler onto the frames created in the machine shop, followed by lagging with asbestos to insulate the outer covering of the boiler. Other integral parts of the locomotive such as the smoke box, cab and axle boxes were then assembled.

2.2.3 Diesel locomotive manufacture

On-site foundries continued to be generally used after the transition to diesel locomotives, but many components, for example the engine, traction motor etc, were then bought in from outside suppliers. There was also a trend towards the use of aluminium rather than steel in the construction of certain locomotives. Facilities for the electroplating of copper, nickel, chromium, cadmium and zinc (ie the brass shop) existed on some sites for the production and repair of metal fittings on vehicles (door handles, locks etc). Nowadays, the assembly of wheels involves

specialist machinery for turning the wheels and axles. Tyres are shrunk onto the wheels in gas hearths. A great deal of welding work, both electric and oxy-arc welding, is undertaken.

The body is normally degreased, filled, rubbed down and undercoated prior to applying the top coat of paint. Painting used to be carried out only by hand but now spray painting methods are also used. The completed locomotive is then fuelled, oiled, greased and then passed to the test section.

2.2.4 Railway carriage manufacture

Railway carriages consist of two components, the chassis and the body. The largest part of the chassis is the underframe, to which wheels, axles, brakes etc are attached. Carriages were first made of wood or had a timber frame covered with sheets of steel panelling. The first all-steel coach was completed in 1945. More recently, aluminium has been used in place of steel.

The method of construction has always involved the prefabrication of standard components (ie doors, ventilators, lights etc) to produce sub-assemblies (for example side panel sections, roofs etc). These are put together in an erecting shop where the underframe is fitted. Welding constitutes a major proportion of the activities taking place in the coach erecting shop. Asbestos was widely used in the past as an insulating material but has been replaced by polyurethane foam filling. The interior fittings and ancillary components are added, followed by painting and decoration.

Where coaches were hauled by a steam or diesel locomotive, a generator was mounted beneath the carriage and lead-acid batteries were used for the provision of electricity when the carriage was stationary. In the past, carriage lighting was sometimes provided by coal-gas which was piped to the carriages at servicing departments from the railway's own gas production plants.

Painting operations include cleaning the surfaces, filling, applying primer and main coats of paint, and lacquering. Hand painting and rollers continue to be used but in recent years, paint spraying has been extensively employed.

2.2.5 Rolling stock manufacture

Goods wagons consist of three components, the body, the underframe and the running gear. The body and underframe were originally constructed mostly from timber. Steel was used later for underframes which were built as separate units and delivered to the assembly shop complete with all the running gear. Construction is similar to that of railway carriages.

2.3 Maintenance and refuelling activities

2.3.1 Steam locomotives

The general routine maintenance operations for steam locomotives included:

Freeing the ash pan and grate of clinker, removing smoke box ash (consisting of unburnt fuel carried through flue tubes) and fire box soot;

Lubrication of up to 60 points, particularly the axle base;

Replacement of lubricating oil and grease for valve gear pins and bearings;

Washing out the boiler and removal of loose scale;

General washing and cleaning (Paraffin-based solvents were used for the removal of soot and grease).

Refuelling operations, which took place from coaling bunkers, involved coal being shovelled into steel tubs on an elevated stage. These were then wheeled to a chute and tipped into the tenders or bunkers of the locomotives below.

Water was replenished from tanks of varying capacity. At large facilities, a tank of 100 000 gallons capacity would have been typical. In some areas, water softening plants used an emulsion of lime and soda to precipitate impurities.

Where more extensive repair or maintenance work was carried out, the component parts, including the boilers, were removed in a stripping shed and renovated in various machine and fitting bays. Asbestos blanketing over the boilers (often blue asbestos) readily came off the vehicle, and removal often took place outside rather than inside the workshops. Some components were placed in tanks of boiling water and soda for the removal of grease and dirt. The engine was rebuilt in the erecting shop followed by testing, often in a dedicated test shop. Repairs were undertaken as part of general servicing operations. Maintenance and repair work occupied a considerable proportion of the life of a steam locomotive and typically only one third of its life was actually spent working.

2.3.2 Diesel locomotives

Diesel engines spend only 2-3 hours out of every 24 in servicing operations. Such operations include replenishment of engine oil, greasing of various components (for example, the driving shafts to the ventilating fans), watering and washing. Fuel tanks are generally replenished at the station depot.

The major maintenance operations include:

Defuelling. This is carried out every time a vehicle is brought in for maintenance. The surplus diesel/fuel oil is removed and later recovered. Lubricating oils are drained from the vehicle into waste oil tanks for disposal.

Cleaning. These operations use automated washing systems in self-contained plants for specific components. Detergents are used for this purpose and caustic products may have been used in the past. Acid washes are sometimes used for washing the body of the locomotive.

Rehabilitation/repair processes. These processes involve the stripping of a number of components and may include replating. Some facilities have dedicated diesel engine repair shops responsible for cleaning, stripping, repairing and reassembling the engines, and the maintenance of fuel injectors, turbochargers, exhausters and radiators.

Specialist functions. At the larger works, activities may include reconditioning of locomotives, carriages and wagon wheels, repairs to braking equipment etc.

Re-painting. This involves filling, priming and painting operations.

Stripping and recalibration of instrumentation.

Refuelling. This takes place by pipe from a storage tank. Engine oil replenishment is carried out using a small electric pump which delivers oil from a drum into the locomotive.

2.3.3 *Other maintenance and dismantling*

Painting was a routine maintenance operation, with full repainting being carried out every 5 to 7 years. Such large-scale operations, as opposed to routine 'touch up' and revarnishing, are similar to some basic manufacturing operations in terms of surface preparation and applications of paint coatings.

Complete dismantling of locomotives, carriages and rolling stock takes place at some sites. After all reclaimable items are removed, the body shells are dismantled in a melt shop. In addition to dismantling operations, general stripping of asbestos lining may have taken place at such facilities. In recent years, some sites have developed dedicated plants for asbestos removal.

Maintenance and repair of cranes, ballast cleaning machines, tamping machines and track relayers is undertaken at larger works.

2.4 **Ancillary activities**

Many sites have their own electrical generation facilities with transformers which have dielectric fluids that may have included polychlorinated biphenyls (PCBs). There could be water pre-treatment facilities in areas where water is particularly hard.

Larger works may have incorporated steelworks and gas works. There are also records of brickworks, soapworks and greaseworks existing in the past on a few properties. Records also indicate that acetylene works existed at a number of railway engineering sites.

Some sites making steam engines may have been involved in other activities, eg ironworks, millwrighting and general engineering.

2.5 **Wastes**

Steam locomotive manufacture and maintenance resulted in the production of large quantities of ash which were deposited in ash pits. This material was eventually removed from site but there was considerable potential for on-site accumulation. On-site disposal of soot and grease at maintenance facilities was also likely.

Most of the solid waste from manufacturing facilities consists of scrap arisings, timber and packing materials and is generally disposed of off site. In the past, wood may have been burned on site; rubber cables may also have been burned in order to recover the copper. Such burning could have been quite extensive and often a particular area of the site was dedicated to such an activity. Plastic wastes may also have been burnt on site.

Specific chemical waste from process operations is usually disposed of off site by a licensed contractor. In the past, drums containing waste may have been stored directly on soil rather than on concrete surfaces. Oil and detergent wastes from washing facilities are generally removed in tankers by licensed contractors. Most of the larger sites have interceptors for collection and recovery of oil spillages via a

network of drains. Some sites may even have their own effluent treatment process. Past housekeeping practices are likely to have been less diligent and there is a strong possibility that liquid wastes, including solvents, oils, lubricants, degreasing agents etc, were disposed of on site, particularly in lagoons and oil pits. Incineration of waste sludge oil on site is considered unlikely to have happened, although some of this material may have been spread on land on site and allowed to degrade.

On-site landfills were common and would have been used as receptacles for sludges and various solid and liquid wastes. These would have included 'out of spec' paints, dry paint, dust mixed with general shavings of wood, metal fines, turnings, ash and containers for the various chemicals used on site, for example herbicides, degreasing agents etc (see profile on Railway land, Section 4.3).

Whilst careful off-site disposal of asbestos is expected from all current operating facilities, on-site disposal of asbestos waste materials is likely to have taken place in the past at many works involved in both maintenance and manufacture.

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. In addition, some of the contamination scenarios discussed above represent a worst case and should not be expected as normal occurrences.

3.1 Factors affecting contamination

The scale of a particular works could greatly influence the potential for particular contaminants to be present; for example it is only on the very large works that gas production might have taken place and any such facilities would imply the potential for a range of organic contaminants. However, the range of conventional railways works operations could still be extensive, and give rise to many groups of contaminants.

3.1.1 Manufacturing

Asbestos which was used in insulation, is likely to be found principally in storage areas and carriage assembly areas.

Leaks and spillages of fuels, oils, acids, paints and solvents are likely in storage, distribution, fabrication areas and fuelling areas. Thus, contamination is likely around bulk or drum storage, transfer areas and pipelines, as well as beneath machines and in metal preparation areas where solvents are likely to have been used. Unless a robust floor covering or formal drainage system existed, such liquids may have entered the ground. Similarly, surface water soakaways may be contaminated, as may be explicit waste disposal areas. Paint shops, and any associated external areas where solvents, oils and pigments were used, are also possible areas for contamination.

Some areas may have been used for burning wood, wire covering and plastics and the like, and so would undoubtedly be contaminated. Some ash from steam locomotives would also be expected in engine test and waste disposal areas.

3.1.2 Maintenance and refuelling

Depending on the period of operations, there could be significant changes in both scale and contaminant types in areas associated with these activities. Steam locomotives will have given rise to extensive ash contamination in disposal areas, as well as resulting in possible residues of coal in storage areas. Similarly, refuelling and fuel storage areas for diesel locomotives are prime areas for contamination, particularly near fuel lines and any underground storage tanks where leaks and spillages may have occurred.

Asbestos contamination is likely to be even more widespread than on manufacturing sites, particularly if carriage breaking was practised on site. Thus, breaking areas, locomotive repair sheds and adjacent areas, plus any landfill sites are most likely to be contaminated, particularly as handling and disposal controls at the relevant time were unlikely to be as rigorous as those demanded by current regulations.

Contamination through spillages and leaks from fuel oils, lubricating oils for locomotives, and machine and repair shops is possible. Similarly, areas where degreasing and other solvents were used or painting operations carried out, are likely areas of contamination.

Areas used for burning materials or landfilling wastes and other materials (for example 'off-spec' paints and contaminated oils) are likely to have been contaminated.

Other important contaminants include heavy metals (from spillages of paint, pigments or 'off-spec' batches) and mineral acids used in cleaning operations, which by their nature are likely to have resulted in releases to the ground.

Radioactive materials would be present in gas mantles, luminous dials and smoke alarms. They are likely to be modest in scale and are probably confined to the waste disposal areas.

Areas under open yards may be subject to accumulation of herbicides.

3.2 Migration and persistence of contaminants

3.2.1 Asbestos and heavy metals

Except where buried in an on-site waste disposal facility, asbestos contamination is likely to be present in the surface horizons of the soil. It is unlikely to have migrated significantly unless it has been lying on the surface and subject to the effects of rain and wind. Similarly, heavy metals are also likely to be concentrated in the top layers of the soil.

The movement of metals through the soil is significantly retarded by the presence of clay minerals and organic matter. The solubility of some metals may increase under acidic conditions (eg copper, zinc and lead). 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 pH levels.

3.2.2 *Organic compounds*

Many of the organic compounds liable to be encountered are volatile (for example carbon tetrachloride, turpentine, white spirit, toluene, methylated spirits) and have 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 saturated zone. Close to the soil surface, some will be lost directly to the atmosphere by evaporation. Free phase product consisting of petroleum hydrocarbons from diesel oil, fuel oil, lubricating oil or other mineral oils used on site, together with extensive spillages of some less soluble solvents, for example toluene, will also tend to migrate to the water-table. In most cases, such compounds are less dense than water and will therefore float on the surface of the water-table, although chlorinated solvents, being more dense, tend to migrate to the bottom of aquifers. The more soluble and miscible organic solvents, such as methylated spirits, turpentine and glycols, will readily migrate through the soil system and eventually to groundwater.

Although the solubility of certain other organic compounds, such as polycyclic aromatic hydrocarbons (PAHs) is relatively low, their dissolved concentrations may be several orders of magnitude greater than water quality standards permit. Also, the occurrence of widespread contamination by solvents may enhance the mobility of particular organic compounds which, although of low aqueous solubility, may dissolve readily in such organic solvents. The potential for groundwater contamination by organic compounds of low aqueous solubility may therefore be increased.

As with the metals, the transport and fate of the organic compounds within the sub-surface environment is dependent upon physical, chemical and biological factors. The less soluble aromatic compounds, which become adsorbed onto clay or organic matter, will provide on-going sources of water pollution long after the source has been removed, by continuing to desorb and dissolve into the soil water. Natural biodegradation may result in a significant removal of some organic compounds but even readily biodegradable compounds, such as petroleum hydrocarbons, may persist under environmental conditions unfavourable for microbial activity. Lateral movement through the soil either in the dissolved or free phase may also affect surface water.

3.2.3 *Other factors*

Uptake of certain heavy metal contaminants by plants may also occur. In addition, PCBs, together with some of the halogenated organics, are fat-soluble and have a propensity to accumulate in food chains. This might be of local significance if, for example, surface waters are affected by the contamination.

4. Sources of further information

4.1 Organisations

For information concerning the railway engineering industry in the United Kingdom, the following organisations and trade associations should be consulted:

ABB Transportation Limited
St. Peter's House
Gower Street
Derby
DE1 1AH

The Association of Wagon Builders and Repairers
6 School Lane
Upper Poppleton
York
YO2 6JS

British Railways Board
Euston House
24 Eversholt Street
London
NW1 1DZ

The Railway Industry Association
6 Buckingham Gate
London
SW1E 6JP

4.2 Sources of further 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.

Essery R J and Morgan K R. *The LMSR wagon.* Newton Abbot, David and Charles, 1977.

Forsythe H G. *Men of the diesels.* Penryn, Cornwall, Atlantic Transport, 1989.

Hewison C H. *From shedmaster to the railway inspectorate.* Newton Abbot, David and Charles, 1981.

Jenkinson D. *British railway carriages of the 20th century.* Volume 1 The end of an era, 1901-1922. Patrick Stephens Limited, 1988.

Lowe J W. *British steam locomotive builders.* Cambridge, Goose and Son, 1975.

Marsden C J. *Life and times series.* Sparkford, BREL. Haynes Publishing Group, 1990.

Mountford E R. *Caerphilly works, 1901-1964.* Aylesbury, Roundhouse books, 1965.

Radford J B. *Derby works and Midland locomotives.* London, Ian Allan, 1971.

Reed B. *Crewe locomotive works and its men.* Newton Abbot, David and Charles, 1982.

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

Chemical works: soap and detergent manufacturing works

Engineering works: mechanical engineering and ordnance works

Gas works, cokeworks 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

Railway land

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.

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:

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.

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

Budavari S et al (Editors). *The Merck Index, An encyclopaedia of chemicals, drugs and biologicals*. Merck and Co Inc, Rahway, New Jersey, USA, 11th Edition, 1989.

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 interest is:

Department of the Environment. *Special waste*. Waste Management Paper No. 23. London, HMSO, 1982.

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.

Asbestos	all types of asbestos (white brown and blue)
Metals, metalloids and their compounds	eg aluminium antimony arsenic cadmium chromium copper iron lead manganese nickel tin zinc
Acids	hydrochloric sulphuric phosphoric
Alkalis	sodium hydroxide solution
Inorganic chemicals	ammonium chloride boron cyanide sulphate sulphide
Organic chemicals	fuel oils (eg diesel) lubricating oils greases chlorinated degreasing solvents (eg 1,1,1 trichloroethane and carbon tetrachloride (tetrachloromethane)) Non-chlorinated solvents and degreasants (eg paraffin-based solvents, white spirit, methylated spirits, toluene) phenols polycyclic aromatic hydrocarbons (PAHs) polychlorinated biphenyls (PCBs) antifreezes (ethylene glycol, methanol) coal

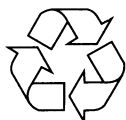
Ash is a potentially ubiquitous contaminant at many railway engineering sites and may contain metals, sulphates, phenols and PAHs.

On site landfills which contain putrescible materials may produce landfill gas, the major constituents of which are methane and carbon dioxide.

Table 1 Main groups of contaminants and their probable locations

Railway engineering works

Main group of potential contaminants	Likely locations
Asbestos	Removal from locomotives and carriages often occurred outside workshops. Buildings, boilers and pipework. On-site landfills and waste burning sites. May be distributed across site.
Metals, metalloids and their compounds	On-site landfills, ash pits, waste storage areas (including waste oils) and areas of made ground. Locomotive cleaning, foundries, workshop areas (eg fabrication, construction, painting, plating, electrical, maintenance, dismantling, 'scrapping lines', repair etc).
Acids	Widespread use throughout sites (eg storage areas, plating shops, fabrication workshops, repair workshops, paint shops, cleaning areas etc.)
Alkalis	Cleaning and degreasing areas.
Inorganic chemicals	All: ash pits and on-site waste storage/disposal. Ammonium chloride: boiler fabrication, welding areas. Boron: maintenance and repair shops (corrosion inhibitors associated with, for example, antifreezes). Cyanide: foundries and smith's shops (metal hardening), gas works. Sulphates/sulphides: ash storage/disposal, gas works.
Organic chemicals	Fuel oils: fuel and oil storage and pipework, fuelling and defuelling areas, dismantling areas, waste storage and on-site waste disposal. Lubricating oils: storage areas, maintenance and repair shops, waste storage areas, on-site waste disposal. Greases: on-site waste disposal. Chlorinated solvents: degreasing shops, metal working areas, paint shops etc, waste storage areas and on-site waste disposal areas. Non-chlorinated solvents: storage areas, repair shops, maintenance shops, paint shops etc, waste storage and waste disposal. Phenols: ash storage/disposal, gasworks. PAHs: ash storage/disposal, waste oil storage, waste disposal sites, gasworks areas. PCBs: electrical transformers and capacitors. Antifreezes: storage areas, repair shops, maintenance shops, waste storage and disposal areas. Coal: fuel storage.



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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