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OIL INDUSTRY

Step 1 Report

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The Oil Industry

Step 1 Report

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1. INTRODUCTION

1.1 The utilisation of natural and mineral oils has a long and international history. This report is concerned with setting out a basis for assessing the importance of archaeological remains of the inland extraction, manufacture and refining of *mineral oils* in England. It should be emphasised that the oil industry was a product of international effort, within the early history of which the British oil industries played a significant part. As such this report necessarily refers to the industry beyond England.

1.2 Prior to the late eighteenth century, the use of mineral oils largely derived from the distillation of tar from wood. Alternatives to wood-tar were being sought in the seventeenth and eighteenth centuries, one product of which was a gradual increase in understanding of the underlying chemistry The coal-tar distilling industry developed in the early nineteenth century, in parallel with the gas industry which subsequently provided large quantities of crude tar to tar distilleries From the end of the nineteenth century, the wide adoption of recovery ovens by the coking industry brought additional supplies of crude tar The refined fractions of coal-tar included creosote which, as a preservative for wooden sleepers, became linked with the expansion of the railways, and in the twentieth century, distilled tar was adopted for road surfacing Coal-tar also became the basis of Europe's (predominantly Germany's) first synthetic chemicals industry, which commenced with the discovery of analine dyes in 1856 and continued until its replacement by the petrochemical industry in the 1950s. The coal-oil and shale-oil industries were also developed, in England and France, in the early nineteenth century, spurred by the needs of the Industrial Revolution for better lubricants and lighting Bituminous rocks in Shropshire were crushed and refined from the 1690s and during the eighteenth century, and the early nineteenth century, attempts were made to distil oil from coal and shales. Following his initial refining experience in Derbyshire in the 1840s, James Young established the Scottish oil industry, initially coal-based and later shale-based, which boomed in the 1860s but continued up to the 1960s and saw smaller offshoots in England. The beginning of the American petroleum oil industry is generally taken as the sinking of the first oil well by Drake in 1859. In England there is very little inland oil, but these supplies have been worked since the 1930s with a series of small wells in the East Midlands and elsewhere.

1.3 The history of the oil industry is well documented, particularly in terms of its technological and business development Surviving archaeological remains of the early industry are limited, with surviving *in situ* machinery very rare The later refining industry is characterised by its large scale and complexity of plant and storage features; as such conservation of remains of the later industry is problematical. To the author's knowledge, no overview of the archaeology of the industry has previously been compiled

1.4 The purpose of this report is to set a framework, with respect to the oil industry, for the 'identification, recording and evaluation of industrial monuments and, where applicable, their selection for statutory protection under existing legislation', in accordance with the approach set down by English Heritage's Archaeology Division

(1992) Specifically the framework includes a technical and historical outline, a breakdown of the archaeological components one would expect to encounter; an attempt to specify sources for identifying sites, and a statement of anticipated priorities for the industry In achieving this, and in view of the dispersed nature of accessible source material, it has been useful to partially pre-empt the data gathering process of Step 2 by circulating a questionnaire to potential contacts The responses to this have formed a valuable source in compiling this report

1 5 Following English Heritage guidance, the report deals specifically with the extraction and production of oil from various inland sources, together with the refining processes It does not deal with the offshore oil industry, the refining of natural oils, the petrochemical industry, industry-related transport, customer consumption or the manufacture of plant. These subjects should be considered in separate reports It should be noted that this report has been written in tandem with the step 1 report for the gas industry This current report has been written at the same time as the step I report for the gas industry Some of the economic imperatives behind, and some of the people associated with, developments within the industry are shared with the gas industry

2. GEOLOGY AND RAW MATERIALS

2.1 The various oils that have formed the basis of a series of oil industries in England derive from a range of sources. This report is specifically concerned with mineral oils derived from deposits of coal, shale, bitumen and petroleum. Tars, manufactured from wood and coal, are included in this group. The extraction and refining of natural oils, that is oils of vegetable and animal origin (whale, fish, pine resins, olive, seeds such as flax, rape and coleseed), is beyond the scope of this report.

2.2 Mineral oils are essentially combinations of hydrocarbons and other organic chemicals formed under compression over geological time-scales. The various forms often occur together. In England, ample deposits of *coal* formed the basis of its significant role in the history of the manufacture of coal-tar and coal-oil. Coking coals (found in Durham, Northumberland, Lancashire, Yorkshire, the Midlands, Somerset, and Kent) and cannel coals (large deposits in South Lancashire) were important (see Gas step 1 report). Particular value was placed on the rarely occurring and thinly deposited *torbanite*, which combined the gas producing qualities of cannel coals and the oil yielding qualities of shales, and hence commanded high prices. The *shale-oil* industry was particularly important in Scotland. In England, limited deposits of *oil shale* have been worked at various times in Shropshire, Staffordshire, Dorset, Somerset and Norfolk. *Bitumen* deposits are similarly limited, but were again discovered and extracted at various times, mainly in Shropshire and Derbyshire. There are equally sparse inland deposits of *petroleum*, the main occurrence is the group of small *oil fields* in the counties of Nottinghamshire, Leicestershire and Lincolnshire, together with tiny deposits in Dorset (Wytch Farm and Kimmeridge wells), Merseyside (Peal Formby well), and Yorkshire (Trumfleet and Fordon wells). Huge offshore *oil fields* in the North Sea have been worked since the 1960s, although this aspect of the industry is beyond the scope of the current report (see BP 1977, 473, 479-80, Buchanan 1972, 69-71, Butt 1964, Hassan 1978, 280-81, 289n18; Trueman 1954).

3. TECHNICAL OUTLINE

This section summarises the processes involved in the oil industry The purpose is to identify the function of components (including *plant*) which are to be used in the site assessments. together with other *important terms*

3.1 DEFINITIONS

3 1 1 There is a large array of technical terms associated with the oil industry. It is not uncommon for these terms to be ambiguous or have different meanings m different countries For example. the term *kerosine* is more generally used for what in England are widely called the *paraffin* series of hydrocarbons. It is also the name for a refined petroleum product intermediate in volatility between *gasoline* ('petrol' in England) and *gas oil* ('diesel') The term originated with a group of 1850s American patents for lamp oils by Abraham Gesner.

3.2 WOOD-TAR AND COAL-TAR

3 2 1 *Tar* is a dark. thick. viscous. inflammable liquid obtained by the dry distillation of wood or coal It also occurs naturally It was used from an early period for preserving timber and cordage. for preserving iron. and as an antiseptic (Trinder 1992. 746) *Tar distillation*. generally done in iron or steel tanks. yields varions *fractions* at increasing temperatures. as below (Campbell 1971. 87)

- up to 110°C — 'first runnings' or naptha (containing benzene and toluene)
- 110-170°C — light oil
- 170-230°C — middle or carbolic oil. or light creosote (producing phenol and naphthalene)
- 230-270°C — heavy oil. or creosote
- 270-330°C — anthracene. or green oil
- residue over 330°C — pitch

3 2 2 The nature of these fractions were established in the early nineteenth century. and their uses developed then and over the latter part of the century These uses are summarised below

Naphtha: used as lamp oil. as a solvent for rubber manufacture and to distil further for benzene and toluene (note it is also one of principle fractions from cracking of petroleum. 'wood naphtha' refers to naturally occurring methanol)

Benzene source of aniline (base for first synthetic dyes). later for plastics and nylon. weedkillers and resins.

Toluene (or methyl benzene) used for saccharine and TNT

Light Oil. used as resin solvent to make varnishes

Phenol. used for azo-dyes

Naphthalene initially a waste product, later used for azo-dyes, indigo and phthaleins

Heavy oil/Creosote: Creosote used for preserving timbers following Bethell's 1838 patent. Heavy oil also bumt to produce 'lampblack' (in various grades suitable for printing, bootblacking and as stove blackleading).

Anthracene. used from 1868 for alizarin dyes.

Pitch: Used for caulking seams of ships, road surfacing, binding small coal to make briquettes for fuel, making asphalt paper, and dissolved in naphtha to make paints (note: pitch was also made from turpentine, and tree resins were sometimes called 'pitch' or 'pine-pitch')

3 2 3 The origin of wood distillation works may be seen as a development of the charcoal industry, with Glauber's beehive kiln of 1657 an early example: although the *wood distillation industry* proper seems to have emerged in the nineteenth century with a variety of retort and oven designs and improved methods of extracting the by-products (Bunbury 1923, Kelley 1986, 12-26, 29-32, Mott 1936, 20-30)

3 2 4 The fundamental component of the coal-tar industry is the *tar distillery* or coal-tar works Amongst the earliest documented *coal-tar distillation plant* is that of Lord Dundonald in the 1780s and 1790s, consisting of a domed oven with a lead condensing chamber to the rear (Trinder 1981, 39-41, 55-8) More broadly, an early coal-tar oven was formed of an upright wrought iron cylinder with domed top and concave base (Campbell 1971, 86-7) It was heated from below and the tar-laden gas then passed through *condensers* (in the form of a 'worm', ie cast iron piping in a water bath) The *thermal distillation* of the collected tar was carried out in iron tanks, making use of water warmed in the *condensers*, and the various fractions were collected in *receivers*, which were changed manually The *chemical washing* of each fraction (for example with sulphuric acid, caustic soda and lime) led to further fractionation. Charcoal kilns and early coke ovens sometimes had associated tar-collecting features and the late nineteenth and early twentieth century saw the appearance of by-product *recovery coke ovens*

3.3 COAL-OIL, SHALE-OIL AND BITUMEN

3 3 1 *Bitumen* is a black or dark brown solid or semi-solid mixture of hydrocarbons and organic material, which gradually liquefies when heated In the eighteenth century, solid bitumen, referred to as 'elaterite' or 'elastic bitumen' was found in Derbyshire, and liquid bitumen was found in the Tar Tunnel in Shropshire [1] *Coal-oil* is oil manufactured by the distillation of coal A range of coal-types were used, but two

[1] NOTE The terms *asphalt* and mineral pitch have also been used to refer to natural deposits of the solid form of bitumen However, from the mid-nineteenth century *asphalt* became more commonly used to refer to a mix of sand with tar-derived pitch, less commonly bitumen, to make pavement and road surfaces

were of particular importance; James Young experimented with coal-oil manufacture using the *cannel coals* of south Lancashire, prior to taking out his 1850 patent and establishing a coal-oil works at Bathgate in Scotland, where production was based on local deposits of *torbanite* (see Hassan 1978, 280-81, 289n18, Butt 1964). *Shale-oil* was derived by the distillation of *oil shales* The crude product could then be further refined to produce paraffins and other oils (Raistrick 1973, 69, Trinder 1992, various entries)

3.3.2 For each of these materials, production processes broadly divided into *extraction*, *crushing*, *distilling* and *refining*. A coal-oil works, a shale-oil works or a bitumen works would therefore include some form of *crushing plant*, together with *oil distilling plant* with *retorts* and *condensers*, and *oil refining plant* for *chemical washing* (with acid and lime) and *deodorising* Technologically, the *distilling process* owed a great deal to the gas industry, for example the 1838-9 retort design of Lowe and Kirkham was subsequently used for the distillation of shale (Butt 1965, 513). Waste tips were an inevitable feature of these works, and within the shale-oil industry these were known as *'bings'* (Cossons 1987, 213-14)

3.3.3 Specific examples from contemporary documentation include the 1790s Shropshire works of Martin Eele, where bituminous rock was ground to a powder *in querns*, then boiled with water in *copper pans*, and the resulting bitumen was skimmed from the surface and *distilled* to form pitch (Forbes 1958, 40, 52-3) Similarly, Young's 1850 patent describes the basic process he used Stone was broken into egg-sized fragments, then *distilled* in horizontal (later vertical) retorts (Forbes 1958, 188-9) A 24-hour process was used, the first 4 hours yielding 'ammoniacal vapours', and the next 20 hours producing the shale-oil, which was then *refined* to produce various fractions, described by Young as naphtha, photogen (a lamp oil), solar oil (a gasoil), and lubricating oils Further refining of the lubricating oil (initially using a 'refrigeration' process, later by a 'sweating' process) produced paraffin wax

3.4 PETROLEUM

3.4.1 'Oil Industry' and 'Mineral oil industry' are popular terms for what is more properly termed the *Petroleum Industry* *Petroleum* is a 'rock oil', which occurs *in oil fields* of underground porous reservoir rocks It *is* composed of a range of hydrocarbons varying from very light gases to solids At ground level and at atmospheric pressure, petroleum comprises *crude oil* and *natural gas* An *oil field* generally contains varying quantities of natural gas with the crude oil, but a *natural gas field* consists only of natural gas *Crude oils* can vary widely in heaviness and can be refined into a range of products which have an even wider range of uses. These are summarised below (BP 1977, Trinder 1992, 530).

PETROLEUM	refining yields	used for:
CRUDE OIL	Natural gas	Methane/Ethane - refinery fuel
	PFD (primary flash distillate)	LPG refinery fuel motor spirit (ie petrol)
	Benzene	motor spirit

	Naphtha	jet engine fuel chemical manufacture
	Kerosene	burning oil
	Atmospheric gas oil	diesel fuel
	Atmospheric residue	fuel oils
NATURAL GAS	LPG (liquefied petroleum gas) - includes	domestic fuel internal combustion engine fuel chemicals raw materials
	• *Burane* (obtained from coal & natural gas)	rubber chewing gum, grease proof paper
	• *Propane*	metal cutting
	• *Propene* (or propylene produced by thermal cracking of propane)	production of plastics
	Town Gas	domestic fuel

3.4.2 The basic field components of the petroleum industry are described in a host of industry publications (for example Anderson 1984, BP 1977), and are summarised by Trinder (1992, 530-32)

3.4.3 Oil is generally extracted at an oil well, which is essentially a bore-hole, drilled using an oil rig (for *offshore drilling*, this is housed on a *drilling platform*). *Cable-tool drilling* was introduced in about 1850 (and was used by Drake to drill his Titusville well in 1859) In this system the oil rig incorporated a *derrick* or tower, originally wooden but later of steel, which held the drilling equipment, and a *steam engine* to power the drilling action Cable-tool drilling depended on the pounding action of the drill-bit to deepen the well and the process was intermittent with the need to remove *cuttings* from the well *Rotary drilling* was introduced in the 1890s m Texas, USA. In this system the drill bit was rotated at the end of a steel tube, and muddy water pimiped down the rotating pipe both as a coolant and to continually flush out the *cuttings*; it is thus a faster process. In both systems, the well needed to be lined at intervals, originally using lengths of iron *casing*, later steel, and from the early twentieth century with the *cementation* of casing Wells up to 300m deep were being driled by 1901 and up to 6,900m by the 1950s, emphasising the rapid evolution in efficiency of drilling technology

3.4.4 Once the drilling of an oil well had been completed, it had to be brought into *production*. Natural pressure was sometimes sufficient to force oil to the surface More usually the oil had to be lifted by means of applied *pneumatic pressure* or by means of an *oil pump*, usually a plunger-type operated by an oscillating beam driven by a prime mover The 'nodding donkeys' of the East Midlands oil fields produced oil in this way, and similar systems continue to be used around the world today, including in the Los Angeles, USA, oil field.

3.4.5 An oil refinery is a works for distilling crude oil into its fractions, and for storing the oil Hence it includes *oil distillation plant* and a tank farm Very broadly, early systems of *oil distillation plant* used simple batch *stills* (with iron kettles and copper tube condensers) to distil the cmde oil into rough fractions - gasoline, kerosene, lubricating oils and fuel oils A sequence of improvements and additional processing stages through the late nineteenth and twentieth centuries led to very fine control of the fractionation. For example in 1885 the 'shell still' was introduced, followed in 1911 by the 'pipe still', with pipes carrying crude oil through a gas- or oil-fired furnace. The 'bubble plate distillation column' was devised in 1920 and forms the basis of the *fractionation tower* where decreasing temperature towards the top of the tower allows different fractions to be drawn off at different heights.

3.4.6 *Cracking* in the petroleum industry refers to a process of heating the oil in short bursts to 'crack' large heavy hydrocarbon molecules into smaller ones, that is to produce lighter oils (Anderson 1984, 219, Trinder 1992, 184). The basic process of *thermal cracking*, where oil is heated under pressure, was established in 1913 by William Burton of Standard Oil, who were using it by 1918 to manufacture propene, a development that may be seen as marking the start of the petrochemical industry. *Continuous thermal cracking* was developed over the next 20 years. In *catalytic cracking*, oil is heated in the presence of a catalyst rather than under pressure. This process, which gives better yields than thermal cracking, was first carried out commercially in 1936.

3.4.7 The bulk of a refinery is taken up by the tank farm, composed of groups of cylindrical and spherical *tanks* for storing crude oil and the various products. Additional features of a refinery may be an *administrative block*, a *power station*, *stores*, *workshops*, *oil jetties*, a *laboratory*, and considerable lengths of above and below-ground *pipework*.

3.4.8 Transportation of both the crude oil and the oil products may be by a variety of means, including sea borne *oil tankers* (dating from 1886), road and rail haulage, or by oil pipeline. The latter may be single pipes or multiple lines. The earliest successful pipeline (over 6 miles using 2" pipe) was operated from 1864 in America, where pipeline technology was largely developed and lengths of over 2500km (1600 miles) had been achieved by 1914. Pipelines are generally buried, although some early pipelines in remote areas were laid above ground, using a zig-zag pattern to allow for expansion and contraction. Diameters of modern pipelines vary from 6" to 50" depending on the volume of oil being transported, and generally require *pumping stations* at intervals of between 30 and 200 miles, which are operated via *control centres*.

4. HISTORICAL OUTLINE

4.1 BACKGROUND

4.1.1 The obtaining of oils for human use has involved a variety of source materials The gradual move from the utilisation of one source to another provides a rough chronology of the development of what was really a group of industries. As already mentioned (*Section 3.1*), there is an extraordinary range of terms relating to the raw materials and products of these industries; in addition there is a degree of confusion in the historical literature regarding the nature of the raw materials extracted and refined products emanating from early 'oil' sites ('bitumen' versus 'oil shale', 'tar' versus 'pitch' versus 'oil' etc) This partly reflects the writings of the seventeenth-, eighteenth- and nineteenth-century men who were developing the processes (and indeed the terms), at the same time as they were gaining an understanding of the chemistry involved In fact this confusion readily leant itself to disagreements and conflicts between pioneers of the early industry, which is characterised by a string of patents and litigations, the original documents of which form a valuable historical source.

4.2 EARLY HISTORY

4.2.1 There is a long history of the use of *natural oils*, which is beyond the scope of this report (see Brace 1960, Forbes 1958) These oils were widely used as lubricants and for lighting, with the raw materials produced in *oil mills* From the seventeenth century, *mineral oils* gradually replaced them.

4.3 WOOD-TAR AND WOOD DISTILLATION

4.3.1 *Wood-tar* manufacture also has a long history, as a by-product of the charcoal industry (Forbes 1958, 134-6, Kelly 1986) The Romans made wide use of pitch derived from wood-tar, for example in the caulking of ships, repairing pottery, water-proofing walls and roofs, for colouring, in paint, for mstproofing metals, for makmg torches, and as core for statutes and modelling Pliny also records the Egyptian use of light tar, or 'cedar juice', for embalming (Forbes 1958, 135) Traditional forest kilns of various forms, together with brick-built kilns, appear to have fomed the basis of this mdustry from at least the Roman period through to the eighteenth century, the tar could be drawn off in channels beneath such a kiln and collected in underground chambers.

4.3.2 Seventeenth-century timber shortages in relation to the demand for charcoal for the expanding iron industry spurred searches for new supplies of wood-tar By the eighteenth century, the main European source was Scandinavia, but from 1703 Britain was able to import major wood-tar supplies from its North American colonies, a supply that was abmptly cut off by the American War of Independence (Mott 1936, 37)

4.3.3 The demand for charcoal also encouraged closer study of the chemistry behind *wood distillation*, and this led to an interest in a wider range of by-products, such as methanol and acetic acid (Kelley 1986, 30). A beehive kiln specifically for the distillation of wood, was described in 1657 by Glauber, a German chemist, and translated to English in 1689 (Mott 1936, 29-30). The *wood distillation industry* seems to have emerged in the late eighteenth and early nineteenth centuries from a combination of this increased chemical understanding, with technology adopted from the newly arrived gas industry. Boosted by further scientific investigations (for example in 1830-5 Reichenbach published findings of detailed studies of wood-tar), specialised plant was developed and improved through the nineteenth century and wood distillation played a minor but significant part in relation to the chemical industry into the twentieth century (Forbes 1958, 182-3, Kelly 1986, 31).

4.4 COAL-TAR

4.4.1 The coal-tar industry was largely a post medieval development, that grew at least partly out of the seventeenth-century interest in wood-tar substitutes, for example in 1667, Spratt stressed a need to make tar out of raw materials other than wood. Very broadly its development may be divided into five periods as detailed below.

4.4.2 ***Period 1:*** the seventeenth and eighteenth centuries were characterized by early attempts to produce coal-tar as an alternative to wood-tar for the caulking of ships (Butt 1965b, 512, Mott 1936, 30, 35). Hence, for example, in 1681 Johan Becher, a German 'projector' studying mines in Cornwall, together with Henry Serle patented a method for distilling tar and pitch from coal, although it failed to become a commercial venture. In 1716 Talbot Edwards used distillation techniques to produce tars which were claimed to be superior to Swedish wood-tar. In 1746 Henry Haskins patented a method of producing fine quality pitch from coal-tar, although again without commercial success.

4.4.3 ***Period 2:*** the late eighteenth century saw the establishment of short-lived coal-tar works. In 1772 Christian Wilhelm (Baron von Haake) took out a British patent for making 'mineral tar' and 'mineral oil' by distilling coal, and this seems to have been successfully put into practice (Butt 1965b, 512). Coal-tar manufacture was being carried out at Bristol in 1779, and by George Dixon at Cockfield in County Durham, the product of the latter being sent to Sunderland for the shipbuilding industry until 1783 (Mott 1936, 37, Stewart 1958, 5-6). In the 1770s there were 'coal-tar buildings' in use at the Madeley Wood ironworks in Shropshire, although these were closed in 1779 (Cossons 1972, 5/238, Trinder 1981, 55).

4.4.4 Better known are the efforts of Archibald Cochrane (Lord Dundonald from 1788) whose 1781 patent covered the distilling of 'pit coal' to make various products. This led to the founding of the 'British Tar Company' in 1782 and the building of a <u>coal-tar works</u> at Culross (where gas was also collected as a by-product and used to light Culross Abbey in 1787), and Dalkieth. In 1785 Cochrane published a book extolling the virtues of his process and his patent was extended for 20 years, apparently being considered of national interest (although his aim of sales to the navy seem to have been thwarted by their preference for copper bottoming, which lasted until 1822, and the British Tar Company seems to have gone out of business by 1800).

4 4 5 Dundonald's company also built coal-tar works in England, notably two in the Ironbridge Gorge in Shropshire and three in Staffordshire (Clark and Alfrey 1988, 76, Trinder 1981, 39-41, 55-8). In the Ironbridge area, 12 kilns were built adjacent to the Calcutts ironworks between 1784-6, and 8 more were added by 1800, these continued in use to 1836 and were demolished in 1838. Tar ovens were also erected beside the Benthall ironworks and used between 1787 and 1799, when they were demolished. Beyond this, William Reynolds, in consultation with Dundonald, built tar ovens at Madeley Wood ironworks (1789) and at the Ketley ironworks (1790); and John Wilkinson built ovens at the Willey ironworks.

4 4 6 Dundonald's coal-tar oven consisted of a domed chamber with a series of air holes to control the fire. Smoke, containing the tar, was fed through horizontal tubes from the top of the ovens into a water-filled lead chamber, where the tar was condensed out, then passed to a boiler and heated to form pitch and other oils (see Campbell 1971, 81, Cochrane 1785, Forbes 1958, 138, Mott 1936, 38-9; Trinder 1981, 55).

4 4 7 *Period 3:* the first half of the nineteenth century seems to have been characterised by considerable advances in understanding, together with the beginning of tar distilleries using crude tar obtained from works of the newly established gas industry (see Gas Industry Step I report) Much of the tar by-product from early gasworks was dumped as waste, although subsequently it was also used to fuel retort bench furnaces, and sold (mixed with coke or coal-dust) to fuel ammonia stills Nevertheless some was sold to *tar distilleries*; for example in the 1820s some Scottish companies used the tar to make pitch for lampblack and spirit use in the manufacture of for waterproof cloth (Williams 1981, 18)

4 4.8 Notable scientific investigation and experimentation during this period included the following (Forbes 1958a, Gardner 1915).

1819 Garden and Kidd separated naphthalene from tar

1825 Faraday separated benzene from gas

1832 Reichenbach made creosote from tar

1834 Runge recounted detailed investigation of tar fractions - including analine

1835 Dumas and Laurent obtained anthracene

1838 John Bethell patented process for using creosote as a wood preserver

1841 Phenol obtained

1842 Leigh obtained benzene from tar (confirmed by A W Hofmann in 1845)

1842 Royal College of Chemistry set up in London in 1845 and Hofmann appointed director. Investigation of coal-tar fractions (specifically naphtha into benzene and toluene and aniline) were carried out here under Hofmann and Mansfield, which laid foundations for many future uses, eg benzene in dry cleaning processes, as a synthetic soap perfume, and in medicine.

4 4 9 Hence by 1850, most of the tar fractions had been discovered, their properties were known and tar was readily available as a by-product of the gas industry, with refining being carried out in tar distilleries, for example by John Bethel, who in the 1840s had the largest tar distilling works in Britain, and at the Crews Hole works in Bristol (Butt 1965b, 516, Day 1987, 14)

4 4 10 ***Period 4:*** the latter half of the nineteenth century, saw the growth of the tar distilling industry spurred by the expansion of the railways and the emergence of a tar-based chemical industry. A major technological development was that of the recovery coke ovens

4 4 11 Following Bethel's work in establishing the wood preservmg qualities of creosote and the 1830s adoption of wooden railway sleepers, the tar distilling industry became linked with the huge nineteenth-century expansion of the railway system. The other boost to distilleries was in relation to the emergence of a major tar-based chemical industry m European, beginning with the development of aniline dyes Important early developments took place in England m 1849 Mansfield obtained aniline from tar-derived benzene, and in 1856, Perkins prepared 'Mauve', the first aniline dye (Gardner 1915) This led to the development of a whole range of dyes, together with synthetic drugs, explosives, photographic chemicals, medical preparations and many other products (Raistrick 1973, 68, Williams 1981, 18). Although this chemical industry remained important in England, by the 1870s Germany had taken a clear lead in the growth of the industry and by 1900 had 90% of the market (Cossons 1987, 209). The early twentieth century witnessed the development in Britain by the Graesser family of the fractionalisation of coal tar and the production of phenols and carbolic acid (LUAU 1996)

4 4 12 During the first half of the nineteenth century, coal-tar was generally not collected from the coking mdustry At this stage the majority of coke produced was for the iron industry and was made in *coke heaps* (as done by Darby in 1709 following the practice of the malting mdustry), or in cheaply built *beehive ovens* (in use in Newcastle in 1765, see Mott 1936, 30, Trinder 1981, 55), and these ovens were not designed with tar recovery in mind However, tar could be collected from *coke heaps* using sunken pits, as at Dudley in 1859 (Mott 1936, 29, 40) In addifion, some ovens were designed to manufacture both coke and tar, as at Sulzbach m 1764 (Mott 1936, 36-7), and the Dundonalds tar works of the 1790s produced both coke and tar Attempts were also made to recover tar from *beehive kilns*, as in 1874 at the Falkirk iron works, where a design by Aitken allowed extraction of tar and ammonia through the base; the design was improved upon by Jamieson in Newcastle-upon Tyne in 1883 (Mott 1936, 69). The first *recovery coke oven* (the Carvès oven) was built in France in 1866. An improved design by Henry Simon in England was used as the basis of ovens built at Crook in County Durham in 1882. Numerous technological refinements are detailed by Mott (Mott 1936, 65-6, Trinder 1992, 165)

4 4 13 ***Period 5:*** the early twentieth century saw the emergence of the automobile industry and the resulting wide use of coal-tar for road surfacing Its role as the basis of the European chemical industry continued imtil the 1950s.

4 4 14 The use of tar for bonding road surfaces grew from initial experiments in Nottingham in 1832-8, via a gradual expansion of use in the late nineteenth century (1854 - used in Paris, 1866 - used in USA, 1870s - used in Sheffield and Liverpool) to the systematic tarring of English roads after the setting up of the Road Board in 1909 (Cossons 1987, 243, Trinder 1992, 632, 746) This led to the increased large-scale producuon of distilled coal-tar Crude tar continued to be supplied from the gas industry, although from 1900, increased supplies were available via the new *recovery ovens* of the coking industry (an increase which led to a large drop m the price of coal-tar)

4 4 15 The European tar-based chemical industry contrasted in terms of technology and by-products with the American petroleum-based chemical industry that grew up in parallel to it The 1950s saw coal-tar derivatives entirely replaced by the products of what now became a world-wide *petrochemical industry* (Anderson 1984, 225-6)

4.5 COAL-OIL, SHALE-OIL AND BITUMEN

4 5 1 Prior to the nineteenth century, naturally occurring mineral oils became slowly but increasingly known in Europe and North America. Their use seems to have been essentially rural, for example as cart grease, wood preservatives, lamp oils, daub for cattle diseases, and in medicinal preparations However, they were also used as an occasional cheap substitute for wood-tar and pitch m the caulking of ships and preservative treatment of rope and cordage (Campbell 1971, 81-89, Forbes 1958, 134-7, Kelly 1986)

4 5 2 Market demands were an important stimulus for the development of the oil industry m the early nineteenth century. At this time tar distillers and gas-works provided for the needs of naval dockyards and subsequently for the emerging chemical industry. The stimuli for mineral oils came instead from a growing demand for lubricants, lamp oil and domestic candles (Butt, 1965b, 514-16)

4 5 3 In the case of *lubricants* this was driven by a change from slow-moving wooden to fast-moving metallic machinery The higher frictional heat of the latter caused natural oils to fail and mineral oil was an ideal replacement Natural oils had also long been the basis of *oil lamps* A significant invention was the Argand lamp of 1782, which greatly reduced smokiness and gave an even light, by using a cylindrical adjustable wick combmed with a central air supply to the flame. The Carcel lamp of 1800 improved on this with a pump mechanism to mamtain the oil supply to the wick, so giving an intense light. Further improvements followed. However, all these early designs were expensive to manufacture. Further designs gradually led to cheaper lamps, but only in the 1850s were mass-produced lamps available - notably the Neuberger lamp of 1854, which was heavily marketed by John and James Young in relation to their shale-oil businesses The early nineteenth century also saw moves towards the mass production of *candles* In 1787 Cooper had devised a machine for making twisted candle wicks, and in 1801 Binns invented a candle casting process In 1823 Chevreul obtained stearine from tallow so that by 1833, stearine candles were being sold However, in 1830 Christison of Edinburgh obtained paraffin wax from rangoon oil, and the ability to distil this product was steadily developed, for example

Selligue produced paraffin wax from oil shale in 1837-8 Paraffin wax candles became the basis of a mechanised industry by 1855

4 5 4 As with the tar-based industry, the development of the oil industry may be roughly divided into periods, as described below (Butt, 1964 & 1965a/b; Forbes 1958, 186-91, Hassan 1978, Raistrick 1973, 69)

4 5 5 *Period 1:* the seventeenth and eighteenth centuries saw some early discovery and working of bituminous rocks. The first English commercial workings of *bituminous rock* seem to have been those of Martin Eele of Broseley, in the 1690s (Cossons 1971, 1/149, Forbes 1958, 40, 52-3; Trinder 1981, 5, 55, 129). In 1694, together with Thomas Hancock and William Portlock, he opened a works at the significantly named Pitchford in Shropshire and made 'pitch, tar and oil' (Butt 1965b, 512 states that Eele's description makes clear the rock was an oil shale!) At the same time Eele erected a works alongside the river Severn at Jackfield, which continued to 1711, utilising coal measure shales in the Ironbridge Gorge (Clark & Alfrey 1988, 75-6). Eele's published account of his workings includes a plan and description of the Pitchford works (Eele 1697) The stone was ground in *querns* to a powder, which was boiled with water in copper pans, and the bitumen skimmed off and distilled to form pitch This material was sold for use in caulking ships, as an alternative to 'Swedish tar' (Ironbridge Gorge Museum Guide no 4.04, Forbes 1958, 40, 52-3) The Pitchford workings seem to have had a long life, being leased in 1745 to Thomas Betton who sold 'Betton's British Oil' as a medicinal preparation In 1767, oil was also obtained from bituminous rocks alongside the Coalbrookdale-Horsehay railway (Trinder 1981, 129) Twenty one years later, a source of liquid bitumen was tapped in driving what came to be known as the 'Tar Tunnel' at Coalport (the original purpose of which was to provide a canal feeder to coal mine shafts) Some of this material was refined and sold as 'Betton's British Oil', but otherwise it was boiled and sold as pitch Production continued until 1843. The 1790s also saw a discovery of 'elaterite', or 'elastic bitumen', at the 'Odin' lead mine near Castleton in Derbyshire, reported by Hatchett in 1798 (Cossons 1971, 1/149, Forbes 1958, 35)

4 5 6 *Period 2:* the first half of the nineteenth century was a period of scientific investigations, with numerous patents issued for refining processes, and some early workings The oil refining uses of sulphuric acid were established in the 1790s, the purifying properties of lime from the first decade of the nineteenth century, and in 1818, the use of steam to *deodorize* oils was established (Butt 1965b) Within this atmosphere of increasing understanding, a series of practical attempts were made to manufacture and refine oil from coal In 1810, William Speer patented a process for making lamp oil, which was apparently limited in its success. In 1813, Thomas Cochrane (10th Earl of Dundonald) patented a scheme for street lighting based on oil, although it was only ever used in one Westminster parish. In 1823, mineral wax was discovered at Loch Fyne, Argyllshire, but not developed In 1833, Richard Butler patented a method for producing oil from shale In the 1840s, there were experiments carried out at Coalbrookdale aimed at producing oil from coal, shale and schist. During this period tram oil was apparently successfully produced from coal in Tyneside and South Wales, and in the 1850s there were attempts to distil peat in Ireland and the Hebrides (Butt 1965b, 516)

4 5 7 *Period 3:* the latter half of the nineteenth century saw an established coal-oil industry intertwined with a shale-oil industry in Europe and the USA. In 1843 Alexander Parkes, of Elkington & Co in Birmingham, began expenments with Staffordshire and Welsh cannel coals In the same year, James Young was appointed manager of Tennant's Ardwick Chemical Works in Manchester. Four years later Young was consulted about the commercial possibilities of an oil seepage at James Oakes' New Deeps coal mine at Riddings (Alfreton), in Derbyshire Young subsequently erected a refinery and produced oils for lubncating and for lighting (the latter what came to be known as kerosene in USA, or paraffin in England). Young's involvement ended m 1847. The mine was still producing oil in 1873-7, but had closed by 1885. Following this expenence, Young studied the cannel coals of Lancashire with a view to manufactunng oil This resulted m 1850 in Young's historically important British patent for a low temperature *oil distillation* and refining process using <u>coal</u> as the raw matenal (it was followed by his USA patent in 1852) The process involved breaking the coal into egg-sized fragments, and distilling it in a honzontal gas retort. Young and his new partners Meldrum and Binney put this process into practice in the world's first <u>coal-oil works</u> at Bathgate, Scotland, which was situated close to a major source of *torbanite* and marked the beginnmg of Scotland's significant oil industry. By 1860 there were 7 coal-oil plants in Britain and Young entered into legal disputes with some of these For example m 1853 Samuel Lees' Hydro-Carbon Gas Company of Salford distilled Lancashire cannel coals and from this sold paraffin lubricating oils. Young sued them and won There was also a dispute with the shale-oil works in Dorset (see below, *Section 4 5 10*)

4 5 8 A similar *coal-oil industry* became established in the USA and a great deal of litigation ensued between Young and various individuals and companies, particularly in relafion to competing patents by Abraham Gesner (1850), for disfilling oil to produce an illuminating gas (although he later claimed the purpose was to produce oil), and Luther Atwood (1853), for high temperature distillation to produce a lubricating oil called *coup-oil* from coal-tar. Young's case was seemingly strengthened by the 1857 adoption of a legal view of torbanite as a coal (Butt 1965a), but in 1858 there were 23 coal-oil firms in the USA using Yoimg's processes, and in 1860 between 30 and 60 plants, mostly usmg torbanite. After 1860, the American coal-oil industry was rapidly eclipsed by the petroleum industry, whilst in Britain, coal-oil was steadily replaced by shale-oil - more or less completely by 1870

4 5 9 Early developments in the *shale-oil industry* occurred in France In 1832 Dijon, Blum & Moneuse obtained a patent for distilling lighting oil from shale This patent was bought by Alexander Selligue m 1836, who improved it in his own 1837 patent and put it into practice using shale from Autun The distilled oil was mixed with sulphuric acid by agitation in a large vessel for about 24 hours, then skimmed to a second vessel, where it was washed with water, and mixed with slaked lime, the resulting gases being removed by an air current This process formed the basis of the Autun shale-oil industry from the 1840s, and saw further developments such as the Laurens and Thomas 1840 patent for disfillation using superheated steam (Forbes 1958, 183-56)

4 5 10 Selligue's process was given a British patent under the names of Dubuisson and Michel Antoine Bertin (Baron du Buisson) in 1845, to produce gas, oils, paraffin wax,

and by-products (pitch, tar, sulphate of ammonia and other 'fertilizers') from shale-oil This patent formed the basis for a brief shale-oil industry in Dorset in the 1840s (Butt 1965b, 513) In 1848 a shale-oil works was erected at Wareham, next to the railway, to make use of nearby Kimmeridge shales. The poor oil-bearing quality of these shales seems to have been the downfall of this company and, following several changes of ownership (plus disputes with Young), it closed m 1864. A second venture at Weymouth in 1849 seems to have been bankrupted and closed in 1850. There was a similarly short-lived attempt to exploit Shropshire oil-shales in 1851, by Samuel Clift and Jesse Fisher. A more successful industry emerged in 1862 with a crude oil works and refinery at Leeswood in Flintshire (the 'St David's works'), followed by smaller firms established elsewhere in Wales and in Staffordshire.

4 5 11 However, the major portion of the British shale-oil industry was in Scotland, following the discovery of oil-bearing shales in the Lothians, and publication of the 1859-61 geological survey giving details of the discoveries. Subsequently a large number of Scottish firms were established to use this material, which was cheaper than torbanite and gave a greater chance of avoiding infringement of Young's patent The lapse of this patent in 1864, and the establishment of yet more companies marked the start of a Scottish 'oil boom' in 1864-6, with 120 firms operating in the area at the end of that short period Although the number of firms subsequently declined (26 works by 1880, 14 by 1890, 9 by 1900), the Scottish shale-oil industry remained important, and the last works survived into the 1960s (see Butt 1967a, 23-4, 25, 149-50).

4 5 12 *Period 5:* the twentieth-century saw some further small-scale shale-oil workings in England. The first was at West Winch and Setchey in Norfolk where shale-oil was extracted and refined between 1918 and 1930 This development included a small community of wooden houses Most of works were dismantled in 1950s (Manning pers comm; Trinder 1992, 681) The second was at Kilve in Somerset, where sea cliff oil shales were worked in the 1920s Remains here include an ***oil distillation plant*** in the form of a brick tower and brick *retort house*, which is listed (Cossons 1987, 214, Miles 1995)

4.6 PETROLEUM

4 6 1 Edwin Drake's successful oil well drillings at Titusville, Pennsylvania in 1859 are generally taken as the start of the modern large-scale petroleum industry (Anderson 19842, 8-9). The development of this industry, although dominated by America, was a world-wide phenomenon. Its expansion is illustrated by the followed figures:

by 1900	20 million tons crude oil produced world wide
1910	44 million tons
1936	244 million tons
1956	824 million tons
1965	1500 million tons

4.6.2 Britain lacks any significant inland oil reserves and its archaeological remains of the extractive petroleum industry are of relatively minor significance. However, exploitation of England's limited reserves did take place in the twentieth century (documented by the HMSO published *Annual Reports of the Secretary for Mines* from 1918 to 1938). Following the Petroleum (Production) Act of 1918, licensing was granted for oil exploration and test wells were drilled by several companies such as Pearson and Sons, Oilfields of England Ltd and D'Arcy Exploration. Very little of this work led to successful production, a notable exception being a well at Hardstoft in Derbyshire which, in 1922 produced 2,652 barrels and continued production through the 1930s. A second wave of exploration followed the Petroleum (Production) Act of 1934 and numerous test wells were drilled in two broad bands of England (the counties north of Lincolnshire-Cheshire and south of Kent-Wiltshire). Companies involved in this work were D'Arcy Exploration, Anglo-American, Gulf Exploration and Steel Brothers. Slightly greater success was achieved and the main area of production was in Nottinghamshire where a series of small *oil-fields* were discovered as part of programme of exploration by the D'Arcy Exploration Company, a subsidiary of Anglo-Iranian Oil Co, later British Petroleum (anon 1954, BP 1977). Oil wells were established during and after World War II, at Eakring (1939), Kelham Hills (1941), Dukes Wood (1941 - where a group of 'nodding donkeys' have been preserved on the now wooded site), and Caunton (1943). In the North West, the Formby oil field (Merseyside) was discovered in 1939.

4.6.3 In the 1950s, further exploration led to the extension of the Midlands wells to north Nottinghamshire, Lincolnshire and Leicestershire. The Nottinghamshire/Lincolnshire wells included Egmanton (1955), Bothamsall (1958), Gainsborough (1959), Beckingham (1964) and South Leverton - all still active in 1992. Wells opened in the 1980s include Farieys Wood Kirklington, Cropwell Butler, Kinoulton, and Rempstone. The headquarters of the BP operation in Nottinghamshire was at Eakring and the main collecting station in Nottinghamshire - the latter continuing to receive oil by pipeline from the Gainsborough and Beckingham fields and by road from other fields. In Leicestershire, the Plungar oil wells were first in operation in 1954, the oil being sent to the Pumpherston refinery near Edinburgh. A small number of wells were also opened in Dorset in the 1950s, these were the Kimmeridge oil wells and Wytch Farm.

4.6.4 Beyond this limited extraction, Britain's oil industry has largely been one of *refining* and *distribution*, initially based on imported oil and, since the 1970s, also using North Sea oil. This industry has been of major economic significance to many areas over a long period, for example Tyneside was a centre of refining by Esso from 1889. Teeside and the Severn estuary were also major centres for oil refining. However, in archaeological terms, the industry is characterised by large plant and storage tanks spread over huge areas and undergoing active and rapid change. Two sites recorded by Hudson (1984, 56-9) illustrate the point:

- Fawley, Hampshire - refinery dates from 1921 when 270ha of land bought by Atlantic, Gulf and West Indies Oil Co. Subsequent take-overs led to Esso ownership. Site expanded to 1939. No refining during war. 1949, further refinery on 1200 ha. 1958, chemical plant added.

- Shell Haven, Essex - refinery from pre WWI 1920s, second refinery (Shell) Post WWI - 1969 plant for lubricating oil built and operated, cleared in 1970s 1978, new lubricating plant.

5. ARCHITECTURAL CONSIDERATIONS

5.1 In compiling this report, insufficient material was located in relation to any potential architectural consideration of the oil industries

6. REGIONALITY

6 1 The oil industries do not appear to have any distinctive regional development The technology for its extraction and processing was very much a national and international effort The only sense in which 'regionality' might be examined relates to the fact that natural sources are limited to certain areas, as already described

7. COMPONENTS

Potential field components are listed and described in alphabetical order under three headings. Terms used are defined for MPP purposes, but have been chosen in an attempt to reflect the terminology used in the industry The general importance of each component in isolation is given: the importance of a particular example depending on its date, condition and typological/regional variation Plant is especially important within the oil industries and major items have been included in the list They are distinguished from stmcture and feature components by the use of *italics* Early plant, as a general mle. rarely survives other than as museum pieces, and therefore *in situ* examples are rated high. The value of any component containing original or notable plant would be enhanced over and above the ratings given here Other terms are given in *italics* In this report a policy has been adopted of minimising the number of component terms - they are essentially an indexing system for the final database and any complex variations of machinery and structure types are most readily covered by descriptive text in the step 3 assessments It is of course anticipated that some modification, addition and deletion of terms may be found appropriate m the light of further work.

7.1 WOOD-TAR AND COAL-TAR

Charcoal kilns	Kiln for manufacture of charcoal from wood Relevance to oil industry where kiln includes facility for recovering by-products. particular *wood-tar*
Date range	Roman - present.
Importance	Early examples are high.
Coal-tar distillation plant	Plant for the manufacture of *coal-tar* and its chemical *fractions* Includes coal-tar oven. *condensers*, *thermal distillation* to *receivers*, and *chemical washmg*
Date range	LC18 - present.
Importance	*In situ* examples generally high
Coal-tar oven	Oven for producing tar by carbonising coal
Date range	LC18 - present
Importance	Early examples are high
Coal-tar works	Works for manufacturing tar and other products by the carbonisation of coal (commonly known as a *tar distillery*)
Date range	LC18 - present
Importance	Early examples are high
Coke ovens	Oven for manufacture of coke from coal. Relevance to oil industry where kiln includes facility for recovering by-products, particular *coal-tar* *Recovery coke ovens* date from LC19
Date range	C18 - present

Importance.	Early examples are high.
<u>Waste tips</u>	Term to cover all forms of waste from various oil manufacturing and refining processes
Date range	Roman - present
Importance	Important withm context of whole site
<u>Wood distillation works</u>	Works for manufacturing tar and other products by the dry distillation of wood.
Date range:	Roman - present.
Importance	Early examples are high

7,2 COAL-OIL AND SHALE-OIL AND BITUMEN

<u>Bitumen works</u>	Works for manufacturing oil and other products by the distillation of bituminous rock deposits and subsequent processes
Date range	C17 - present.
Importance	Any examples are high
<u>Coal-oil works</u>	Works for manufacturing oil and other products by the distillation of coal and subsequent refining processes
Date range	EC19 - present.
Importance	Any examples are high
<u>*Crushing plant*</u>	Plant for crushing and breaking coal, shale oil or other rock Specific plant may vary (for example from *querns* to *jaw crushers*) For the purposes of this report, refers specifically to an oil works.
Date range	C17 - present
Importance.	Early examples are high.
<u>*Oil distillation plant*</u>	Plant for the distillation of oil from coal or shale oils or bituminous rocks, incorporates *retorts* and *condensers*
Date range.	EC19 - present.
Importance:	Early examples are high
<u>*Oil refining plant*</u>	Plant for the chemical washing and deodorising of crude oil
Date range:	EC19 - present.
Importance:	Early examples are high
<u>Shale-oil works</u>	Works for manufacturing oil and other products by the distillation of oil shales and subsequent refining processes.
Date range:	EC19 - present
Importance:	Any examples are high

<u>Waste tips</u> | Term to cover all forms of waste from various oil manufacturing and refining processes, within the shale-oil industry these were known as *'bings'* (Cossons 1987, 213-14)
Date range | EC19 - present
Importance | Important within context of whole site

7.3 PETROLEUM

<u>Oil distillation plant</u> | Plant for distilling crude oil into its fractions. Early systems used simple batch *stills* Sequence of improvements and additional processing stages through LC19 and C20. 1885 'shell still', 1911 - 'pipe still'. 1920 'bubble plate distillation column' as basis of *fractionation tower*, 1913 - *thermal cracking* plant. 1936 - *catalytic cracking* plant
Date range | 1850s - present
Importance | Early examples are high

<u>Oil pipeline</u> | System for transportation of both crude oil and the oil products, may be single pipes or multiple lines generally buried, occasionally above ground Generally require *pumping stations* at intervals of between 30 and 200 miles, which are operated via *control centres*
Date range | 1864 - present.
Importance | Early examples are high

<u>Oil pump</u> | Pump used to *produce* oil from an <u>oil well</u> Commonly by a *plunger-type* operated by an oscillating beam driven by a prime mover (eg 'nodding donkeys' of the East Midlands oil fields).
Date range | 1850s - present.
Importance: | *In situ* examples are high.

<u>Oil refinery</u> | A works for distilling crude oil into its fractions, and for storing the oil Hence it includes *<u>oil distillation plant</u>* and a <u>tank farm</u> Additional features may be an *administrative block*, a *power station*, *stores*, *workshops*, *oil jetties*, a *laboratory*, and considerable lengths of above and below-ground *pipework*.
Date range | 1850s - present
Importance | Early examples are high.

<u>Oil rig</u> | Structure that houses drilling equipment at an oil well (for *offshore* sites, it is located on *drilling platform*) *Cable-tool drilling* (from about 1850) used pounding action of drill, incorporating a *derrick* to hold the drilling equipment, and a *steam engine* to power the drilling action *Rotary drilling*

	(from 1890s) used same setup but with rotary action of drill and continuous flushing of *cuttings*
Date range	1850s - present.
Importance	Early examples are high
<u>Oil well</u>	Site at which crude oil is extracted through a drilled bore-hole *Casings*, originally iron, later steel, and from the EC20 with *cementation*.
Date range:	1859 - present
Importance	Early examples are high
<u>Tank farm</u>	The bulk of a refinery is taken up by the composed of groups of cylindrical and spherical *tanks* for storing crude oil and the various products
Date range	LC19 - present.
Importance	Early examples are high

8. SOURCES OF INFORMATION

The bibliography to this report has been arranged to reflect the varying types of sources described in this section Contacts and consultees for compiling the step 2 shortlist are given as an appendix. A comprehensive review of historical sources is beyond the scope of this study, the following summary is intended to be a statement regarding the sources of immediate use to MPP work and an indication of the type of historical source material that is available.

8.1 PUBLISHED WORKS

8 1 1 There is a widely distributed literature on the history of the oil industry, and this material tends to focus on technological and business history with less on field remains. There is no one text which deals with all aspects of oil production and refining as defined for this report. However, several general textbooks of industrial archaeology include sections on wood-tar, coal-tar and oil. In combination these works give a basic but useful introduction to the subject They include Buchanan (1980, 164-170), Bracegirdle (1973, 145-7), Cossons (1987, 209-10, 213-14), Raistrick (1973, 67-9) and Singer et al (1958) In addition, Trinder (1992) includes many useful relevant entries, including CRACKING, CRUDE OIL, OIL INDUSTRY, OIL LAMP, OIL PIPELINE, OIL REFINERY, OIL TANKER, OIL WELL, PETROLEUM, SHALE OIL, and TAR and its various fractions

8 1 2 A still important general history of the early oil industries, which includes the early development of tar, coal-oil and shale-oil is that of Forbes (1958, especially 40-1, 52-3, 134-40, 182-91) The history of these various aspects is further covered by a range of books and articles, including the following. The charcoal and wood distillation industries are covered by Armstrong (1978), and Kelley (1986); the coal-tar and chemical industry by Campbell (1971, 81-89) and Gardner (1915), the coking industry by Mott (1936) & Trinder (1992 coke entry), coal- and shale-oil by Butt (1964b & 1965b), and the petroleum industry by Anderson (1984) and BP (1977). The Scottish oil industry has been described by Butt (1964a, 1965a, 1967a & b), and Butt & Donnachie (1979, 143-4); and Hassan (1978) has discussed its development in relation to the coal and gas industries.

8.2 REGIONAL WORKS

8 2 1 The series of *Bibliographies of Industrial Archaeology and Industrial History* by Greenwood (1985, 1987, 1988; 1990) provide the quickest inroad to what had, by the date of each volume, been published for North England (1985), the Midlands (1987), London (1988), and the South East (1990) There appears to be relatively little on the oil industries within regional publications (although the current review has fallen short of an exhaustive search) Historical accounts are distinguished from the industrial archaeology guides published by David & Charles and others

8.3 CONTEMPORARY WORKS AND PRIMARY RECORDS

8 3 1 There is a large body of works that have been written by oil industry practitioners These constitute a valuable group of historical sources, and frequently contain information about specific sites, examples are BP (1977), Bunbury (1923), Cochrane (1785), Eele (1697), Hatchett (1798), Klar (1903), Lunge (1882) and Shell (1966). Alongside these are the many patents for oil manufacturing and refining processes, taken out from the seventeenth century on In addition various academic and trade journals contain a great deal of useful historical information, much of it with regard to specific sites (see bibliography) Other important sources include the Dundonald collection at the Scottish Record Office, papers relating to James Young (various sources, see Butt 1964a/b, 1965a/b), and the British Geological Society library

8.4 SOURCES FOR STEP 2 DATA AND CONSULTATION

8 4 1 The following categories of source material should be consulted m compiling a step 2 shortlist published works suggesting historically important sites, published works covering specific sites (including Pevsner volumes, and local industrial archaeology guides such as those published by the AIA, David & Charles and others), archaeological databases (the NMR and SMR, English Heritage's listed buildings database and Scheduled Monuments databases, PHEW, and the AIA's IRIS database), correspondents, to include AIA societies and identified individuals beyond the constant list of consultees The latter are given in the address list.

8 4 2 During the course of the step 1 work, a questionnaire was circulated to County Sites and Monuments Records and National Park Officers and to AIA affiliated societies All responses were helpful and the majority gave useful information All expressed willingness to provide further information for the step 2 work Dr Peter Wakelin (Cadw) and Dr Miles Oglethorne (RCAHMS) should be consulted for comparative information in Wales and Scotland.

9. PRIORITIES AND RECOMMENDATIONS

9.1 IMPORTANCE

9.1.1 The history of the early oil industry in England is a topic of international importance in terms both of scientific and technological development and in social and economic history. Any remains of Britain's wood-tar, coal-tar and various rock-oil industries for the period up to the late nineteenth century have the potential to contribute significantly to our knowledge of these fields and are therefore of significance. The twentieth-century extraction of inland crude oil in England constitutes a very minor part of the global petroleum industry. It has nevertheless had some national significance, particularly in the case of war-time extraction. The more widespread twentieth-century oil refineries are also part of a global industry, but within Britain are obviously of considerable economic importance, technologically these sites are dominated by complex plant and large areas, and would be difficult to preserve.

9.2 RARITY

9.2.1 The level of survival of oil industry sites is low. In terms of statutory protection, there are no sites with Scheduled Monument status. A brick retort house of the Kilve shale oil works in Somerset is listed and the site of Dukes Wood oil well in Nottinghamshire is now a nature reserve with restored nodding donkeys and foundations of other features.

9.3 RECOMMENDATIONS

9.3.1 The following general criteria should be applied in selecting sites for protection.

- The aim should be a balanced sample of sites covering the chronological, regional, and typological range of the industry.
- Sites may be important as representing technical advances and, equally, for demonstrating widely adopted practices.
- In general terms, oil works are sufficiently rare that any above-ground remains are likely to be of archaeological importance. It is unlikely that complete sites survive to a level approaching their original condition. Plant in particular is unlikely to survive. However, where buildings have survived, they should be assessed in terms of the potential for archaeological investigation of standing fabric, and the potential survival of buried remains. Both standing fabric and buried remains may contain evidence for the particular oil technology in use on a given site, over and above information available from documentary sources.
- The oil refining industry is closely associated with the petrochemical industry and is dominated by large-scale plant, pipelines and storage facilities. A policy of seeking the preservation *in situ* of elements of this late twentieth-century industry is unlikely to be either practical or desirable. It is recommended however that a policy

should be pursued of carrying out selective recording, particularly photographic, and the preservation of documentary records, preferably in conjunction with a study of the petrochemical industry

BIBLIOGRAPHY

GENERAL

anon	1954	\ New Centre ol Oil Production	*I. Mids Geogr* i/l 42
Bracegirdle B	1973	*The Archaeology of the Industrial Revolution*	London Heinemann
Buchanan R A	1982	*Industrial Archaeology in Britain*	Penguin
Butt, J	1967 a	*The Industrial Archaeology of Scotland*	
Butt J	1967 h	*Industrial Archaeology in the British Isles*	
Butt, J & Donnachie I	1979	*I I in the British Isles*	
Clark C & Allrey J	1988	*Jackfield and Broseley Fourth Interim Report of the Nuffield Survey of the Ironbridge Gorge*	Ironbridge Institute Research Report no 17
Cossons N	1987	*The BP Book of Industrial Archaeology*	Newton Abbot David & Charles
Hardie D W F	1950	*A History of the Chemical Industry in Widnes*	
Hassan J A	1978	'Relationships between Coal Gas and Oil Production a nineteenth-century Scottish case study'	*Ind Arch Rev* 2/3 277-89
Miles S	1995	'Oil at Kilve'	*Bull SIAS* 70 19-23
Nixon F	1969	*The Industrial Archaeology of Derbyshire*	David & Charles
Raistrick A	1973	*Industrial Archaeology*	London Granada Publishing
Thorold H	1984	*Nottinghamshire a Shell guide*	London Faber & Faber
Trinder B (ed)	1992	*The Blackwell Encyclopedia of Industrial Archaeology*	Oxford Blackwell

INDUSTRY JOURNALS

Chemistry and Industry

Journal of the Society of Chemical Industry

Oil and Gas Journal

Oil News

Petroleum Times

Philosophical Transactions of the Royal Society

West's Gas

INDUSTRY HISTORY

	1933	*The Scottish Shale Oil Industry*	Wonders of World Engineering (London IPC Magazines)
	1938	*Oil Shale and Cannel Coal*	Institute of Petroleum
	1961	*History of Petroleum Engineering*	American Petroleum Institute
	1967	Oil retort house at Kilve	*Country Life* magazine 26 Oct 1967
Armstrong L	1978	*Woodcolliers and Charcoal Burning*	Coach Publishing

Bailey E M	1948		James Young, Founder of the Mineral Oil Industry	*Inst of Petroleum Review* vol II 180-3, 216-21 249-52, 357-60
Beaton K	1957		*Enterprise in Oil a history of Shell in the United States*	New York Appleton-Century-Crofts
Beaton, K	1959		Founder's Incentives the pre-Drake Refining Industry	in *Oil's First Century* Camb Mass Harvard Business School
Beaton K F	1955		Dr Kesner's Kerosene	*Business History review* Mar 1955 28-63
Beer J J	1959		*The emergence of the German dye industry*	Illinois University of Illinois Press
Brace H W	1960		*The history of seed crushing in Great Britain*	London Land Books
Brantly J E	1971		*History of Oil Well Drilling*	Houston Gulf Publishing Co
Butt, J	1964	a	*James Young, Scottish Industrialist and Philanthropist, 1811-1883*	unpublished University of Glasgow PhD thesis
Butt, J	1964	b	'Legends of the Coal-Oil Industry'	*Explorations in Entrepreneurial History* II 24
Butt J	1965	a	'The Scottish Oil Mania of 1864-6'	*Scottish Journal of Political Economy* xii, 203
Butt J	1965	b	'Technical Change and the Growth of the British Shale-Oil Industry'	*Econ Hist Rev* 2nd ser xxxv/3 511-21
Campbell W A	1971		*The Chemical Industry*	Longmans
Clark J A	1963		*The Chronological History of the Petroleum and Natural Gas Industries*	Houston Clark Boot Co
Clow A & N I	1952		*The Chemical Revolution a contribution to social technology*	Batchworth
Clow A & N L	1941		'Lord Dundonald'	*Econ Hist Rev* xii 47-58
Conacher H R	1938		'The Mineral-Oil Industry in Scotland its Raw Materials and Methods'	in *Oil Shale and Cannel Coal* (Institute of Petroleum London)
Cooper B & Gaskell T F	1966		*North Sea Oil the great gamble*	London Heinemann
Easton S J M	1866		*Petroleum a History of the Oil region*	Philadelphia J P Skelly & Co
Ferrier, R W	1982		*History of BP*	vol 1
Forbes R J	1955		*Bitumen and Petroleum in Antiquity*	Leiden
Forbes, R J	1958		*Chronology of Oil*	Shell
Forbes, R J	1958		*Studies in Early Petroleum History*	Leydon Brill
Forbes R J	1959		*More Studies in Early Petroleum History 1860-1880*	Leydon Brill
Forbes R J & O'Beirne D R	1957		*Technical Developments of the Royal Dutch/Shell 1890-1940*	Leiden Brill
Gardner W	1915		*The British Coal Tar Industry*	London
Gerretson F C	1953		*History of the Royal Dutch*	Leiden Brill (4 vols)
Giddens P H	1938		*The Birth of the Oil Industry*	New York Macmillan
Giddens P H	1948		*Early Days of Oil a pictorial history of the beginnings of the industry in Pennsylvania*	Princetown NJ Princetown University Press
Gilford H P W	1938		'The former cannel oil industry in North Wales and Staffordshire'	in *Oil Shale and Cannel Coal* (Institute of Petroleum London) 78-92
Goodrich H B	1932		Early Discoveries of Petroleum in the USA	*Economic Geology* xxvii 160-8

Haber L F	1958	*The Chemical Industry during the nineteenth century*	OUP
Haber L F	1971	*The Chemical Industry 1900-1930*	OUP
Hardie D W F & Pratt J D	1966	*A History of the Modern British Chemical Industry*	Pergamon
Harvard	1960	*Oil's First Century papers given at the Centenial Seminar on the History of the Petroleum Industry*	Cambridge MA Harvard Business School
Hidy, R W and Hidy M L	1955	*Pioneering in Big Business the history of the Standard Oil Company, NJ 1882-1911*	New York Harper
Jouan, R	1949	*Le Petrole roi du monde (Petroleum king of the world)*	Paris Monde Payot
Kelley D W	1986	*Charcoal and Charcoal Burning*	Shire Publications (Shire Album 159)
Lee S	1900	*Dictionary of National Biography vol lxiii*	London Smith, Elder & Co
Longhurst, H	1959	*Adventure in oil story of BP*	
LUAU	1996	*McCain Site, Sandycroft, Clwyd*	Unpubl client rep
Miall S	1931	*History of the British Chemical Industry*	Benn
Morgan G T & Pratt D D	1938	*The British Chemical Industry its rise and development*	London Edward Arnold
Mott R A	1936	*History of Coke Making*	Cambridge Heffer for Coke Oven Manager's Association
Multhauf R P	1984	*The History of Chemical Technology*	Garland Publishing
Robins F W	1939	*The Story of the Lamp (and the Candle)*	Oxford University Press
Singer, C, Holmyard E J, Hall A R & Williams T I	1958	*A History of Technology, vols 4 & 5*	Clarendon Press Oxford
Stephen W M	1968	*The Binnend Oilworks and the Binn Village*	Kirkcaldy Fife CC
Stewart D & Forbes, C E	1938	'The Retorting of Oil Shales in Scotland'	in *Oil Shale and Cannel Coal* (Institute of Petroleum, London)
Stewart E G	1958	*Town Gas its manufacture and distribution*	London HMSO for Science Museum
Talbot F A	1914	*The Oil Conquest of the World*	London Heinemann
Taylor F S	1957	*A History of the Chemical Industry*	Heinemann, 2 vols
Trinder B	1981	*The Industrial Revolution in Shropshire*	London Phillimore
Webb K R	1943	The Story of the Distillation of Coal	*Chemistry and Industry* 62 158-9
White GT	1962	*Formative Years in the Far West a history of Standard Oil of California and predecessors through 1919*	New York Appleton-Century-Crofts
Williams T I	1953	*The Chemical Industry, past and present*	Hamondsworth Penguin Books
Williams, T I	1981	*A History of the British Gas Industry*	OUP
Williams T I	1982	*A Short History of Twentieth-Century Technology c1900-c1950*	Oxford Clarendon Press
Williamson H F & Daum A R	1959	*The American Petroleum Industry 1859-1959 the age of illumination*	Evanston North Western University press

INDUSTRY TEXTBOOKS

	1992	*Notts Minerals Local Plan*	
Anderson, R O	1984	*Fundamentals of the Petroleum Industry*	London Weidenfield & Nicolson
Arnold G	1978	*Britain's Oil*	London Hamish Hamilton
Bailey L M	1927	*The Oil Shales of the Lothians*	London (3rd edn)
BP	1977	*Our Industry Petroleum*	British Petroleum Company (5th edn 1st edn 1947 2nd end 1949)
British Geological Survey	1996 ?	*Radon Methane, Carbon Dioxide Oil Seeps etc - relevance to planning and development in Great Britain*	BGS
Bunbury H M	1923	*The Destructive Distillation of Wood*	Benn Brothers
Carruthers R *et al*	1927	*The Oil Shales of the Lothians*	Dept of Sci & Ind Res, Mem Geol Soc, Scotland 3rd edn HMSO
Cochrane A	1785	*An account of the qualities and uses of coal tar and coal varnish with certificates from ship-masters and others*	
Cossons N	1972	*Rees' Manufacturing Industry 1819-20*	David & Charles reprint
Eele M	1697	An account of the making of pitch tar and oil out of a blackish stone in Shropshire	*Phil Trans* xix 544
Gale T A	1860	*The Wonder of the Nineteenth Century rock oil in Pennsylvania and elsewhere*	Erie Sloane & Griffeth 1952 reprint - New York Ethyl Corporation
Gesner A	1861	*Practical treatise on Coal, Petroleum and other distilled oils*	New York
Hager D	1939	*Fundamentals of the Petroleum Industry*	New York McGraw-Hill
Hatchett C	1798	Observations on Bituminous Substances with a description of the Elastic Bitumen	*Trans Linn Soc* iv 129-54
Hofer, H	1888	*Das Erdol (Petroleum)*	Brunswick Bieweg
Klar, M	1925	*The Technology of Wood Distillation*	Chapman & Hall (translated from original of 1903 by Rule)
Lunge G	1882	*Distillation of Coal Tar*	London
Lunge, G	1916	*Coal-tar and ammonia*	London Gurney & Jackson
Mansfield C B	1848	Researches on Coal Tar	*J Chem Soc* 1848 244
Murdock, W	1808	Utility and advantages of gas-lights	*Phil Trans* 1808 p124
Muspratt, S	1850	*Chemistry, Theoretical Practical and Analytical, as applied and related to the Arts and Manufactures*	William McKenzie various edns 1850s-1870s
Oakley C A (ed)	1953	*Edinburgh The Scottish Conned*	
Pirson, S J	1950	*Elements of Oil reservoir Engineering*	New York McGraw-Hill
Pliny H N	0	*Historia Naturalis*	Loeb edition
Redwood, B	1922	*Treatise on Petroleum*	
Redwood I I	1897	*Mineral Oils and their By-Products*	London
Scarle	1912	*British Clays Shales and Sands*	
Shell	1966	*The Petroleum Handbook*	London Shell International Petroleum Co (5th edn)

Shell	1982	*The Petroleum Handbook*	London Shell International Petroleum Co
Thompson A & Beeby H	1916	*Oil Field Development and Petroleum Mining*	London Crosby Lockwood
Thompson A B	1908	*The Oil Fields of Russia*	London Crosby Lockwood
van der Have J H & Verver C G	1957	*Petroleum and its Products*	London Pitman
Ward E R	1969	Researches on Coal Tar	*Chemistry and Industry* 1969 1530 also *Chemistry in Britain* 1962 373
Wilson P J & Wells J H	1950	*Coal Coke and Coal Chemicals*	New York McGraw-Hill

APPENDIX I - ILLUSTRATIONS

Figure 1 Wood-tar distillation works of 1657 (by Glauber), incorporating beehive oven, condenser and tar collector (Mott 1936, 30)

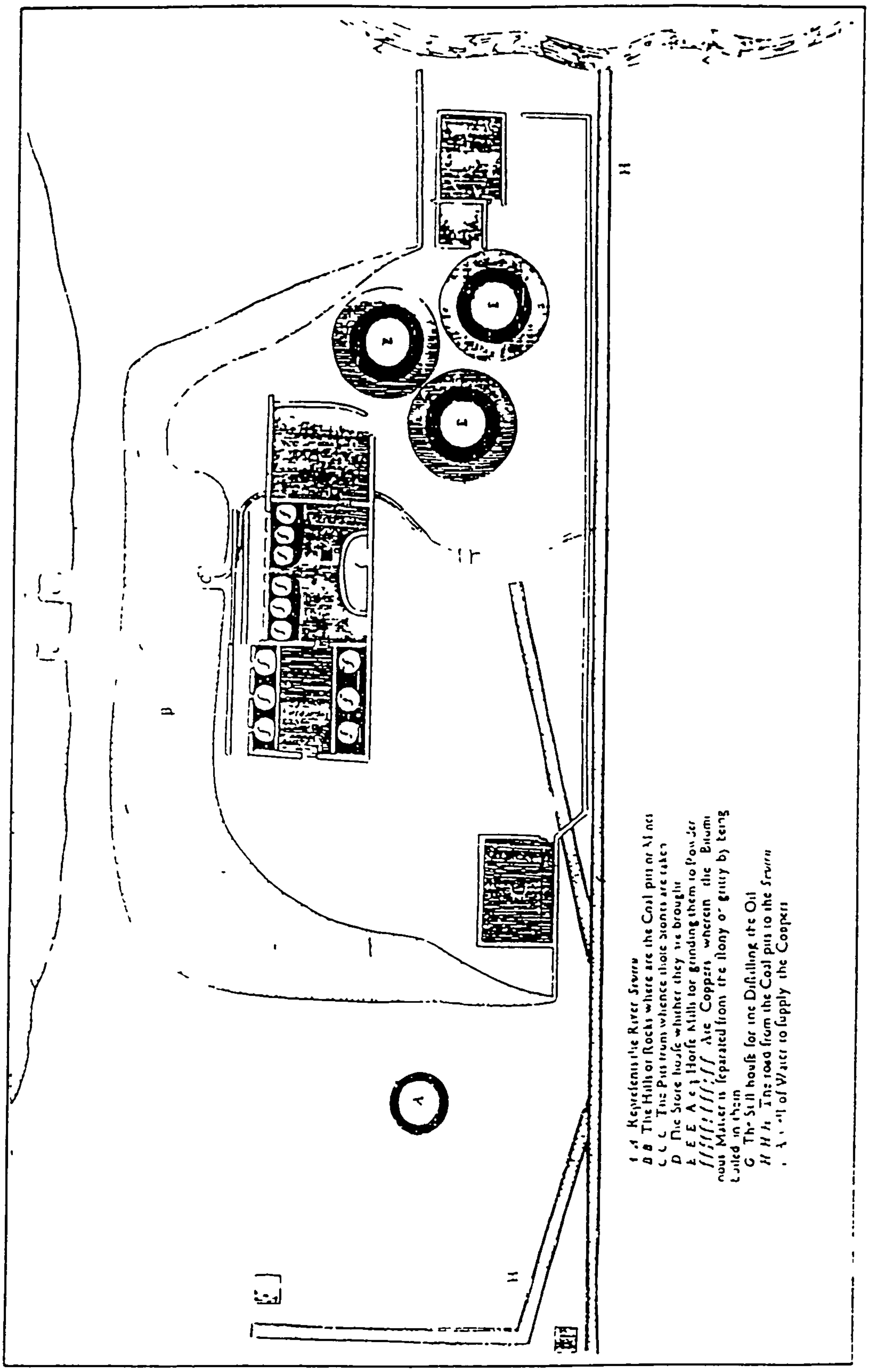

Figure 2. Martin Eele's *oil distillation plant* of the 1690s, at Pitchford in Shropshire (Eele 1697)

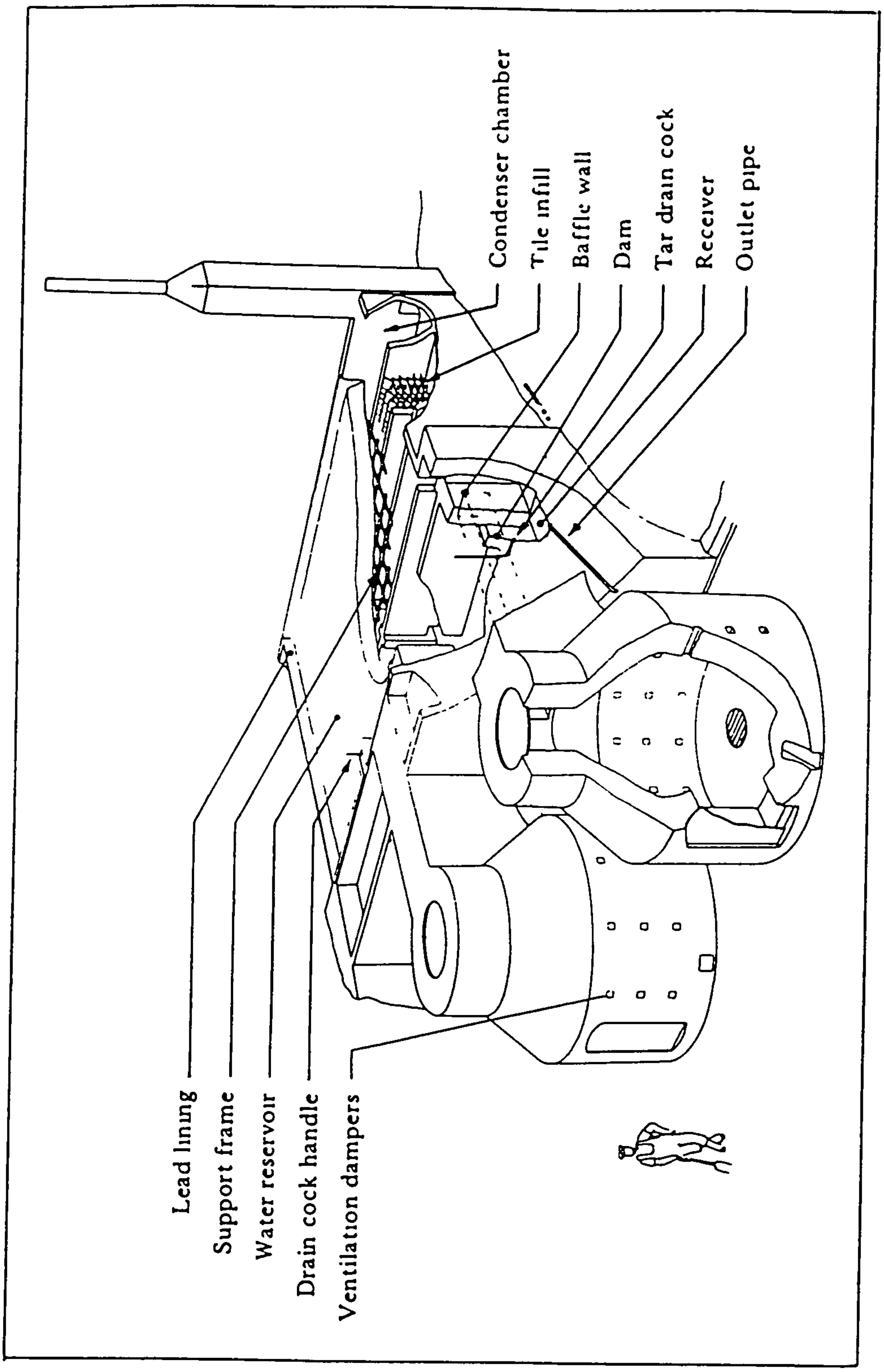

Figure 3 Reconstruction of Dundonalds coal-tar oven and *coal-tar distillation plant* of the 1790s, at the Calcutts Ironworks in Shropshire (Trinder 1981, 56)

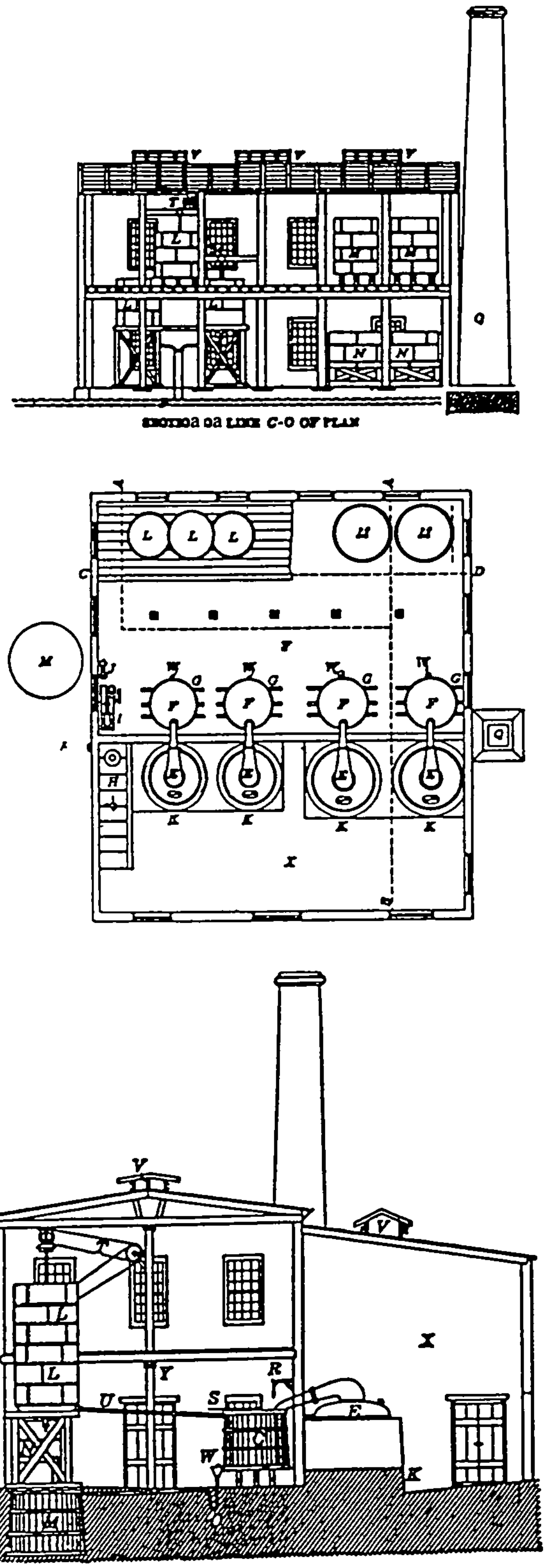

Figure 4· A coal-oil works of the 1860s. (Forbes 1958, 184)

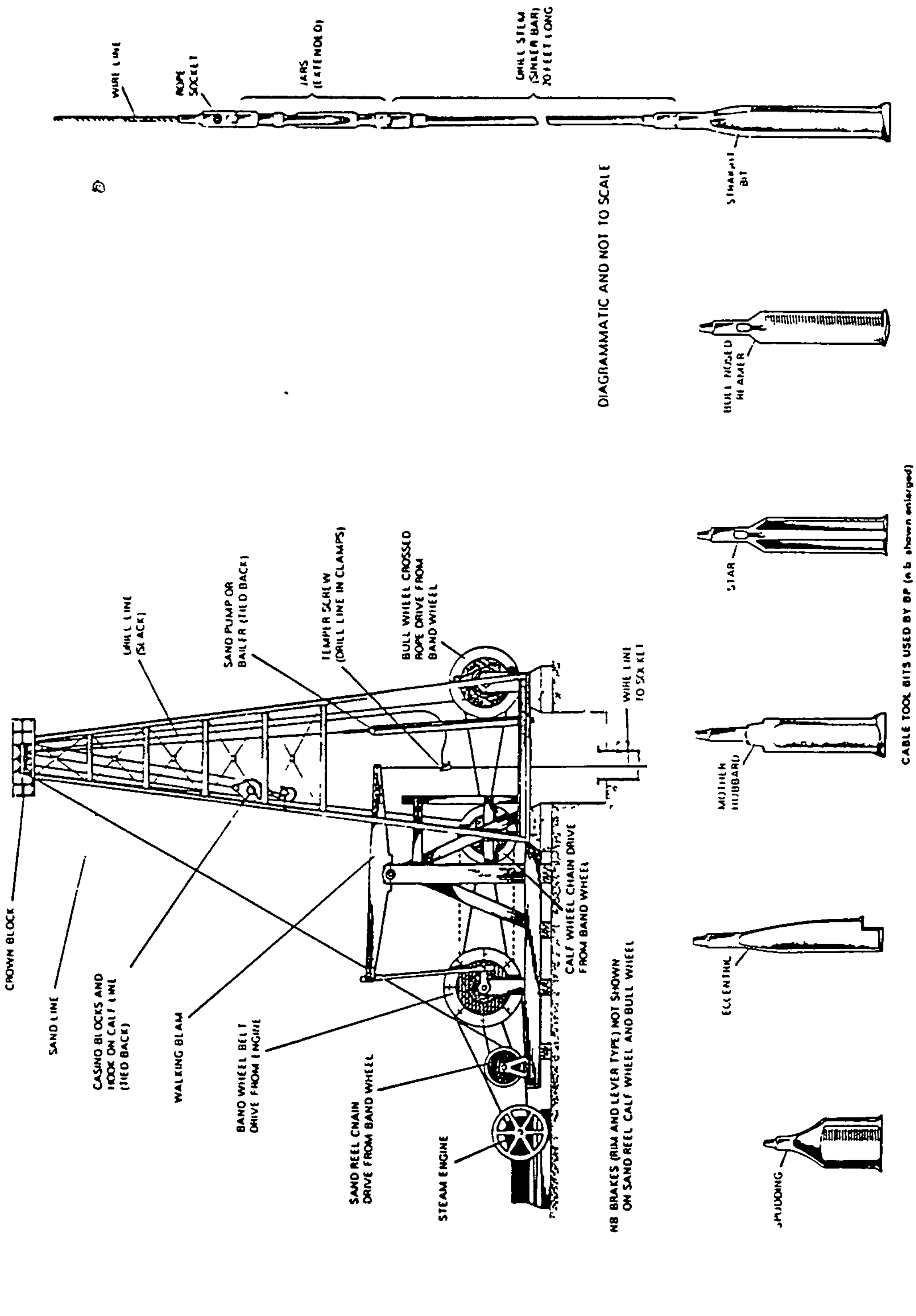

Figure 5 Diagram of cable-tool drilling oil rig (BP 1977, 94)

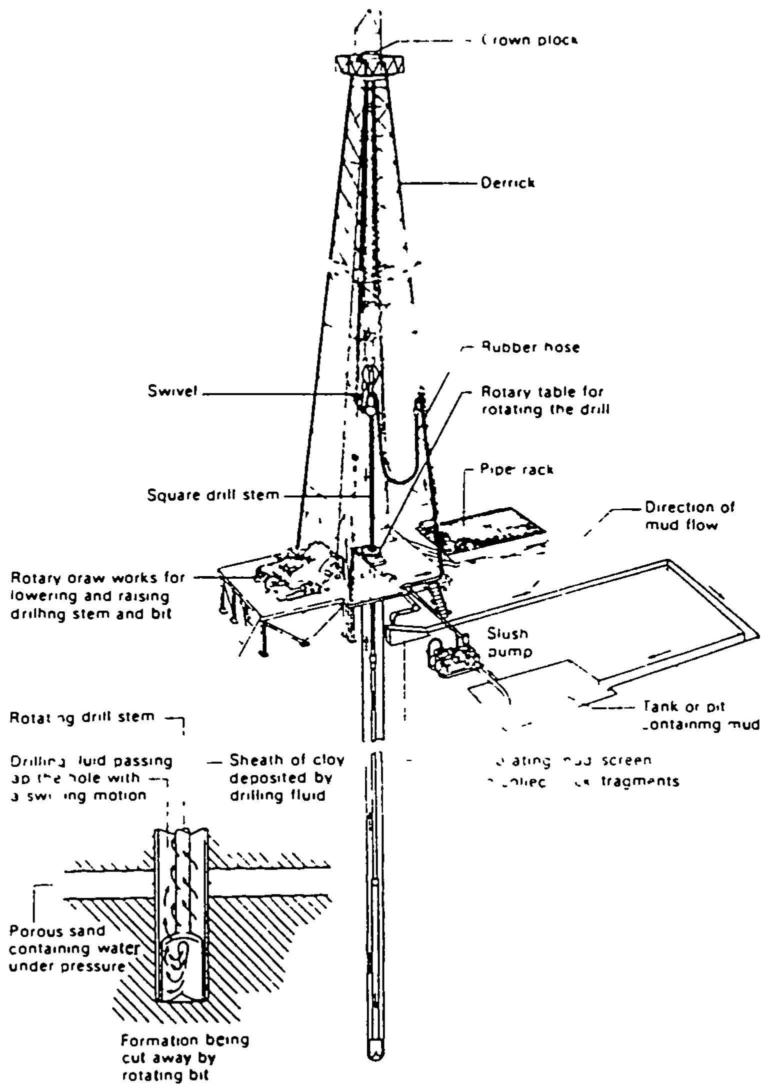

Fıgure 6 Diagram of rotary dnllıng <u>oil rig</u> (Wıllıams 1982, 114)

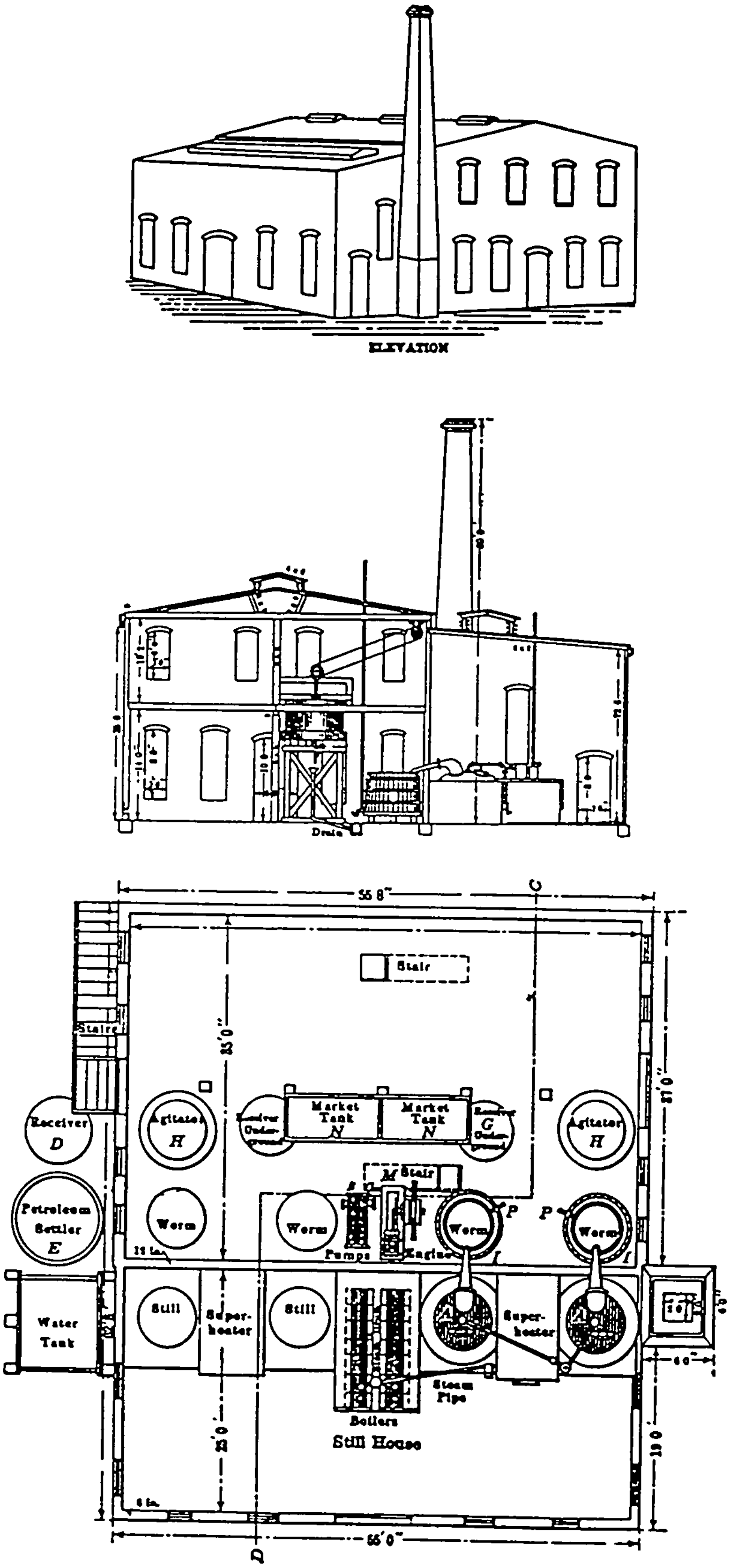

Figure 7. An oil refinery of the 1860s (Forbes 1958, 187)

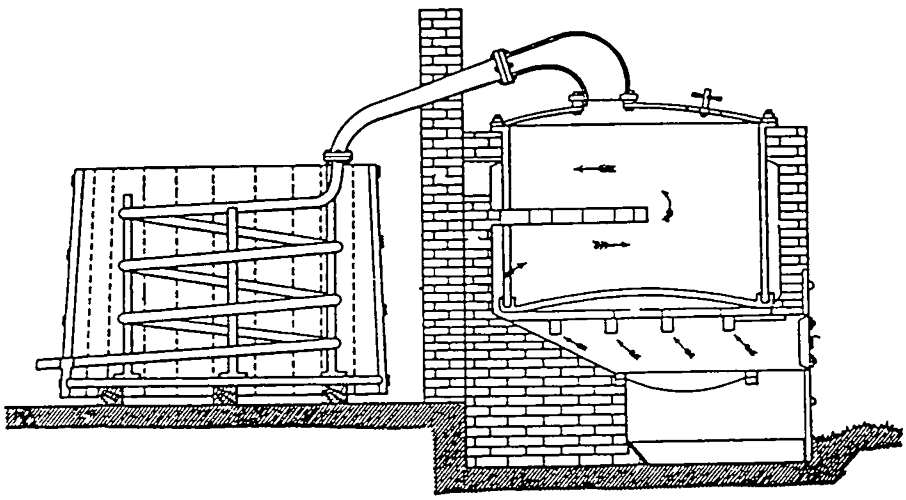

Figure 8 <u>*Oil distillation plant*</u> of the 1860s (Forbes 1958, 189)

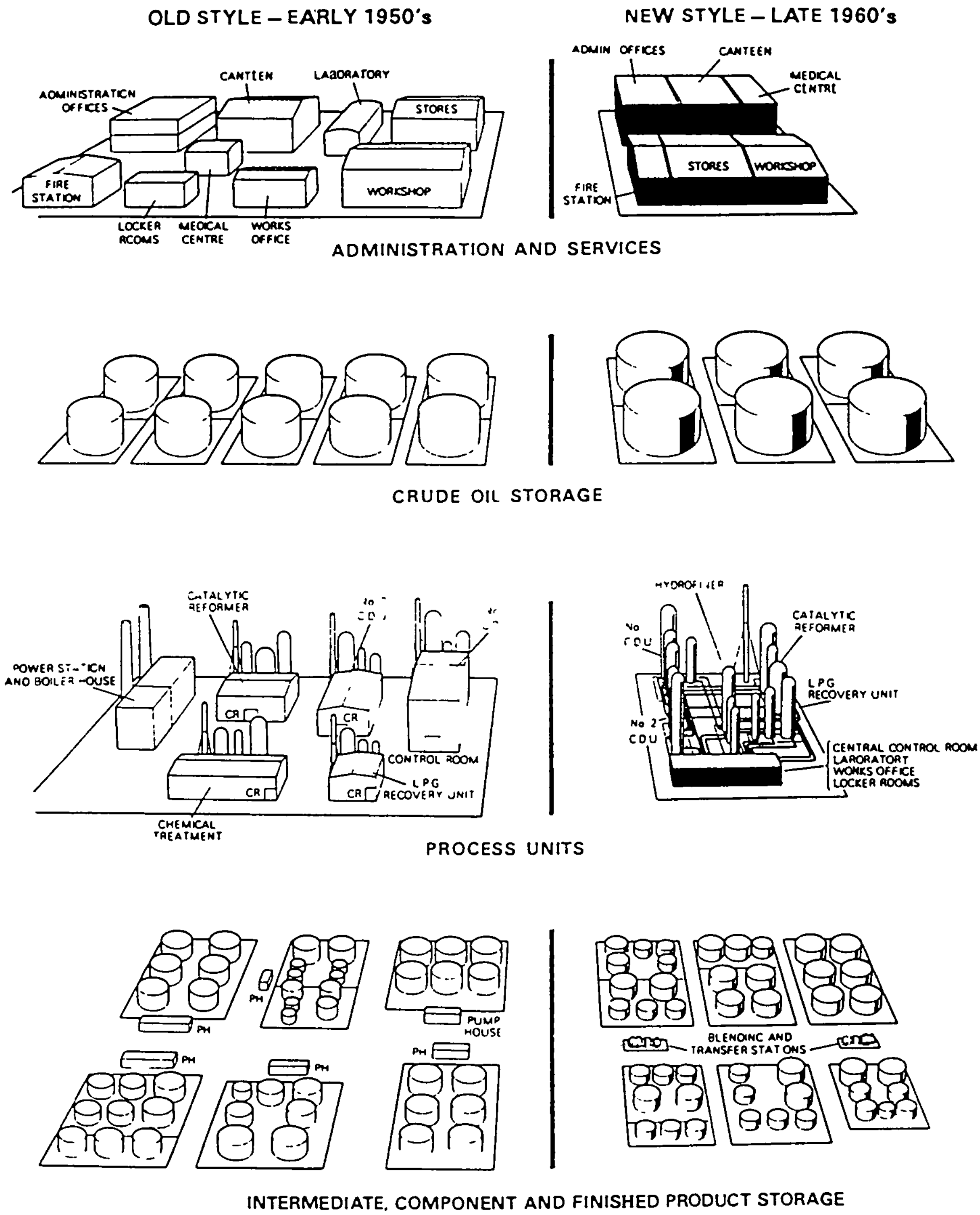

Figure 9 Diagram of oil refinery components of the 1950s and 1960s (BP 1977, 267)

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