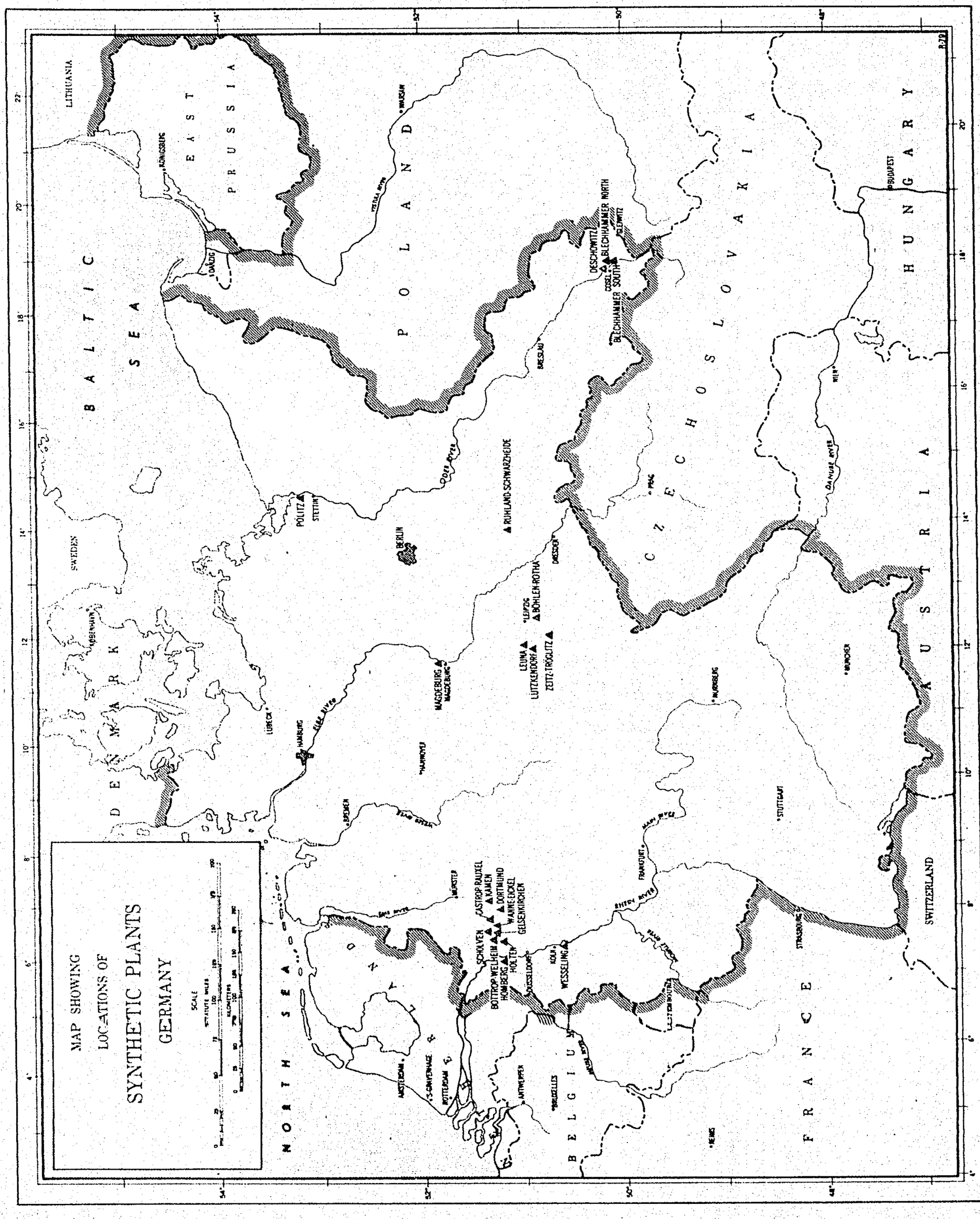
Synthetic plants



4.0 SYNTHETIC OIL PRODUCTION

4.1 GENERAL

The outstanding feature of German oil economy during the past ten years has been the spectacular development of her synthetic oil plants for the production of oil from coal. This attempt at complete oil autarchy, made without regard to cost or orthodox financial considerations, has no parallel elsewhere and is a striking example of the character of the German master plan for world domination which called for the production, within her own boundaries, of all the resources essential to modern warfare. It is evident that one of the essentials in such a plan is the securing of adequate oil supplies and since the attempts to find natural petroleum deposits within her own borders met with a very limited success Germany naturally turned to other expedients. The complicated structure of the enormous synthetic oil industry has been built up, therefore, on the basis of political and strategic expediency, and on the foundation of Germany's wealth of coal deposits, especially of lignite or brown coal, as compared with her poverty in natural oil resources.

The extent to which the programme of synthetic production has been carried forward may be illustrated by the fact that approximately five out of every six gallons of gasoline and gas oil produced in Germany are derived not from oil wells, but from synthetic oil plants, and that the German synthetic production amounts to something like 60 per cent of total European (a) natural crude oil production.

A detailed history and an accurate economic appraisal of the synthetic oil industry is rendered difficult by the fact that, almost from its inception, the Germans realized the potential strategic importance of this industry, with the result that all but its broad outlines were closely shrouded in a cloak of secrecy, as were many features of their armament industries and other important elements of their national planning. Also, despite the rapid basic progress made in the prewar years, the greatest expansion in the synthetic industry actually has taken place since 1938. However, as a result of certain early commercial contracts a considerable amount of technical data were acquired from the Germans prior to the war which, supplemented by Allied aerial reconnaissance over the German synthetic plants themselves, has made possible fairly accurate appraisals of their processing methods and capacities.

What the synthetic program has cost the German nation, either in terms of monetary investment or of materials and manpower required for the construction and operation of the plants and the production of the required coal, has never been revealed. The structure of the industry is so complicated by government participation that it is difficult to estimate with any accuracy the capital investment in the synthetic oil industry or the cost of the synthetic oil produced. Both, however, are known to be enormous as compared to the cost of plant and production in the natural petroleum products industry. It has been estimated that the present German synthetic plants (b), having a total capacity of close to 5,000,000 metric tons of product per year, cost something like 4 or 5 billion Reichsmark or 1.6 to 2 billions of dollars. This is said to be from ten to thirty times the plant cost to produce similar quantities of liquid fuels from petroleum, depending upon the processes used.

By way of further comparison, prior to the war, the cost of a gallon of gasoline ex American refineries, excluding profits and taxes, was generally considered to be approximately 4 U.S. cents per gallon (adding some 2 cents for profits and shipping cost this gasoline could be layed down in Germany for about 6 cents per gallon), while the cost to manufacture a gallon of gasoline from coal by either of the major synthetic processes is at least 20 cents (c), or five times as great.

(a) Excluding Russia.
(b) The bare plant cost exclusive of mines, coke ovens, coal carbonization plants, or other ancillary or auxiliary processes.
(c) Approximately 200 Reichsmarks per ton.

In consideration of the foregoing, as well as for other reasons, the participation of the German petroleum companies, and particularly those with international affiliations, in the synthetic oil industry has been small. Rather, it is the German coal, chemical, and heavy industries, under government direction and subsidy, which have been responsible for the development of synthetic plants and production.

From its earliest days the synthetic oil industry has been the subject of government encouragement and subsidies, and eventually and inevitably due to the magnitude of the program and the nature of the German state, to government direction and control. All the experimental work with the process discovered by Professor Bergius was carried on under the sponsorship of I.G. Farbenindustrie, and the second of the two main synthetic processes was worked out by Professor Fischer and Dr. Tropsch under the auspices of the Ruhr Coal Owners Association, but because of the heavy investments required, industry was slow to embark on large scale commercial production. However, the leaders of the German coal, chemical, and heavy industries no doubt realized the vital role these processes might play in any future war and proceeded with their development fully confident that any German government would, sooner or later. foster their growth.

The advent of the Nazi government merely accelerated the development of this and other German key industries by greatly increasing the already existing governmental subsidies and direction. This trend came into full maturity with the inauguration of the Four Year Plan under which all resources and industries were incorporated in a gigantic and strictly controlled production program subordinated to national strategy, regardless of the usual commercial and economic considerations. To carry out the ambitious and vital synthetic program, companies, in which the coal, chemical, and heavy industries participated, were formed under State direction. The State assisted by granting extensive and generous credits and subsidies, which, in many cases, covered half the cost of new plant construction which from then on was pushed with intensity. As pointed out under "Government Corporations " on page 13, all the companies in the industry must belong to the "trade association", Wirtschaftsgruppe Kraftstoffindustrie, through which channel government instructions to the industry are passed.

4.2 PRINCIPAL COMPANIES

Although German corporate structures are complex, the more important companies that have been identified as engaged in the production of synthetic oil in Germany are listed below. Further details on these and other companies may be found in the German year book "Handbuch der Internationalen Petroleum-Industrie".

Braunkohle-Benzin A.G. (Brabag).- This company with head office at Berlin W8, Schinkelplats 1/2, was formed in 1935, under State direction which required joint participation by the various German brown coal (lignite) interests. The capital stock is subscribed jointly by:

A.G. Sächsische Werke, Dresden
Anhaltische Kohlenwerke, Halle
Braunkohlen- und Brikettindustrie A.G., Berlin
Deutsche Erdöl A.G., Berlin
Elektrowerke A.G., Berlin
I. G. Farbenindustrie A.G.
Ilse Bergbau A.G., Grube Ilse
Mitteldeutsche Stahlwerke, Riesa
Rheinische A.G. für Braunkohlen Bergbau und Brikettfabrikation, Cologne (Köln)
Werschen-Weissenfelser Braunkohlen A. G., Halle

In June 1939, the capital of the company was RM. 100 million, and provision was made for increasing this by RM. 25 million over the next five years. The value of the plants already erected or under construction in 1938 was, according to the balance sheet, RM. 295 million.

It operates three large hydrogenation plants (Magdeburg, Böhlen and Zeitz) and one large Fischer-Tropsch plant (Schwarzheide).

Chemische Werke Essener Steinkohle A.G.- This company, with head office at Essen, Huyssenallee 92, operates the Fischer-Tropsch plant at Kamen-Dortmund. It was organized in January 1937, with a capital of RM. 12 million, and is a joint subsidiary of:

Essener Steinkohlenbergwerke A. G., Essen
Harpener Bergau A. G., Dortmund
Dortmunder Grundstücks A. G., Essen
Gewerkschaft Stolberg, Essen
Fritz Körzel G.m.b.H., Dortmund

Gelsenberg Benzin A.G.- Gelsenberg Benzin A.G. of Gelsenkirchen was formed in December 1936, as a joint subsidiary of:

Vereinigte Stahlwerke A. G., Düsseldorf
Gelsenkirchener Bergwerks A. G., Essen
August Thyssen Hütte A. G., Duisburg
Bochumer Verein für Gusstahlfabrikation A. G.
Dortmund Hörder Hüttenverein A. G., Dortmund.

The original capital of RM. one million was increased to RM. 50 million in 1937 and to RM. 100 million in 1930.

Gewerkschaft Viktor.- This concern operates the Fischer-Tropsch synthesis plant at Castrop-Rauxel and is owned jointly by Wintershall A.G. and Klocknerwerke A.G.

Hoesch Benzin G.m.b.H.- This company, with head office at Dortmund, was formed in 1936 as a subsidiary of the Hoesch A.G. of Dortmund. It was capitalized for RM. 3 million.

Hydrierwerke Pölitz A.G.- Hydrierwerke Pölitz A.G., with office and plant at Pölitz, was founded in 1937 by I. G. Farbenindustrie with a capital of RM. 20,000, under the name Hydro G.m.b.H. Later the capital was raised to RM. 4 million, and the name changed to Norddeutsche Hydrierwerke G.m.b.H. Still later capital was increased to RM. 80 million and the name changed to Hydrierwerke Pölitz A.G. The capital was later reported increased to RM. 110 million. The capital stock is held as follows:

I.G. Farbenindustrie A.G.	25 Per cent
Ammoniakwerke Merseburg (a)	34 " "
Deutsche Gasolin A.G. (a)	6 " "
Delbrück Schickler & Co. (Banking firm)	35 " "

I. G. Farbenindustrie has assumed a 25 per cent guarantee, and the Industriebank Berlin a 75 per cent guarantee covering a bond issue of RM. 80 million.

Hydrierwerke Scholven A.G.- Hydrierwerke Scholven A.G., at Scholven-Buer, was organized by the Hibernia A.G., which in turn is controlled by the Prussian State. In July 1939, the share capital of the Hibernia company was increased from RM. 100 million to RM. 250 million and the company received permission to issue a public loan of RM. 120 million.

I.G. Farbenindustrie A. G.- I. G. Farbenindustrie A. G., head office Frankfurt, occupies the leading position in the German chemical and synthetic oil industries. This company holds the Bergius hydrogenation process patents and was the pioneer of experimental and commercial production at its Leuna plant operated by a subsidiary company, Ammoniakwerke Merseburg G.m.b.H. Together with Ammoniakwerke Merseburg and Deutsche Gasolin A.G. (also a partial subsidiary of I.G.), I.G. has a controlling interest in the Pölitz synthetic oil plant, and, though details are lacking, is known to have a large interest in the two plants at Blechhammer and in a plant at Oswiecim in Poland.

(a) This company is a subsidiary of the I. G. Farbenindustrie A.G.

Krupp Triebstoffwerke G.m.b.H.- Head office address, Essen, Thomaestrasse 100. Formed in 1937 with a capital of RM. 20 million as a joint subsidiary of Friedrich Krupp A.G., and the A.G. für Unternehmungen der Eisen- und Stahlindustrie.

Oberschlesische Hydrierwerke A.G.- This company, operating the large new hydrogenation plant at Blechhammer, North and South, was organized by I. G. Farbenindustrie A.G. in early 1940. The original capital of RM. 50 million was subsequently raised to RM. 100 million and again, in January 1941, to a total of RM. 150 million.

Rheinpreussen, G.m.b.H.- This company, with head office at Hamburg, is controlled by Gutehoffnungshütte who also controls Mülheimer Bergwerks Verein. Capital RM. 500,000.

Ruhrbenzin A.G.- This company, with head office at Oberhausen-Holten, was formed in 1935 through participation of twenty-two Rhenish-Westphalian mining companies and Ruhrchemie A.G.; there is an agreement for the pooling of profits or losses on a 50-50 basis between Ruhrbenzin A.G. and Ruhrchemie A.G. Capital is RM. 9 million.

Ruhröl G.m.b.H.- Head office Mülheim, Ruhr. Controlled by Matthias Stinnes G.m.b.H. and capitalized for RM. 1 million.

Schaffgottsch'sche Benzin G.m.b.H.- A subsidiary of Gräfliche Schaffgottsch-'sche Werke G.m.b.H. of Gleiwitz. Capitalized for RM. 10 million.

Union Rheinische Braunkohlen Kraftstoff A.G.- This company, with head office at Köln, Kaiser Freidrich-Ufer 47 and whose plant is at Wesseling, was formed in January 1937 as a joint subsidiary:

Rheinische A.G. für Braunkohlenbergbau & Brikettfabrikation, Cologne (Köln)
Braunkohlen Industrie A.G., Weisweiler bei Aachen
Horremer Brikettfabrik G.m.b.H., Cologne
Braunkohlenbergwerk & Brikettfabrik Leblar G.m.b.H., Leblar
Hubertus Braunkohlen A.G., Brüggen
Vereinigungsgesselschaft Rheinische Braunkohlenbergwerke G.m.b.H., Cologne

This company was formed with a capital of RM. 45 million and a State loan of RM. 45 million.

Wintershall A.G.- Head office, Kassel, Hohenzollernstrasse 139. Originally a potash concern, this large German firm has many interests in the petroleum and the synthetic oil industries. It is capitalized for RM. 125 million. Wintershall A.G. owns the synthetic plant at Lützkendorf and interests in Gewerkschaft Viktor and Mitteldeutscher-Treibstoff und Oelwerke A.G.

The important hydrogenation plant at Brüx, in Sudetenland (Czechoslovakia), while not located in the area covered by this report, is operated by Sudetenländische Treibstoff A.G., which is probably controlled by Brabag, though all such plants are, no doubt, State enterprises directly under Göring's Four-Year Plan organization.

No attempt is made to list the numerous coal mining companies, and companies operating coke ovens and low temperature carbonization plants which are, in varying degrees, associated with the synthetic oil industry.

4.3 PROCESSES

4.3.1 General

The four important processes in use for the synthetic production of oil are:

1. High Temperature Carbonization of coal (coke ovens and gas plants). (H.T.C.)
2. Low Temperature Carbonization of coal, lignite, shale, etc. (L.T.C.)
3. Hydrogenation (Bergius-I.G.).
4. Hydrocarbon Synthesis (Fischer-Tropsch).

It is the last two of these processes that are commonly thought of when synthetic oil is mentioned and which are, by far, the most important means of production.

All these processes are more or less closely interrelated. Ordinarily, the low temperature carbonization (L.T.C.) plants are operated as ancillaries to hydrogenation plants, the tar produced by the L.T.C. plants providing the feed stock for the hydrogenation plants. The low temperature coke produced as a by-product in these plants is mostly utilized as fuel for big power plants, whereas a smaller part is used for the manufacture of hydrogen for hydrogenation plants or other chemical enterprises. High temperature carbonization plants are usually run primarily for the production of metallurgical coke or for the production of industrial or town gas and the tars produced are merely by-products. Consequently, there is ordinarily no such close tie-up between these plants and the hydrogenation plants as exists in the case of the L.T.C. plants. In common practice the liquid products from all these processes are referred to as synthetic oil, though technically only the Fischer-Tropsch is truly a process of synthesis.

The fundamental fact upon which the manufacture of synthetic oil is based, is that coal contains the same basic elements as petroleum, but in different proportions, and the conversion of coal into oil, stating the problem in its simplest terms, requires the addition of more hydrogen to the coal molecules; the result is oil. The two major synthetic processes, however, differ fundamentally in their means of obtaining this end. The hydrogenation, or Bergius process, proceeds to liquefy coal by forcibly combining the coal with hydrogen under great pressure. The Fischer-Tropsch process is one of synthesis--that is, it first reduces the coal to a simpler form, similar to water gas, and then builds up this gas to liquid oil.

Considerable work has been done on the development of the Pott-Broche process where coal is de-ashed by solvent-extraction and the resultant pitch hydrogenated, but this is a variation in detail rather than in principle and has not reached great importance industrially.

4.3.2 High Temperature Carbonization of Coal

This process is over 100 years old, and is widely used throughout the industrial world primarily for the production of metallurgical coke and gas. Coke ovens and gas plants distill coal at high temperatures (above 600°C). In the process about three per cent tar and one per cent crude benzol is produced, depending on the type of coal used. These by-products are essential in the manufacture of chemicals, dyes, drugs, explosives, solvents, plastics and a variety of other products.

Much of the H.T.C. tar is a heavy pitch which is not readily convertible to liquid fuels. However, the lighter fractions of the tar, the so-called tar oils, are more readily usable as feed stock for hydrogenation (Bergius) plants. Also, a relatively small portion of the tar oils is distilled and blended by conventional refining methods to produce gas oils and fuel oils, and in some instances, low grade lubricants. Some synthetic oil is made from reacting benzol or naphthalene from HTC tar with paraffin oils or wax from the Fischer-Tropsch process. However, the major production of H.T.C. products is based on the demand for coke by the steel industry and the liquid fuels production, though important, is merely a by-product.

4.3.3 Low Temperature Carbonization

The low temperature carbonization of coal, lignite, shale, etc. also has been known for many years. However, it is primarily a German process and is very little used in other countries. During the ten years preceding the present war this process was greatly improved and expanded as a means for utilizing Germany's extensive deposits of low grade lignites as feed stocks for the hydrogenation (Bergius) process synthetic oil plants.

The principal L.T.C. process is that developed by the Lurgi Gesellschaft für Warmetechnik. Lignite, after air drying to about 15 per cent moisture content (a), is briquetted and fed through a shaft divided into two compartments where hot gases pass horizontally across the briquets. In the first section the remaining moisture is driven off and the lignite pre-heated to reaction temperature. In the second section the volatile hydrocarbons which form the L.T.C. tar are driven off by hot gases passing horizontally through the second section. Each shaft or oven has a capacity of between 250 and 300 tons of briquets per day and a plant will have batteries of these ovens providing individual total plant capacities ranging from 500,000 to 5,000,000 tons of lignite per year. A rotating grate at the bottom removes the coke. This process is of high thermal efficiency, some 80 per cent of the fuel value of a low grade lignite being converted to tar and coke. Three or more tons of coke, depending on the quality of the lignite, are produced for each ton of liquid tar. Most of the tar is used as feed stock for the production of gasoline and other liquid fuels by the hydrogenation process. The coke is mostly utilized as fuel for the generation of power, and some of it for the manufacture of hydrogen (H_2) for the hydrogenation and other processes.

4.3.4 Hydrogenation (Bergius - I.G.)

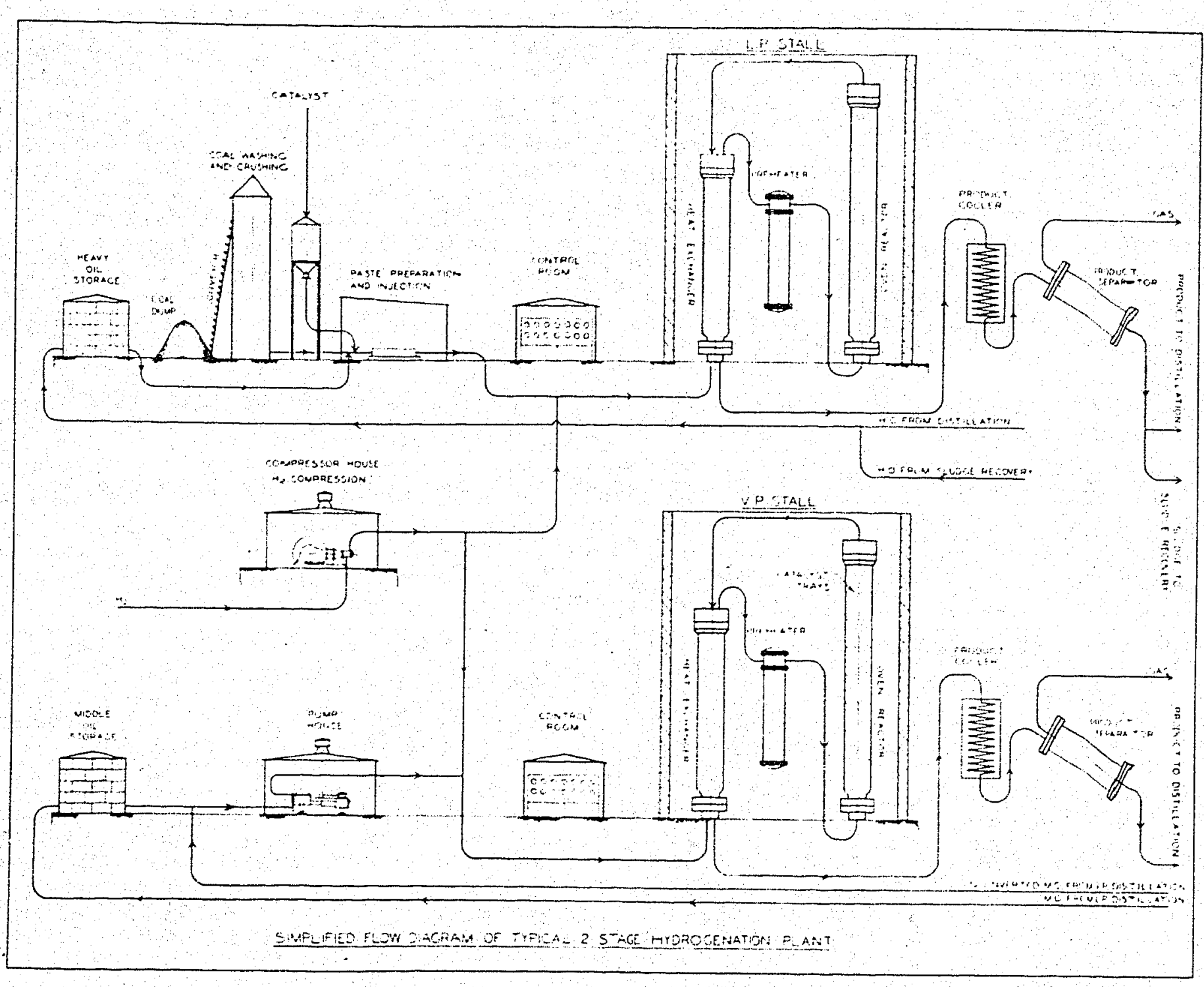
During World War I considerable amount of work was done in the German laboratories toward the manufacture of oil from coal and it was Professor Bergius of the Heidelberg University who succeeded in adding hydrogen to coal under a pressure of 200 atmospheres and a temperature between 400 and 500° C. In 1916 a small scale experimental plant to further develop the work of Bergius was built at Mannheim and in the years following World War I, considerable amounts were spent on research by the Bergius group. However, it was not until the I.G. Farbenindustrie with their much greater resources and background of experience with catalysis (I.G. developed the high-pressure synthesis of ammonia) took an active interest in the matter, that substantial progress was made with this process. Dr. Pier developed catalysts which made it possible to convert brown coal tar into gasoline with substantially higher yields than had previously been possible and in 1927 I.G. constructed in their hydrogenation plant at Leuna, the first industrial plant to produce gasoline from lignite and tar on a commercial scale. I.G. has continued to carry on intensive research for the perfecting of the process and eventually plants were constructed in Germany to manufacture gasoline and other fuels and lubricants, not only from brown coal tar but from brown coal, bituminous coal, bituminous coal pitch, etc. The center of I.G.'s hydrogenation research is located at their extensive chemical works and research laboratories at Ludwigshafen (Oppau). A location plan of this plant appears on page 214, I.G. Farbenindustrie holds the basic hydrogenation process patents in Germany, but the patent rights outside Germany were acquired by some of the American and British/Dutch Oil companies. The hydrogenation process is often referred to as the Bergius process and also sometimes as the I. G. process.

The hydrogenation process operates at high pressure (3,000 to 10,000 pounds per square inch) and at temperatures of 350 to 550° C. The feed stock may be either coal or a liquid hydrocarbon such as tar or petroleum. About half of the hydrogenation plants in Germany operate on tar produced for that purpose from lignite by the L.T.C. plants.

When coal is the feed stock the process is as follows. The coal is finely ground, a catalyst added, and mixed into a paste with heavy recycle oil from the process. This paste is pumped through a heating coil where it is heated to about 420-450°C, mixed with hydrogen and passed at a pressure of 300-700 atmospheres through a series of reactors (the paste contains 40 per cent pure coal (b) and 5 to 10 per cent ash), where some 90 to 93 per cent of the a.m.f. coal is converted into gaseous and liquid hydrocarbons (including wax) with a consumption of hydrogen of 7 to 10 per cent based on the a.m.f. coal. The ash, unconverted coal and catalyst

---

(a) German lignite has about a 53 per cent ash and moisture content.
(b) Pure coal is defined as ash and moisture free, often abbreviated to a.m.f. coal.



SIMPLIFIED FLOW DIAGRAM OF TYPICAL 2 STAGE HYDROGENATION PLANT

are drawn off as an oil sludge, from which part of the oil can be recovered and recycled to the process. The liquid product is fractionated, the heavy fraction boiling above 325° C being recycled to paste the coal, the middle oil or 185-325° C boiling point fractions being further hydrogenated in a second stage to gasoline. The sump or liquid phase product also contains some gasoline which is recovered. None of the products from this first stage of hydrogenation are finished products; they contain oxygen (phenols and cresols) and other impurities requiring further treatment. The gasoline may be hydrofined by vapor phase treatment with hydrogen over a catalyst. This hydrofining process operates to dehydrogenate naphthenes to aromatics while reducing the unsaturated oxygen compounds and removing sulphur almost completely.

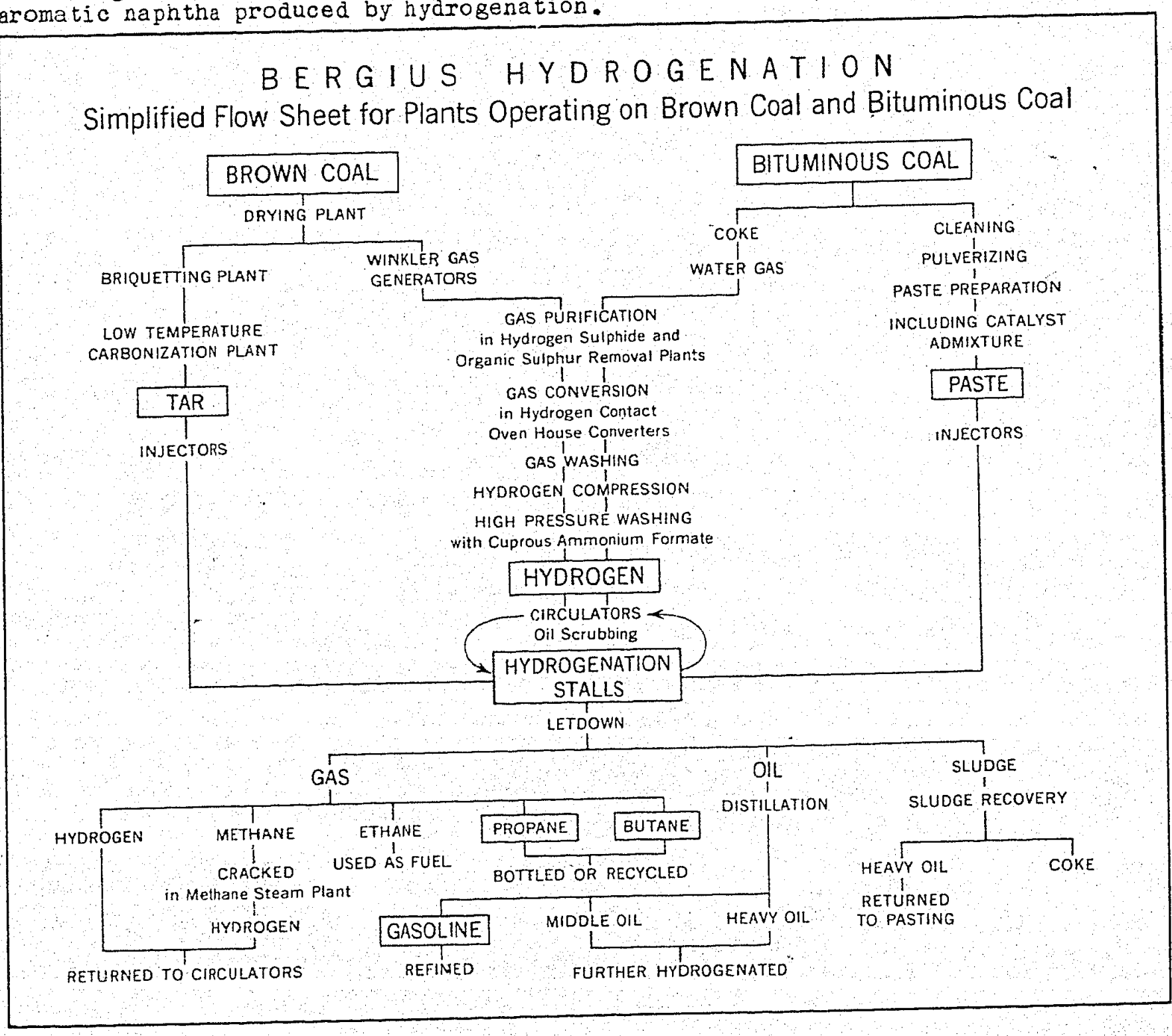
The middle oil is hydrogenated in a second stage in the vapor phase over fixed bed catalysts at conversions to gasoline of from 10 to 60 per cent per pass depending on the products desired. This may be done in one or two stages. If a delicate catalyst is to be used there is a preliminary refining step with low conversion to gasoline but directed to remove oxygen and nitrogen impurities from the oil before carrying out the main reaction over a sensitive catalyst. The type of gasoline produced depends upon operating conditions. With a sensitive catalyst and low temperatures the gasoline is primarily naphthenic with an octane number of 70 to 74 (motor method), but if the conversion is carried out at high temperatures a gasoline is produced with 40 to 50 per cent aromatics. The yields are lower in the latter operation and the gases contain a substantially lower percentage of butane than in the low temperature conversion.

A large excess of hydrogen is circulated through the reactors (about 10 times consumption) and an important part of the process is the purification of the hydrogen and recycling it to the process. The hydrogen is purified to 70 to 80 per cent by either of two methods: (1) by scrubbing with oil to remove gaseous hydrocarbons or (2) by fractional distillation of part of the gas at low temperatures to remove the gaseous hydrocarbons.

When tar or oil is hydrogenated the process is much simpler and the plant investment considerably less. The heavy fractions of tar (boiling above 325°C) are hydrogenated in the liquid phase at temperatures where the tar is largely liquid. The catalyst is suspended in the oil and hydrogen blown through it. Tar (or oil), catalyst and hydrogen are pumped through heat exchangers and a heating coil under pressures of about 300 atmospheres into a series of reactors as in the coal liquification step. The oil is fractionally distilled and the heavy fraction recycled to the process while the lighter fractions are treated by vapor phase hydrogenation over fixed bed catalysts in the same manner as the lighter fractions from coal.

The thermal efficiency of converting a good young bituminous coal to gasoline by this process is about 30 per cent. From the thermal efficiency point of view it is somewhat more efficient to convert the coal first to tar by low temperature carbonization and hydrogenate the tar to gasoline.

The hydrogenation plants produce aviation and motor gasoline, diesel oil, lubricating oil and wax. The base stock for German aviation gasoline is a highly aromatic naphtha produced by hydrogenation.

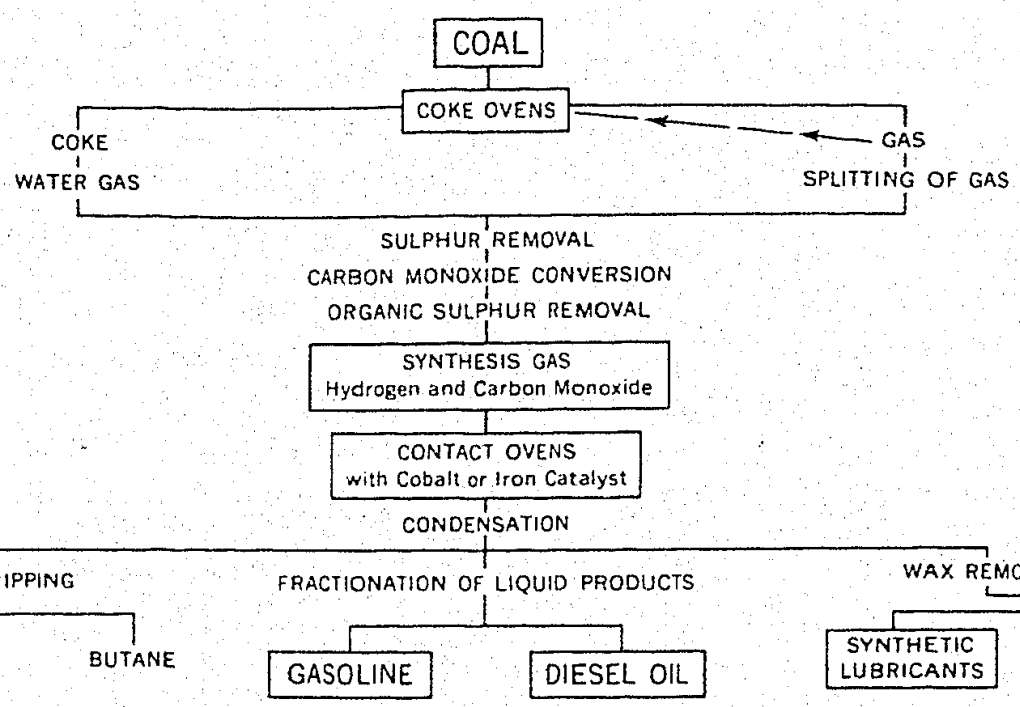


4.3.5 Hydrocarbon Synthesis (Fischer-Tropsch)

This process for the production of liquid fuels from gaseous mixtures of carbon and hydrogen (which can be readily produced from coal or other solid carbonaceous materials) was evolved in 1926 by Professor Frans Fischer and Dr. Hans Tropsch at the Coal Research Institute at Mulheim/Ruhr under the auspices of the Ruhr Coal Owner's Association. During the 1930's the process was further developed under government stimulation and industrial scale production began in 1936.

In this process the solid fuel, usually coal or coke, though any combustible form of carbon may be used (a), is gasified to produce a synthesis gas, which is water gas (CO + H_2) enriched with H_2 to get the desired proportion between H_2 and CO. This synthesis gas, after exhaustive purification, is passed over a catalyst at rigidly controlled temperatures (about 200°C) and at either atmospheric or low pressures (5 to 20 ats.) with the result that a series of hydrocarbons are formed.

FISCHER - TROPSCH PROCESS
Simplified Flow Sheet for a Plant Operating on Hard Coal



A typical arrangement for a plant using hard coal would be as follows: after being raised, the coal is washed and graded, and passed to a battery of coke ovens. The coke from the ovens is fed to a water-gas generator, which produces a hydrogen/carbon monoxide mixture. The coke oven gas is cracked in a decomposer or split by a deep cooling process to provide more synthesis gas. This gas, together with that from the water-gas generators, is purified from hydrogen sulphide by passage through iron oxide or by other means, and the excess of carbon monoxide in the mixture is corrected by passage through converters in which the gas is brought into contact with a catalyst in the presence of steam, with the result that further hydrogen is produced, together with carbon dioxide, which is removed by washing with water under pressure.

The synthesis gas, now in correct proportion is passed through the organic-sulphur purification plant, and when purified, passes to the contact ovens, in which actual synthesis takes place over the catalyst at temperatures ranging from 185° to 360°C, depending upon the catalyst used, and at pressures ranging from atmospheric to 20 atmospheres. The earlier designs operated at atmospheric pressure but most of the plants now operate at 15 to 20 atmospheres pressure. One catalyst used is the metal cobalt on magnesia and activated with thoria. This catalyst is operative at about 200°C and at pressures from atmospheric to about 15 atmospheres. Another catalyst is activated iron that operates at around 350°C and at higher pressures, preferably about 20 atmospheres.

(a) In the United States the process has received serious consideration for converting natural gas to oil.

The reaction is highly exothermic, with the result that large quantities of heat must be dissipated by means of cooling towers usually situated near the contact oven house, and an abundant water supply is essential. The process usually takes place in two stages; in the second the gas, which has already passed through the first stage, is sent over the catalyst a second time to complete the synthesis. By this two-stage process it is said that yields as high as 90 per cent of the theoretical yield of the synthesis gas have been obtained.

The products of synthesis, all in gaseous form, are taken from the contact ovens to condensers, where the liquid hydrocarbons are drawn off, fractionally distilled, and passed on to the refinery for appropriate treatment. Surplus gases are washed with a light oil, the butane-propane fractions are drawn off, and the remainder is passed on to gas holders for ultimate use as fuel, either in the plant or in neighboring towns. In addition to oil and gases, the Fischer-Tropsch process produces paraffin wax, which is of value as a starting point for the manufacture of lubricating oils and synthetic soap. The most recent develpments include successful research, on a laboratory scale, into the synthetic production of iso-compounds as constitutents of high octane fuels.

The primary product from the Fischer-Tropsch process is a mixture of paraffins and olefins distributed over a wide boiling range that varies somewhat with operating conditions within the range.

Distribution of Products in Fischer-Tropsch Process
Synthetic Crude Oil

	Per Cent of Weight
C_3 and C_4 (propane and butane)	5 to 10
Gasoline 200°C End Point	30 to 60
Diesel Oil 200 - 325°	20 to 30
Wax and heavy oil	40 to 5

The gasoline quality varies between 50-70 octane number (motor method) and the diesel fuel between 70 and 100 cetane number. A substantial fraction of the wax has a high melting point; over 90°C. A high grade lubricating oil is made either from the highly olefinic 150-250°C fraction or from wax by cracking and polymerization. This process has an over-all energy efficiency of about 25% in converting the heating value of low grade solid fuels to oil. It can be generally stated that whereas the hydrogenation process produces better gasoline, including aviation gasoline, the advantages of the Fischer-Tropsch process are in the better quality diesel oils and the lubricating oils.

4.4 PRODUCTION

Statistics on the production of fuels and lubricants from the German synthetic oil industry are of necessity based on estimates. However, it is believed that these estimates can be made with a fair degree of accuracy. Although rumors concerning new synthetic plants are both numerous and persistent, intensive aerial reconnaissance over Germany has failed to reveal the existence of any major plants other than those listed herein. An industrial scale synthetic plant is, by its nature, complex and extensive and not easily concealed. Rumors of other synthetic plants probably refer to unidentified L.T.C. plants and benzol units of which, without doubt, a goodly number exist throughout Germany's industrial districts.

Frequent and excellent aerial photographic reconnaissance of the German synthetic plants has permitted Allied experts to closely appraise the activity and productive capacities of each plant. A knowledge of the raw material available, the product possibilities of each process, and the general consumption needs of Germany

makes it possible to arrive at a breakdown, by products, of probable production which may be accepted as reasonably indicative of the production pattern and volume. In establishing the production figures, normal plant capacity is considered to be that (estimated) as of January 1, 1944. This date is chosen as the base since, due to completion of plants, the increasing scarcity of materials and the beginning of the intensive Allied bombing attacks, it more or less coincides with the turning point from new construction and plant expansion to the equally difficult and costly task of maintenance and reconstruction necessitated by the increasingly heavy bomb damage.

The actual output of the plants, of course, varies with every flight of attacking Allied bombers over them. After the concentrated attacks in mid 1944, damage interpretation revealed that, at least temporarily, the total German synthetic productive capacity was reduced to amounts varying between 35 and 50 per cent of estimated normal. The Germans have demonstrated a willingness and an ability, born of necessity no doubt, to rehabilitate these plants at a much faster rate than had been anticipated. However, it may be confidently stated that they now are, and will continue to be, forced to operate at much less than the normal production rates stated in capacities as of Jan. 1, 1944.

Estimates of normal total production for each process are given in the succeeding paragraphs.

4.4.1 High Temperature Carbonization

Coke ovens and gas plants distill coal at high temperatures (above 600°C) primarily for the production of metallurgical coke or gas. In the process there is also produced about 3 per cent tar and 1 per cent crude benzol based on the coal distilled. Most of this production is from coke ovens and is governed by the demand for metallurgical coke. Germany has some 20 or 30 major coke oven plants, each with a capacity for coking over 1,000,000 tons of coal per year. There are also a large number of smaller plants, all located near bituminous coal mines in the Ruhr, Silesia, Saar, etc. (See last paragraph on page 159).

As previously stated a large part of the tar produced in these plants is a heavy pitch that is not readily convertible to liquid fuels. Some of the lighter tar is utilized as feed stock for hydrogenation plants and only a relatively small quantity is directly refined and blended for gasoline, fuel oil, etc. The production from H.T.C. tar and benzol that is refined directly to liquid fuel and lubricants without passing as feed stock to other processes is estimated, as of December 1943, to be:

Liquid Fuels and Lubricants Refined From High Temperature Tars

	Metric Tons per Year
Aviation Gasoline (Benzol)	100,000
Motor Gasoline (Benzol)	530,000
Diesel Oil Blenders (from light tar)	90,000
Fuel Oil (from tar oils)	780,000
Total	1,500,000

4.4.2 Low Temperature Carbonization

The low temperature carbonization (L.T.C.) plants are Germany's synthetic oil mills and produce most of the tar used as feed stock for the hydrogenation (Bergius) plants. There is a large number of L.T.C. plants located at or near the lignite

deposits and having capacities ranging from 25,000 to 250,000 tons per year of tar or synthetic crude oil. The normal total L.T.C. tar production is estimated at 2,500,000 tons per year. These plants convert low grade coal - especially lignite - to tar (crude oil), coke and gas. The yield of tar, on a weight basis, is generally not more than 5 per cent on the raw lignite of middle Germany but other coals and lignites show higher yields. There is at least three times as much coke produced as tar, and because of its high ash content (when made from lignite) and its soft character, it never received wide acceptance in commerce. The Germans dispose of considerable quantities of this by-product coke as fuel in large power houses built near the L.T.C. plants and may also have found other uses. Approximately two million tons of L.T.C. tar is converted to gasoline in hydrogenation plants but some of the L.T.C. plants also contain refining equipment and it is estimated that some 500,000 tons per year are refined by conventional refining processes (distillation, solvent extraction and cracking) to gasoline, diesel oil, fuel oil and possibly some lubricating oil and wax. The crude tar contains 40 to 50 per cent volatile fractions distilling over at less than 325°C and around 1 per cent solids (ash and dust) and 2 per cent water. The bottoms are not satisfactory fuel oil without further treatment. A much higher yield and better products are obtained when the L.T.C. tar is hydrogenated.

The breakdown of products obtained by the conventional refining of L.T.C. tars that are not consumed as feed stock for hydrogenation plants is estimated as follows:

Liquid Fuels and Lubricants Refined From Low Temperature Carbonization Tars

	Metric Tons per Year
Gasoline	50,000
Diesel Oil	110,000
Fuel Oil	220,000
Total	380,000
Gas and Losses	120,000
Crude tar before refining	500,000

4.4.3 Hydrogenation (Bergius)

There are twelve hydrogenation plants in Germany (a) with an estimated normal total production capacity of motor gasoline of 3,775,000 metric tons per year (b). As there is considerable flexibility with respect to products which may be produced in hydrogenation plants, it is customary to establish their rated capacity on the basis of motor gasoline. In general the capacity is less when producing aviation gasoline and greater when making heavier products.

The feed stock to hydrogenation plants may be coal, tar or petroleum oil, of which in actual practice L.T.C. tar produced from lignite or brown coal constitutes the largest single item. As compared to the direct hydrogenation of coal the over-all investment per unit of gasoline production capacity is lower when the low grade coals are first carbonized to produce L.T.C. tar and the tar hydrogenated, but the coal consumption is higher and there is the problem of disposing of a large pro-

(a) Location maps and individual plant descriptions are given in section 4.6, pages 159 to 213.
(b) The Germans have also built a plant at Bruex in Czechoslovakia that has an estimated capacity of 700,000 metric tons per year and a plant at Oswiecim in Poland having a capacity of about 200,000 tons per year.

duction of low grade coke, of the order of some four tons or more of coke per ton of gasoline. This the Germans appear to have taken care of by the utilization of much of this coke in large power plants located at or near the L.T.C. plants. As previously explained low ash bituminous coal is hydrogenated directly, the first step liquifying the coal to a synthetic crude oil with about 7 to 10 per cent gasoline, 35 to 45 per gas oil (200 to 325° C fraction) and around 50 per cent heavy fuel oil content. The latter is recycled, being used to paste the coal for convenient pumping, etc. The gasoline requires some further refining, usually hydrofining, whereby it is converted directly to aviation gasoline base stock. The gas oil from the coal liquification step contains phenols and other impurities and may be hydrofined either to a mixture of diesel oil and gasoline or completely to gasoline. The hydrogenation of tars or oil follows similar processing without the step of liquification of coal.

The hydrogenation plants and their rated capacities, in terms of motor gasoline, are listed below:

Annual Capacities of Hydrogenation Plants

Plants Operating on	Feed Stocks	Production Motor Gasoline Metric Tons/Year
Bituminous Coal and Tar		
Blechhammer North	H.T.C. Tar	200,000
Blechhammer South	Bituminous Coal	300,000
Bottrop-Welheim	H.T.C. Tar	100,000
Gelsenkirchen	Bituminous Coal	350,000
Pölitz	Bituminous Coal & Tar	600,000
Scholven	Bituminous Coal	400,000
Lignite Coal and Tar		
Böhlen-Rotha	L.T.C. Tar	300,000
Leuna	Lignite and Tar	600,000
Lützkendorf	L.T.C. Tar	125,000
Magdeburg	L.T.C. Tar	250,000
Wesseling	Lignite	200,000
Zeitz-Tröglitz	L.T.C. Tar	350,000
T o t a l		3,775,000

Taking into consideration Germany's consumption requirement pattern and the fact that the hydrogenation plants are the chief source of supply for Germany's aviation gasoline requirements the breakdown of hydrogenation plant production, by products, is estimated to be as follows:

Product	Metric Tons Per Year
Aviation Gasoline	1,050,000
Motor Gasoline	1,725,000
Diesel Oil (and kerosene)	700,000
Lubricating Oils	100,000
T o t a l	3,575,000

Due to the emphasis on aviation gasoline the total production is estimated to be somewhat below the rated capacity of 3,775,000 tons on the basis of ordinary motor gasoline production. This also accounts, in part, for the Germans' shortage

of diesel fuel which has resulted in their resorting to the use of blends of approximately 2/3 gasoline (naphtha) and 1/3 diesel oil as diesel fuel.

4.4.4 Hydrocarbon Synthesis (Fischer-Tropsch)

There are nine Fischer plants in Germany (a) with normal total production capacity of 720,000 metric tons per year. As already described, in this process synthesis gas ($Co+H_2$) is converted to oil (liquid hydrocarbons). Water gas or synthesis gas can be made from any combustible form of carbon, but in Germany coke or lignite are the raw materials commonly used.

The hydrocarbon synthesis plants in Germany and their estimated capacities in terms of primary product (synthetic crude oil) are as follows:

Hydrocarbon Synthesis (Fischer-Tropsch) Plants
Annual Capacity in Metric Tons of Primary Product

Plant	Feed Stocks	Annual Capacity Metric Tons
Castrop-Rauxel	Hard coal or coke	60,000
Deschowitz (Odertal)	Hard coal or coke	60,000
Dortmund	Coke oven gas	60,000
Holten-Sterkrade	Hard coal or coke	80,000
Homberg	Hard coal or coke	80,000
Kamen	Hard coal or coke	60,000
Lützkendorf (b)	Lignite	80,000
Ruhland-Schwarzheide	Lignite	180,000
Wanne Eickel	Coke and gas	60,000
T o t a l		720,000

The primary product is essentially paraffinic and olefinic in varying proportions depending on the catalyst and operating conditions. It is believed that the plants will run to maximum olefin content which is: liquified gases (C_3 and C_4) 75 per cent, gasoline 60 to 65 per cent and diesel oil 40 to 50 per cent olefin contents. Under these conditions the octane number of the gasoline will be between 60 and 80, depending on operating conditions. The C_4 (butane) fraction of the liquified gases are assumed to be entirely converted to aviation gasoline by polymerization or alkylation and the C_3 (propane) fraction entirely into motor gasoline, but in actual practice a portion of these gases may be sold directly as liquified gases or consumed as raw materials in chemical processes. The fraction distilling between 150 and 250°C is polymerized to high grade lubricating oil with yields up to 18 per cent of the total product. This is made at the expense of gasoline and diesel oil. The wax generally has a greater value than has fuels and some of the plants operate for maximum wax production. Among the products made from wax are synthetic lubricating oil, fatty acids, and various coating materials. Typical breakdowns of products actually produced in the Fischer-Tropsch process are given on the following page.

(a) Location maps and individual plant descriptions are given in section 4.6 pages 159 to 213.
(b) Located within same plant as the Lützkendorf Bergius process hydrogenation works listed in preceding section.

Hydrocarbon Synthesis Products

	Weight % of Constituents	
	Example I	Example II
Liquified Gas (C_3 and C_4)	10	5
Gasoline 200°C End Point	60	30
Diesel Oil	20	25
Wax	10	40
T o t a l	100	100

Taking into consideration the auxiliary processes, the estimated actual finished product production from the German hydrocarbon synthesis plants in round figures is as follows:

	Wt. %	Metric Tons/Year
Aviation Gasoline	7	50,000
Motor Gasoline	30	216,000
Diesel Oil	15	108,000
Lubricating Oil	18	130,000
Wax	22	158,000
	92	662,000
Gas and Losses	8	58,000
Total	100	720,000

4.4.5 Total Production

Given below is the summary of the estimated normal production of finished products by each process and the grand total of production. In arriving at the estimates consideration is given to both the various product possibilities of each process and the relative importance of each product to Germany's consumption needs.

Estimated Annual Production of Finished Products by German Synthetic Oil Plants As of January 1, 1944 and Without Allowances for War Damage to Plants

(Figures in metric tons per year)

	Gasolines		Diesel and Kerosene	Lubes	Fuel Oil	Wax
	Aviation	Motor				
High Temperature Carbonization(a)	100,000	530,000	90,000	Nil	780,000	-
Low Temperature Carbonization (b)	Nil	50,000	110,000	Nil	220,000	-
Hydrogenation	1,050,000	1,725,000	700,000	100,000	Nil	
Hydrocarbon Synthesis	50,000	216,000	108,000	130,000	Nil	158,000
T o t a l	1,200,000	2,521,000	1,008,000	230,000	1,000,000	158,000

(a) This includes only tar and benzol that goes to marketable liquid fuel.
(b) This does not include tons of L.T.C. tar used as feed stock in hydro plants.

4.5 Coal Consumption

Since for every ton of synthetic oil produced, there is required, including both the coal used for power and steam and as raw material for processing, five or six tons of bituminous coal or ten to fifteen tons of brown coal, dependent upon quality and processes used, the quantities consumed by the synthetic oil industry, directly or indirectly are very large.

The German synthetic oil plants, with the exception of Pölitz, are located in close proximity to lignite (brown) or bituminous coal deposits, and are in general, in three main areas of concentration, namely the Ruhr, the central German brown coal (lignite) area, and the Silesian coal area. See map on page 142.

Of the hydrogenation (Bergius) plants operating on brown coal or brown coal tars, the majority are in central Germany at Böhlen-Rotha, Leuna, Lützkendorf, Zeitz-Tröglitz, and Magdeburg. The Wesseling plant in the Rhine Valley also uses brown coal. The two hydrogenation plants in the Ruhr, at Gelsenkirchen and at Scholven, both operate principally on bituminous coal, while, of the two at Blechhammer, one operates on hard coal and the other on bituminous coal tars. The Pölitz plant was designed to operate with great flexibility on almost any type of fuel, bituminous or brown coal, pitch, tar or on a petroleum feed stock, including crude oil from Estonian shale. This is the only plant not built close to sources of raw material, but it is conveniently situated for the transport of any one of the raw materials on which it can run. The Bottrop-Welheim plant was specially designed to run on pitch.

Fischer-Tropsch synthesis plants can be designed to work on either hard or brown coal or on coke. Those in the Ruhr at Castrop-Rauxel, Dortmund, Holten-Sterkrade, Homberg, Kamen and Wanne-Eickel, and the Silesian plant at Deschowitz, use hard coal or coke, while the central German plants at Lützkendorf and Ruhland-Schwarzheide use brown coal.

In the direct hydrogenation of coals approximately five tons of bituminous coal are required per ton of gasoline (of which slightly over two tons are processing coal and slightly less than three tons are utility coal: steam, power and hydrogen manufacture), or in the case of brown coal about ten to fifteen tons of raw lignite, depending on its quality, per ton of gasoline (equally about forty per cent of which is processing lignite, the balance for utilities). On this basis, the German hydrogenation plants designed for the direct hydrogenation of coal and lignite have an annual requirement of about 6.25 million tons of bituminous coal per year and five million tons of lignite. In addition to these plants, however, a larger capacity is operating on the hydrogenation of L.T.C. and H.T.C. tar. The plants for the hydrogenation of L.T.C. tar require about 1.8 million tons of L.T.C. lignite tar per year. Assuming a tar yield based on raw lignite of five per cent, the requirements of the L.T.C. industry to supply this much tar are 36 million tons of raw lignite per annum. Assuming that the utility requirements of these hydrogenation plants are met out of the L.T.C. coke produced, the total lignite production directly or indirectly is connected with the hydrogenation industry would thus be about 40 million tons of raw lignite per annum.

The plants for the hydrogenation of H.T.C. tar have a capacity of about 600,000 tons of gasoline per annum. Taking the coal requirements of these plants for utilities at 2.5 tons of coal per ton of gasoline, about 1.5 million tons of coal are required. If the coal required in the manufacture of the H.T.C. tar is disregarded (on the theory that this tar is produced as a by-product), the total bituminous coal requirements of the German hydrogenation plants amount to about seven or eight million tons per year.

It is much more difficult to express the raw material requirements of the Fischer-Tropsch plants in terms of coal, since these plants use a great variety of raw materials some of which are actually by-products, such as coke-oven gas, that are recouperated from other industries. However, if we rather arbitrarily disregard this and take the required coal equivalent of six tons of bituminous coal or fifteen tons

of raw lignite per ton of primary product, then the Fischer-Tropsch plants require, either directly or indirectly, nearly three million tons of bituminous coal and nearly four million tons of lignite per year.

On the basis of the above, then the total annual consumption of coal related to the manufacture of synthetic oil would be somewhere in the neighborhood of 10,000,000 metric tons of bituminous coal and 45,000,000 metric tons of lignite. Consumption of electric power by the synthetic oil plants is great and has been said to amount to no less than sixteen per cent of the total power used in Germany. The power is derived partly from the grid and partly from power stations at the plants themselves. These very rough calculations will serve to illustrate the magnitude of the synthetic program and the severe demands it makes upon the coal mining, electric power, and other elements of the German industrial economy.

4.6 INDIVIDUAL PLANT DESCRIPTIONS

4.6.1 General

Bergius hydrogenation and the Fischer-Tropsch synthetic plants in Germany are listed in the table on page 160 and their locations are shown on the map on page 142. Individual plant descriptions, accompanied by layout plans and detailed location maps, and in some cases photographs, are given in alphabetical order in the following pages. It should be born in mind that much of the data available is, of necessity, based on interpretation of aerial reconnaissance. Hence, the capacity and production figures, albeit painstakingly arrived at, are largely estimates. The identification, from aerial photographs, of individual units within the plants is often rendered difficult by camouflage. All of the synthetic plants, and particularly the tankage therein, have been more or less camouflaged. Some have even been provided with decoys located in open country some distance away in the effort to divert bombing attacks from the actual plants. However, these plants have enjoyed a high priority in Allied air attacks and damage has been extensive. No attempt has been made in these plant descriptions to list or evaluate the constantly increasing bomb damage.

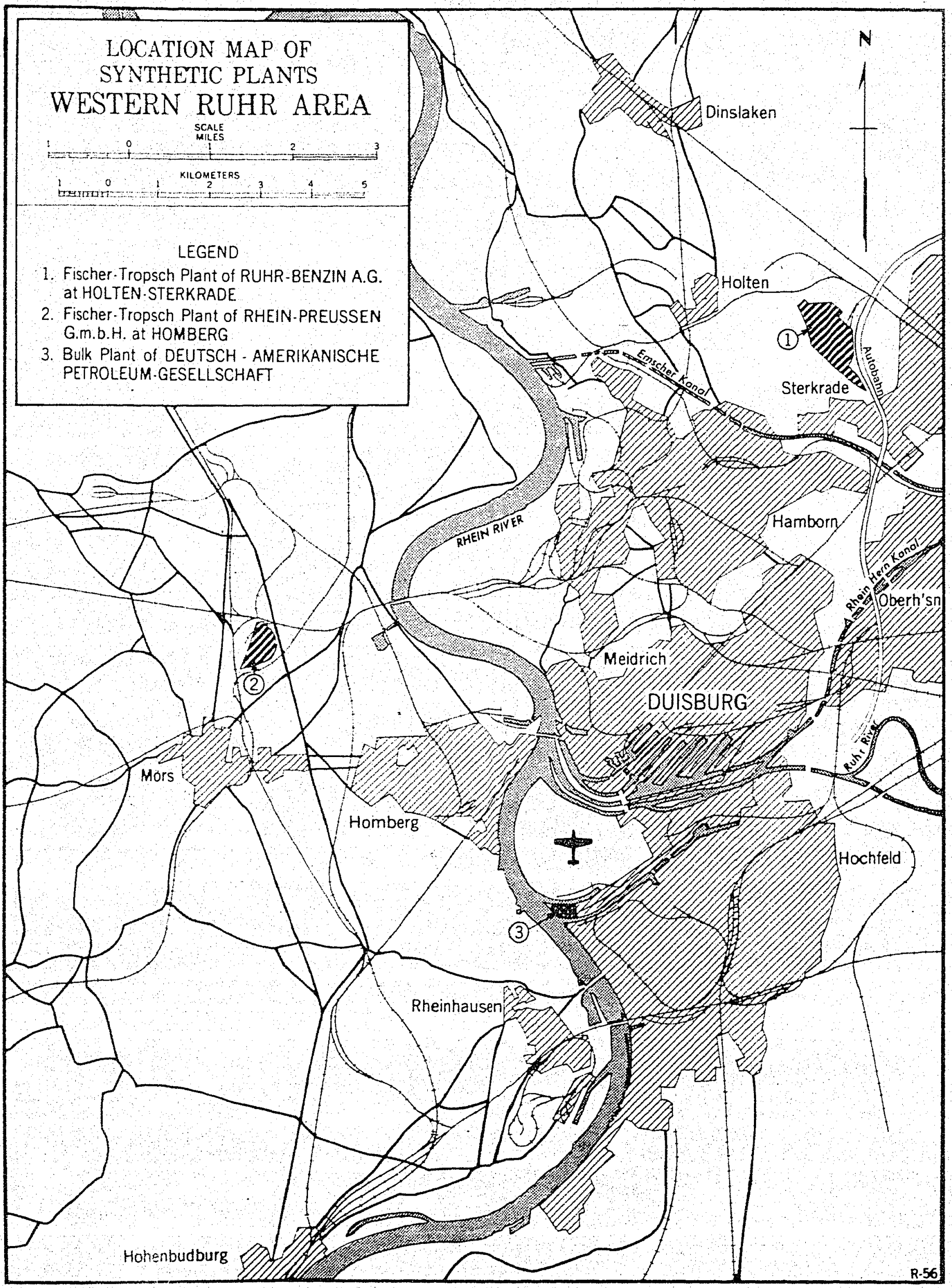
It has proved impossible to catalogue the innumerable L.T.C. plants in Germany but many of them exist entirely for the purpose of serving the synthetic oil plants. They are scattered throughout the coal mining regions and are usually conveniently located in reference to both the mines and the synthetic plants they serve.

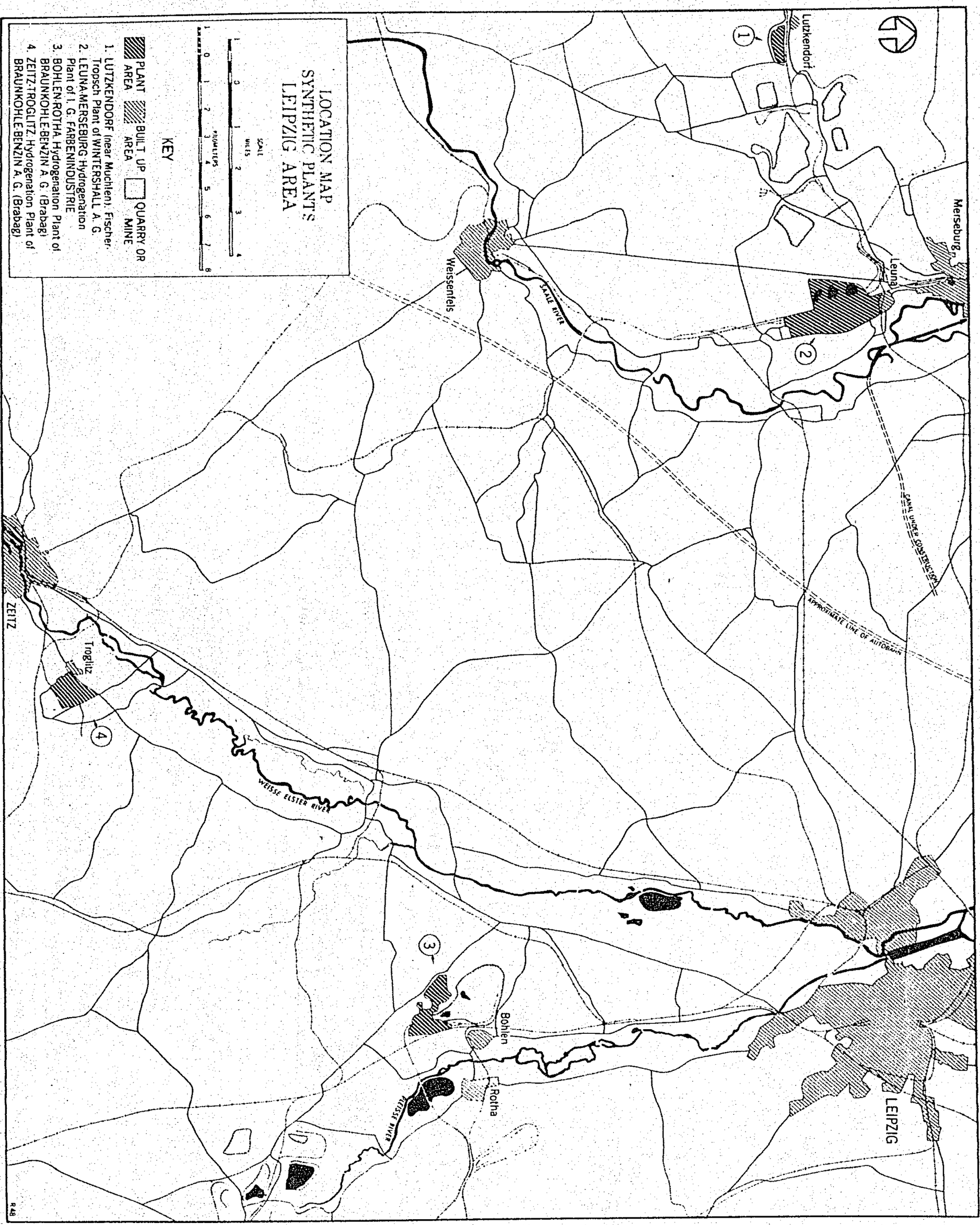
While the coke oven plants contribute the production of synthetic oil, both directly and in the form of raw materials for the major synthetic plants, their primary production is coke for the steel and gas industry. There are at least 116 important coking plants situated, mostly, in the bituminous coal mining areas of the Ruhr, Saar, and Silesia and, no doubt, many smaller plants also exist throughout the industrial areas. As previously mentioned, however, benzol is a by-product of coke manufacture and is produced by the high temperature carbonization of coal. A list of the plants known to figure most prominently in Germany's production of benzol are given in the table on page 215 (a), and many of these plants are, no doubt, either identical or operated in conjunction with the principal H.T.C. coke ovens.

(a) Other concerns known to have important plants for the distillation of coal tars, and hence probably capable of producing liquid fuels are A. G. Sachischwerke, of Dresden, Rütgerswerke A.G., of Berlin, and Gesellschaft für Teerverwertung m.b.H. of Duisburg-Meiderich.

SYNTHETIC OIL PLANTS IN GERMANY

Plant Place Name	Company	Location	Process	Normal Feed Stock	Capacity (Estimated) Metric Tons per year	Tankage (Estimated) Metric Tons	Plant Area Acres	Remarks
Blechhammer North	Oberschlesische Hydrierwerke A.G.	Lat. 50° 21'N, long. 18° 18'E, six miles E of Cosel in Silesia.	Hydrogenation	Bituminous coal H.T. and L.T.C. tar	200,000	74,600	1,150	Belongs to I.G. Farbenindustrie. Construction terminated late in 1943. Contains complete L.T.C. plant and refinery units.
Blechhammer South	Oberschlesische Hydrierwerke A.G.	Lat. 50° 18'N, long. 18° 15'E, four miles SW of Blechhammer North.	Hydrogenation	Bituminous coal and H.T. tar	300,000	41,000	1,160	Belongs to I.G. Farbenindustrie. Construction terminated late in 1943.
Böhlen-Rotha	Braunkohle-Benzin A.G. (Brabag)	South of Böhlen, lat. 51° 11'N, long. 12° 23'E, 10 miles S of Leipzig.	Hydrogenation	Lignite, L.T.C. tar	300,000	51,600	400	Adjacent to Sächsische Werke brown coal mine. Very large power station.
Bottrop-Welheim	Ruhröl A.G.	South of road from Bottrop to Horst and NW of Gelsenkirchen in Ruhr. Lat. 51° 32'N, long. 6° 59'E.	Hydrogenation	H.T. tar	100,000	-	150	Designed for Pott-Broche process but believed converted to Bergius.
Castrop-Rauxel	Gewerkschaft Viktor	About 2 miles north of villages of Castrop-Rauxel. Lat. 51° 35'N, long. 7° 20'E. NW of Dortmund, Ruhr.	Fischer-Tropsch	Hard coal or coke	60,000	22,000	110	Adjoining Gewerkschaft Viktor coal mine. Also near canal.
Deschowitz	Schaffgotsch Benzin, G.m.b.H.	Sometimes known as Odertal, five miles north of Cosel, in Silesia. Lat. 50° 25'N, long. 18° 8'E.	Fischer-Tropsch	Hard coal or coke	60,000	3,400	250	Additional tankage located in Cosel. Oil conveyed there by pipe line.
Dortmund	Hoesch Benzin G.m.b.H.	At Hoesch, in the Wambelerhold suburb of Dortmund, Ruhr. Lat. 51° 32'N, long. 7° 30'E.	Fischer-Tropsch	Gas from adjacent coking plants	60,000	23,400	40	The Koelin-Neuessen steel works are adjacent on the west.
Gelsenkirchen	Gelsenberg Benzin A.G.	NW of Gelsenkirchen, Emscher Canal, Ruhr. Lat. 51° 32'N, long. 7° 3'E.	Hydrogenation	Bituminous coal and H.T. tar	350,000	87,000	160	Adjacent to Nordstern III, bituminous coal mine
Holten-Sterkrade	Ruhrbenzin A.G.	1 mile east of Holten, on road to Sterkrade. NW of Essen, Ruhr. Lat. 51° 32'N, long. 6° 48'E.	Fischer-Tropsch	Hard coal or coke	80,000	33,465	27	Annex to chemical works, Ruhrchemie A.G., which occupies considerable additional area.
Homberg	Rheinpreussen G.m.b.H.	1-3/4 miles west of Rhine, lat. 51° 28'N, long. 6° 38'E. West of Duisberg, Ruhr.	Fischer-Tropsch	Hard coal or coke	80,000	11,300	220	Adjoins Rheinpreussen's Haniel coal mine and a railroad junction.
Kamen	Chemische Werke Essener Steinkohle A.G.	2½ miles NW of Kamen and 10 miles NE of Dortmund, Ruhr. Lat. 51° 38'N, long. 7° 38'E.	Fischer-Tropsch	Hard coal or coke	60,000	16,000	90	Adjoins Monopol Grimberg coal mine shafts I and II, also referred to as Kamen Essener Verein Monople A.G.
Leuna	I.G. Farbenindustrie A.G.	Lat. 51° 19'N, long. 12° 0'E, Two miles S of Merseburg, and ten miles S of Halle, central Germany.	Hydrogenation	Lignite and L.T.C. tar	600,000	60,800	850	Largest fixed nitrogen plant in world. Also contains extensive chemical works.
Lützkendorf	Wintershall A.G.	2 miles E of village of Mücheln, lat. 51° 17'N, long. 11° 52'E, approximately 14 miles SW of Halle.	Fischer-Tropsch and Hydrogenation	Lignite and L.T.C. tar	60,000 and 125,000	75,000	210	Two plants combined. Connected by conveyor to south end of Lützkendorf Grube mine. Extensive additional tankage reported.
Magdeburg	Braunkohle-Benzin A.G. (Brabag)	In Rothensee four miles NNE of center of Magdeburg. In central Germany. Lat. 52° 11'N, long. 11° 40'E	Hydrogenation	L.T.C. tar from lignite	250,000	49,100	100	Power and steam is drawn from the Mikramag power plant about ½ mile SE.
Pölitz	Hydrierwerke Pölitz A.G.	10 miles N of Stettin. West of the mouth of the Oder River. Lat. 53° 33'N, long. 14° 33'E.	Hydrogenation	Bituminous coal, tars and petroleum	600,000	261,100	450	Plant very flexible, capable of treating almost any type of raw material.
Ruhland-Schwarzheide	Braunkohle-Benzin A.G. (Brabag)	1-½ miles N of Ruhland, lat. 51° 29' N, long. 13° 53'E. Approximately 30 miles N of Dresden.	Fischer-Tropsch	Lignite	180,000	44,000	350	Two complete Fischer-Tropsch plants combined.
Scholven	Hydrierwerke Scholven A.G.	South of Niederscholven, NW of Buer, on Buer-Dorsten road, Ruhr. Lat. 51° 36'N, long. 7° 2'E.	Hydrogenation	Bituminous coal and H.T. tar	400,000	46,000	260	Subsidiary of Hibernia A.G. plant, adjoins Scholven I & II bituminous coal mines and Bergmannsglück mine is 3/4 mile E.
Wanne-Eickel	Krupp Treibstoffwerke G.m.b.H.	4 miles NNW of center of Bochum, Ruhr. Lat. 51° 31'N, long. 7° 11'E.	Fischer-Tropsch	Coke and gas from Ruhr grid.	60,000	14,500	75	Supplied by neighboring coke ovens.
Wesseling	Union Rheinische Braunkohlen Kraftstoff A.G.	1½ miles ESE of Wesseling RR station on Rhine approximately 8 miles S of Köln. Lat. 50° 49'N, long. 7° 0'E.	Hydrogenation	Lignite and H.T. tar	200,000	58,300	190	Additional tankage totalling approx. 30,000 tons reported built 600 yards S of plant. Plant may have been dismantled in 1944 due to bomb damage.
Zeitz-Tröglitz	Braunkohle-Benzin A.G. (Brabag)	At Tröglitz 3 miles NE of Zeitz in central Germany. Lat. 51° 4'N, long. 12° 12'E.	Hydrogenation	L.T.C. tar from lignite	350,000	97,400	460	5 L.T.C. plants from which Zeitz may draw supplies are located within radius of 9 miles.


LOCATION MAP OF
SYNTHETIC PLANTS
WESTERN RUHR AREA
SCALE
MILES
1 0 1 2 3
KILOMETERS
1 0 1 2 3 4 5
LEGEND
1. Fischer-Tropsch Plant of RUHR-BENZIN A.G. at HOLTEN-STERKRADE
2. Fischer-Tropsch Plant of RHEIN-PREUSSEN G.m.b.H. at HOMBERG
3. Bulk Plant of DEUTSCH - AMERIKANISCHE PETROLEUM-GESELLSCHAFT
N
Dinslaken
Holten
Sterkrade
Emscher Kanal
Autobahn
RHEIN RIVER
Hamborn
Rhein Herne Kanal
Oberh'sn
Meidrich
DUISBURG
Ruhr River
Mörs
Homberg
Hochfeld
Rheinhausen
Hohenbudburg
R-56


LOCATION MAP
SYNTHETIC PLANTS
LEIPZIG AREA
SCALE
MILES
KILOMETERS
KEY
PLANT AREA
BUILT UP AREA
QUARRY OR MINE
1. LUTZKENDORF (near Muchlen). Fischer-Tropsch Plant of WINTERSHALL A. G.
2. LEUNA-MERSEBURG Hydrogenation Plant of I. G. FARBENINDUSTRIE
3. BOHLEN-ROTHA Hydrogenation Plant of BRAUNKOHLE-BENZIN A. G. (Brabag)
4. ZEITZ-TROGLITZ Hydrogenation Plant of BRAUNKOHLE-BENZIN A. G. (Brabag)
Lutzkendorf
Merseburg
Leuna
Weissenfels
SAALE RIVER
CANAL UNDER CONSTRUCTION
APPROXIMATE LINE OF AUTOBAHN
ZEITZ
Troglitz
WEISSE ELSTER RIVER
Bohlen
Rotha
PLEISSE RIVER
LEIPZIG
R48

Location Map of

SYNTHETIC PLANTS and Petroleum Refinery

CENTRAL RUHR AREA

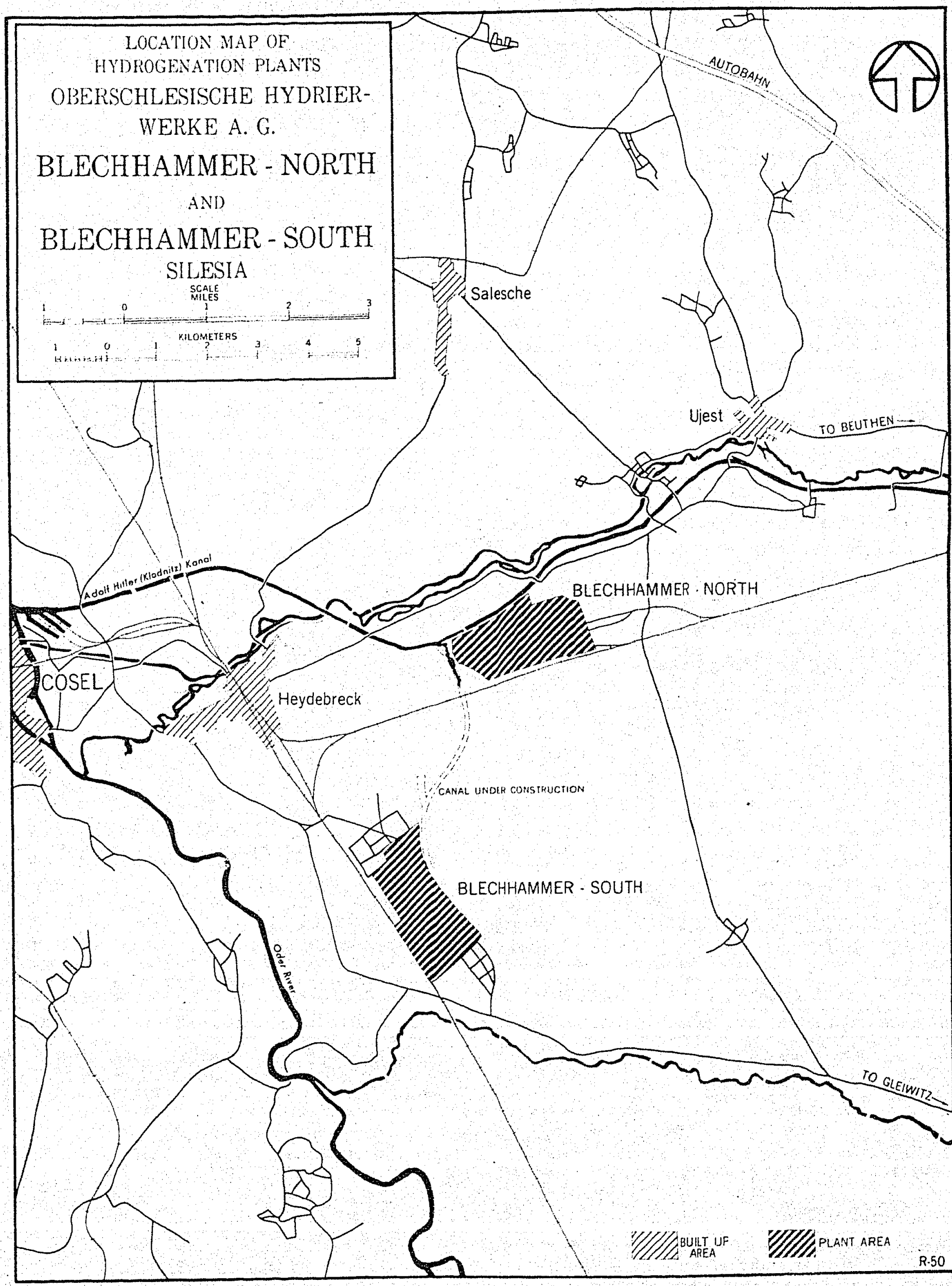
SCALE

LEGEND

1. Hydrogenation Plant, RUHRÖL A. G. at BOTTROP-WELHEIM.
2. Hydrogenation Plant, GELSENBERG BENZIN A. G. at GELSENKIRCHEN.
3. Pipelines Connecting Various Plant Installations.
4. Gelsenkirchen Coke Oven Plant.
5. Hydrogenation Plant, HYDRIERWERKE SCHOLVEN A. G. at SCHOLVEN.
6. Zweckel Coke Oven Plant.
7. Bergmannsglück Power Station and Colliery.
8. Huls Synthetic Rubber Plant.
9. Fischer-Tropsch Plant, KRUPP TREIBSTOFFWERKE G.m.b.H. at WANNE-EICKEL.
10. Fischer-Tropsch Plant, GEWERKSCHAFT VIKTOR at CASTROP-RAUXEL.
11. Oil Refinery, WESTFALISCHE MINERALÖL und ASPHALT-WERKE W. H. SCHMITZ K. G. at DORTMUND.
12. Fischer-Tropsch Plant, HOESCH BENZIN G.m.b.H. at DORTMUND.
13. Fischer-Tropsch Plant, CHEMISCHE WERKE ESSENER STEIN-KOHLE A. G. at KAMEN.

Dorsten
Datteln
Werne
Lunen
Kamen
RECKLINGHAUSEN
Suderwich
Henrichenburg
GLADBECK
Buer
Derne
Mengede
Horst
BOTTROP
CASTROP-RAUXEL
Herne
Bismark
WANNE-EICKEL
DORTMUND
Welheim
Marten
GELSENKIRCHEN
Lutgendortmund
Altenessen
Horde
Wattenscheid
Borbeck
BOCHUM
Werne
ESSEN

UPPER RIVER
UPPER CANAL
EMSCHER CANAL
DORTMUND-EMS CANAL
EMSCHER CANAL
EWIG CANAL
AUTOBAHN


LOCATION MAP OF
HYDROGENATION PLANTS
OBERSCHLESISCHE HYDRIER-
WERKE A. G.
BLECHHAMMER - NORTH
AND
BLECHHAMMER - SOUTH
SILESIA
SCALE
MILES
1 0 1 2 3
KILOMETERS
1 0 1 2 3 4 5
AUTOBAHN
Salesche
Ujest
TO BEUTHEN
Adolf Hitler (Kladnitz) Kanal
BLECHHAMMER · NORTH
COSEL
Heydebreck
CANAL UNDER CONSTRUCTION
BLECHHAMMER - SOUTH
Oder River
TO GLEIWITZ
BUILT UP AREA
PLANT AREA
R-50

4.6.2 Blechhammer North

Company: Oberschlesische Hydrierwerke (I.G. Farbenindustrie controlled).

Location: In Silesia, six miles E. of Cosel, latitude 50° 21' N., longitude 18° 18' E., on S. bank of Adolf Hitler Canal (Klodnitz Canal). There is also a canal to Blechhammer South, four miles to the SW.

References: Layout plan, page 166. Location sketch, page 164. Photograph, page 167.

Plant Area: 10,000 feet x 5,000 feet (1,150 acres).

Description: (a) Process: Hydrogenation of bituminous coal and tars by Bergius process. This plant is of recent construction and did not come into production until 1943.

(b) Power Plant: There are two powerhouses, complete with generator halls, etc., located in two different parts of the plant. The one to the north, about 440 x 1,000 feet, has six cooling towers, two of 170 feet and four of 130 feet. The south powerhouse consists of two buildings 160 x 210 feet and 280 x 240 feet.

(c) L.T.C. Plant: One carbonization house, 430 x 90 feet, of 10 stacks with room for three more houses. Coke is delivered to watergas plant and south power plant.

(d) Gas Manufacture: Watergas plant, 350 x 100 feet, with 18 generators, with H_2S removal (building 290 x 52 feet with 20 columns, 15 feet in diameter), etc. A group of large buildings may be a Linde plant. Main compressor house, 460 x 110 feet.

(e) Hydrogenation: Eight stalls (4 pairs) with room for many more. Size of stall: 40 x 26 feet.

(f) Refinery: One section with eight distillation columns for L.T.C. products and one section with three columns for hydrogenated products.

(g) Tankage: Four large tanks are located in the woods near the southwest corner of the plant and two isolated groups south of the plant. Estimated capacities are as follows:

Details of Tankage

	Number	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
Southwest group	4	90	6,000	24,000
South group	2	90	6,000	12,000
	6	70	3,500	21,000
	4	60	3,000	12,000
	4	40	1,000	4,000
	2	35	800	1,600
TOTAL				74,600

Estimated capacity: 200,000 metric tons per year estimated normal production capacity

Hydrogenation Plant

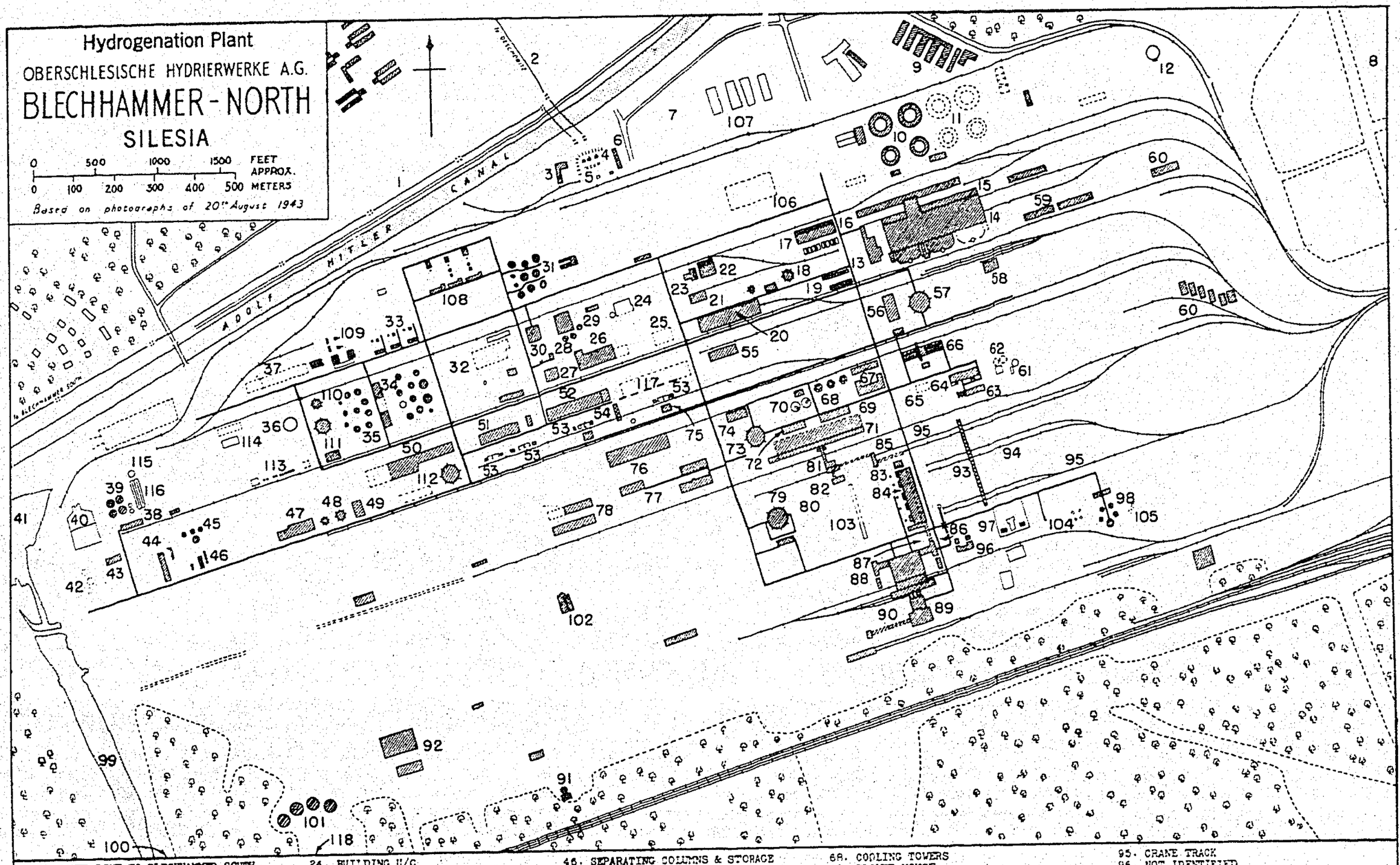
OBERSCHLESISCHE HYDRIERWERKE A.G.

BLECHHAMMER - NORTH

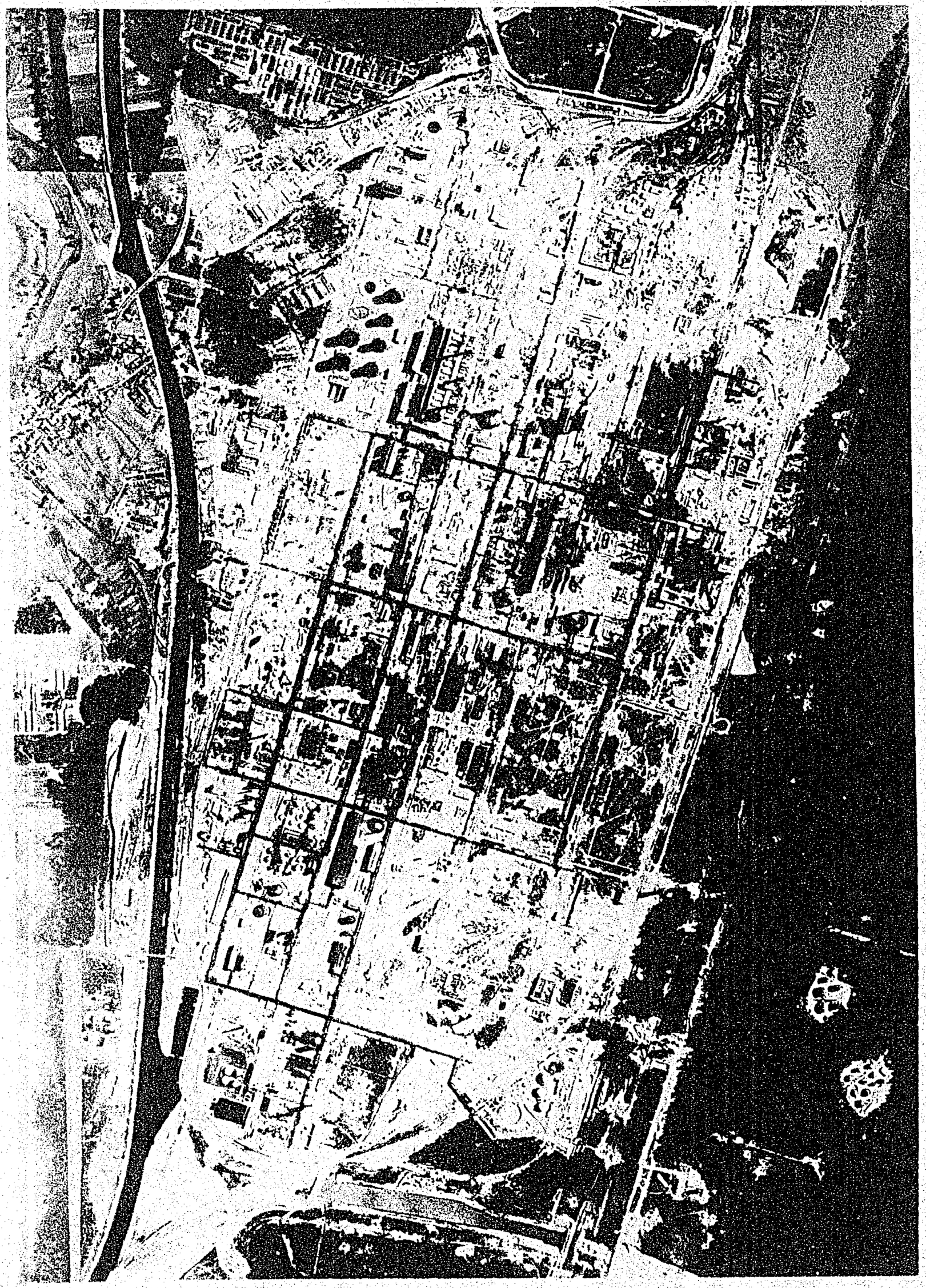
SILESIA

0 500 1000 1500 FEET APPROX.
0 100 200 300 400 500 METERS

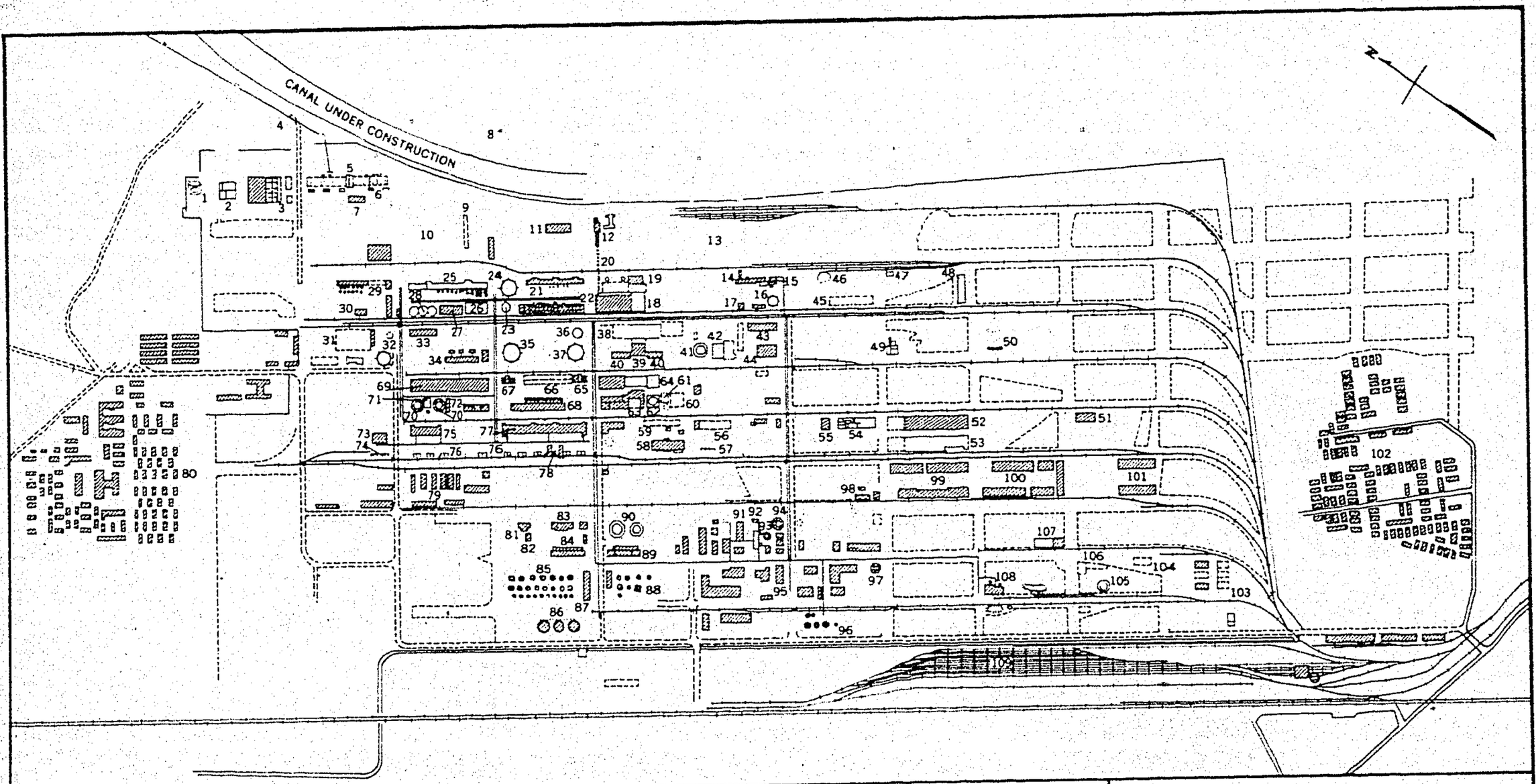
Based on photographs of 20th August 1943



1. POWER LINE TO BLECHHAMMER-SOUTH
2. POWER LINE TO DESCHOWITZ
3. TRANSFORMER STATION
4. TRANSFORMERS
5. ISOLATING SWITCHES
6. CONTROL HOUSE
7. STORES AREA
8. LABOUR CAMP
9. HUTMENTS
10. COOLING TOWERS
11. COOLING TOWERS U/C (under construction)
12. GASHOLDER U/C
13. H.T. SWITCH HOUSE
14. BOILER HOUSE
15. GENERATOR HALL
16. L.T. SWITCHHOUSE
17. CO_2 WASHING PLANT
18. HYDROGEN GASHOLDER
19. CONVERSION UNIT
20. MAIN COMPRESSOR HOUSE
21. WORKSHOP
22. FORMATE RECOVERY COLUMNS
23. CO - WASHING PLANT
24. BUILDING U/C
25. FOUNDATIONS
26. COAL PREPARATION ?
27,28. LET DOWN
29. NOT INDENTIFIED
30. CENTRIFUGE HOUSE ?
31. PRIMARY PRODUCTS TANKS
32. CARBONISING OVEN U/C ?
33. OIL REFINERY UNITS
34. INTERMEDIATE PRODUCTS TANKS
35. FINAL PRODUCTS TANKS
36. GASHOLDER U/C
37. FOUNDATIONS
38. PUMP HOUSE
39. FILTER TANKS
40. FILTER BED
41. CANAL JUNCTION U/C
42. TANK SITES
43. PUMP HOUSE ?
44. COMPRESSOR HOUSE & STORAGE CYLINDERS
45. ISO. OCTANE TANKS ?
46. SEPARATING COLUMNS & STORAGE CYLINDERS
47. PUMP HOUSE ?
48. GASHOLDERS
49. PUMP HOUSE
50. WORKSHOP ?
51. INJECTOR / CIRCULATOR HOUSE
52. INJECTOR & PASTE PREPARATION HOUSE
53. STALLS
54. STALLS CRANE
55,56. WORKSHOPS
57. PURE GASHOLDER
58. WORKSHOP
59. STORES DUMPS
60. HUTS
61. COOLING TOWER SITE
62. TANK SITES ?
63. NOT IDENTIFIED
64. COMPRESSOR HOUSE ?
65. FOUNDATIONS
66. H_2S REMOVAL
67. WORKSHOPS
68. COOLING TOWERS
69. BLOWER HOUSE
70. ASH SETTLING PONDS
71. WATER GAS PLANT
72. BLOWER HOUSE
73. RAW-GAS HOLDER
74. PUMP HOUSE
75,76,77,78. WORKSHOPS
79. L.T.C. PLANT GASHOLDER
80. GAS PIPELINE, NOW REMOVED WHICH CONNECTED 79 AND 80
81,82. COKE CRUSHING PLANT
83. PUMP HOUSE ?
84. L.T.C. PLANT
85. COKE CONVEYER
86. COAL CONVEYER
87. BRIQUETTE CONVEYER
88,89. BRIQUETTING PLANT
90. COAL CONVEYER
91. WATER TOWER
92. NOT IDENTIFIED
93. BUNKER CRANE
94. COAL BUNKER
95. CRANE TRACK
96. NOT IDENTIFIED
97. TAR DISTILLERY
98. BENZOL TANKS
99. BRANCH CANAL U/C
100. RAILWAY BRIDGE U/C
101. TANK SITES
102. NOT IDENTIFIED
103. SECOND L.T.C. PLANT U/C
104,105. TANK SITES
106. FOUNDATIONS
107. HUTS U/C
108. OIL REFINERY
109. GAS SEPARATION PLANT
110,111,112. GASHOLDERS
113,114. BUILDINGS U/C
115. TANK ? U/C
116. SEPARATING PONDS
117. INJECTOR/CIRCULATOR HOUSE U/C
118. TWO GROUPS OF TANKS ARE LOCATED APPROXIMATELY 500 YARDS SOUTH OF R.R.



AERIAL VIEW OF HYDROGENATION PLANT, OBERSCHLESISCHE HYDRIERWERKE A.G., BLECHHAMMER NORTH (NEAR COSEL)



LEGEND

NOTE: Buildings with roofs are hatched: those with walls only are shown by outlines only. Foundations are indicated by broken liner.
The stippled areas are dumps of building material.

1. Bunded enclosure.
2, 3. Buildings under construction.
4. Power line to BLECHHAMER NORTH.
5. Transformer Station.
6. Transformer enclosures.
7. Control House.
8. Power line under construction.
9. Bunker crane under construction.
10. Site for open bunker.
11. Workshop.
12. Coal Crushing plant.
13. Stores dump.
14. Gas plant?
15. Blower House?
16. Gasholder under construction.
17. Possible gas cleaning plant.
18. Boiler House.
19. Feed water pumps etc.
20. Coal conveyor under construction
21. Gasplant?
22. H_2S removal.
23, 24. Gasholders under construction.
25. Water gas plant under construction.
26. Filtration Pond.
27. Blower house.
28. Cooling towers under construction.
29. Water gas plant under construction.
30. Blower house under construction.
31. Foundations.
32. Gasholder under construction.
33. Workshop?
34. Gas treatment.
35, 36, 37. Gasholders.
38. Generator hall under construction.
39. L.T. switch house.
40. H.T. switch house.
41. Cooling tower under construction.
42. Pond under construction.
43. Workshop.
44. Not identified.
45. Foundations for gas plant?
46. Foundations for cooling tower.
47. Not identified.
48. Building under construction.
49. Building under construction.
50. Storage tanks.
51. Not identified.
52, 53. Possibly contact oven houses under construction.
54. Laboratory block under construction.
55. Building under construction.
56. Injector house under construction.
57. Triple set of stalls.
58. Carbonising Plant?
59. Paste Preparation?
60. Foundation for cooling tower.
61. Pond under construction.
62. Cooling tower.
63. Maintenance buildings; etc.
64. Compressor house under construction.
65. CO_2 washing.
66. Organic sulphur removal.
67. CO_2 washing.
68. Conversion, etc.
69. Compressor house.
70. Cooling towers.
71. Pond.
72. Workshops.
73. Compressor house.
74. Small stalls.
75. Injector house.
76. Stalls.
77. Injector house.
78. Stalls cranes.
79. Workshops, etc.
80. Labour camp.
81. Flash columns?
82. Gas storage.
83. Not identified.
84. Distillation units.
85. Intermediate products storage.
86. Bulk oil storage.
87. Pump house.
88. Oil storage.
89. Distillation units.
90. Cooling towers under construction.
91. Gas storage.
92. Gas separating columns.
93. Gasholder.
94. Cooling tower.
95. Unidentified plant.
96. Oil storage.
97. Cooling tower.
98. Gas treatment.
99, 100. Workshops.
101. Store.
102. Labour camp.
103, 104. Buildings under construction.
105. Cooling tower under constrution.
106. Foundations.
107. Building under construction.
108. Boiler House.
109. Rail sidings

HYDROGENATION PLANT

OBERSCHLESISCHE HYDRIERWERKE A. G.

BLECHHAMMER SOUTH

SILESIA

SCALE

500 0 500 1000 1500 FEET

100 0 100 200 300 400 500 METERS

R-40

4.6.3 Blechhammer South

Company: Oberschlesische Hydrierwerke (I.G. Farbenindustrie controlled).

Location: Latitude 50° 18' N., longitude 18° 15' E. In Silesia, four miles southwest of Blechhammer North with which it is connected by a canal.

References: Layout plan, page 168. Location sketch, page 164.

Plant Area: 17,700 feet x 4,000 feet (1,160 acres).

Description: (a) Process: Direct hydrogenation of coal by Bergius process. This plant was under construction in 1943 and came into production in the latter half of that year.

(b) Power Plant: Unusual construction - boiler house 400 x 270 feet, generator hall 300 x 110 feet, probably extended to 600 feet. Another power plant, 160 x 135 feet, is southeast of the refinery.

(c) Gas Manufacture: Watergas plant, 660 x 55 feet (120 feet high), with at least 18 generators but probably totaling about 25. H_2S removal, 510 x 80 feet with 34 columns, 16 feet in diameter. There are several unidentified buildings which seem to be connected with gas production and/or gas synthesis. Gasholders, one at 67 feet, one at 80 feet, one at 110 feet and one at 135 feet. CO_2 removal plant with 20 columns. Two compressor houses, one of 670 x 107 feet with twelve compressors, and one of 500 x 107 feet with eight compressors.

(d) Hydrogenation Plant: Stalls number 13 pairs and two triples (one only fundaments), namely 22 stalls at 27 x 20 feet, four stalls at 20 x 12 feet. Stalls in triple stalls 27 x 20 feet but isolated location and probable lower height (26 feet) make it possible they are for either buna or hydrofining.

(e) Refinery: Two rows of distilling columns: 1st row, 6 columns 60 feet high and 4 columns 40 feet high; 2nd row, 8 columns 60 feet high. There is some unidentified construction in the refinery section which appears to have a small throughput of some valuable product.

(f) Tankage: Four groups of tanks with total capacity of 41,000 metric tons.

Estimated Capacity: 300,000 metric tons per year estimated normal production capacity.

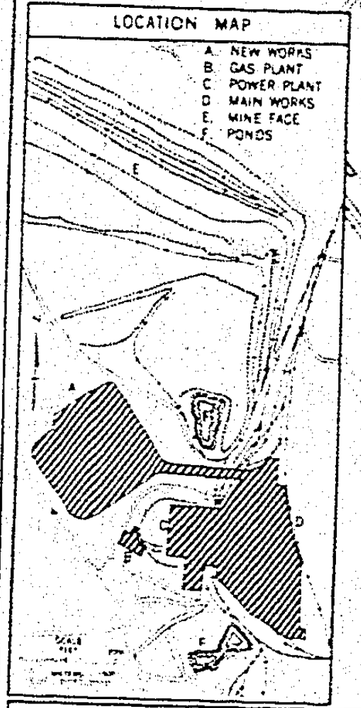
HYDROGENATION PLANT

BRAUNKOHLE - BENZIN A. G. (BRABAG)

BÖHLEN - ROTHA

(NEAR LEIPZIG)

APPROXIMATE SCALE



LEGEND

1. MINOR OFFICES & FIRE STATION
2. MAIN WORKSHOPS
3. SETTLING POND
4. EASTERN AIR INTAKE
5. PIPELINES FROM REFINERY TO NEW WORKS
6. STATIC WATER TANK
7. STALLS CRANE
8. STORAGE CYLINDERS
9. STALLS
10. WESTERN AIR INTAKE
11. CIRCULATOR HOUSE
12. MAIN INJECTOR HOUSE
13. PUMPHOUSE
14. LETDOWN HOUSE?
15. RESIDUAL GASHOLDERS
16. PRIMARY PRODUCTS TANKS
17. RUNDOWN TANKS
18. CONTROL HOUSE & LABS ?
19. FRACTIONATING COLUMNS AND PUMP & CONTROL HOUSE
20. TUBE STILLS
21. BUTANE COMPRESSING & BOTTLING PLANT
22. HORIZONTAL TANKS
23. OXYGEN GASHOLDER
24. LIQUID AIR PLANT
25. FINAL GAS WASHING HOUSE
26. MAIN COMPRESSOR HOUSE
27. GAS WASHING
28. CO2 WASHING COLUMNS
29. FORMATE WASHING COLUMNS
30. FORMATE RECOVERY COLUMNS
31. SATURATION COLUMNS ETC FOR CONVERTORS
32. CONVERTOR COLUMNS
33. CONVERTOR SERVICING CRANE
34. PURE GASHOLDER
35. MAIN BLOWER HOUSE
36. SULPHUR FREE GASHOLDER
37. GASHOLDERS
38. SULPHUR REMOVAL COLUMNS
39. TAIL GAS SEPARATION?
40. BUTANE GASHOLDER?
41. PONDS
42. ISO-OCTANE PLANT
43. BUTANE BLOWDOWN
44. ISO-OCTANE PLANT WORKING TANKS
45. WINKLER GENERATORS
46. MAIN OIL LOADING SIDINGS
47. COOLING TOWERS FOR GAS PLANT
48. SETTLING PONDS
49. FINAL PRODUCTS STORAGE
50. COOLING CONVEYORS
51. BRIQUETTE STORAGE
52. CRANE
53. COAL DUMP
54. COAL LOADING DOCKS
55. FEED STOCK & TAR DISTILLATE TANKS
56. COOLING TOWERS FOR LT.C. PLANT
57. L.T.C. PLANT
58. TAR DISTILLATION COLUMNS AND STILLS
59. CONVEYORS
60. TAR CONDENSORS
61. CONTROL BUILDING
62. BRIQUETTE CONVEYORS
63. CONTROL BLDG. FOR L.T.C. PLANT
64. COAL DRYING PLANT
65. GRINDING PLANT
66. DRYING PLANT
67. COAL CRUSHING PLANT
68. COKE CRUSHINGS?
69. RAW COAL INTAKE
70. MAIN SWITCH HOUSE
71. L.T. SWITCH HOUSE
72. BOILER HOUSE
73. GENERATOR HALL
74. MAIN OFFICES
75. LABORATORIES
76. COOLING TOWERS
77. GAS PLANT
78. FILTER BEDS
79. WATER WORKS FILTER BEDS
80. GASHOLDER FOUNDATION
81. LABOR CAMP
82. BURIED STORAGE TANKS UNDER CONSTRUCTION
83. GASHOLDER PROBABLY FOR RESIDUAL GAS
84. INJECTOR OR COMPRESSOR HOUSE
85. PUMPS, CONTROLS ETC. FOR RESIDUAL GAS
86. FRACTIONATION PLANT
87. OIL STORAGE TANKS
88. DISTILLATION PLANT
89. PUMPS, CONTROLS ETC
90. DISTILLATION UNITS

— — — PIPELINES

R-93

4.6.4 Böhlen-Rotha

Company: Braunkohle-Benzin A.G. (Brabag)

Location: South of the village of Böhlen, ten miles south of Leipzig, adjacent to the Säschische Werke brown coal mine and power station. Latitude 51° 11' N., longitude 12° 23' E.

Reference: Layout plan, page 170. Location map, page 162.

Plant Area: Main plant 4,500 x 3,900 feet, or about 400 acres. New extension 2,500 x 2,000 feet or about 115 acres.

Description: (a) Process: Hydrogenation, Bergius process, of lignite from the adjacent mine.

(b) Power Plant: A large powerhouse with generator hall 725 feet x 77 feet and a boilerhouse 450 feet x 210 feet, capacity 230,000 k.w. One of the largest in central Germany and supplies power over a wide area.

(c) Low Temperature Carbonization: There is a large L.T.C. plant with 24 stacks and having a daily capacity of 750 metric tons of L.T.C. tar and 3,000 tons of coke. Of this coke it is reported that 2,200 tons are used daily under the power station boilers, 400 tons in the Winkler generators and the remaining 400 tons sold to other users.

(d) Gas Manufacture: There are three Winkler generators and four watergas generators. There are two buildings identified as compressor houses 270 x 90 feet and 340 x 77 feet. There are seven gas washing towers.

(e) Hydrogenation: There are seven stalls, six arranged in pairs, each stall 30 feet x 25 feet.

(f) Refinery: There are four furnace houses, each measures 47 x 41 feet, associated with distillation columns and pump houses; also pressure equipment for handling liquefiable gases. New plant contains additional refining equipment.

(g) New Plant: The new plant was under construction in 1943 and product storage tanks, refining distillation units and a high pressure synthesis plant, either Fischer-Tropsch or hydrogenation-polymerization, appeared to be its salient features.

(h) Tankage:

Details of Tankage - Approximate

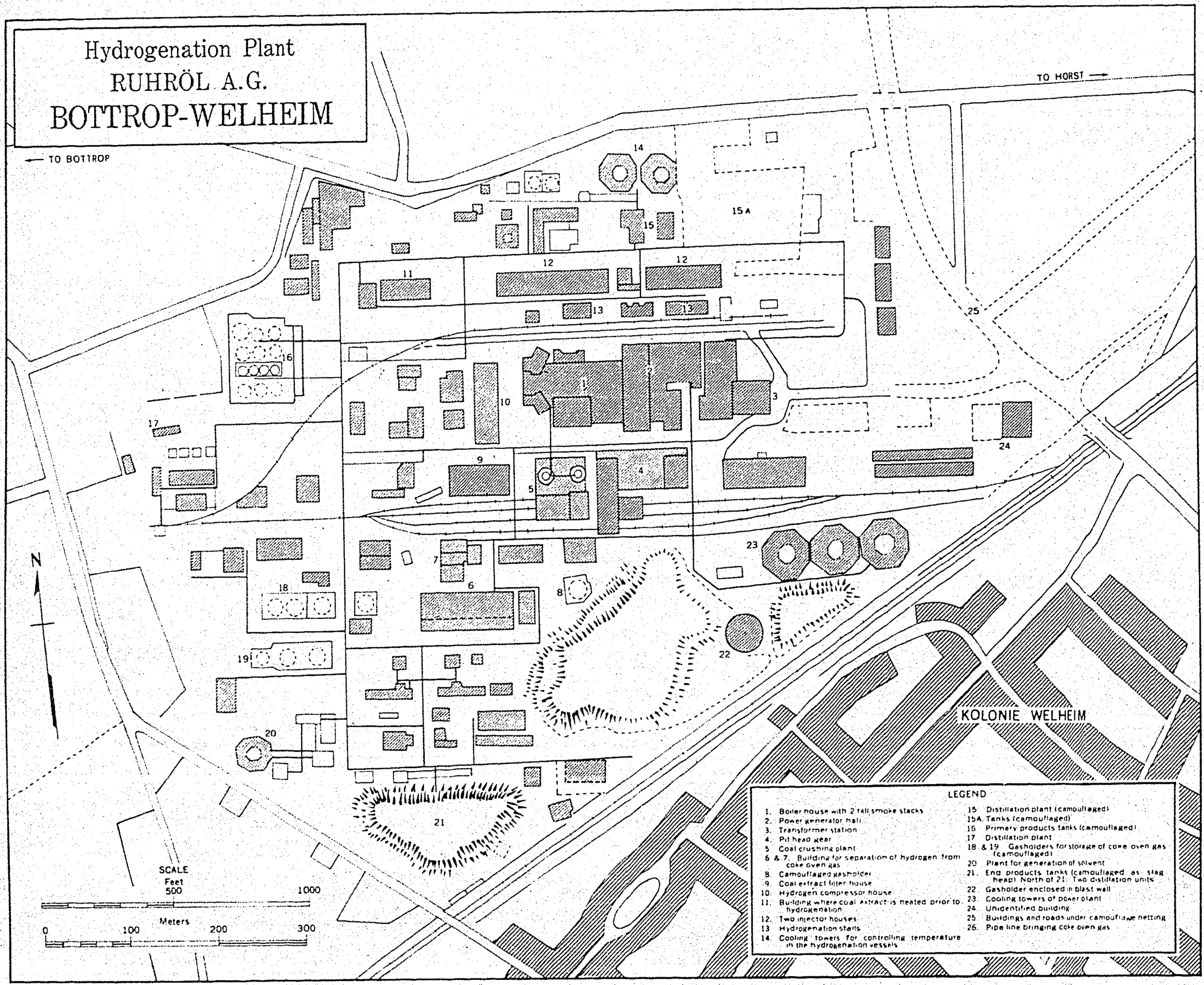
No. of Tanks	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
12	42	1,200	14,400
2	120	12,000	24,000
2	60	3,000	6,000
3	48	2,000	6,000
3	42	1,200	3,600
T o t a l			54,000

Estimated Capacity: 300,000 metric tons per year estimated normal production capacity.

Remarks: The lignite is supplied partly from the open mine north of the plant and partly from the mine at Espenhein, also belonging to A.G. Sächsische Werke. Raw coal intake of the plants around the mine is approximately as follows:

To boilerhouse	2,500	metric tons per day
Manufacture of briquettes for sale	4,000	" " " " "
Manufacture of briquettes for L.T.C. plant	11,500	" " " " "
Gasworks (Leipzig city gas supply, capacity 400,000 M^3 per day by Luigi system)	1,000	" " " " "
T o t a l	19,000	" " " " "

Hydrogenation Plant
RUHRÖL A.G.
BOTTROP-WELHEIM



4.6.5 Bottrop - Welheim

Company: Ruhröl A.G.

Location: Latitude 51° 32' N., longitude 6° 59' E. Zeche Vereinigte Welheim, south of road from Bottrop to Horst and northwest of railway Bottrop to Gelsenkirchen in highly built up section of Ruhr.

Reference: Layout plan, page 172. Location map, page 163.

Plant Area: Triangle, 3,150 x 3,150 x 2,100 feet, or approximately 150 acres.

Description: (a) Process: Designed as pilot plant for hydrogenation (700 atms). of Pott Broche extract, but probably converted to Bergius hydrogenation process. Coal supplied from Matthias Stinnes shafts III and IV, about 1 mile to the north.

(b) Power Plant: Large power plant with two chimneys.

(c) Gas manufacture: Linde separation of H_2 from coke oven gas. Plant dimensions: 280 feet x 110 feet.

(d) Pott-Broche Process: Two towers and a filter house (180 x 90 feet for P.B. process)

(e) Hydrogenation: Five stalls, viz.,

2 of 45 x 28 feet
1 of 55 x 28 feet
1 of 62 x 25 feet
1 of 40 x 25 feet

(f) Refinery: Three furnaces (1 large, 2 small)

(g) Tankage: Several large groups of tanks, extensively camouflaged.

Estimated Capacity: 100,000 metric tons per year estimated normal productive capacity.

4.6.6 Castrop-Rauxel

Company: Gewerkschaft Viktor (owned by Wintershall A.G. and Klocknerwerke A.G.)

Location: Latitude 51° 35' N., longitude 7° 20' E., approximately two miles north of villages of Castrop-Rauxel and some eight miles northwest of Dortmund in the Ruhr. Alongside the Gewerkschaft Viktor coal mine.

Reference: Layout plan, page 174. Location map, page 163.

Plant Area: 3,300 feet x 1,800 feet, or approximately 110 acres.

Description: (a) Process: Fischer-Tropsch synthesis, probably both low pressure and medium pressure. Operates on hard coal or coke.

(b) Coke oven Plant: Battery 450 feet long, about 150 ovens. By-products plant includes NH_3 and benzol recovery and purification.

(c) Power Station: Boilerhouse 200 x 125 feet. Generator hall 115 x 90 feet.

(d) Gas manufacture: CO from coke ovens, supplemented by CO + H_2 from watergas plant, dimentions 180 x 120 feet, with four generators. H_2S removal 200 x 90 feet with four towers of 40 feet diameter. Organic sulphur removal, 6 towers, 18 feet diameter.

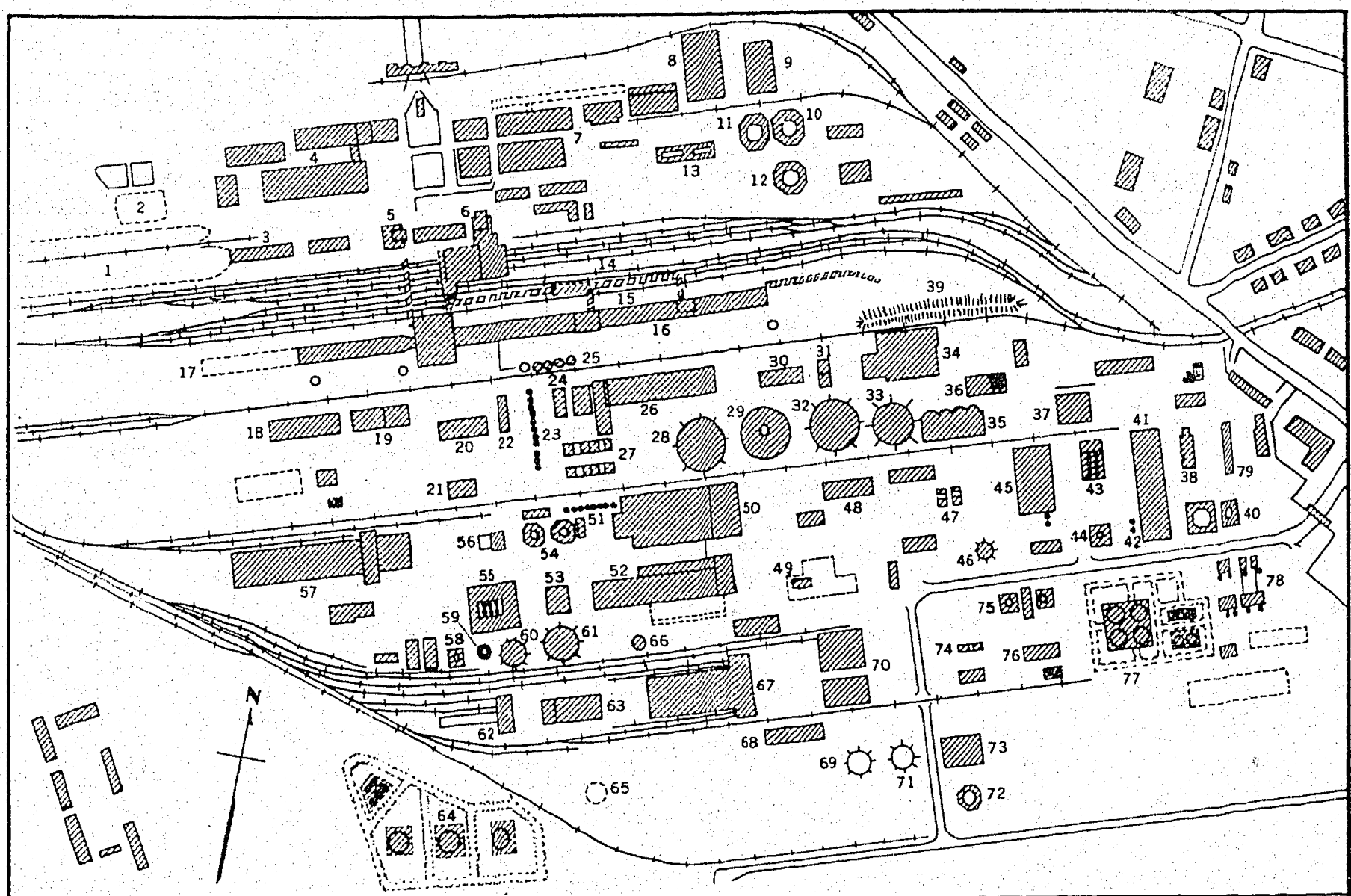
(e) Synthesis: Old contact oven house 310 x 90 feet, probably 30 low pressure and 60 medium pressure ovens. New oven house about same size.

(f) Refinery: Distillation units.

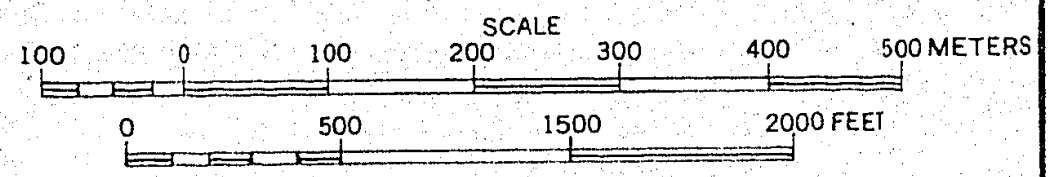
(g) Tankage: Total capacity about 22,700 metric tons.

(h) Sundries: There is also an NH_3 Synthesis plant on the site.

Estimated Capacity: 60,000 metric tons per year estimated normal production capacity.



Fischer - Tropsch Plant
GEWERKSCHAFT VIKTOR
CASTROP-RAUXEL



LEGEND

1, 2. Pit prop yards
3. Coal handling plant
4. Colliery offices
5, 6. Pithead gear
7. ? Briquetting plant
8. Boiler house
9. Generator hall
10.-13. Cooling towers
14. Colliery sidings
15. Conveyors
16. Coke ovens
17. Foundation for coke oven extension
18.-22. By-products treatment
23. Gaswashing columns
24. Blower house and tar precipitation
25. Liquor tanks
26. By-products plant silo
27. Cooling towers
28. Gas holder
29. Dry gasholder
30. Pump house
31. Cooling towers
32, 33. Gasholders
34. Water gas plant
35. H_2S removal
36. ? Gas coolers etc.
37. Works transformer station
38. Not identified
39. Coke dump
40. Cooling towers
41. Contact oven house
42. Oil washing columns
43. Active carbon plant
44. Cooling tower
45. Organic sulphur removal
46. Gasholder
47. Cooling towers
48, 49. Not identified
50. Ammonia plant compressors
51. Gas washing towers
52. Ammonia synthesis plant
53. Pumphouse
54. Cooling towers
55. Nitric acid plant
56. Not identified
57. Fertilizer silo
58, 59. Cooling towers
60, 61. Residual gasholders
62. New building
63. Distillation building u/c
64. Oil storage
65. Cooling tower u/c
66. Ammonia tank
67. ? New contact oven house
68. Pumphouse
69. Gasholder u/c
70. Not identified
71. Gasholder
72. Cooling tower
73. Pumphouse
74, 75. Cooling towers
76. Compressor house and gas storage cylinders
77. Oil storage tanks
78. Distillation plant
79. New building

4.6.7 Deschowitz

Company: Schaffgotsch Benzin G.m.b.H.

Location: Latitude 50° 25' N., longitude 18° 08' E. Deschowitz, sometimes known as Odertal, lies five miles north of Cosel, in Silesia, approximately eight miles from Blechhammer.

References: Layout plan, page 176. Location map, page 176.

Plant Area: 5,150 x 2,150 feet or approximately 250 acres.

Description: (a) Process: Fischer-Tropsch synthesis at medium pressures. Operates on hard coal or coke.

(b) Power Plant: 1 boilerhouse, 286 feet x 195 feet. Generator halls, one of 85 x 45 feet and one of 85 x 70 feet. Four large cooling towers and an open air transformer station 325 x 195 feet.

(c) Coke Oven Plant: About 190 ovens. By-product plant includes NH_3 separation, benzol plant. One tar pitch treatment and fractionation tank, 40 feet in diameter, capacity approximately 2,000 tons for final benzol storage.

(d) Gas Manufacture: Watergas plant 205 x 95 feet with new extension of 420 feet in length (and possibly more). Wet gasholders 85 feet in diameter. H_2S removal 98 x 90 feet with four towers 34 feet in diameter. Organic sulphur removal 210 x 65 feet having six towers 13 feet in diameter. Compressor house 210 x 117 feet.

(e) Synthesis: Old contact oven house of open type 143 x 70 feet, extended to 285 feet. Older section had 48 ovens 9 feet in diameter; 10 more added with total room for about 90.

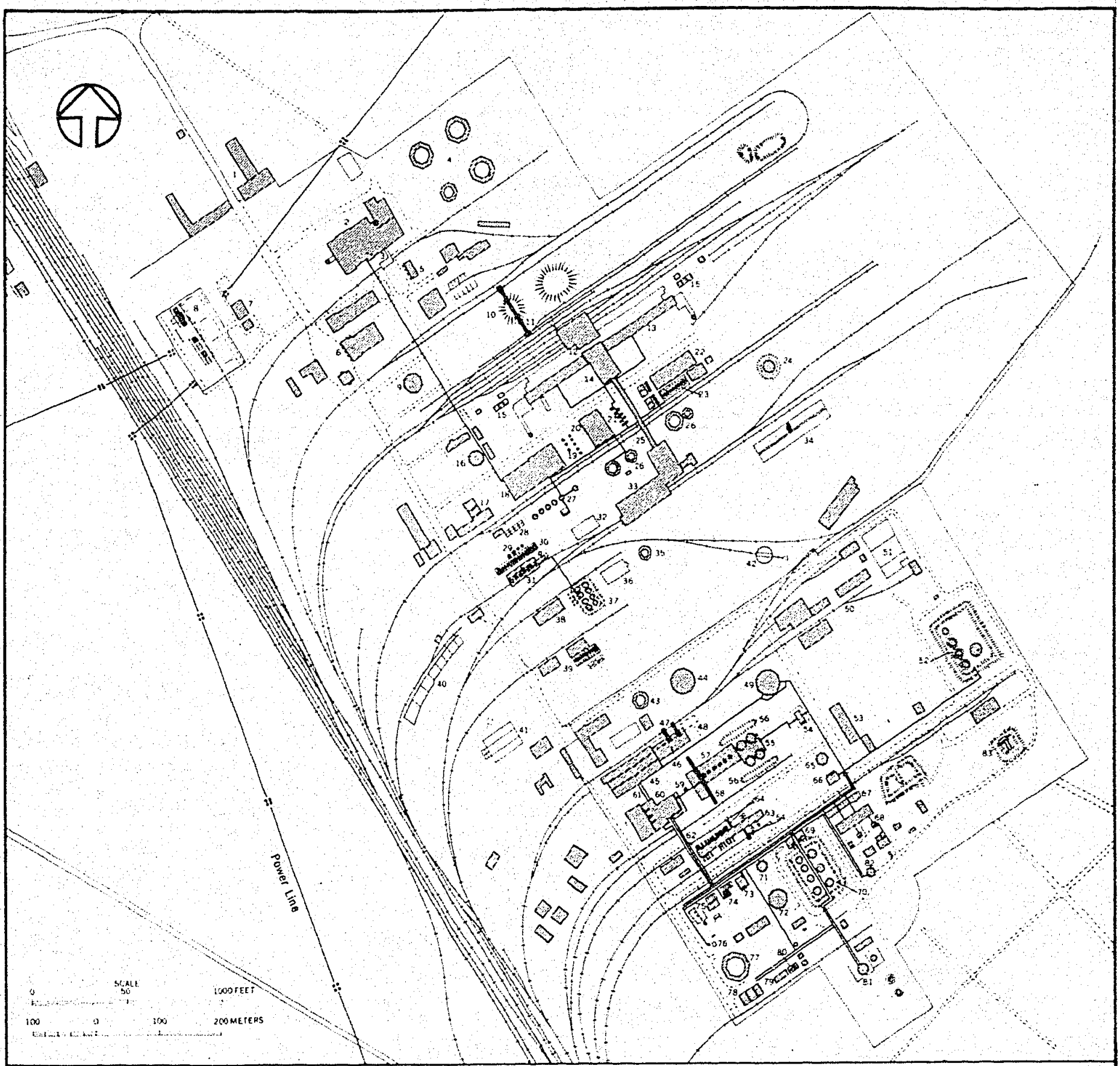
(f) Refinery: Fractionating and stabilization columns. May also include lube oil manufacture. Probably no cracking unit.

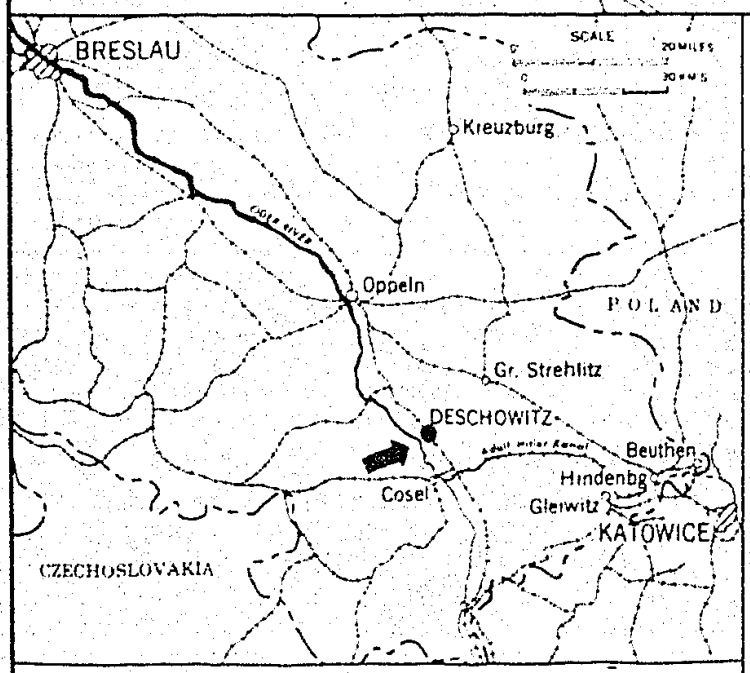
(g) Tankage: Two groups of tanks with the following approximate capacities. Additional tankage is located in Cosel whence oil is conveyed by pipe line.

Details of Tankage

No. on Plan	No. of Tanks	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
70 and 81	3	35	800	2,400
	2	33	700	1,400
	1	30	500	500
	3	25	400	1,200
	2	20	200	400
52	1	45	1,500	1,500
	4	22	225	1,000
TOTAL				8,400

Estimated Capacity: 60,000 metric tons per year estimated normal production capacity.





LOCATION MAP

FISCHER-TROPSCH PLANT OF SCHAFFGOTSCH BENZIN G. m. b. H. DESCHOWITZ.

LEGEND

1. OFFICES AND WEIGHHOUSE
2. POWER STATION
3. COAL CONVEYOR
4. COOLING TOWERS
5. WORKSHOPS ETC
6. OFFICES
7. CONTROL HOUSE
8. TRANSFORMER STATION
9. WET GASHOLDER
10. COKE DUMP
11. CRANE
12. COKE CRUSHING PLANT
13. COKE OVENS
14. 15. COOLING TOWERS
16. WET GASHOLDER
17. CONTROL BUILDING
18. AMMONIUM SULPHATE
19. FRACTIONATING COLUMNS
20. TAR TREATMENT?
21. WASHING COLUMN
22. BY PRODUCTS TREATMENT
23. STORAGE CYLINDERS
24. BENZOLE STORAGE
25. COAL CONVEYOR
26. COOLING TOWERS
27. TREATMENT VESSELS
28. COOLING TOWER
29. WASHING TOWERS
30. STORAGE CYLINDERS
31. ACTIVE CARBON PLANT
32. POND
33. COAL CRUSHING PLANT
34. SETTLING TANKS
35. COOLING TOWER
37. STORAGE TANKS
38. PUMP HOUSE
39. STORAGE CYLINDERS &c
40. EMPTY STORE DUMP
41. PONDS
42. TURNTABLE
43. COOLING TOWER
44. WET GASHOLDER
45. WATER GAS PLANT
46. BLOWER HOUSE
47. CRANES
48. WATER GAS PLANT EXTENSION
49. WET GASHOLDER
50. WORKSHOPS ETC
51. SETTLING TANKS
52. OIL STORAGE
53. NOT IDENTIFIED
54. PUMP HOUSE
55. H_2S REMOVAL
56. MINERAL DUMPS
57. ORGANIC SULPHUR REMOVAL
58. CRANE
59. CONVERSION COLUMN?
60. PUMP HOUSE, CO_2 REMOVAL &c
61. 62. PIPE BRIDGES
63. CONTACT OVENHOUSE
64. CRANES
65. WET GASHOLDER
66. STRIPPING PLANT
67. STORAGE CYLINDERS
68. CRACKING PLANT?
69. PUMP HOUSE
70. STORAGE TANKS
71, 72. WET GASHOLDERS
73. DISTILLATION PLANT
74. WASHING COLUMNS
75. STRIPPING PLANT
76. STABILIZATION COLUMN
77. COOLING TOWER
78, 79. LUBRICATING OIL TREATMENT?
80. DISTILLATION COLUMN
81. OIL STORAGE TANKS
82. DAMAGED GASHOLDER
83. STORAGE CYLINDERS

R.37

4.6.8 Dortmund

Company: Hoesch Benzin G.m.b.H.

Location: At Hoesch in the suburb Wambelerholz, 2-1/2 miles NE of center of Dortmund. Latitude 51° 32' N., longitude 7° 30' E. The Koelin-Neuessen steelworks are to the west of the plant.

References: Layout plan, page 178. Location map, page 163. Photograph, page 179.

Plant Area: 2,100 x 870 feet or approximately 40 acres.

Description: (a) Process: Fischer-Tropsch synthesis. Uses gas from adjacent coking plants.

(b) Power Station: 175 x 70 feet, extended with a new section of 70 feet. Includes generator hall and transformer station.

(c) Gas Manufacture: Watergas generators, probably supplemented by gas from adjacent coking plant. Original building 200 x 95 feet with 6 generators, extended to 305 x 95 feet with three more generators. H_2S removal, 280 x 100 feet, four towers at 35 feet. Organic sulphur removal, 6 (3 pairs) towers 18 feet in diameter, with room for 2 (1 pair) more.

(d) Synthesis: Contact oven house 300 x 90 feet, apparently only of medium pressure. Type (reaction in open), 72 ovens, 9 feet in diameter.

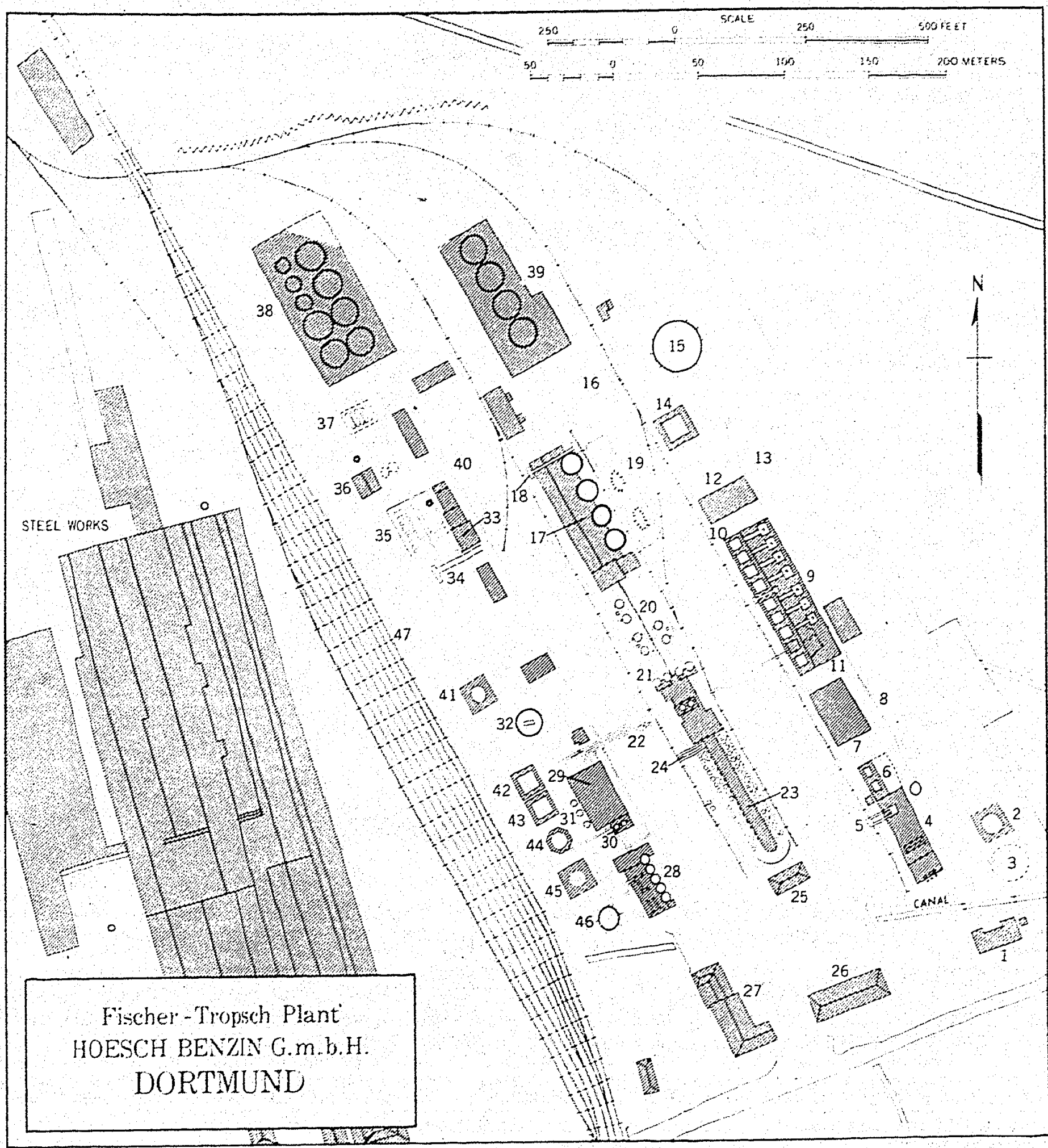
(e) Refinery: Tube still house with chimney, probably also cracking, wax removal and lube oil facilities.

(f) Tankage: At the northwestern end of the plant are two groups of storage tanks, camouflaged. Dimensions and estimated capacities are as follows:

Details of Tankage

No. on Plan	No. of Tanks	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
38	6	50	2,000	12,000
	3	35	800	2,400
39	1	60	3,000	3,000
	3	50	2,000	6,000
Total	13			23,400

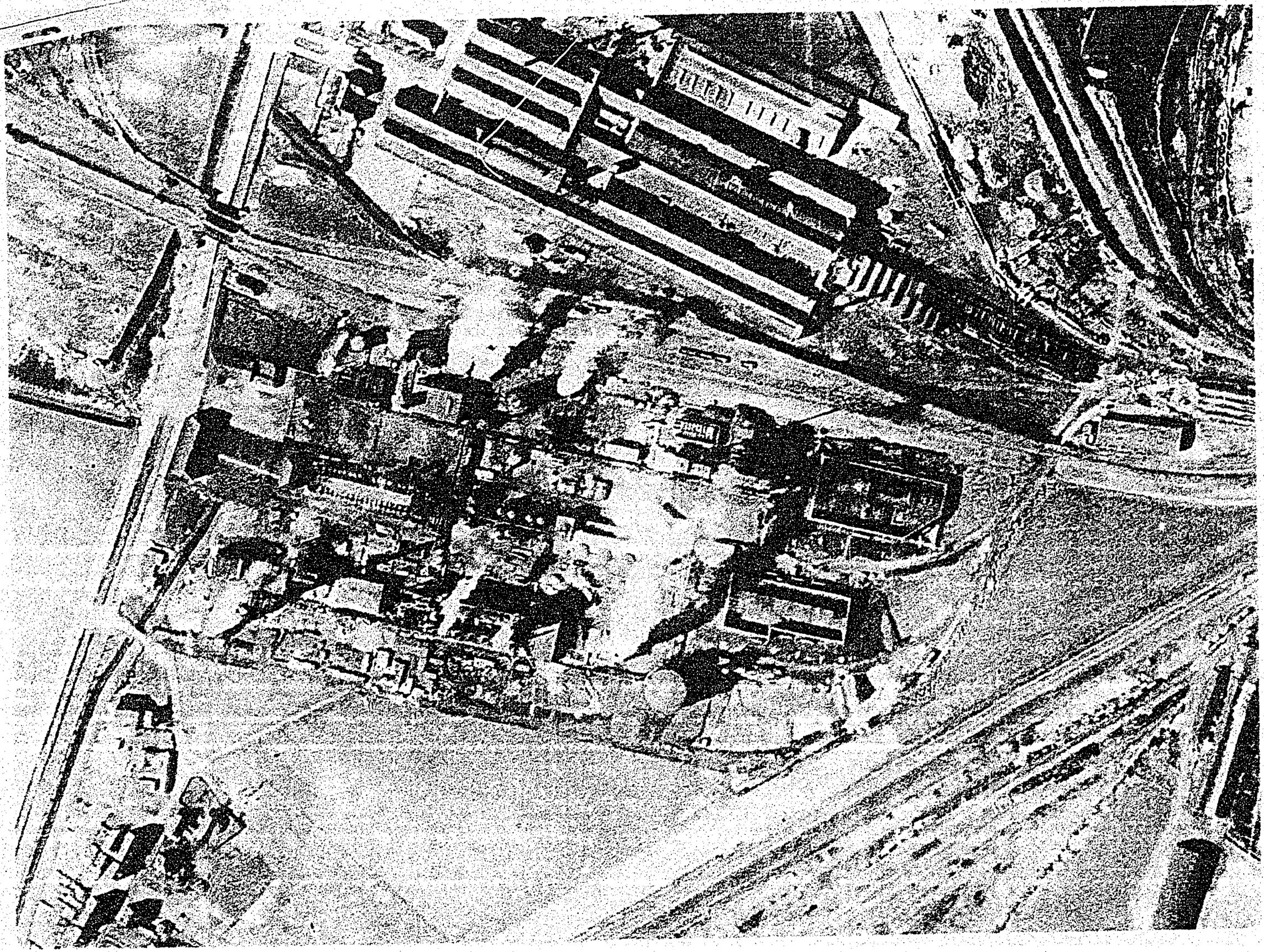
stimated Capacity: 60,000 metric tons per year estimated normal production capacity



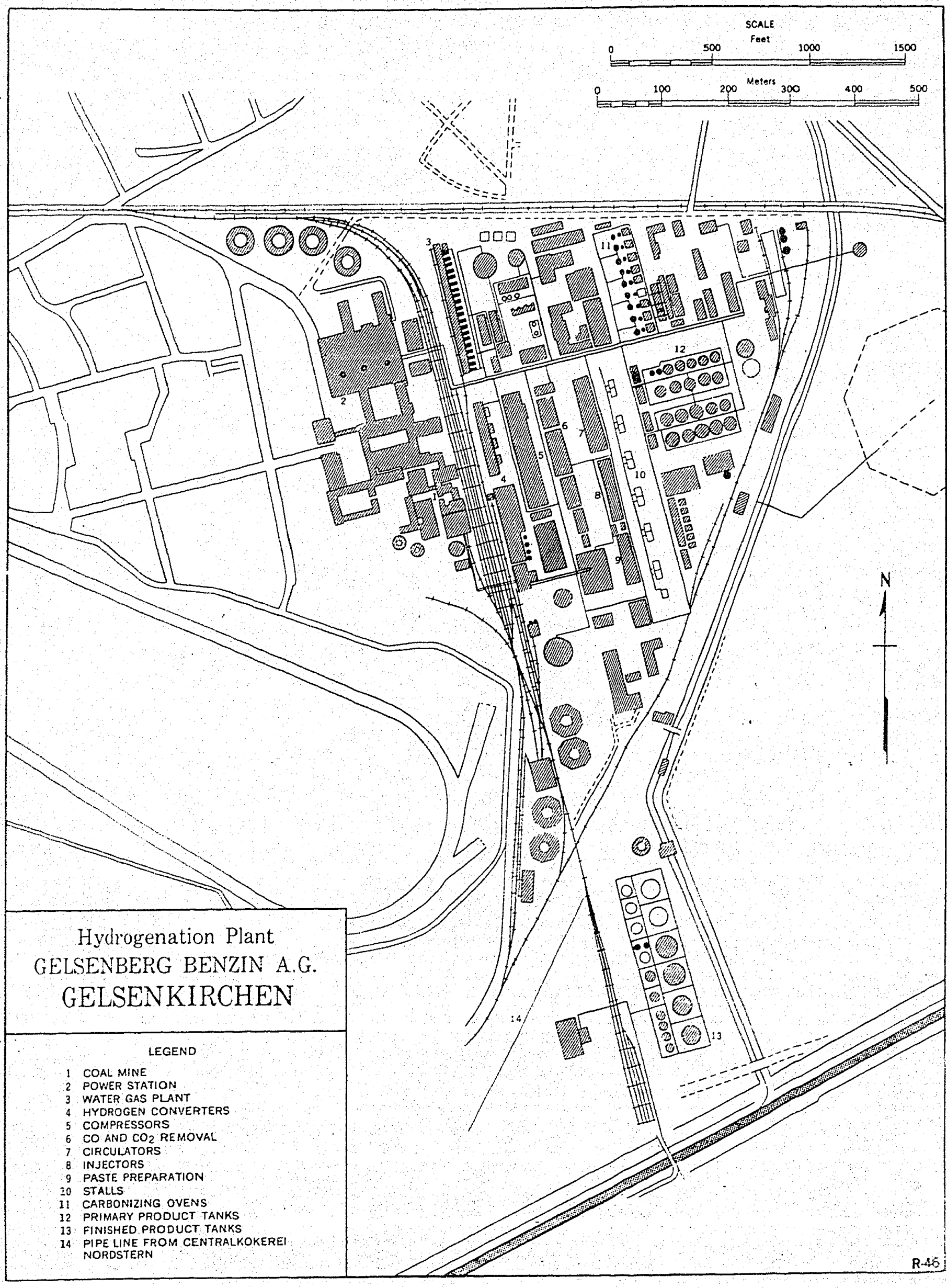
LEGEND

1. Pumphouse.
2. Cooling Tower.
3. Foundations for cooling tower.
4. Power Station.
5. Coal elevator.
6. Power Station extension.
7. Workshop?
8. Steam pipe.
9. Water Gas Plant.
10. Bunkers.
11. Water Gas Plant Extension.
12. Blower House.
13. Gas Pipe Line.
14. Cooling Tower.
15. Wet Gasholder.
16. Gas Pipeline.
17. H2S Removal Plant.
18. Crane.
19. Dumps of Reagent.
20. Organic Sulphur Removal.
21. Heat Exchangers.
22. Pipe Bridge.
23. Contact Oven House.
24. Crane.
25. Workshop.
26, 27. Offices etc.
28. Oil condensation.
29. Compressor House.
30. CO Converters.
31. CO2 Removal.
32. Dry Gasholder.
33. Wax removal plant.
34. New construction.
35. Butane cylinders.
36. Cracking Plant?
37. Butane cylinders.
38. Oil Storage Tanks
    6 Tanks 2000 M3, 12,600 BBLS.
    3 Tanks 800 M3, 5,040 BBLS.
39. Oil Storage Tanks
    3 Tanks 2,000 M3, 12,600 BBLS.
    1 Tank 3,000 M3, 18,900 BBLS.
40. Overhead pipe line.
41, 42, 43. Cooling Towers.
44. Degassing tower.
45. Cooling tower.
46. Residual Gasholder.
47. Rail sidings.

R-30



AERIAL VIEW OF FISCHER-TROPSCH PLANT, HOESCH BENZIN G.m.b.H., DORTMUND


SCALE
Feet
0
500
1000
1500
Meters
0
100
200
300
400
500
N
Hydrogenation Plant
GELSENBERG BENZIN A.G.
GELSENKIRCHEN
LEGEND
1 COAL MINE
2 POWER STATION
3 WATER GAS PLANT
4 HYDROGEN CONVERTERS
5 COMPRESSORS
6 CO AND CO_2 REMOVAL
7 CIRCULATORS
8 INJECTORS
9 PASTE PREPARATION
10 STALLS
11 CARBONIZING OVENS
12 PRIMARY PRODUCT TANKS
13 FINISHED PRODUCT TANKS
14 PIPE LINE FROM CENTRALKOKEREI NORDSTERN
R-46

4.6.9 Gelsenkirchen

Company: Gelsenberg Benzin A.G.

Location: Adjacent to Nordstern III mine, on the north side of the Emscher Canal, northwest of Gelsenkirchen in the highly built-up area of the Ruhr. Latitude 51° 32' N., longitude 7° 03' E.

References: Layout plan, page 180. Location map, page 163.

Plant Area: Triangular shape 4,500 x 3,000 feet or about 160 acres.

Description: (a) Process: Hydrogenation of bituminous coal and H.T.C. tar at 700 atms. by Bergius process. Mine and power station located on west side of plant and separated from it by the colliery sidings. Conveyors connect the mine with the gas plant.

(b) Power Plant: 380 x 307 feet, 3 chimneys, 4 cooling towers 84 feet in diameter. The colliery also has a small power station alongside the southern winding engine house with two cooling towers, 30 feet in diameter.

(c) Gas Plant: There seem to be three independent plants:

(i) Direct gasification of coal (probably Winkler type), building 90 x 70 feet, 8 columns, gasholders 95 feet in diameter.

(ii) Watergas plant: 20 generators in line, 450 x 72 feet, 2 gasholders, 143 feet and 90 feet in diameter, respectively.

(iii) A third plant erected between March 1940 and March 1941. Building 100 x 40 feet with 4 chimneys. It is suggested that the gas plant is oversize and supplies Hüls with gas through a pipe line laid in 1941.

(d) Hydrogenation: Compressor house 600 x 87 feet, probably 12 compressors. Number of stalls: 12 (6 pairs): 5 pairs at 89 x 30 overall, 1 pair at 107 x 30 ft. overall Carbonization of residue: 6 ovens at 47 x 37 feet.

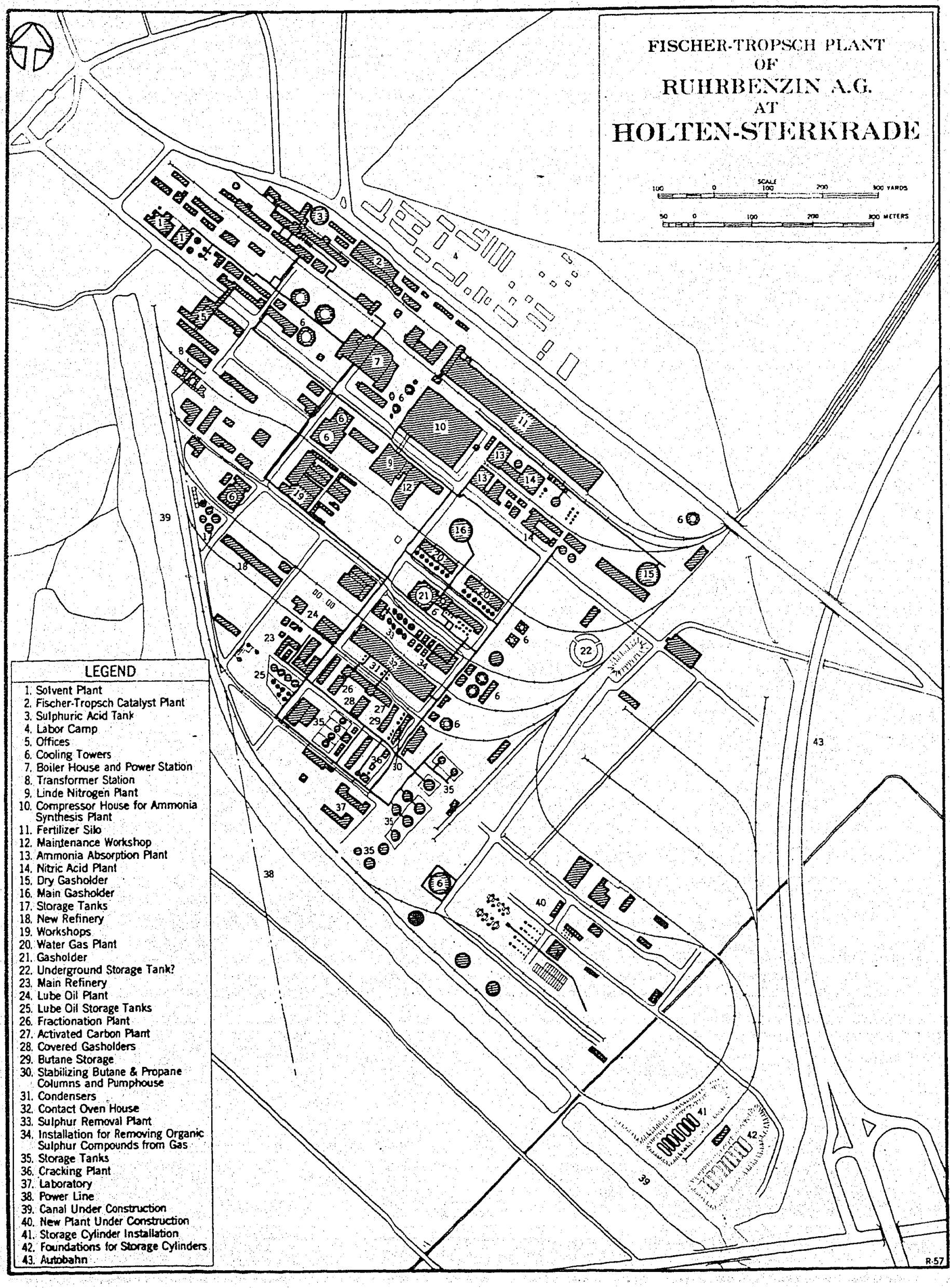
(e) Refining: Nine furnaces with fractionating columns. There is a separate section for the working up of light ends that may include a polymerization or alkylation plant.

(f) Storage Tanks: **Details of Tankage - Approximate**

	No. on Plan	No. of Tanks	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
Primary products	12	10	60	3,000	30,000
Intermediate products	12	9	60	3,000	27,000
		2	30	500	1,000
Finished products	13	4	90	6,000	24,000
		2	45	1,500	3,000
		4	30	500	2,000
T o t a l					87,000

Sundries: The syntnetic plant is connected by pipe lines to the Hüls synthetic rubber plant and the Gelsenberg Benzin A.G. synthetic plant at Gelsenkirchen. By this means raw or pure gas can be transmitted from any one plant to another and tail gases sent to Hüls from the synthetic plants. There are also pipe connections with the coke oven plants at Zineckel and from Scholven to the Bergmannglueck power station. This latter believed to convey tail gases from the synthetic plant to the power station.

Estimated Capacity: 350,000 metric tons per year estimated normal production capacity.


FISCHER-TROPSCH PLANT
OF
RUHRBENZIN A.G.
AT
HOLTEN-STERKRADE
SCALE
100 0 100 200 300 YARDS
50 0 100 200 300 METERS
LEGEND
1. Solvent Plant
2. Fischer-Tropsch Catalyst Plant
3. Sulphuric Acid Tank
4. Labor Camp
5. Offices
6. Cooling Towers
7. Boiler House and Power Station
8. Transformer Station
9. Linde Nitrogen Plant
10. Compressor House for Ammonia Synthesis Plant
11. Fertilizer Silo
12. Maintenance Workshop
13. Ammonia Absorption Plant
14. Nitric Acid Plant
15. Dry Gasholder
16. Main Gasholder
17. Storage Tanks
18. New Refinery
19. Workshops
20. Water Gas Plant
21. Gasholder
22. Underground Storage Tank?
23. Main Refinery
24. Lube Oil Plant
25. Lube Oil Storage Tanks
26. Fractionation Plant
27. Activated Carbon Plant
28. Covered Gasholders
29. Butane Storage
30. Stabilizing Butane & Propane Columns and Pumphouse
31. Condensers
32. Contact Oven House
33. Sulphur Removal Plant
34. Installation for Removing Organic Sulphur Compounds from Gas
35. Storage Tanks
36. Cracking Plant
37. Laboratory
38. Power Line
39. Canal Under Construction
40. New Plant Under Construction
41. Storage Cylinder Installation
42. Foundations for Storage Cylinders
43. Autobahn
R-57

4.6.10 Holten - Sterkrade

Company: Ruhrbenzin A.G.

Location: On road between Sterkrade and Holten, about one mile east of village of Holten, latitude 51° 32' N., longitude 6° 48' E., in the Ruhr, approximately three miles east of the Rhine. Annex to ammonia and chemical works of Ruhrchemie A.G.

References: Layout plan, page 182. Location map, page 161.

Plant Area: Triangle 3,700 x 4,100 x 2,250 feet, of which oil synthesis section, in southern part, measures 1,300 x 900 feet or about 27 acres.

Description: (a) Process: Fischer-Tropsch synthesis from CO + H_2.

(b) Power Plant: Serves both chemical works and oil plant.

(c) Gas Manufacture: Two groups of watergas generators, 1 with 7 generators and 1 with 6 generators. Gasholder 110 feet in diameter. Cooling tower 48 feet in diameter. H_2S removal, 8 towers, 36 feet in diameter. Organic sulphur removal (Feinreinigung), 12 towers, 18 feet in diameter. There is also a Linde plant. The watergas generators seem to point to an insufficient supply of coke oven gas to meet the requirements of both the NH_3 and the Fischer-Tropsch Plant.

(d) Synthesis: Contact oven house, 540 x 115 feet, with probably 90 to 100 low pressure ovens, 60 of which may be for first stage, 30 in second stage and 6 standby.

(e) Refinery: Two groups of condensers, 18 feet in diameter, activated carbon plant, stabilizing, propane and butane columns, fractionating plant for primary products, T.V.P. cracking plant, lubricating oil plant.

(f) Tankage: Approximately as follows:

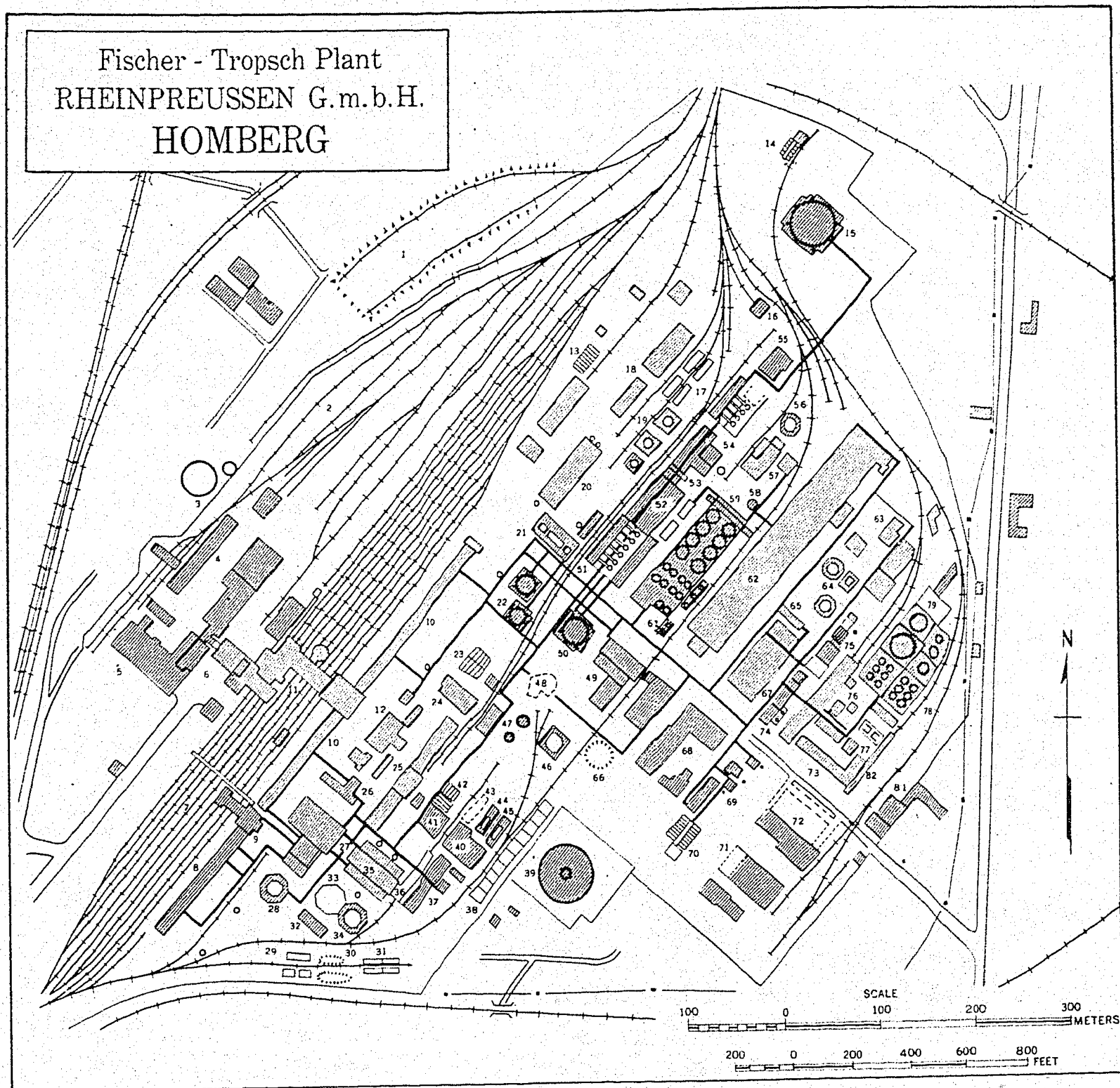
	Metric Tons
Lube oil storage	4,712
Finished product	25,795
Primary product	2,958
Total	33,465

There may also be some underground storage tanks.

(g) Sundries: There is quite some unidentified new construction extending to the northwest which seems connected with the oil plant. There is also a catalyst plant, one of the three in Germany (the other two being at Schwarzheide and at Lützkendorf).

Estimated Capacity: 80,000 metric tons per year estimated normal production capacity.

184 - SYNTHETIC OIL
Homberg



LEGEND

1. Tip heap
2. Pit prop yard
3. Filter tanks?
4. Lamp rooms etc.
5. Colliery offices
6. Mine headgear
7. Colliery sidings
8. Modern coke oven plant and crushing plant
9. Coaling tower
10. "Old" coke oven plant
11. Crushing and loading plant
12. Distillation unit
13. Storage cylinders
14. Not identified
15. Wet gasholder
16. Loco. coaling tower
17. Pitch bays
18. Ammonium sulphate preparation
19. Cooling towers
20. Not identified
21. Boiler house
22. Wet gasholder
23. Storage cylinders
24. Benzole fractionation
25. Ammonium sulphate factory
26. Tar stills
27. Condensation & tar recovery
28. Cooling tower
29. Water purification?
30. Mineral dumps
31. Pitch bays
32. Pump house
33. Partly dismantled cooling tower
34. Cooling tower
35. Boiler house
36. Covered loading bay
37. Pump house
38. H_2S removal boxes
39. Dry gasholder
40, 41. Linde plant
42. Cylinder Storage
43. Cooling tower – half dismantled
44. Cooling tower – partly dismantled
45. Cooling tower (intact)
46. Cooling tower (inactive)
47. Benzole tanks
48. Destroyed gasholder
49. Pump house
50. Wet gasholder
51. Water gas plant
52. Blower house
53. Converter unit
54. Water gas plant
55. Pump house
56. Cooling tower
57. Nitrogen plant
58. Let down point
59. H_2S removal
60. Organic sulphur removal
61. Catalyst recovery
62. Contact oven house
63. Condensation columns
64. Cooling towers
65. Condensers
66. Excavation
67. Active carbon plant
68. Workshops
69. Distillation plant
70. Storage cylinders
71. Laboratory or workshop
72. Main offices
73. Packed products shed
74, 75, 76, 77. Distillation plants
78. Oil storage tanks
    1 Tank 4,000 M3 - 25,200 BBLS.
    1 Tank 3,000 M3 - 18,900 BBLS.
    1 Tank 1,000 M3 - 6,300 BBLS.
    1 Tank 500 M3 - 3,150 BBLS.
    1 Tank 400 M3 - 2,520 BBLS.
    12 Tanks 200 M3 - 1,260 BBLS.
79. Vacant tank site
80. Offices
81. Covered loading bay

R 28

4.6.11 Homberg

Company: Rheinpreussen G.m.b.H.

Location: Homberg, latitude 51° 28' N., longitude 6° 38' E, west of Duisburg adjoining Rheinpreussen Haniel coal mine Shaft V to the NW, 1-3/4 miles west of the Rhine in the angle formed by the Rheinberg-Krefeld and Duisburg-Kleve railways.

Reference: Layout plan, page 184. Location map, page 161.

Plant Area: 3,200 x 3,000 feet or approximately 220 acres.

Description: (a) Process: Fischer-Tropsch synthesis, probably both low pressure and medium pressure, operating on hard coal and coke. Shaft V of the Rheinpreussen Company's Haniel mine adjoins the plant on the northwest. Coal goes directly from the pit head to the coking ovens. The coke oven gas may possibly be supplemented by gas from the Ruhr gas grid.

(b) Power Plant: Small boilerhouse and generator hall.

(c) Gas Manufacture: Two watergas plants, each with six generators. Two banks of coke ovens, one of 1,100 feet with about 300 ovens, one of 430 feet with about 130 ovens (modern). NH_3 and benzol, etc., recovery; possibly ethylene recovery through deep cooling, tar separation and treatment. H_2S removal of coke oven gas in 10 boxes. H_2S removal from watergas, 8 towers 45 ft. in diameter. Organic sulphur removal, 10 towers 20 ft. in diameter.

(d) Synthesis: Contact oven house 790 x 120 feet, probably 200 ovens (2 rows of 100).

(e) Refinery: Columns with heater houses, etc. Probably also lube oil manufacture.

(f) Tankage: Storage tankage capacities, approximately:

Details of Tankage

Number	Diameter Feet	Capacity (Metric Tons)
1	80	4,000
1	60	3,000
1	40	1,000
1	30	500
1	25	400
12	20	2,400
TOTAL		11,300

Estimated Production: 80,000 metric tons per year estimated normal production capacity.

4.6.12 Kamen

Company: Chemische Werke Essener Steinkohle A.G. (This plant has also been referred to as belonging to the Kamen Essener Verein Monople A.G.).

Location: 2-1/2 miles northwest of Kamen, latitude 51° 38' N., longitude 7° 38' E. Kamen lies approximately ten miles northeast of Dortmund, midway on the Dortmund-Hamm road. The plant adjoins the Monopol Grimberg Coal mine, shafts I and II and the Lipp Canal is one mile north.

References: Layout plan below. Location map, page 163.

Plant Area: 2,200 x 1,800 feet or approximately 90 acres.

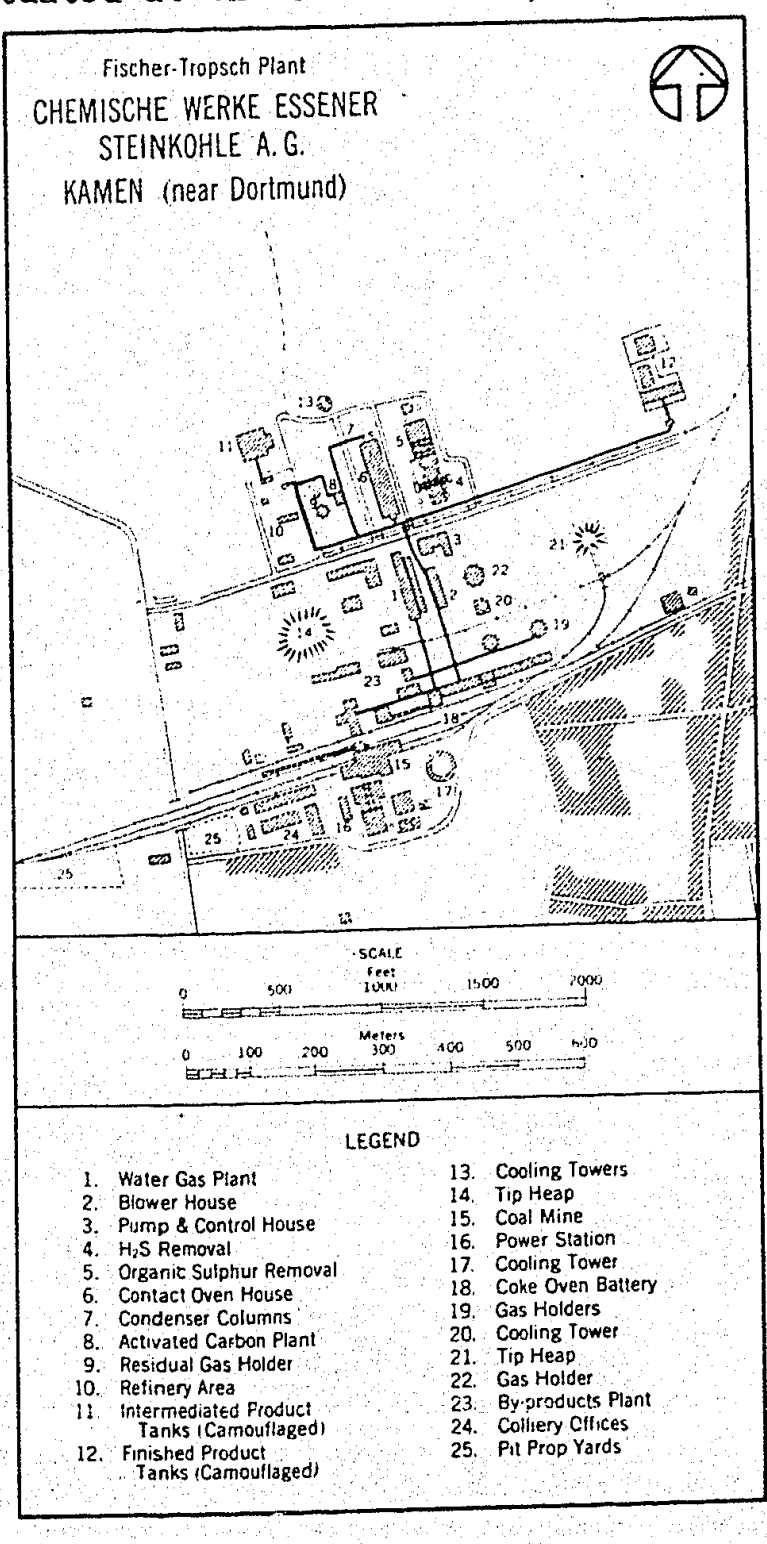
Description: (a) Process: Fischer-Tropsch synthesis, probably at atmospheric pressure. Operates on hard coal and coke from adjacent mine.

(b) Power Plant: Small power plant located alongside the coal mine is fed by conveyor direct from the colliery.

(c) Gas Manufacture: Northeast of the colliery are the coke oven batteries (No. 19 on layout plan). These measure 630 feet in length and are reported to contain 140 ovens. A cooling tower is situated at the eastern end, connected by conveyor with the colliery complex. There is a central quenching tower.

Volatile products from the coke ovens are passed to a small by-products plant (23) where benzol, tar, etc. are separated, but are probably exported in the crude state for treatment elsewhere. Coke oven gas is stored in two gasholders (19), each 75 feet in diameter. For hydrogen supply the works has a water-gas plant consisting of two buildings, one containing the generators (1) and the other the blowing machinery (2). The generator building (330 x 82 feet) apparently contains eight generators, and has a high western section containing bunkers. The blower house measures 200 x 45 feet. A cooling tower (20) and a gasholder (22) measuring 125 feet in diameter are situated a short distance to the east. An L-shaped building nearby (3) is probably a control room and pumphouse. The gas is passed to a hydrogen sulphide removal plant (4). This is a building 470 x 130 feet with eight towers, each 25 feet in diameter. These are served by a gantry or portal crane (for renewal of the reagent)

The more northerly part of the building is occupied by organic sulphur removal, with eight columns, each about 7 feet in diameter (5). These are probably served by the same crane as the hydrogen sulphide



Kamen (Continued)

removal columns. Columns alongside this plant may be for the conversion of a proportion of the carbon monoxide in the synthesis gas to hydrogen.

(d) Synthesis: The correct mixture of carbon monoxide and hydrogen is passed to the contact oven house (6) which is a building measuring 410 x 100 feet.

From the presence of condenser columns, an activated carbon plant and other details, it is deduced that the plant uses the atmospheric pressure process. The ovens for this measure 2.5 meters wide and are spaced approximately 0.5 meters apart. There would, therefore, be room for two rows each of 40 ovens. Allowing for standby ovens, not normally on stream, this would give an annual production of about 60,000 tons.

Two tall columns (7) at the end of the contact oven house are identified as condensers. From them a pipe leads to the activated carbon plant (8), near which are situated two residual gasholders measuring 60 and 40 feet in diameter, respectively. A pipe connection allows for return of residual gas for recirculation.

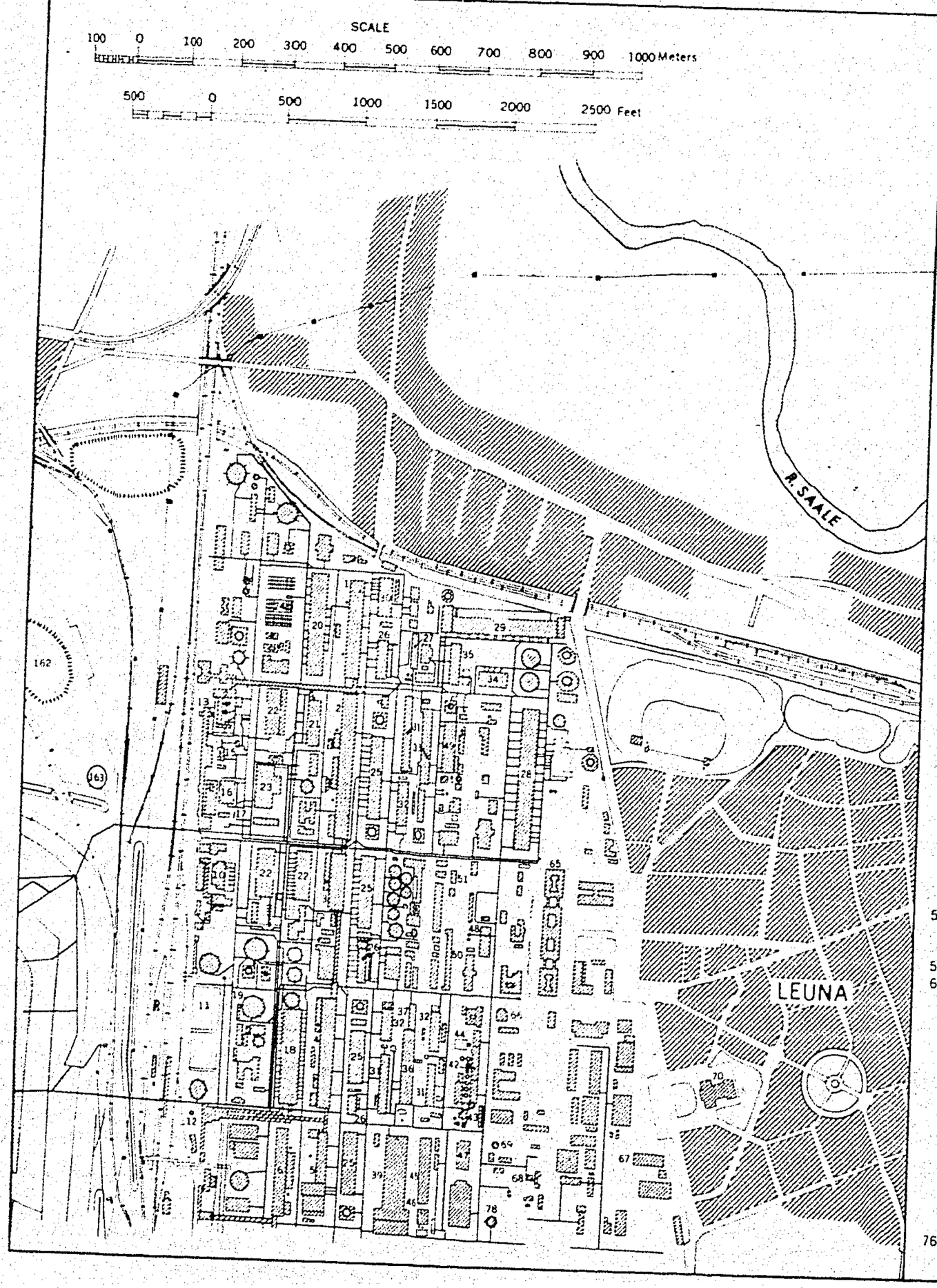
Overhead pipes lead from the condensers and from the activated carbon plant to the refinery section (10) occupying an area 500 x 270 feet and is believed to contain a cracking unit.

(e) Tankage: Storage tanks capacities are approximately as follows:

Details of Tankage

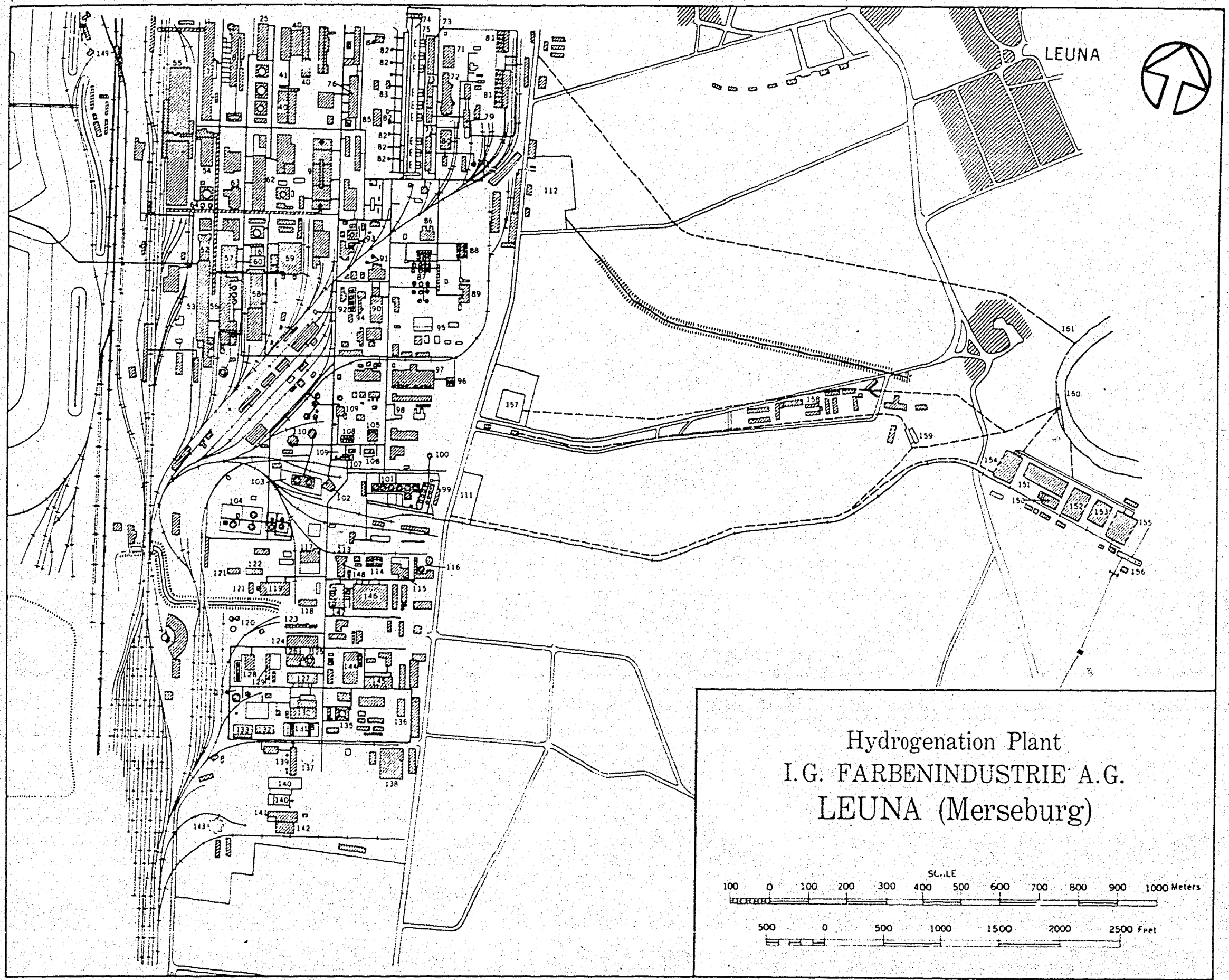
No. on Plan	No. of Tanks	Diameter Feet	Tons Capacity Each	Total Capacity Metric tons
11	4	40	1,000	4,000
12	1	90	6,000	6,000
	1	60	3,000	3,000
	3	40	1,000	3,000
T o t a l				16,000

Estimated Capacity: 60,000 metric tons per year estimated normal production capacity.



LEGEND

1-7	Boiler houses
8	Probable water purification plant
9	Power plant
10	Brown coal drying plant
11	Fuel bunker
12	Water tower
13	Winkler generators
14	Brown coal drying plant
15	Gas centrifuges
16	Sulphur removal
17	Ammonium sulphide distillation columns
18	Water gas plant
19	Water gas holder
20	Water gas plant
21	Producer gas plant
22	Hydrogen contact oven houses
23	Linde oxygen plant
24	Settling tanks
25	Gas compression
26-27	Compression and carbon dioxide absorption
28	Hydrogen contact oven house
29	Probable compressor house
30	Probable compressor house
31	Ammonia absorption houses
32	Compression and carbon monoxide removal
33	Ammonia synthesis
34	Probable gas pump house
35	Compressor house or Linde liquid air plant
36	Ammonia synthesis
37	Unknown
38	Ammonia liquor tanks
39	Maintenance workshops
40	Workshops and stores
41	Stores yard
42-43	Plant for formaldehyde or hexmethylene tetramine
44	New addition to (42)
45-47	Possible methanol or isobutanol synthesis buildings
46	Possible distillation buildings
47	See 45
48	Distillation columns
49	Probable Linde liquid air plant
50	Unknown
51	Storage tanks
52	Gypsum mill
53	Ammonium sulphate manufacture
54-55	Ammonium sulphate silos
56	Calcium nitrate plant
57	Calcium nitrate silo
58-59	Ammonium nitrate silo
60-61	Possible nitric acid plant
62	Phosphate fertilizer plant
63	Possible Petersen sulphuric acid plant
64	Tanks for sulphuric acid
65	Main offices
66	Small building under construction
67	Stores yard
68	Unknown
69	Water tower
70	Works Casino
71	Coal store
72	Paste preparation building
73	Injector buildings
74	Hydrogenation stalls
75	Preheaters
76-77	Gas washing and circulation
78	Wet gasholder probably for recycled gas
79	Centrifuge house
80	Possibly paste preparation
81	Carbonizing ovens
82-84	Let down system
85	Unknown
86	Liquid phase distillation plant
87-88	Primary products tanks
89	Unknown
90	Probable pump house
91	Gasholders possibly for separated gases
92	Horizontal cylinders, possibly for isooctane
93	Horizontal cylinders, possibly for butane and propane
94	Possible selective polymerisation plant
95	New hydrogenation and compressor house
96	Vapor phase distillation plant
97-98	Distillation plants
99-104	Final products tanks
105-109	Unknown
110	Gasholders
111-112	Stores yard
113	Cooling tower under construction
114	Storage tanks
115	Buildings under construction
116	Possible condensation or absorption towers
117	Building with columns
118	Probable office block
119	Buildings with storage tanks
120	Tanks
121-122	New buildings
123	Hydrogenation stalls
124	Injector house
125	Cooling tower
126	Probable pump house
127	Unknown
128	Building with columns and cylinders associated
129-130	Unknown
131	Horizontal cylinders
133	New building
134	Wet gasholders
135	Cooling towers
136	Unknown
137	Cooling tower under construction
138	Probable workshop
139	New building
140	Probably foundations for generator house
141	Boiler house under construction
142	Extension to 141
143	Foundations for cooling tower
144	Building with horizontal cylinders
145	Line of fractionating columns
146-147	Unknown
148	Building with possible gas washing towers
149	Probable transformer station
150	Boiler house of waterworks
151	Pump house
152-155	Filtration houses
156	Transformer and switching stations
157	Filter beds
158	Labour camp
159	Overfall for waste water
160	Outlet for waste water
161	Outlet pipe for waste water
162	Coal dump
163	Gasholder


LEUNA
Hydrogenation Plant
I.G. FARBENINDUSTRIE A.G.
LEUNA (Merseburg)
SCALE
100 0 100 200 300 400 500 600 700 800 900 1000 Meters
500 0 500 1000 1500 2000 2500 Feet

4.6.13 Leuna

Company: I.G. Farbenindustrie A.G.

Location: Leuna, latitude 51° 19' N., longitude 12° 00' E., is located two miles south of Merseberg and about one mile from the Saale River. It is approximately ten miles south of Halle. The main line railroad from Frankfort to Berlin borders the plant.

References: Layout plan, pages 188-189. Location map, page 162.

Plant Area: Two miles x 2/3 miles (850 acres). Includes chemical works as well as synthetic oil plant.

Description: (a) Process: Leuna is the largest fixed nitrogen plant in the world at the rated capacity of 850,000 tons of nitrogen per year and having numerous other chemical operations in addition to the synthetic oil plant. The Bergius process hydrogenation plant operates on lignite and L.T.C. tar.

(b) Power Plant: There are five old boilerhouses occupying an area 3,800 feet long by 90 feet wide, and since 1935 a new boilerhouse was built near the synthetic oil plant, 575 feet x 165 feet. The latter is reported to generate steam of 1,500 pounds pressure. The plant is also connected with Gross Kayma, Gross Korbetha, Schkopau, and probably with Bitterfeld, Golpa, Böhlen Rotha, Moelbis and Ober Beuna.

(c) Gas Manufacture: There are two watergas plants and two Winkler generators, and prior to the war a great deal of producer gas was produced for fuel and the generation of power with gas engines. These plants supply the whole works.

(d) Hydrogenation: There are two rows of 18 stalls, one of which is used for synthesis vessels and the others for heating furnaces, etc. Each stall measures 36 feet x 30 feet. The synthetic oil plant operated before the war at 200 atms. pressure which is somewhat less efficient than the more modern plants. The plant is designed to operate on brown coal and L.T.C. tar.

(e) Refinery: There is considerable refinery equipment.

(f) Tankage: Known tankage is approximately as follows:

	Metric Tons
Primary product	18,600
Finished product	42,200
Total	60,800

Estimated Capacity: 600,000 metric tons per year estimated normal production capacity

4.6.14 Lützkendorf

Company: Wintershall A.G.

Location: Two miles east of village of Müchlen, latitude 51° 17' N., longitude 11° 52' E., approximately 14 miles SW of Halle in Central Germany. Plant is connected by conveyor with south end of Lützkendorf Grube mine.

References: Layout plan, page 192. Location map, page 162.

Plant Area: One mile x 1,740 feet, or approximately 210 acres.

Description: (a) Process: Both hydrogenation (Bergius) and synthesis (Fischer-Tropsch) processes are employed within the Lützkendorf plant. Operates on lignite (brown coal).

(b) Power Plant: Boilerhouse, 400 x 70 feet, built in two parts--old part 330 feet, new part 70 feet. Generator house 400 x 20 feet. Fuel probably brown coal briquettes. Works also draw electricity from Gross Kayma power station.

(c) Fischer-Tropsch: (1) Gas manufacture: four Winkler generators at 100 x 100 feet or Bamag pattern. Two wet gasholders and one dry gasholder.

(2) Two contact oven houses, 306 x 80 feet and 415 x 80 feet, houses being some 350 feet apart, which may be used for extension. Five towers.

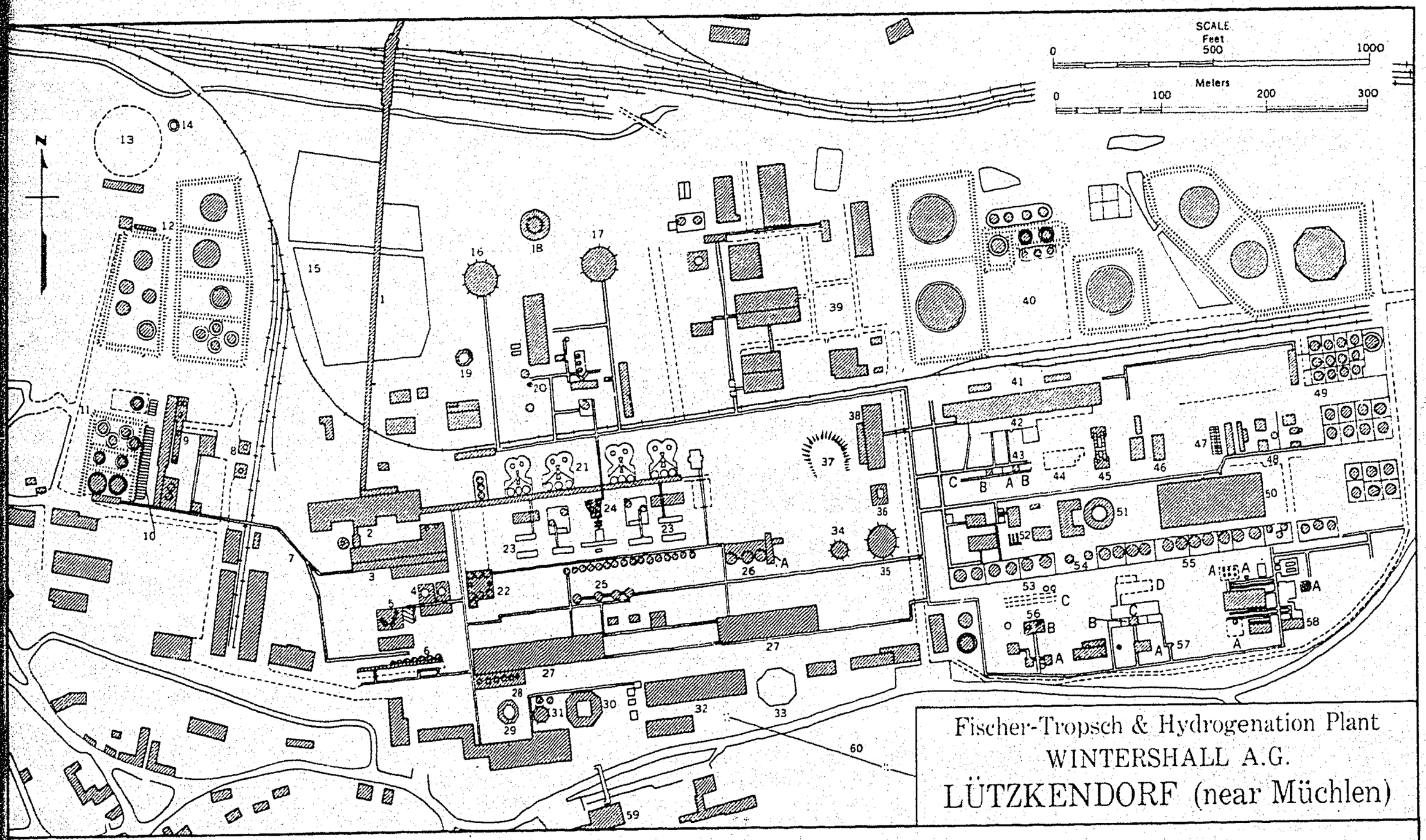
(d) Hydrogenation: (1) Gas manufacture: H_2 drawn from Winkler generators mentioned above. H_2 storage 100 feet in diameter. Compressor house 190 x 70 feet.

(2) Hydrogenation proper: One pair of stalls, stall size 36 x 27 feet. Reaction vessels 40 to 50 feet long, 5 feet in diameter. Suggesting 700 atmospheres.

(e) Refinery: Two furnace houses, two columns for distillation and stabilization. May include lube oil production facilities and iso-octane.

(f) Tankage: Tankage is enormous. Apart from sizeable tankage in various parts of the works there is a tank farm of about 75,000 metric tons capacity on the north side of hydro plant.

Estimated Capacity: Fischer-Tropsch plant 80,000 metric tons, hydrogenation plant 125,000 metric tons, totaling 205,000 metric tons per year estimated normal production capacity.



Fischer-Tropsch & Hydrogenation Plant
WINTERSHALL A.G.
LÜTZKENDORF (near Müchlen)

1. CONVEYOR FROM BROWN COAL BRIQUETTING PLANTS
2. BROWN COAL BUNKER
3. POWER STATION
4. COOLING TOWERS
5. ASH DISPOSAL PLANT
6. ACTIVATED CARBON PLANT?
7. PIPE BRIDGE PROBABLY FOR STEAM FROM POWER STATION AND OIL PIPE LINE
8. COOLING TOWERS
9. BUTANE TREATMENT?
10. CYLINDERS, POSSIBLY FOR BUTANE STORAGE
11. OIL STORAGE TANKS
12. OIL STORAGE TANKS
13. FILTER BED
14. COOLING TOWER
15. ASH PONDS

16-17. WET GASHOLDER
18. DRY GASHOLDER
19. COOLING TOWER
20. GAS PURIFICATION
21. GAS GENERATORS
22. WINTERSHALL-SCHMALFELD GAS GENERATOR
23. RECTANGULAR COOLING TOWER
24-25. GAS PURIFICATION PLANT AND CONVERTERS
26. HYDROGEN SULPHIDE REMOVAL
A - CRANE
27. TWO CONTACT OVEN HOUSES
28. FISCHER-TROPSCH GAS CONDENSATION
29-30. COOLING TOWERS
31. RESIDUAL GASHOLDERS
32. TRANSFORMER STATION?
33. COOLING TOWER
34-35. HYDROGEN GASHOLDERS

36. COOLING TOWER
37. MINERAL DUMP
38. COMPRESSOR HOUSE
39. CATALYST PLANT
40. OIL AND POSSIBLY TAR STORAGE TANKS
41. INJECTOR HOUSE
42. HEAT EXCHANGERS
43. HYDROGENATION STALLS
A - STALLS
B - PREHEATERS
C - LETDOWN PLANT
44. HYDROGENATION VESSELS UNDERGOING OVERHAUL
45. CRANE
46. WORKSHOPS
47. BUTANE CYLINDERS
48. POLYMERISATION UNIT?
49. INTERMEDIATE AND FINAL PRODUCTS TANKS

50. NOT IDENTIFIED
51. COOLING TOWER
52. UNIDENTIFIED PLANT
53. PRIMARY PRODUCTS OF HYDROGENATION
54. HEAVY RESIDUES
55. PARTIALLY TREATED PRODUCTS
56. CRACKING PLANT?
A - HEATERS
B - COLUMNS
C - RUNDOWN TANKS
57. DISTILLATION UNIT
A - HEATERS
B - HEAT EXCHANGERS
C - FRACTIONATING COLUMNS
D - COOLER
58. UNIDENTIFIED
59. OFFICES
60. POWER LINE

4.6.15 Magdeburg

Company: Braunkohle-Benzin A.G. (Brabag)

Location: Plant is located in Rothensee, latitude 52° 11' N., longitude 11° 40' E., a suburb four miles NNE of center of Magdeburg in central Germany. Plant location is east of the Zweig Canal and 3/4 mile from the freight yards of Rothensee.

References: Layout plan, page 194. Location map, page 195. Photograph, page 195.

Plant Area: 3,300 x 1,600 feet, or about 100 acres.

Description: (a) Process: Hydrogenation of brown coal tar by Bergius process. Plant has no L.T.C. plant and draws its tar from outside sources.

(b) Power Plant: Power and steam is drawn from the Mikramag station located on the canal about 1/2 mile away.

(c) Gas Manufacture: (1) The gas generation and treatment section occupies the southwesternmost third of the works. Gas is produced in three Winkler generators (Nos. 8 and 11 on layout plan). Coal is brought in high capacity wagons to the plant (No. 21), which presumably crushes it and elevates it to a high level conveyor, from which it is discharged to the generators. A branch conveyor connects the generators to the main conveyor.

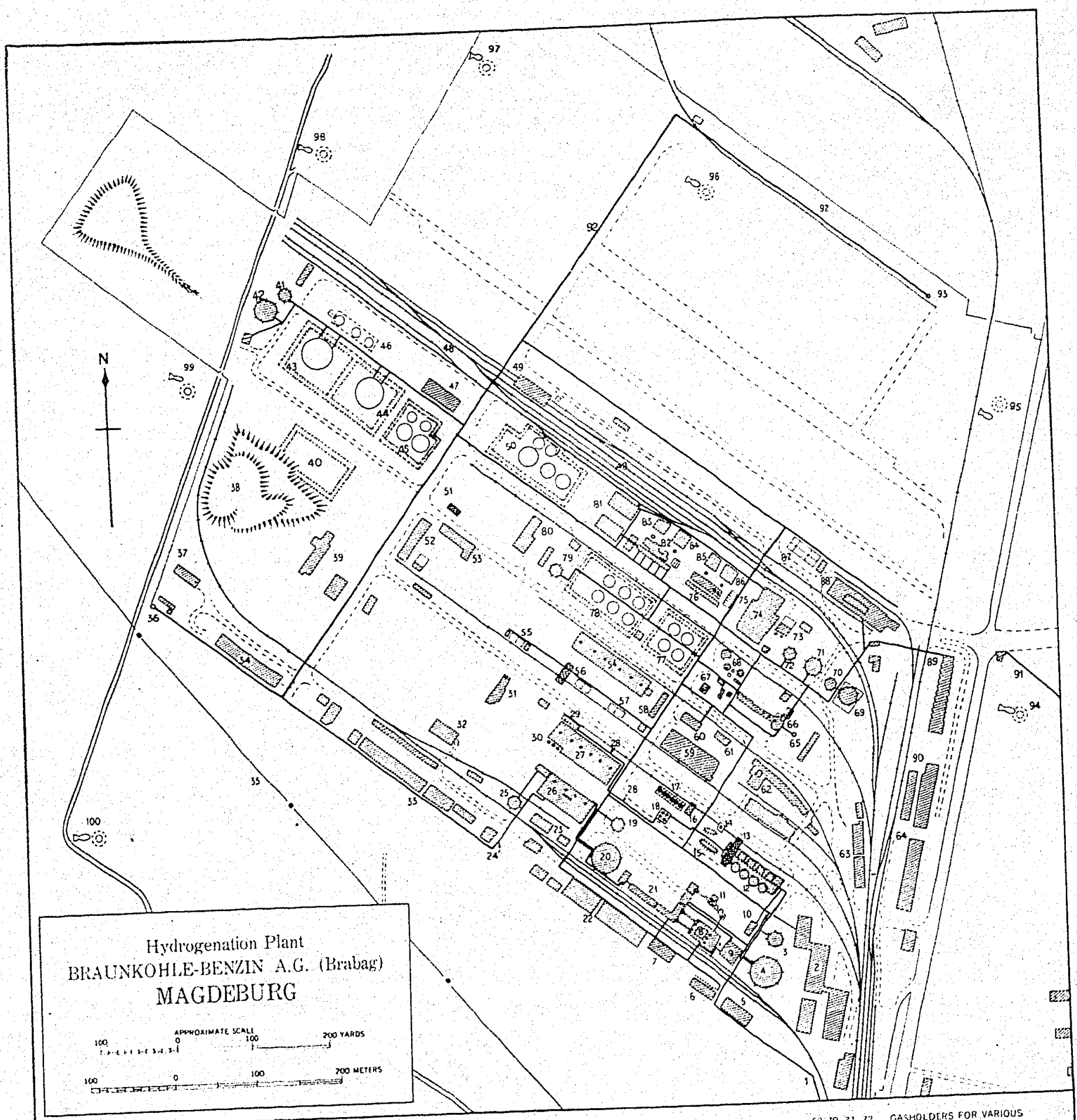
(2) The generators are blown with oxygen. Two air intakes (Nos. 36, 93) on opposite sides of the plant (for use alternatively according to the direction of the wind) deliver air by a large diameter pipe (No. 92) to an air liquification plant (No. 26). This measures 200 x 92 feet and has two towers on the roof which may be for cooling. The plant discharges to three gasholders (Nos. 19, 20, 25) of which the largest, 100 feet in diameter (No. 20), has a connection to a small pump and/or motor house and thence to the Winklers. The other holders each measure 45 feet in diameter.

(3) The generators occupy an area approximately 205 x 180 feet. At the northwestern end are the tall cylinders in which the coal is gasified, and from them sloping tubes 6-1/2 feet in diameter run down towards dust precipitators and gas coolers and a blower house (No. 9). From the latter pipe connections run to a raw gasholder (No. 4) 110 feet in diameter.

(4) Low pressure pipes connect the raw gasholder to the H_2S removal plant (No. 12). This has five columns each 40 feet in diameter and is served by a portal crane (No. 13) which renews the reagent from the oxide dump (No. 15) and discharges spent oxide into trucks by way of a traveling hopper (No. 14). The sulphur removal plant has its own blower house (No. 10), connected to it by a double low pressure pipe line.

(5) The pruified gas is passed from the oxide columns to the conversion plant (Nos. 17, 18). It goes first to the group of four 10 foot diameter columns (No. 18) in which it is saturated with steam, and is then led through the seven conversion columns (No. 17), each 13 feet in diameter. This plant is served by its own portal crane.

(6) The gas, now consisting of hydrogen and carbon dioxide with traces of carbon monoxide, is passed from the columns (No. 18) in which it has been cooled by heat exchange direct to the main compressor house (No. 27). This building measures 282 x 97 feet (including a low section on the eastern side which may house controls) and is unusual in that it serves for compression in addition to gaswashing, and hence houses gas compressors in addition to the injectors required for the water for CO_2 removal and for the formate for CO removal. Three pairs of narrow columns, each two feet in diameter, and three columns (No. 29), each four feet in diameter, are situated at the northern angle of the building. The former are probably for CO removal and the latter



1. STEAM LINE TO ROTHENSEE POWER STATION
2. OFFICES
3, 4. GASHOLDERS FOR RAW GAS
5. WORKSHOP ?
6. COMPRESSOR HOUSE ?
7. BLOWER HOUSE
8. WINKLER GENERATORS
9. EXHAUSTER HOUSE ?
10. BLOWER HOUSE ?
11. WINKLER GENERATOR
12. H_2S REMOVAL
13. PORTAL CRANE
14. TRAVELLING HOPPER
15. OXIDE DUMPS
16. PORTAL CRANE
17. CONVERSION COLUMNS
18. SATURATION COLUMNS, ETC.
19, 20. GASHOLDERS SERVING LINDE PLANT
21. FUEL INTAKE FOR WINKLERS
22. WORKSHOPS
23. SMALL BUILDINGS
24. AIR INLET PIPE
25. NITROGEN GASHOLDER ?
26. LINDE PLANT
27. COMPRESSORS, CO_2 REMOVAL AND C.O. WASHING PUMPS
28. PURE GAS LINE
29. CO AND CO_2 WASHING COLUMNS
30. FORMATE RECOVERY
31, 32. NOT IDENTIFIED
33, 34. WORKSHOPS, ETC.
35. POWER LINE
36. AIR INTAKE
37. NOT IDENTIFIED
38. SPOIL DUMP
39. WORKSHOPS
40. BUNDED ENCLOSURE
41, 42. RESIDUAL GASHOLDERS
43, 44, 45, 46. FEED STOCK TANKS AND POSSIBLE TAR STORAGE

NO. OF TANKS	APPROXIMATE TOTAL CAPACITY M3	BARRELS
2	23,809	150,000
2	5,952	37,500
4	4,762	30,000

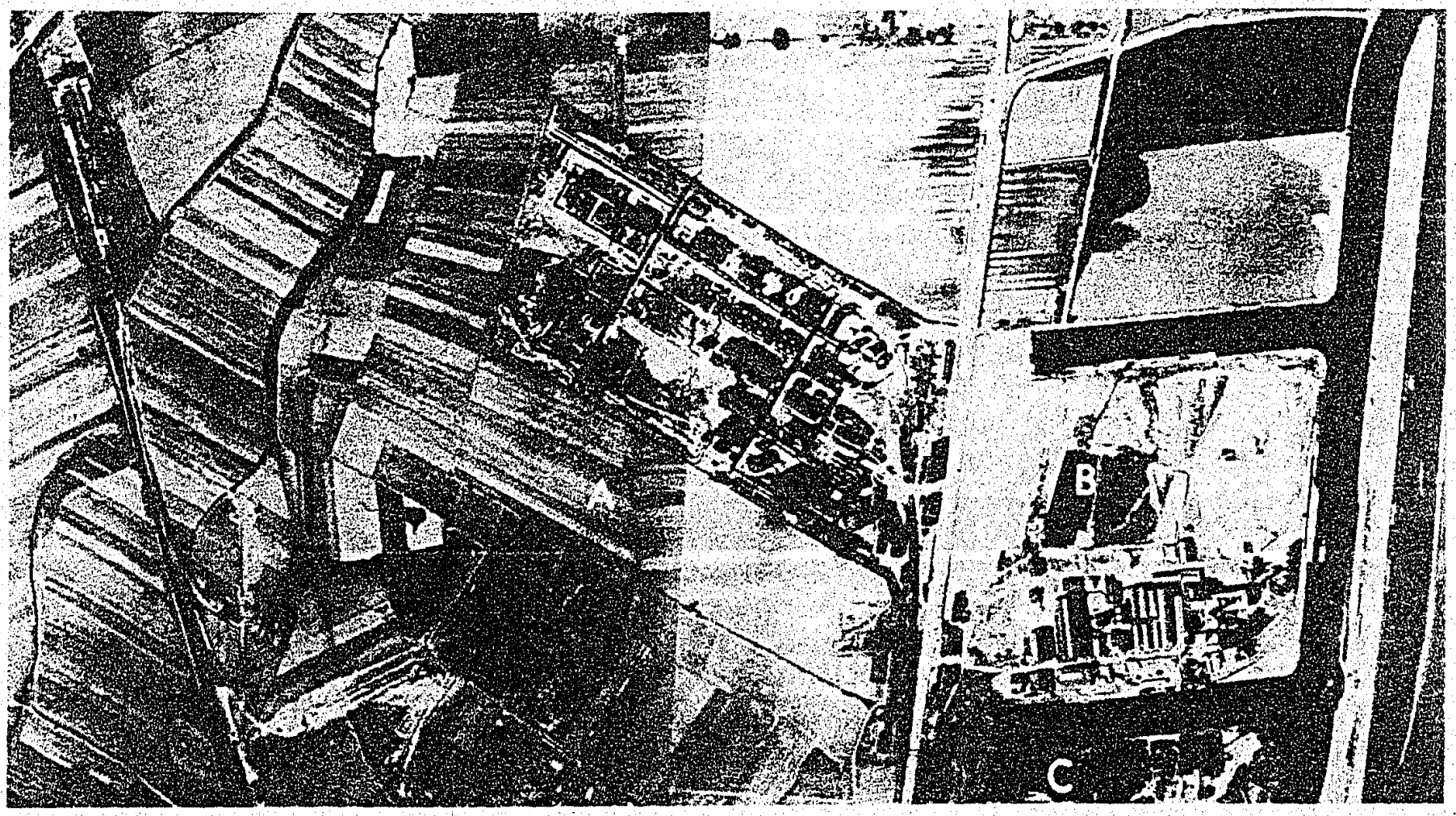
47. PUMP HOUSE
48. OIL LOADING SIDINGS
49. OIL LOADING POINT AND OR WEIGHHOUSE
50. FINAL PRODUCTS STORAGE

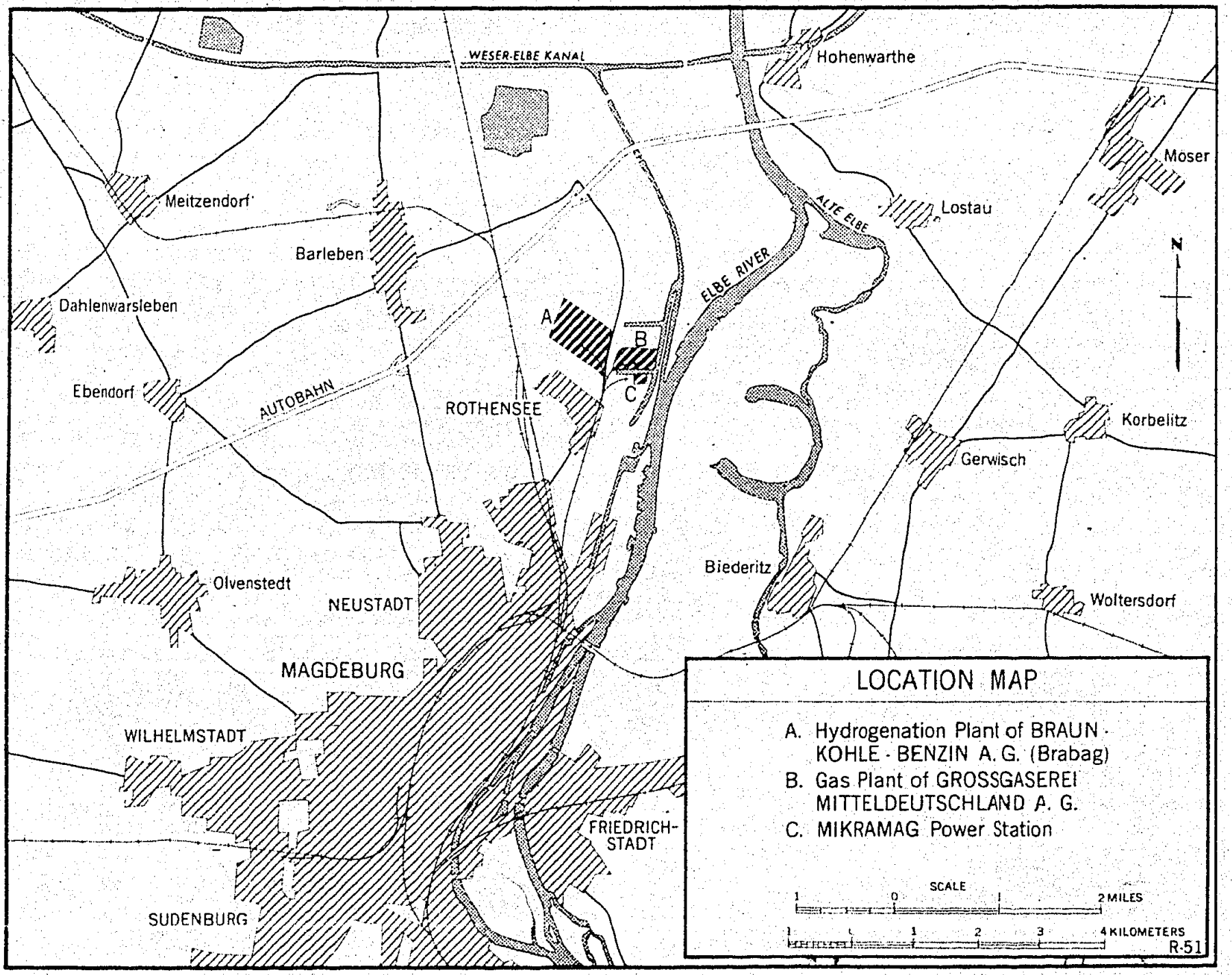
NO. OF TANKS	APPROXIMATE TOTAL CAPACITY M3	BARRELS
1	4,167	26,250
2	5,952	37,500
2	1,905	12,000

51, 52, 53. WORKSHOPS, ETC.
54. INJECTOR CIRCULATOR HOUSE
55. NEW PAIR OF STALLS, ONE IN USE
56, 57. ORIGINAL STALLS
58. LET DOWN HOUSE ?
59. MAINTENANCE BUILDING
60. COMPRESSOR HOUSE
61. WORKSHOP
62. STORES SIDINGS
63, 64. OFFICES
65. BLOWDOWN
66. ISO OCTANE PLANT
67. CRACKING FURNACE FOR 66
68. STORAGE TANKS FOR 66
69, 70, 71, 72. GASHOLDERS FOR VARIOUS HYDRO CARBONS
73. STRIPPING COLUMNS ?
74. DISTILLATION PLANT ?
75. STORAGE CYLINDERS
76. DISTILLATION PLANT
77, 78. PRIMARY PRODUCTS AND RUNDOWN TANKS

NO. OF TANKS	APPROXIMATE TOTAL CAPACITY M3	BARRELS
10	11,905	75,000

79. GASHOLDER
80. NOT IDENTIFIED
81. TAIL GAS SEPARATION ?
82. DISTILLATION COLUMNS
83, 84, 85, 86. TUBE STILLS
87. PONDS
88. EDIBLE FAT MANUFACTURE ?
89. STORE
90. STORES
91. WATER INTAKE ?
92. AIR INTAKE PIPE
93. AIR INTAKE
94 to 100. BALLOON SITES


A
B
C


WESER-ELBE KANAL
Hohenwarthe
Moser
Meitzendorf
Barleben
ALTE ELBE
Lostau
ELBE RIVER
N
Dahlenwarsleben
A
B
C
Ebendorf
AUTOBAHN
ROTHENSEE
Korbelitz
Gerwisch
Biederitz
Olvenstedt
NEUSTADT
Woltersdorf
MAGDEBURG
WILHELMSTADT
FRIEDRICH-
STADT
SUDENBURG
LOCATION MAP
A. Hydrogenation Plant of BRAUN - KOHLE - BENZIN A. G. (Brabag)
B. Gas Plant of GROSSGASEREI MITTELDEUTSCHLAND A. G.
C. MIKRAMAG Power Station
SCALE
1 0 2 MILES
1 0 1 2 3 4 KILOMETERS
R-51

Magdeburg (Continued)

for CO_2 removal. Two columns, each 13 feet in diameter, (No. 30) at the western angle of building are identified as for formate recovery.

(d) Hydrogenation: (1) The plant has three pairs of stalls. These pairs each measure 68 x 24 feet without the external heat exchangers. The presence of overhead pipe connections to the hydrogenation vessels prevents appraisal of the number of vessels in any of the stalls.

(2) Parallel with and north of the stalls is the injector house (No. 54). This measures 360 x 66 feet and has a number of catch pots along its southwestern side. A pipe bridge runs along the southwestern side of the house, and is connected with each of the stalls by means of a trench.

(3) The letdown units have not been definitely identified, but the unit (No. 58) at the end of the line of stalls or a structure between the primary products tanks (Nos. 77, 78) may serve this function.

(e) Refinery: (1) The main refining section is situated in the center of the northeastern side of the plant. This has four furnace houses (Nos. 83 to 86) with tall chimneys and fractionation complexes on the southwestern side (Nos. 76, 82). Three groups of horizontal cylinders are situated close to the distillation units. The columns (No. 82) serving the two heater houses at the eastern end of the row are markedly taller than the others, and it seems likely that they are separating a greater range of products. They may well be for primary distillation, with the group (No. 76) for secondary fractionation.

(2) The row of distillation units is connected by pipe lines with three buildings. Two of these (No. 81) at the northwestern end of the row show no very characteristic features and one or both may be for separation of tail gases by compression and cooling. The third (No. 74) measuring 175 x 102 feet has a high northeastern section and may be concerned with distillation of relatively small quantities of material. As far as can be seen the pipe connections of this plant are with the distillation section, and not with the nearby gasholders.

(3) In line with the primary products tanks (No. 77) is a complex of buildings which is identified as probably an iso-octane plant. At one end is a large furnace house with three chimneys (No. 17), which is probably for isobutane dehydrogenation, and the row of columns (No. 66) is probably for polymerization, hydrogenation and distillation. The stout chimney-like structure at the end (No. 65) is probably a blowdown column. The four gasholders (Nos. 69, 70, 71, 72) are presumably for storage of different gases used in this synthesis (and possibly other comparable processes), and the wall enclosing the end one of these (No. 69) suggests that it is for a heavy gas such as isobutane which might give rise to dangerous fires if it escaped. The tanks (No. 68) are probably working tanks for the iso-octane plant.

(f) Tankage: (1) The number and size is rendered difficult by heavy camouflage.

(2) There are two groups of tanks (Nos. 77, 78) behind the injector house. They apparently serve as both primary products and rundown tanks; the group (No. 77) may serve the former function, and (No. 78) be for the distillation plants. A "balloon" gasholder (No. 79) is situated at the end of the row of tanks, with which it is connected by pipe lines.

(3) A third group of tanks (No. 50) situated alongside the loading sidings can be identified as final products tanks.

(4) At the northwestern end of the site are two large and some smaller tanks (Nos. 43, 44, 45, 46). The two large tanks are evidently tar tanks, and the smaller tanks may be for alternative feedstocks available in smaller quantities.

Magdeburg (Continued)

(5) The size and approximate capacities of the tanks are as follows:

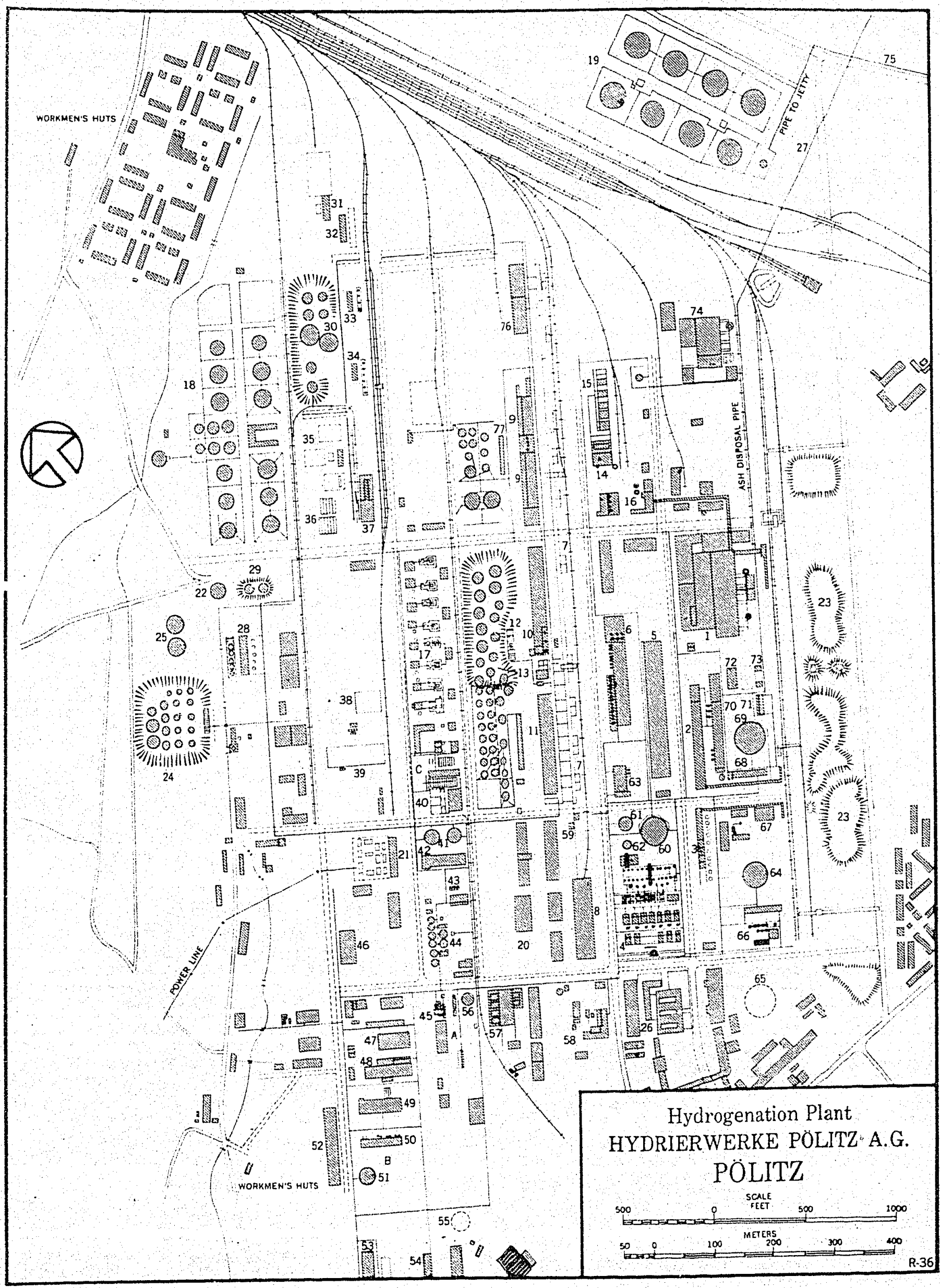
Details of Tankage

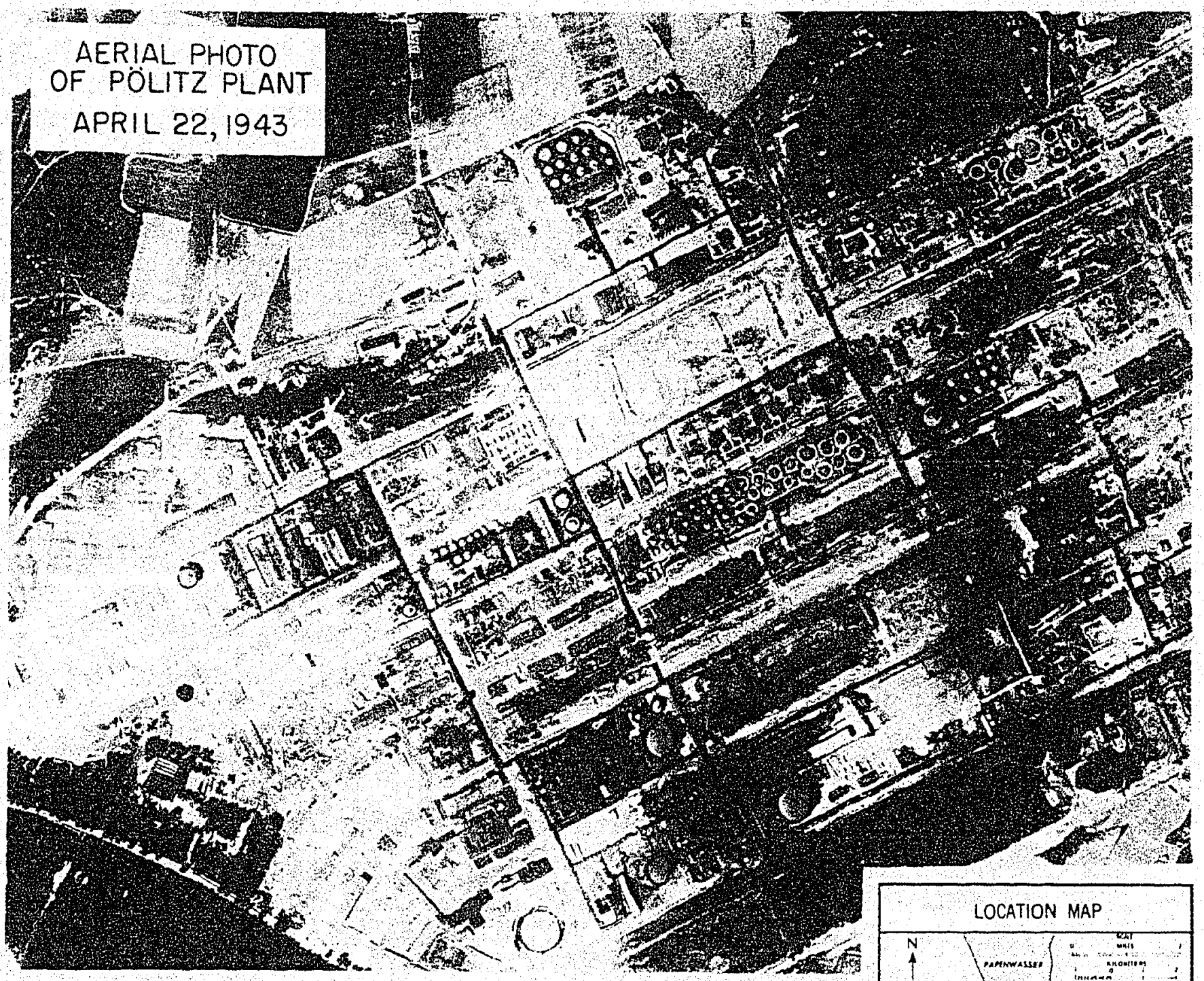
	No. on Plan	No. of Tanks	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
Primary products and rundown tanks	77, 78	10	40	1,000	10,000
Final products tanks	50	1	70	3,500	3,500
		2	55	2,500	5,000
		2	35	800	1,600
Feedstock tanks	43,44	2	110	10,000	20,000
	45,46	2	55	2,500	5,000
		4	40	1,000	4,000
TOTAL					49,100

(g) Sundries: (1) It has been reported that the Magdeburg plant is concerned, inter alia, with preparation of edible fats. The use of the pure hydrogen available for this purpose would be very reasonable. The building (No. 88) has pipe connections which may well convey gas and steam, and is, from its general type, quite likely to serve this function.

(2) The building (No. 6) near the southern angle of the site has a pipe connection with the liquid air plant, and has a row of columns along one side. Its function is not known. Other buildings such as (Nos. 31 and 39) seem to be for purposes other than oil synthesis, but the nature of those has not been determined.

Estimated Capacity: 250,000 metric tons per year estimated normal production capacity.

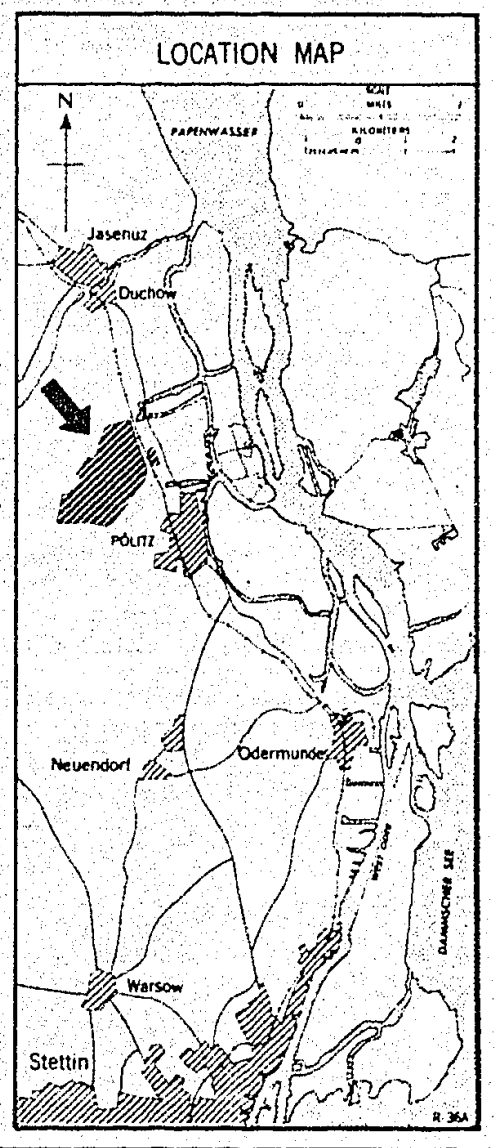

WORKMEN'S HUTS
PIPE TO JETTY
ASH DISPOSAL PIPE
POWER LINE
WORKMEN'S HUTS
Hydrogenation Plant
HYDRIERWERKE PÖLITZ A.G.
PÖLITZ
SCALE
FEET
500 0 500 1000
METERS
50 0 100 200 300 400
R-36



HYDRIERWERKE PÖLITZ A.G.

LEGEND

1. MAIN POWER STATION.
2. WATERGAS PLANT. (MODIFIED TYPE)
3. WATERGAS PLANT.
4. METHANE STEAM PLANT AND GAS PURIFICATION.
5. COMPRESSOR HOUSE.
6. GAS WASHING AND PURIFICATION. (CO_2 AND CO REMOVAL)
7. STALLS.
8. SERVICING BUILDING.
9. COAL PASTING, INJECTION, ETC.
10. INJECTOR/CIRCULATOR HOUSE.
11. CIRCULATOR HOUSE.
12. LETDOWN UNITS.
13. PRIMARY PRODUCTS AND RUNDOWN, TANKS.
14. CENTRIFUGE HOUSE.
15. CARBONISING OVENS.
16. COAL PREPARATION.
17. OIL REFINERY.
18. FINAL PRODUCTS TANKS.
19. FEEDSTOCK TANKS APPROX. CAP. EACH 11,905 M^3, 75,000 BBLS.
20. WORKSHOPS ETC.
21. MAIN TRANSFORMER STATION.
22. GASHOLDER.
23. COAL BUNKER.
24. ISO OCTANE TANKS.
25. 100-OCTANE STORAGE TANKS?
26. OFFICES, ETC.
27. ASH DISPOSAL PIPE.
28. NOT IDENTIFIED.
29. MOUNDED TANKS.
30. MOUNDED TANKS.
31. TRANSFORMER STATION.
32. TOPPING UNIT? U/C.
33,34. TOPPING, UNITS?
35. TRANSFORMER STATION.
36. CYLINDER STORAGE.
37. PUMP HOUSE?
38,39. BUILDINGS U/C.
40. ISO OCTANE PLANT.
41. GASHOLDERS (FOR HYDRO-CARBON GASES?)
42. COMPRESSOR HOUSE.
43. GAS SEPARATION PLANT.
44. ISO OCTANE TANKS?
45,46. NOT IDENTIFIED.
47. NOT IDENTIFIED - POSSIBLE STYRENE PLANT.
48.) 49.) NOT IDENTIFIED.
50. DISTILLATION PLANT.
51. GASHOLDER.
52. WORKSHOP.
53,54. NOT IDENTIFIED.
55. SITE FOR GASHOLDER.
56. WET GASHOLDER.
57. ENGINEERING SHOP.
58. NOT IDENTIFIED.
59. H.p. REACTION VESSEL STAND.
60. HYDROGEN GASHOLDER.
61. OXYGEN GASHOLDER?
62. RESIDUAL GASHOLDER.
63. OXYGEN PLANT?
64. NEW GASHOLDER.
65. GASHOLDER U/C.
66. GAS PURIFICATION?
67. BLOWER HOUSES, ETC.
68. BLOWER HOUSE.
69. RAW GASHOLDER.
70. WASTE HEAT BOILERS, DUST EXTRACTION PLANT, ETC.
71. BLOWER HOUSE.
72. PUMP HOUSE.
73. COOLING TOWER.
74. NEW POWER STATION.
75. PIPELINE TO JETTY.
76. NEW CIRCULATOR HOUSE.
77. PRIMARY PRODUCTS TANKS.



4.6.16 Pölitz

Company. Hydrierwerke Pölitz A.G.

Location: Plant situated WNW of Pölitz, latitude 53° 33' N., longitude 14° 33' E., west of the mouth of the River Oder, 10 miles north of Stettin.

References: Layout plan, page 198. Location map, page 199. Photograph, page 199.

Plant Area: 5,500 feet x 3,600 feet, or approximately 450 acres.

Description: (a) Process: Bergius process hydrogenation plant of great flexibility, capable of treating practically any type of raw material. Probably now operates primarily on bituminous coal and tars. Early in the war the feed stocks may have included Estonian shale oil and Rumanian crude oil.

(b) Power Plant: Buildings 550 x 380 feet. A new power station, somewhat smaller in size, was added in 1943, probably making the plant independent of outside sources.

(c) Gas Manufacture: There are two watergas plants and a methane steam plant. The southern plant, No. 3 on the layout plan, has at least eight large generators. The northern watergas plant, No. 2 on the layout plan, contains 21 generators. What process this latter plant uses is not clear. It is evidently a system of complete gasification, possibly with coke as a raw material, but it appears not to be a normal watergas process. There are three gasholders.

(d) Hydrogenation: There seem to be at least 29 stalls, viz., 10 sets of double stalls measuring 97 x 25 feet and three or more sets of triple stalls measuring 126 x 29 feet.

(e) Refinery: Refinery contains eight refining units and appears to include an iso-octane plant. The plant is believed to be run to produce the maximum proportion of aviation gasoline.

(f) Tankage:

Details of Tankage - Approximate

	No. on Plan	No. of Tanks	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
Feed stock tanks	19	8	115	10,000	80,000
		1	40	1,000	1,000
Primary products tanks	13, 77	2	80	4,000	8,000
		8	50	2,000	16,000
		14	40	1,000	14,000
		24	25	400	9,600
Final products tanks	18	12	80	4,000	48,000
		6	50	2,000	12,000
Mounded tanks	30	2	80	4,000	8,000
		4	50	2,000	8,000
		2	35	800	1,600
Iso-octane tanks plant rundown tanks ?	44	5	35	800	4,000
		2	30	500	1,000
Iso-octane tanks	24, 25	2	90	6,000	12,000
		2	50	2,000	4,000
		15	40	1,000	15,000
		3	30	500	1,500
TOTAL					261,100

Estimated Capacity: 600,000 metric tons per year estimated normal production capacity.

4.6.17 Ruhland - Schwarzheide

Company: Braunkohle-Benzin A.G. (Brabag)

Location: 1-1/4 miles N. of Ruhland, latitude 51° 29' N., longitude 13° 53' E., approximately 30 miles north of Dresden, west of railway from Dresden to Cottbus. New autobahn runs along northwest side of plant; has branch canal to Schwarze Elster Canal.

References: Layout plan, page 203. Location map, page 202.

Plant Area: 5,100 x 3,000 feet or approximately 350 acres.

Description: (a) Process: Two complete Fischer-Tropsch synthesis units, oil refinery and catalyst plant. The largest known synthesis (Fischer-Tropsch) plant. Operates on brown coal (lignite) briquettes from neighboring briquetting plants at mines Lauchhammer, Zschornegorda Sued and Victoria III.

(b) Power Plant: Boilerhouse, 245 x 80 feet, with a new extension 108 x 111 feet. Generator hall 115 x 115 feet.

(c) Gas Manufacture: (1) Old Plant: One Wintershall Schmalfeldt generator for production gas directly from brown coal (probably no longer in use because of unsatisfactory performance). A gas plant of unidentified type of 350 x 50 ft. with two gasholders, 110 feet in diameter (probably not in use). Two Koppers generators using briquettes with two gasholders, 110 feet in diameter. H_2S removal, 8 towers, 38 feet in diameter. Organic sulphur removal, 12 towers, 15 feet in diameter.

(2) New Plant: Five or six Koppers generators. Four gasholders--1 of 70 ft. diameter, 1 of 123 ft. diameter, and 2 of 75 ft. diameter. H_2S removal, 8 towers, 38 feet in diameter. Organic sulphur removal, 14 towers, 15 feet in diameter.

(d) Synthesis Proper: (1) Old Plant: Atmospheric pressure type. Contact oven house, 700 x 115 feet. Residual gasholder, 50 feet in diameter.

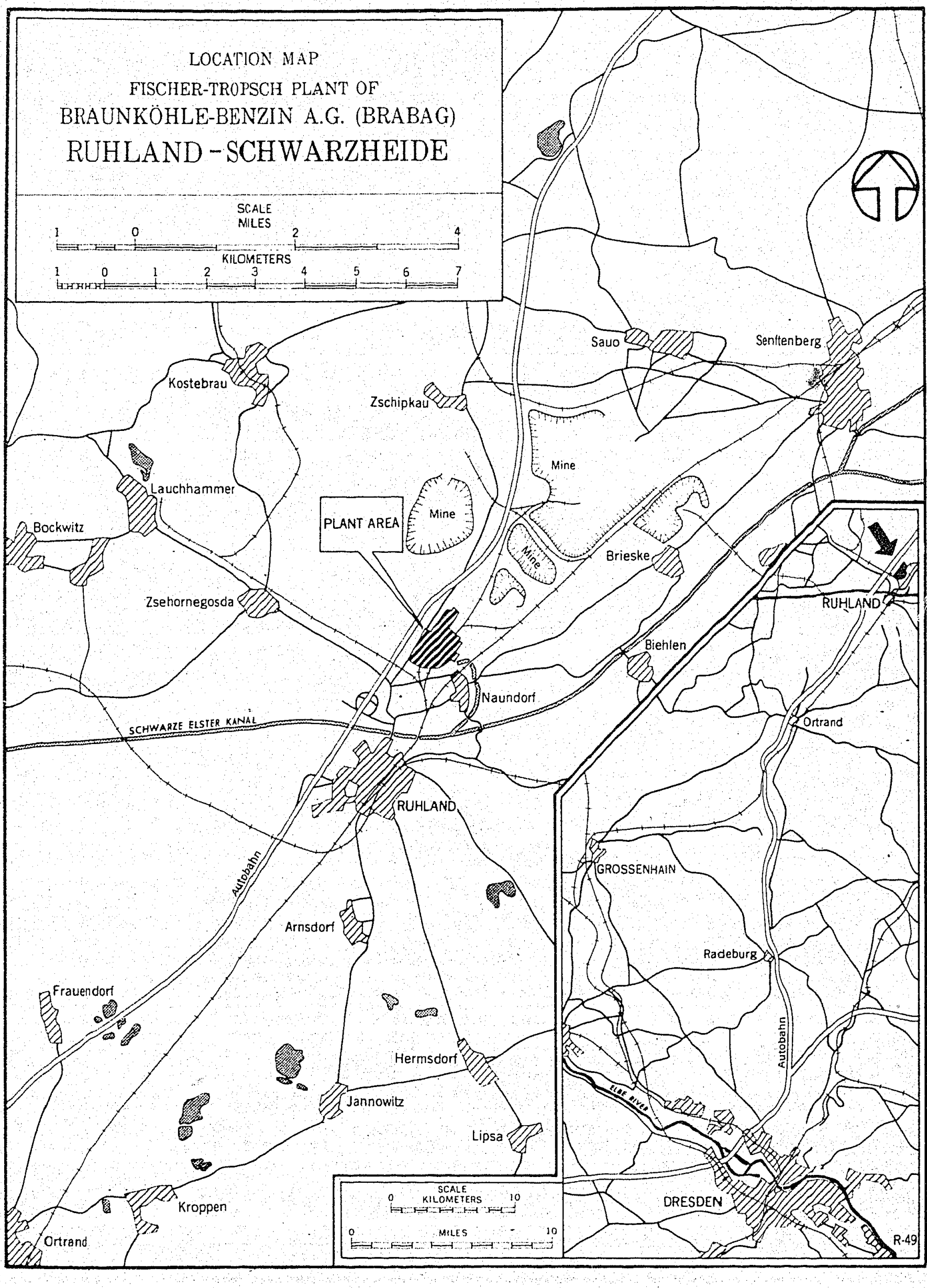
(2) New Plant: Medium pressure type. Contact oven house 930 x 90 feet with only central part roofed, ovens standing in open. 480 ovens, diameter 6 feet, arranged in groups of six, 40 groups on each side. Ovens are of unknown type, residual gasholders 65 feet in diameter.

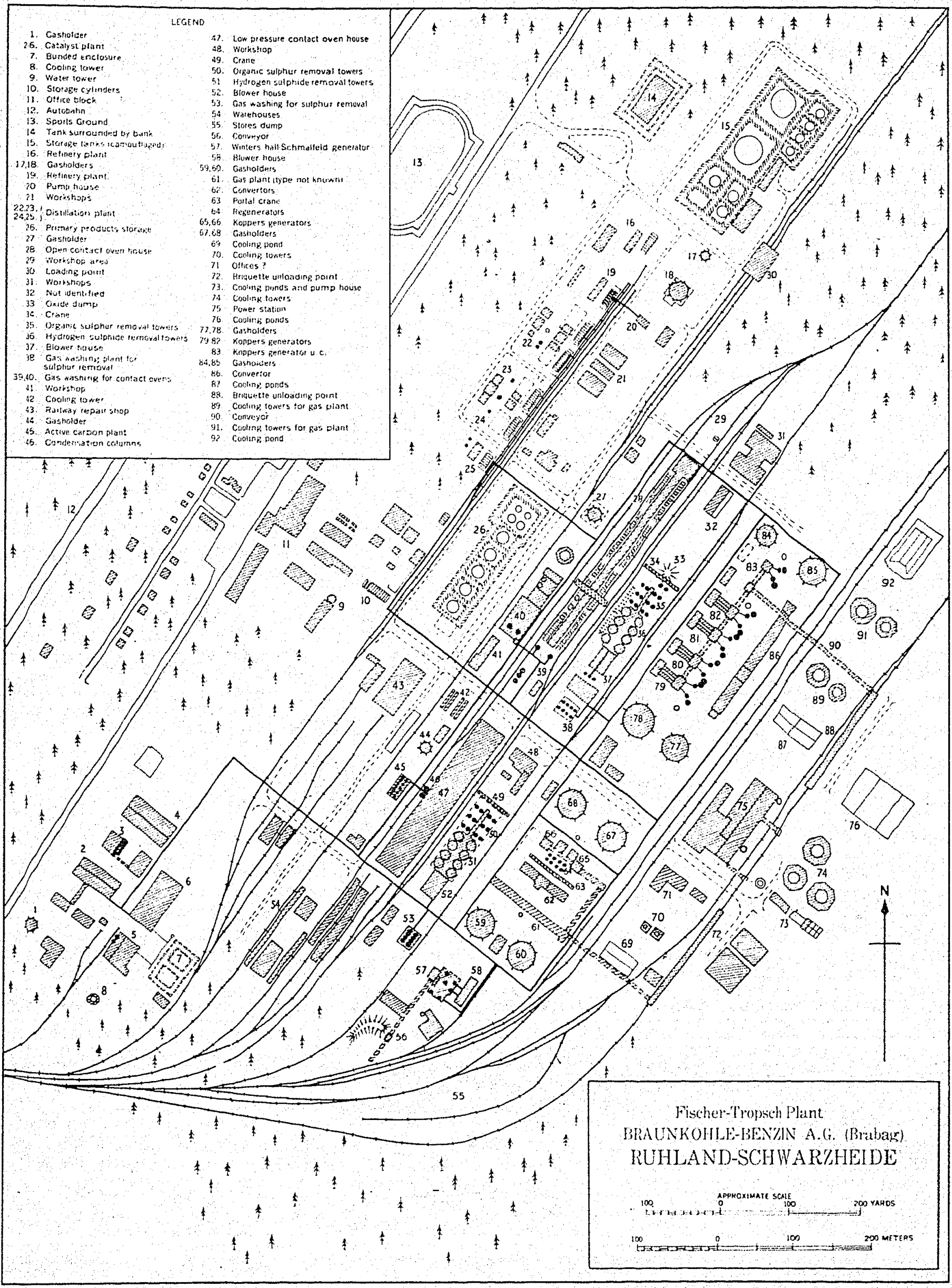
(e) Refinery: Five units of usual type with tube heater houses, pumphouses and fractionating columns.

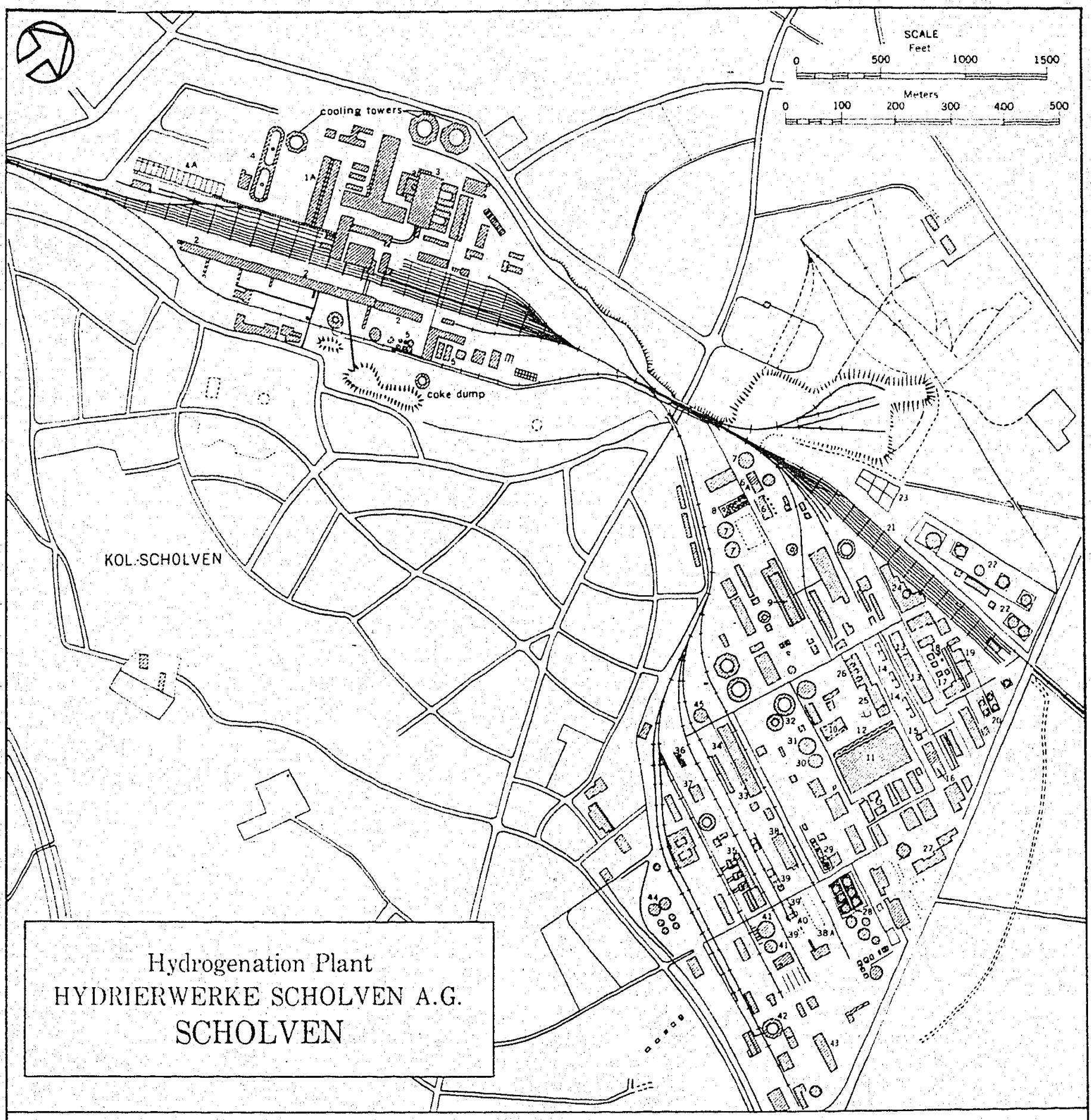
(f) Tankage:

	Metric Tons (Approximately)
Primary products	14,000
Finished products	30,000
Total	44,000

Estimated Capacity: 180,000 metric tons per year estimated normal production capacity.


LOCATION MAP
FISCHER-TROPSCH PLANT OF
BRAUNKÖHLE-BENZIN A.G. (BRABAG)
RUHLAND - SCHWARZHEIDE
SCALE
MILES
1 0 2 4
KILOMETERS
1 0 1 2 3 4 5 6 7
Kostebrau
Zschipkau
Sauo
Senftenberg
Lauchhammer
Bockwitz
PLANT AREA
Mine
Mine
Mine
Brieske
RUHLAND
Zsehornegosda
Biehlen
Naundorf
SCHWARZE ELSTER KANAL
Ortrand
RUHLAND
Autobahn
GROSSENHAIN
Arnsdorf
Radeburg
Frauendorf
Hermsdorf
Jannowitz
Lipsa
ELBE RIVER
Autobahn
Kroppen
Ortrand
SCALE
0 KILOMETERS 10
0 MILES 10
DRESDEN
R-49


LEGEND
1. Gasholder
2-6. Catalyst plant
7. Bunded enclosure
8. Cooling tower
9. Water tower
10. Storage cylinders
11. Office block
12. Autobahn
13. Sports Ground
14. Tank surrounded by bank
15. Storage tanks (camouflaged)
16. Refinery plant
17,18. Gasholders
19. Refinery plant
20. Pump house
21. Workshops
22,23, 24,25. Distillation plant
26. Primary products storage
27. Gasholder
28. Open contact oven house
29. Workshop area
30. Loading point
31. Workshops
32. Not identified
33. Oxide dump
34. Crane
35. Organic sulphur removal towers
36. Hydrogen sulphide removal towers
37. Blower house
38. Gas washing plant for sulphur removal
39,40. Gas washing for contact ovens
41. Workshop
42. Cooling tower
43. Railway repair shop
44. Gasholder
45. Active carbon plant
46. Condensation columns
47. Low pressure contact oven house
48. Workshop
49. Crane
50. Organic sulphur removal towers
51. Hydrogen sulphide removal towers
52. Blower house
53. Gas washing for sulphur removal
54. Warehouses
55. Stores dump
56. Conveyor
57. Winters hall-Schmalfeld generator
58. Blower house
59,60. Gasholders
61. Gas plant (type not known)
62. Convertors
63. Portal crane
64. Regenerators
65,66. Koppers generators
67,68. Gasholders
69. Cooling pond
70. Cooling towers
71. Offices ?
72. Briquette unloading point
73. Cooling ponds and pump house
74. Cooling towers
75. Power station
76. Cooling ponds
77,78. Gasholders
79,82. Koppers generators
83. Koppers generator u. c.
84,85. Gasholders
86. Convertor
87. Cooling ponds
88. Briquette unloading point
89. Cooling towers for gas plant
90. Conveyor
91. Cooling towers for gas plant
92. Cooling pond
N
Fischer-Tropsch Plant
BRAUNKOHLE-BENZIN A.G. (Brabag)
RUHLAND-SCHWARZHEIDE
APPROXIMATE SCALE
100 0 100 200 YARDS
100 0 100 200 METERS



Hydrogenation Plant
HYDRIERWERKE SCHOLVEN A.G.
SCHOLVEN

LEGEND

COAL MINE, COKING PLANT AND POWER STATION

1. COAL MINE SCHOLVEN I AND II
1A. COAL SCREENING PLANT
2. COKE OVENS
3. BOILERHOUSE AND POWER STATION
4. TILE WORKS
4A. COAL BUNKER
5. BY-PRODUC . RECOVER PLANT FOR COKE OVENS

SYNTHETIC OIL PLANT

6. WATER GAS PLANT
6A. BLOWER HOUSE
7. WET GASHOLDER
8. H_2S REMOVAL PLANT
9. CONTACT OVEN HOUSE
10. LIQUID AIR PLANT
11. COMPRESSOR HOUSE
12. AMMONIA SYNTHESIS TOWERS
13. PASTE PREPARATION AND INJECTION HOUSE
14. HYDROGENATION STALLS
15. CRANE
16. MAINTENANCE BUILDING
17. TUBE HEATER HOUSE
18. DISTILLATION COLUMNS
19. LUBE OIL PLANT
20. LUBE OIL TANKS
21. RAILWAY YARD
22. FINISHED PRODUCTS TANKS
23. SETTLING TANKS OR FILTER BEDS
24. UNIDENTIFIED
25. CENTRIFUGAL HOUSE
26. CARBONIZING OVENS
27. OFFICES
28. PRIMARY PRODUCT TANKS
29. DISTILLATION PLANT
30. WET GASHOLDER
31. DRY GASHOLDER
32. COOLING TOWERS
33. COMPRESSOR HOUSE
34. GAS WASHING COLUMNS
35. WATER GAS PLANT
35A. BLOWER HOUSE
36. CONVERTERS
37. PROBABLE ALKACID PLANT
38. INJECTOR HOUSE
38A. FOUNDATION FOR NEW INJECTOR HOUSE
39. NEW HYDROGENATION STALLS
40. CRANE
41. WET GASHOLDERS
42. COOLING TOWER
43. UNIDENTIFIED
44. CAMOUFLAGED TANKS
45. HYDROGEN GASHOLDERS

4.6.18 Scholven

Company: Hydrierwerke Scholven A.G.

Location: South of village Niederscholven (latitude 51° 36' N., longitude 7° 02' E.) in the highly built up section of the Ruhr. The plant is located on the road from Buer to Dorsten, immediately east of Scholven I and II coal mines, coking plant and power station and 3/4 mile west of mine Bergmannglueck.

References: Layout plan, page 204. Location map, page 163.

Plant Area: Two sections approximately 3,500 x 2,000 feet and 3,000 x 1,500 feet, respectively, or a total of about 260 acres.

Description: (a) Process: Hydrogenation of bituminous coal and H.T.C. tar at 300 atmospheres by Bergius process. Originally built as a synthetic ammonia plant. However, it seems likely that ammonia is not now produced at Scholven, and that the synthesis plant, instead of being used to effect the combination of hydrogen and nitrogen, is being used for the production of methanol from hydrogen and carbon monoxide. Both these gases are available, and can be separated from the coke oven gas. This source produces an excess of carbon monoxide. The hydrogen deficiency for methanol production is made up from watergas, which also provides hydrogen for hydrogenation.

(b) Power Plant: Large power plant at mine pit head. Part of exhaust steam from turbines is passed on at low pressure for use in synthetic plant processes.

(c) Coking Plant: Large battery of coke ovens 1,560 feet in length near the mine head supplies gas to the synthetic plant, to the power station at Bergmannglueck mine and to Ruhr gas grid. Coke is also supplied from here to the water gas generators in the Hibernia plant, though this represents only a very small part of the total coke produced.

(d) Gas Manufacture: From four watergas generators and eight new generators supplied with coke from coke ovens referred to above.

(e) Hydrogenation: (1) Old Plant: First operated in conjunction with the ammonia plant, shared with that plant the hydrogen supply, purification and compression installations. There are six stalls, each measuring 37 x 27 feet, an injector house, measuring 420 feet x 70 feet, where also the coal is made up into a paste with heavy oil preparatory to being pumped into the reaction cylinders. There are also a centrifuge house and carbonizing ovens for the recovery of oil from the residue left after hydrogenation.

(2) New Plant: The new hydrogenation plant forms a compact and separate unit to the south of the ammonia plant and old hydrogenation plant. It is dependent on the Scholven power plant for power and steam, but has its own independent hydrogen plant. There are eight stalls measuring, like the old ones, 37 x 27 feet.

(f) Refinery: Considerable additional refining equipment was installed in 1942, but details are unreported. Thought to include a lube oil plant.

(g) Sundries: The synthetic plant is connected by pipe lines to the Hüls synthetic rubber plant and the Gelsenberg Benzin A.G. synthetic plant at Gelsenkirchen. By this means raw or pure gas can be transmitted from any one plant to another and tail gases sent to Hüls from the synthetic plants. There are also pipe connections with the coke oven plants at Zineckel and from Scholven to the Bergmannglueck power station. This latter believed to convey tail gases from the synthetic plant to the power station.

Scholven (Continued)

(h) Tankage: Approximate tankage capacity as follows:

Details of Tankage

	No. on Plan	No. of Tanks	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
Primary products	28	2 8	60 40	3,000 1,000	6,000 8,000
Lub. oils (?)	20	5	30	500	2,500
Storage	22	1 5 1	80 60 50	4,500 3,000 2,000	4,500 15,000 2,000
Storage	44	2 4	60 30	3,000 500	6,000 2,000
TOTAL					46,000

Estimated Capacity: 400,000 metric tons per year estimated normal production capacity.

4.6.19 Wanne Eickel

Company: Krupp Triebstoffwerke G.m.b.H.

Location: At Wanne Eickel, latitude 51° 31' N., longitude 7° 11' E., approximately four miles NNW of center of Bochum in the Ruhr.

References: Layout plan, page 207. Location map, page 163.

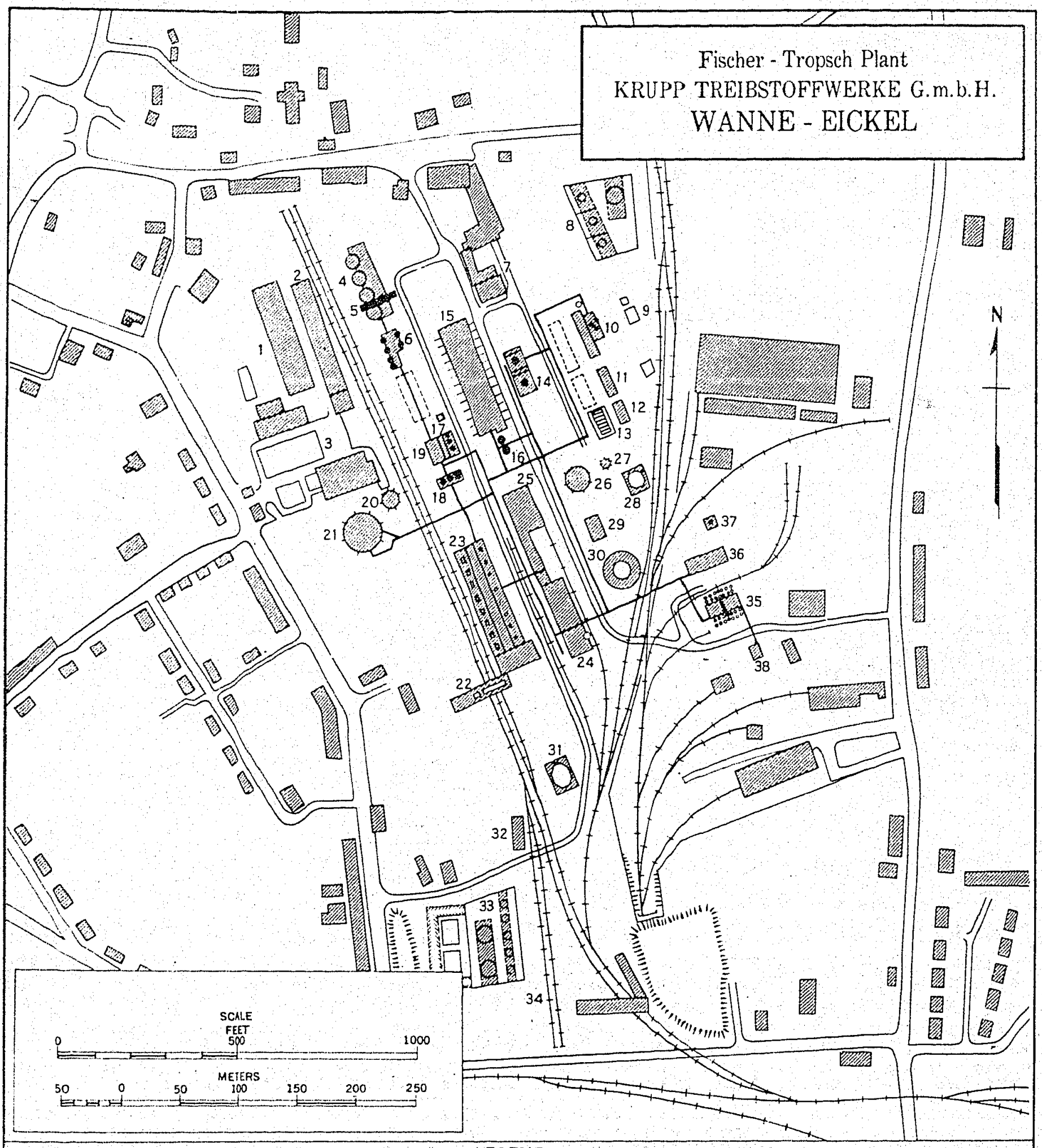
Plant Area: 2,500 x 1,000 to 1,500 feet, or approximately 75 acres.

Description: (a) Process: Fischer-Tropsch synthesis at medium pressure. Operates on coke supplied by nearby coke oven plants and gas from the Ruhr gas grid.

(b) Power Plant: Boilerhouse supplying process steam and also one small generating plant. Power largely supplied from outside the plant.

(c) Gas Manufacture: Gas is generated on the works by a watergas plant--primarily to provide hydrogen for admixture with coke oven gas from the Ruhr gas grid. The water gas plant, measuring 300 x 87 feet (No. 23 on the layout plan), has eight generators with high bunkers along the western side, and has a blower house at the southern end. Coke is supplied from a crushing plant (No. 22) which has a gantry over the sidings, direct to the bunkers.

The gas is passed through three washing columns (No. 18) and then to the purification plant which is situated NNW of the watergas generators. Hydrogen sulphide is removed in four stout purification towers (No. 4), each 50 feet in diameter, served by a portal crane. From this plant the gas is passed to the six organic sulphur removal columns (No. 6). These measure 16 feet in diameter and protrude through the roof of a small building.



LEGEND

1. Workshop
2. Old Colliery with Malakoff tower at S. end
3. Offices
4. H_2S removal
5. Crane
6. Organic S. removal
7. Workshops
8. 1 Tank 3570 M3, 22,500 BBLS.
   3 Tanks 1190 M3, 7,500 BBLS.
9. Ponds
10. Cracking Plant
11. Stabilisation Plant
12. Polymerisation Unit
13. Storage cylinders
14. Distillation complex
15. Main Contact oven house
16. Condenser columns
17. Conversion
18. Gas washing columns
19. Compressor
20, 21. Wet gasholder
22. Coke crushing plant
23. Water gas generators and blower house
24. Boiler house
25. Workshop
26, 27. Wet gasholders
28. Cooling tower
29. Pump house
30, 31. Cooling towers
32. Weigh house
33. Finished Products
    2 Tanks 3570 M3, 22,500 BBLS.
    5 Tanks 595 M3, 3,750 BBLS.
34. Oil loading sidings
35. Second Contact oven house
36. Compressor House
37. Cooling Tower
38. Gas stripping plant for 35

R 32

Wanne Eickel (Continued)

Further south is a group of three columns (No. 17) alongside a small compressor house (No. 19), which are probably convertor columns for increasing the hydrogen percentage of the synthesis gas. From this point the gas is led to the two contact oven houses (Nos. 15 and 35).

(d) Synthesis: The main contact oven house (No. 15) is a building 270 x 90 ft. with ten compartments along each side of the house. It appears from various features that the medium pressure process is used, hence there is room for four ovens in each compartment or a total of 80 ovens. At the end of the main contact oven house is a pair of columns (No. 16) in which are carried out stripping of the gases between first and second stage processing, and which probably contain heat exchangers in which the incoming gases cool the outgoing volatile products.

A pipe connection leads from the main site to a second contact oven house (No. 35) with associated compressor house (No. 36) and cooling tower (No. 37). This house has double rows of ovens along each side, only the central control section being covered. A portal crane spans the whole building for servicing the ovens. A stripping plant (No. 38) is situated nearby at the southern side. The second contact oven house contains four rows each of 8 medium pressure ovens--a total of 32 ovens. The two contact oven houses, together, thus contain 112 ovens.

(e) Refinery: The products from both contact oven houses are led to the refinery section in the northeastern section of the works. The main fractionation of the products is probably carried out in the two columns (No. 14) on the eastern side of the contact oven house. From these the products are passed to the units Nos. 10, 11 and 12 for further treatment. The first unit (No. 10) is a cracking complex, and is reported to be a carburol plant with a daily capacity possibly of 1,500 barrels (say 200 tons). The other units (Nos. 11 and 12) are reported to be for stabilization and polymerization, respectively. Easily liquefiable hydrocarbons are stored in the cylinders (No. 13), and residual gas is stored in the holders (Nos. 26 and/or 27).

(f) Storage: Primary and intermediate products are stored in the tanks (8) near the refinery, and the finished stocks accommodated in the tanks (No. 33) near the loading sidings (No. 34). Tank capacities are approximately as follows:

	No. of Tanks	Metric Tons
Primary and intermediate products	4	6,000
Finished products	7	8,500
		14,500

Estimated Capacity: 60,000 metric tons per year estimated normal production capacity.

4.6.20 Wesseling

Company: Union Rheinische Braunkohlen Kraftstoff A.G.

Location: West bank of Rhine, about 1-1/2 miles ESE of railway station of Wesseling, latitude 50° 49' N., longitude 7° 00' E., approximately eight miles south of Köln (Cologne).

References: Layout plan, page 211. Location map, page 210. Photograph, page 210.

Plant Area: 4,590 x 1,800 feet or approximately 190 acres.

Description: (a) Process: Direct hydrogenation of brown coal (lignite) and H.T.C. tar by Bergius process.

(b) Power Plant: Building 350 x 350 feet. Plant also has transformer station connected with grid power lines. The plant was very severely damaged by aerial bombing in 1944 and believed became inactive if not actually dismantled.

(c) Gas Manufacture: There is a watergas plant connected with a battery of coke ovens and a row of ten gas generators. There are six purifying columns and 3 gasholders with diameters of 130 feet, 118 feet and 87 feet, respectively; a compressor house, a recycle house, sulphur removal house with 14 columns 14 feet in diameter, and converter house with 8 columns.

(d) Hydrogenation: There is a coal grinding ash paste preparation plant. There are eight stalls arranged in 4 pairs of the following dimensions:

1 pair, 90 x 35 feet,
1 pair, obscured by crane,
2 pairs 70 x 35 feet,
one other pair is believed to have been added.

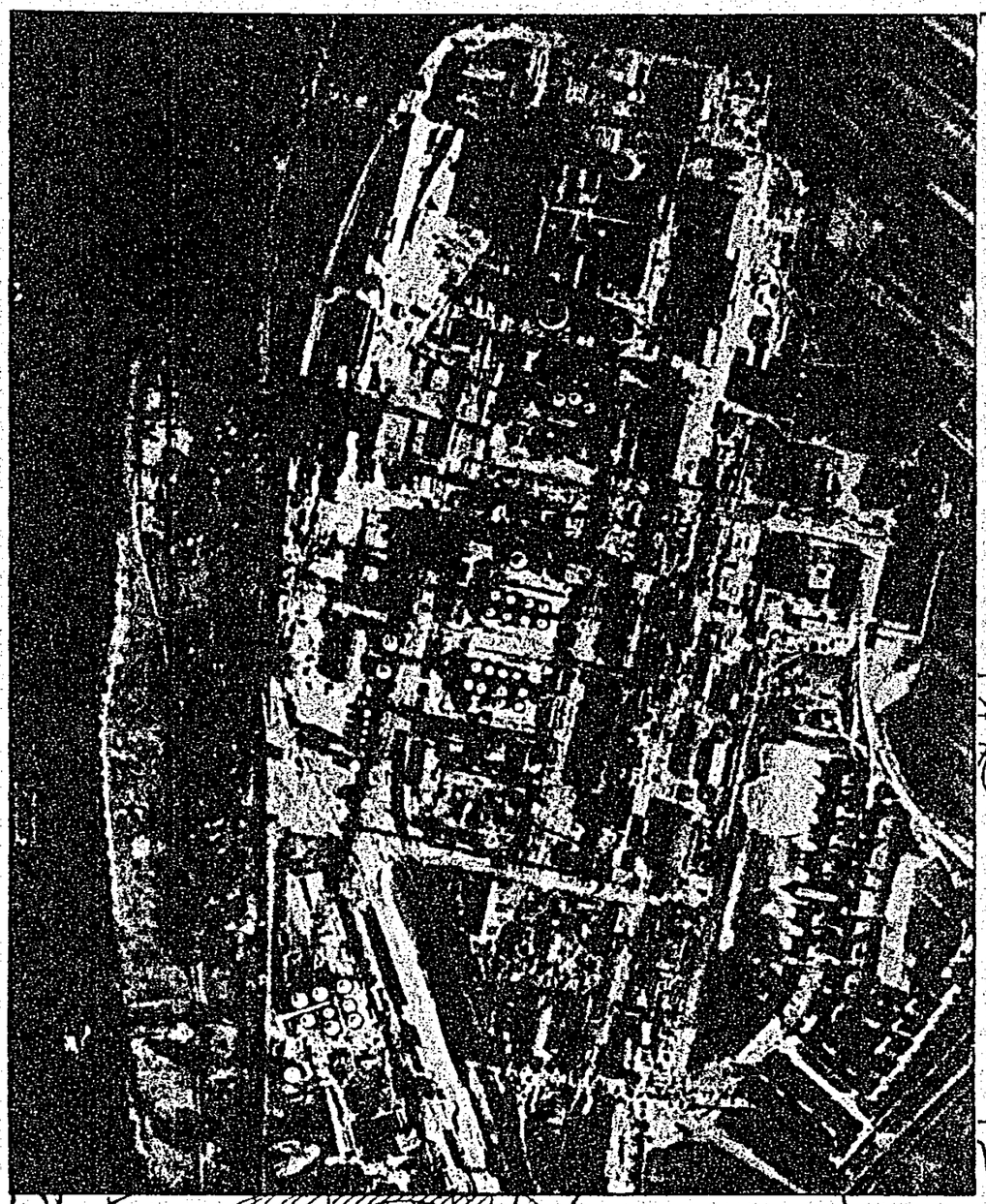
(e) Refinery: Contains three sets of refining columns. Appears adequate for the estimated capacity. May contain an iso-octane plant.

(f) Tankage: **Details of Tankage - Approximate**

	No. on Plan	No. of Tanks	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
Primary products	21	8	45	1,500	12,000
Intermediate products	20	7	45	1,500	10,500
		9	33	700	6,300
Finished products	3	6	60	3,000	18,000
		2	45	1,500	3,000
	6	2	50	2,000	4,000
		3	45	1,500	4,500
T o t a l					58,300

Additional tankage totaling something like 30,000 metric tons is understood to have been built some 800 yards south of the plant.

Estimated Capacity: 200,000metric tons per year estimated normal production capacity.

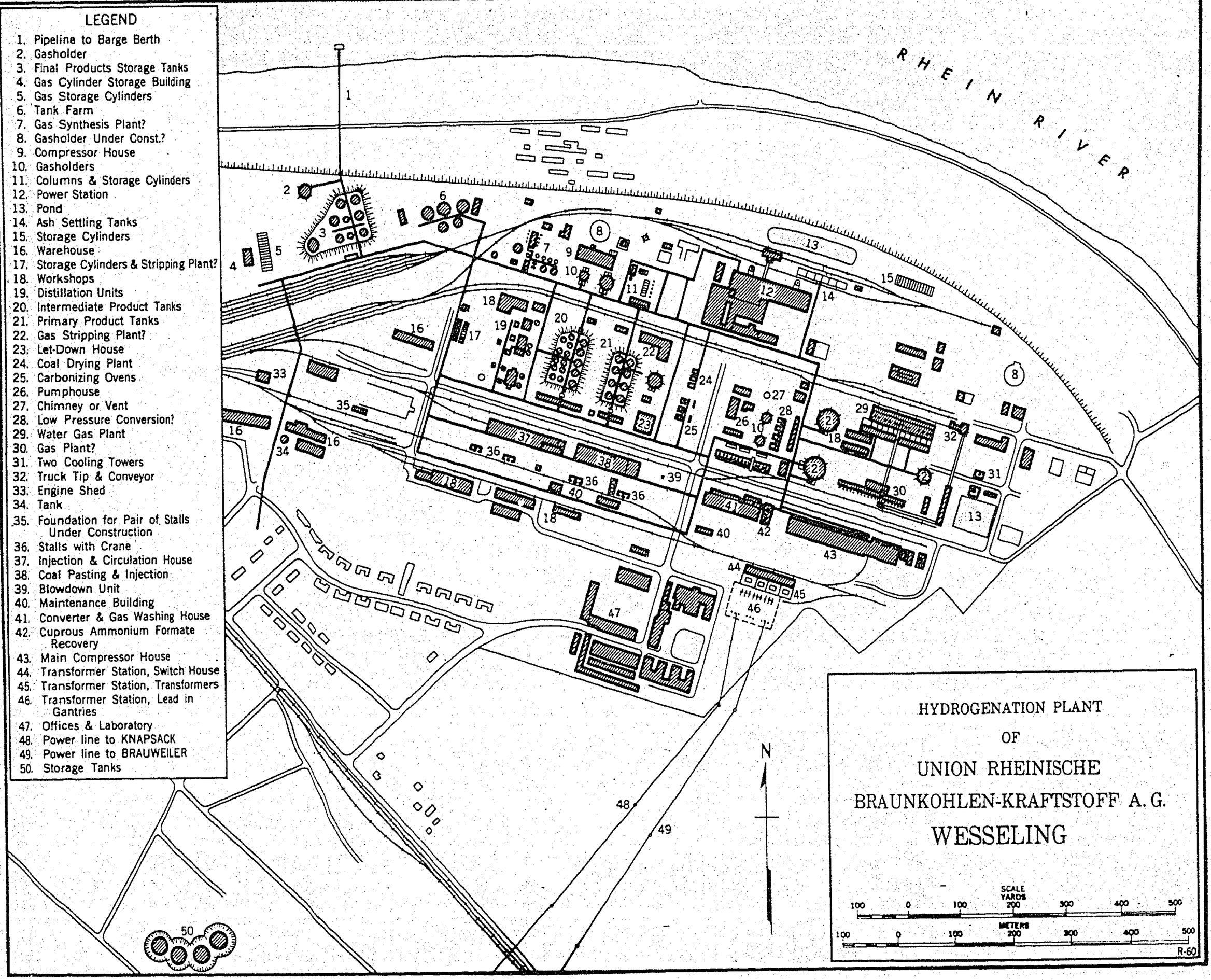


ABOVE: AERIAL PHOTOGRAPH OF WESSELING INSTALLATION, DATED 1941

LOCATION MAP
HYDROGENATION PLANT OF
UNION RHEINISCHE
BRAUNKOHLEN-KRAFTSTOFF
A. G.
WESSELING

SCALE 0 1 2 MILES
0 1 2 3 KILOMETERS

R-60A


LEGEND
1. Pipeline to Barge Berth
2. Gasholder
3. Final Products Storage Tanks
4. Gas Cylinder Storage Building
5. Gas Storage Cylinders
6. Tank Farm
7. Gas Synthesis Plant?
8. Gasholder Under Const.?
9. Compressor House
10. Gasholders
11. Columns & Storage Cylinders
12. Power Station
13. Pond
14. Ash Settling Tanks
15. Storage Cylinders
16. Warehouse
17. Storage Cylinders & Stripping Plant?
18. Workshops
19. Distillation Units
20. Intermediate Product Tanks
21. Primary Product Tanks
22. Gas Stripping Plant?
23. Let-Down House
24. Coal Drying Plant
25. Carbonizing Ovens
26. Pumphouse
27. Chimney or Vent
28. Low Pressure Conversion?
29. Water Gas Plant
30. Gas Plant?
31. Two Cooling Towers
32. Truck Tip & Conveyor
33. Engine Shed
34. Tank
35. Foundation for Pair of Stalls Under Construction
36. Stalls with Crane
37. Injection & Circulation House
38. Coal Pasting & Injection
39. Blowdown Unit
40. Maintenance Building
41. Converter & Gas Washing House
42. Cuprous Ammonium Formate Recovery
43. Main Compressor House
44. Transformer Station, Switch House
45. Transformer Station, Transformers
46. Transformer Station, Lead in Gantries
47. Offices & Laboratory
48. Power line to KNAPSACK
49. Power line to BRAUWEILER
50. Storage Tanks
RHEIN RIVER
N
HYDROGENATION PLANT
OF
UNION RHEINISCHE
BRAUNKOHLEN-KRAFTSTOFF A. G.
WESSELING
SCALE
YARDS
100 0 100 200 300 400 500
METERS
100 0 100 200 300 400 500
R-60

4.6.21 Zeitz - Tröglitz

Company: Braunkohle-Benzin A.G. (Brabag)

Location: Plant is located on the southeast side of the road from Zeitz to Groitzsch at village of Tröglitz, about three miles northeast of Zeitz. Latitude 51° 04' N., longitude 12° 12' E. In central Germany. Five L.T.C. tar plants are located within a radius of nine miles, at Deuben, Luckenau, Profen, Rositz and Techwitz, and from which this plant draws its raw materials.

References: Layout plan, page 213. Location map, page 162.

Plant Area: 4,500 x 4,500 feet or 460 acres.

Description: (a) Process: Hydrogenation, Bergius process of L.T.C. tar from brown coal. Plant was still partly under construction late in 1943 and it would appear that increasing difficulties in obtaining high pressure equipment delayed or curtailed construction.

(b) Power Plant: Large power plant 450 x 325 feet, including a generator hall, 215 x 100 feet.

(c) Gas Manufacture: The gas generator plant covers an area 265 x 215 feet and is of a type probably similar to Winkler. There appears to be a good Linde liquid air plant. The sulphur removal plant is similar to that at Magdeburg, containing at least 5 columns. There is a large plant in the gas generator area with a tall smoke stack and two gasholders, which is not definitely identifiable.

(d) Hydrogenation: Originally there were six stalls (3 pairs), 30 x 21 feet, and foundations for three more pairs. A new quadruple set, or 8 stalls was built in 1943.

(e) Refinery: There is a large amount of refining equipment, including five rows of treating plants and a group of stills with two furnaces. At the extreme south of the works is a large plant whose nature and purpose is not known. It occupies an area of 530 x 425 feet, contains tall buildings and a cooling tower 65 feet in diameter and may be a propane dewaxing plant for treating primary tar. The plant may also contain an iso-octane unit.

(f) Tankage: **Details of Tankage - Approximate**

	No. on Plans	No. of Tanks	Diameter Feet	Capacity Tons	Total Capacity Metric Tons
Primary and intermediate products	45 and 47	12 2 6	53 40 30	2,000 1,000 500	24,000 2,000 3,000
Final products		6	53	2,000	12,000
Feedstock tanks	50	4 4 6	80 53 35	4,000 2,000 800	16,000 8,000 4,800
Octane tanks	55	6 7	35 25	800 400	4,800 2,800
New tanks (northern group)	80	4	53	2,000	8,000
New tanks (southern group)	63	6	53	2,000	12,000
T o t a l					97,400

Estimated Capacity: 350,000 metric tons per year estimated normal production capacity.

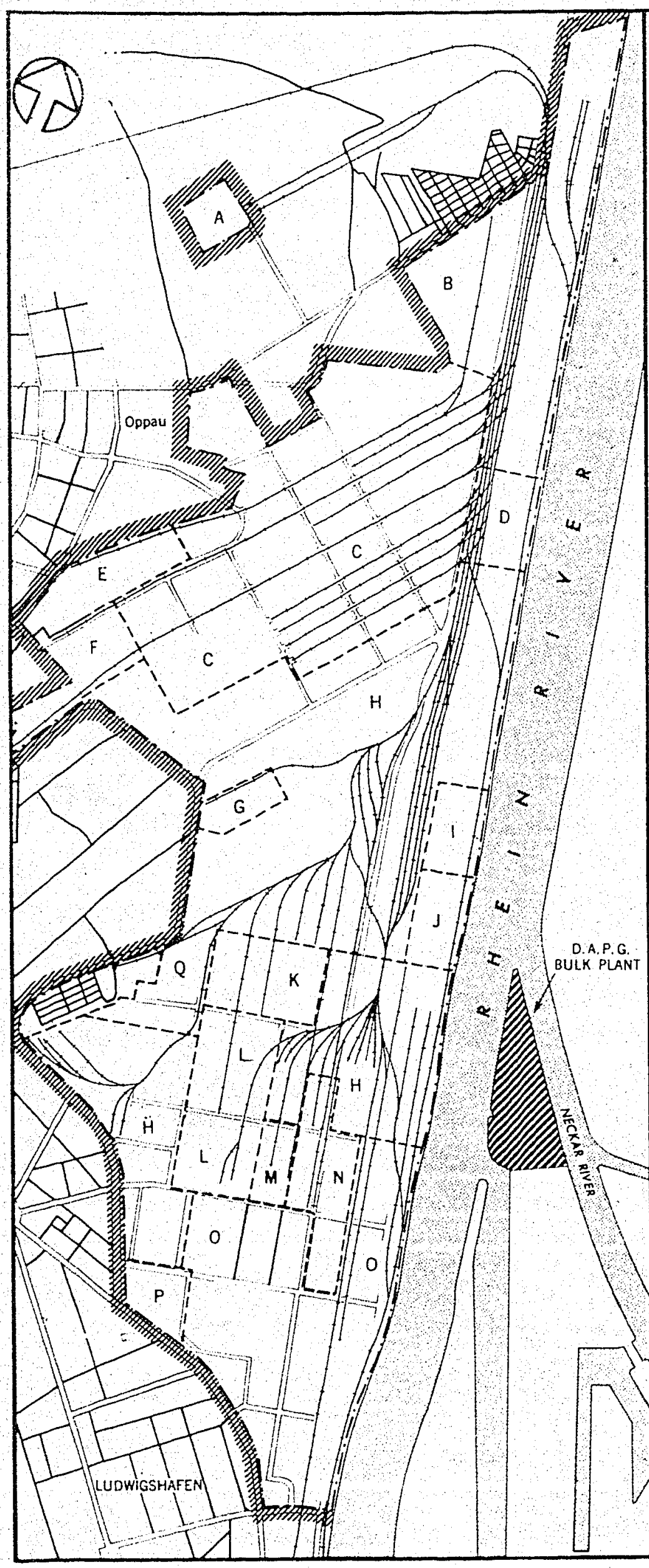
Hydrogenation Plant
BRAUNKOHLE-BENZIN A.G. (Brabag)
ZEITZ-TRÖGLITZ

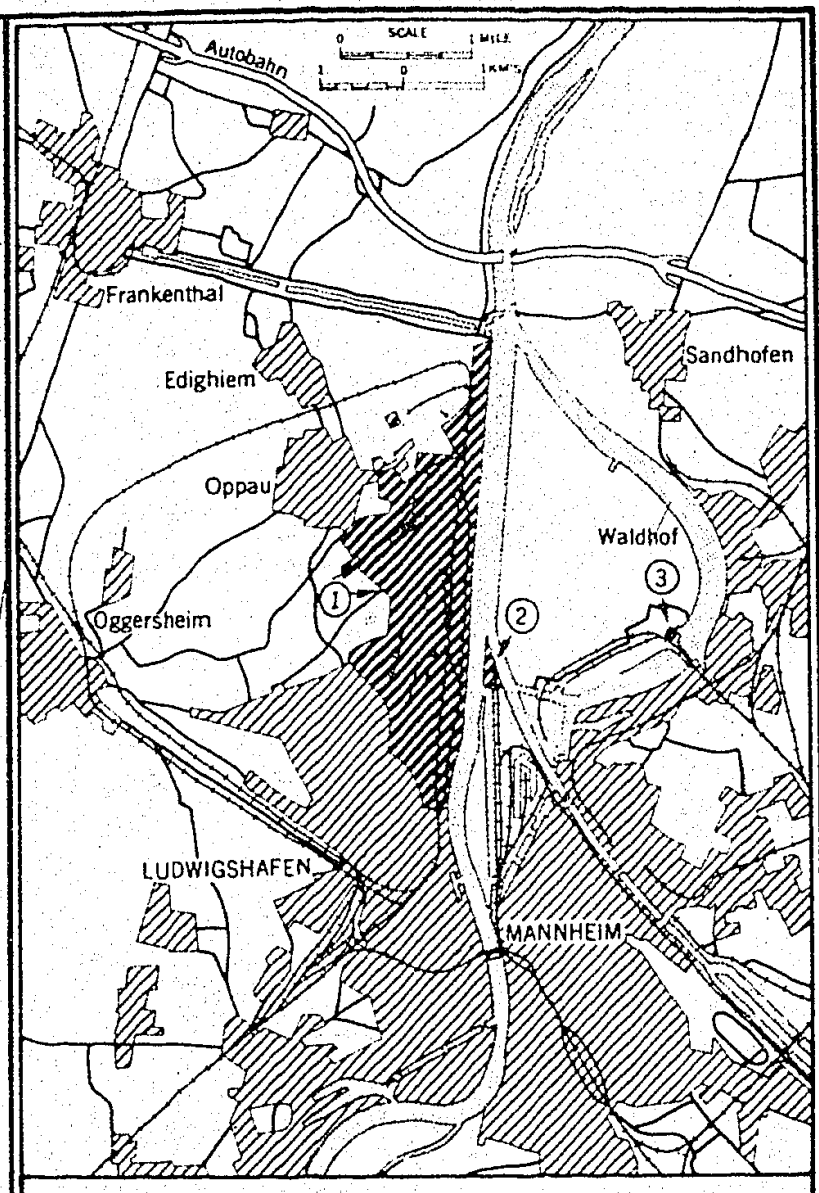
SCALE
Feet
0 500 1000 1500
Meters
0 100 200 300 400 500

N

LEGEND

1. Office
2. Cooling Towers
3. Cooling Tower
4. Pump house
5. Pond
6. Wet gasholder
7. Pond
8. Gas Purification columns
9. Generator Hall
10. Boiler House
11. Boiler House Chimneys
12. Cooling Towers
13. Ash settling pond
14. Transformer Station
15. Shelter trenches
16. Stores Yard
17. Workshops
18. Tank
19. Gas vent
20. Portal Coal Crane
21-23. Gas treatment plant
24. Gas generators (Winkler)
25. Hydrogen sulphide removal plant, with crane
26. Mineral dump
27. Hydrogen conversion plant
28,29. Wet gasholders
30. Liquid air plant
31. Oxygen gasholders
32. Stores dump
33. Compression and CO_2 removal
34. Final compression
35-38. Gas treatment plant
39. Workshop
40. Hydrogenation stalls
41. Stalls crane
42. New pair of stalls u.c.
43. Foundation for stalls u.c.
44. Injector houses
45. Primary and intermediate products tanks
46. Pump house
47. Intermediate products tanks
48,49. Oil refinery plant
50. Feed stock tanks
51. Gas compressors and storage
52-54. Iso-octane plant ?
55. Iso-octane tanks ?
56. Pump house
57. Building u.c.
58. Catalyst plant ?
59. Cooling tower
60. Sulphuric acid plant
61,62. Gasholder u.c.
63. Tanks u.c.
64,65,66. Distillation units u.c.
67. Compressor or pump house
68. Injector circulator house u.c.
69. Reaction vessel servicing point u.c.
70. Quadruple set of stalls
71. Foundation, not identified
72. Injector circulator house u.c.
73. New building, not identified
74. Cooling water pond
75. Coal unloading plant
76,77,78. Not identified
79. Traverser
80. Tanks u.c.





1. I. G. FARBENINDUSTRIE A. G. INSTALLATION
2. BULK PLANT, DEUTSCHE-AMERIKANISCHE PETROLEUM-GES.
3. BULK PLANT, "OLEX" DEUTSCHE BENZIN UND PETROLEUM G.m.b.H

LOCATION MAP

CHEMICAL PLANT, SYNTHETIC OIL & RUBBER EXPERIMENTAL STATION OF I. G. FARBENINDUSTRIE A. G. LUDWIGSHAFEN

LEGEND

PLANT LIMIT ----- AREA LIMIT

AREA A: TRANSFORMER STATION
B: COKE OVENS ETC.
C: NITROGEN & METHANOL PLANT
D: WATER WORKS
E: LUBE OIL PLANT
F: NEW PLANT (UNIDENTIFIED)
G: OIL REFINERY
H: WORKSHOPS & STORAGE
I: CARBIDE PLANT
J: NEW POWER PLANT
K: BUNA PLANT
L: PLASTICS PLANT
M: EXPERIMENTAL SYNTHETIC OIL PLANT
N: HEAVY CHEMICALS
O: INTERMEDIATES & DRYSTUFFS
P: GAS WORKS
Q: AREA BEING DEVELOPED

SCALE
0 500 1000 1500 YARDS
0 200 400 600 800 1000 METERS

R-53

IMPORTANT GERMAN BENZOL PLANTS

Location	Plant Name	Company Name	Normal Yearly Output Capacity Metric Tons
Altenessen (N of Essen)	Emil	Hoesch A.G.	10,800
Bochum	Robert Müser	Harpener Bergbau A.G.	14,400
Bottrop	Jacobi	Gutehoffnungshütte A.G.	10,800
"	Prosper	Rheinische Stahlwerke A.G.	20,400
Castrop	Erin	Gelsenkirchener Bergwerks A.G.	10,800
Dattelm (ENE of Recklinghausen)	Emscher Lippe	Gewerkschaft Emscher Lippe	10,800
Derne (NE of Dortmund)	Gneisenau	Hapener Bergwerks A.G.	12,000
Dortmund	Hansa	Gelsenkirchener Bergwerks A.G.	24,000
"	Hörderverein	Dortmund-Hörder Hüttenverein A.G.	7,200
"	Kaiserstuhl	Hoesch A.G.	18,000
"	Minster Stein	Gelsenkirchener Bergwerks A.G.	12,000
Duisburg-Meiderich	Phoenix-Westende	Gelsenkirchener Bergwerks A.G.	8,400
Erkenschwick (NE of Recklinghausen)	Ewald Fortsetzung	Ewald-König Ludwig Bergau A.G.	14,400
Gelsenkirchen	Almo-Pluto	Gelsenkirchener Bergwerks A.G.	12,000
"	Consolidation I/VI	Mannesmannröhrenwerke A.G.	13,200
"	Dahlbusch	Bergwerksgesellschaft Dahlbusch	9,600
"	Nordstern	Gelsenkirchener Bergwerks A.G.	25,200
Gladbeck	Scholven	Bergwerksgesellschaft Hibernia A.G.	16,800
Hallendorf (N of Salzgitter)	Salzgitter	Reichswerke Herman Goering	24,000
Hamborn (N of Duisburg)	Bruckhausen	Gelsenkirchener Bergwerks A.G.	22,800
"	Meiderich	Gelsenkirchener Bergwerks A.G.	20,400
Hamm	Sachsen	Mansfeld A.G.	6,600
Hamme (WNW of Bochum)	Carolinen-Glück	Gelsenkirchener Bergwerks A.G.	24,000
Hattingen (S of Bochum)	Heinrichshütte	Ruhrstahl A.G.	6,600
Homberg	Homberg	Gewerkschaft Rheinpreussen	8,400
Horst (S of Gladbeck)	Mathias Stinnes III/IV	Stinnes'schen Zechen	7,200
Hüls (NNW of Recklinghausen)	Auguste Viktoria	Gewerkschaft Auguste Viktoria	10,800
Kamen	Kamen	Essener Steinkohlenbergwerke A.G.	12,000
Langendreer (E of Bochum)	Bruchstrasse	Gelsenkirchener Bergwerks A.G.	6,600
Lintfort (NW of Mörs)	Friedrich Heinrich I/II	Steinkohlenbergwerks Friedrich Heinrich A.G.	10,800
Neumühl (NW of Oberhausen)	Neumühl	Gewerkschaft Neumühl	6,600
Neunkirchen (NE of Saarbrücken)	Neunkirchen	Neunkircher Eisenwerk A.G.	13,200
Oberhausen	Concordia	Concordia Bergbau A.G.	7,200
Osterfeld (NNE of Oberhausen)	Osterfeld	Gutehoffnungshütte A.G.	18,000
Rauxel (NW of Dortmund)	Victor III/IV	Klöckner-Werke A.G.	15,600
Rheinhausen (SW of Duisburg)	Friedrich Alfred	Friedrich Krupp A.G.	6,600
Saarbrücken (7 miles west)	Völklingen	Röchling'sche Eisen- und Stahlwerke	13,200
Unna-Königsborn	Königsborn	Klöckner-Werke A.G.	6,600
Wanne-Eickel (NE of Gelsenkirchen)	Shamrock III/IV	Bergwerksgesellschaft Hibernia A.G.	8,400
		TOTAL	506,400