ENEMY OIL COMMITTEE

Western Axis Sub-Committee

ESTIMATED PRODUCTION OF "OIL FROM COAL" IN AXIS EUROPE - 1943

(with a forecast for the first six months of 1944)

December 30th, 1943

ESTIMATED PRODUCTION OF "OIL FROM COAL"

IN AXIS EUROPE -- 1943

INTRODUCTION

The material assembled in this paper is designed to bring under one cover all current estimates and supporting data relating to the Western Axis "oil from coal" industry in 1943 that will be required for inclusion in the year-end report covering all aspects of the German oil economy. Included in the present discussion will be found current estimates covering production from the hydrogenation and hydrocarbon synthesis (Fischer-Tropsch) processes, from the carbonization industry, and from the processing of hydrocarbon gases. No summary table will here appear consolidating the output estimates for these various processes, as the separate estimates will later be integrated with the other production estimates appearing in the year-end report.

Other special considerations that should be noted include the following:

Wax. Estimates of wax production, as such, are not included in this paper, though the products resulting from the cracking of wax (lubes, etc) are so included. To cover wax as a separate product in a report dealing with the enemy liquid fuel position is felt to be confusing, just as the production of asphalt, coke, impregnating oils, etc. would be. This aspect will be stressed in the year-end report, apart from the special significance of wax in the "oil from coal" estimates.

War Factors. Extended discussions have taken place as to whether or not "war factors" should be applied to reflect the indirect effects on production of aerial or general warfare, this apart from the loss of production directly resulting from plant damage caused by bombing operations.

Pending more extensive study of this subject, which it is understood is now underway in England, the adoption of any such factors would be highly arbitrary and problematic. Moreover, to the extent the war has slowed down new construction of synthetic plants, the present estimates already reflect the effects of the mentioned circumstances, inasmuch as they have been based as nearly as possible on actual observed construction. Until the position is clarified by the further studies in England, no "war factors" will be applied.

"Unknown" Plants. Insofar as concerns the hydrogenation plants current estimates allocate no production to "unknown" plants — unless the A. G. Kraftstoff installation should be considered in that category. The procedure is thus in line with the London discussions. Meanwhile, the whole subject of "unknown" plants is being separately considered, and will be the subject of a special report — which may or may not lead to a subsequent alternative handling of the problem. Estimates of the output of the "unknown" hydrocarbon synthesis plants (Fischer-Tropsch) are, of course, included as heretofore.

1944 Estimates. Preliminary estimates are supplied in this report for the first six months of 1944, this insofar as concerns the output of the hydrogenation and Fischer-Tropsch plants. For the purposes of a general "look ahead", the output of other "oil from coal" products, can be estimated at their 1943 rates. No account has been taken in the 1944 estimates of the probable effects of bomb damage, or other military action.

I - SYNTHETIC FUELS AND LUBRICANTS

GENERAL

The synthetic fuels and lubricants production included under this category in this estimate are derived from the following sources:

Hydrogenation of coal and tars (Bergius)
Hydrocarbon synthesis (Fischer-Tropsch)

There are supplementary processes that draw on these basic operations for raw materials, as follows:

1. The production of octanes (alkylate and iso-octanes) from liquefied gases (C_3 and C_4).
2. The production of liquid fuels from hydro plant tail gases by hydrocarbon synthesis.
3. Lubricating oil production from wax produced in either hydrogenation or hydrocarbon synthesis.

Besides a full range of liquid fuels and lubricants which are thus produced synthetically in Axis Europe, these plants also produce large quantities of valuable gases some of which are used as substitute fuels. Their contribution to the liquid fuel pool depends on distribution and other factors rather than production. These gases and their possible uses are dealt with more fully in Section III.

In addition to the production of fuels and lubricants, the synthetic oil plants produce many of the basic materials for the chemical industry: drugs, dyes, plastics, fabrics, acetones, soaps and probably synthetic fats being the most noteworthy. This is another fraction of the synthetic plant production that does not enter the liquid fuel pool. Indeed, it is quite probable that the increasing diversion from the liquid fuel pool to more important synthesis is indicated by the increasing manufacturing facilities ancillary to the synthetic oil plants that are not identified with liquid fuel or lube production. A substantial volume of military intelligence points to the production of fatty acids and other essential materials from synthetic oil plant intermediates. The costly expansion of these plants in critical times emphasizes the urgency of the need for this production.

The production of synthetic liquid fuels and lubricants is estimated for 1943 to be as shown in Table I. The distribution of this production among plants and products is discussed below.

TABLE I

Estimated production of liquid fuels and lubricants from Axis European synthetic plants for the year 1943 (in thousands of metric tons)

	Total	Aviation	Motor	Diesel	Lubes
1. Hydrogenation	4,340(1)	1,125(1)	1,740	1,150	325
2. Hydrocarbon Synthesis					
(a) From known plants	1,200(2)	50(2)	575	515	60
(b) From "unknown" plants (probably mostly from hydro tail gases)	170	-	85	75	10
Total synthetics	5,710	1,175(3)	2,400(3)	1,740(3)	395(3)

(1) These figures include 150,000 tons of octanes (alkylate and iso-octanes), but otherwise are derived as indicated in Appendix A.
(2) These figures include 50,000 tons octanes, but do not include gaseous fuel.
(3) The product breakdown as assumed in this report can be modified within certain limits to take account of fluctuations in demand for the various products. Final year-end estimates of demand are not as yet available.

A - HYDROGENATION

The capacities of the plants (in terms of motor gasoline) have been taken at the figures agreed upon with the British last summer, subject to some minor revisions called for by the British interpretation of subsequent air coverage. The basis for the product breakdown of the plants running on bituminous coal tars is the same as in the previous Enemy Oil Committee Report (EOC 45-3). However, the product breakdown for the plants operating on brown coal and LTC tars has been revised as described below. In the previous report the product distribution for the plants operating on brown coal and brown coal tar was based on the yield relation as follows:

	In terms of motor gasoline	In terms of diesel oil, etc.
Gasoline	100	50
Diesel Oil, etc.	0	55
Total Products	100	105

On the basis of reaction volume required, the capacity in terms of products when operating for diesel oil, etc. would be about 25% higher than the motor gasoline capacity; based on the H_2 consumption the capacity might even be as much as 50% higher. Nevertheless, in the previous Enemy Oil Committee Report (EOC 45-3) the yield basis rather than either the stall volume or the H_2 consumption basis was taken not only to remain on the conservative side, but also it was felt that if a plant designed to run all the way to motor gasoline were run to Diesel oil, etc., a number of bottlenecks (such as distillation, circulating pumps, etc.) would limit the amount of throughput, and therefore, the possibility of taking full advantage of the smaller reaction volume or H_2 consumption required when operating on Diesel oil, etc.

However, in the case of a plant like Bruex, which has been designed to run to Diesel oil, etc. rather than to motor gasoline, it is believed that the stall factor or the H_2 factor is a better one. As far as the older plants are concerned (Boehlen, Magdeburg, Zeitz and Wesseling), it is likely that by now the bottlenecks, if any, have been ironed out; also since some allowance at least must be made for improvements in technique. Since high pressure equipment, including specifically stalls, seem to be a bottleneck the stall factor has been taken at 1.25 rather than the H_2 factor of 1.5. However, to the extent this stall bottleneck is corrected, the Germans may be able to push their production nearer to the H_2 factor (1.5). Appendix B gives the formula used in this estimate for the product breakdown.

The above is probably offset somewhat by the fact that certain of the brown coal tar plants are making other commercial products with a consequent reduction in the output of liquid fuels and lubricants. The products that seem most probable from the intelligence on hand are soaps, fats and possibly other products made from waxes, phenols and creosols. On the other hand, some of the wax may also be extracted and processed to make lubricating oils with some gasoline and Diesel oil as by-products. For the purpose of the present estimate this factor has been neglected, but it is suggested that for each of the plants this matter of redistribution of product be given further study in the light of the above.

The 1943 production of the hydrogenation plants is shown by products in Appendix A and is estimated as follows:

TABLE II

Estimated liquid fuel and lubricant production of hydrogenation plants in Axis Europe during 1943

	Metric Tons
Aviation Gasoline	975,000
Motor Gasoline	1,740,000
Diesel Oil	1,150,000
Lubes	325,000
Total liquid products	4,190,000

Bomb damage to hydrogenation plants during 1943 (estimated by Medmenham at about 20,000 tons) appears very small and has been neglected as being within the limits of reasonable error.

The production of the hydrogenation plants during the first half of 1944 is estimated in Appendix C, and their product output during this period is summarized in Table III, hereunder. No deductions have been made for bombing or other loss, and production figures have been increased over the 1943 estimates to allow for the Upper Silesian plants getting into full production, and for the expansions at Zeitz.

TABLE III

Estimated liquid fuel and lubricant production of hydrogenation plants in Axis Europe during the first six months of 1944

	Metric Tons
Aviation Gasoline	675,000
Motor Gasoline	1,160,000
Diesel Oil	730,000
Lubes	215,000
Total liquid products	2,780,000

There is additional production to be credited to the hydrogenation plants from the tail gases. There are three forms in which these gases may enter the liquid fuels pool, i.e., (1) as substitute fuels, bottled gas and liquefied gases, (2) as octanes (alkylate and iso-octanes) manufactured from the butanes, and (3) as hydrocarbon synthesis products made from the tail gases.

There are competitive sources of the substitute gaseous fuels coming also from oil refineries, coke ovens and hydrocarbon synthesis plants. These fuels are awkward to distribute, which makes the consumption essentially a local matter.

Octanes (alkylate and iso-octanes)

There has been a noteable improvement in the German "green" grade aviation

gasoline since the summer of 1942 which is identified with increased concentration of iso-octanes. This parallels information on the completion of the Roumanian alkylate plant. The chemical and physical analyses of enemy fuels leave some doubt as to the manufacturing processes that produced the iso-octanes but when the most probable figure - the percentage of 2,2,4 trimethyl pentane - is taken as an index and a factor applied corresponding to the percentage of this constituent in American alkylate it appears that the 1943 grade of German "green" fuel contains from 30 - 40% of alkylate.

The estimation of alkylate in the "blue" grade is less certain but may be 10% in some samples. There are adequate supplies of butanes to raise the production of alkylate to over 500,000 tons per annum; indeed this might be the easiest way for Germany to expand their aviation gasoline supplies quite aside from the very substantial improvement in quality. It is suggested that this component of aviation gasoline be given special consideration both as an index of quality and of expanding supplies.

Alkylate is understood to be produced at the following locations: Ploesti (oil refineries), Holten (Fischer-Tropsch), and the Leuna and Poelitz hydro plants. The alkylate plants at Ploesti, Leuna and Poelitz are believed to have approximately the same capacity, this is, about 50,000 tons per annum each. Recent aerial photographs of Boehlen, Zeitz, Bruex and Blechhammer South suggest alkylate plants at these locations. It is noteworthy that the Nazis have recently prohibited the use of liquefied gases as motor fuels -- suggesting a more important use for butanes. Such use might well be aviation gasoline by the alkylate route.

For the year 1943 it is estimated that the Ploesti, Holten, Leuna and Poelitz octane plants have been operating at their rated capacity of about 50,000 tons per annum, and that Boehlen and Zeitz have been producing at about 50% of their ultimate capacity, or say at 25,000 tons each per annum. The Bruex and Blechhammer South plants are assumed not to have been producing any significant amount of alkylate during 1943. On the above basis the total octane production for 1943 (after allowing for bomb damage) has been estimated at 235,000 tons as shown in Table IV. For the first six months of 1944 it is assumed that all the octane plants except Bruex and Blechhammer South will be producing at their rated capacity of 50,000 tons per annum, and that Bruex and Blechhammer South will be operating at a 50% rate -- giving for the six-month period a total estimated output of say 175,000 tons of octanes.

TABLE IV

Estimated production of octanes (alkylate and iso-octane) in Axis Europe during 1943

	Metric Tons
Hydro plants	150,000
Fischer-Tropsch	50,000
Rumanian refineries	35,000*
Total octanes	235,000

Serious consideration should be given to crediting hydro plants with additional production from the hydrocarbon synthesis process because: (1) The I. G. Farben has developed a process that is in some way superior to the Fischer-Tropsch process, (2) the tail gases from the hydro plants make an ideal material for the process because they are substantially purged of the catalyst poisons that are so expensive to deal with where the synthesis gas is made from other sources, and (3) there is ancillary equipment observed in the aerial photographs of some of the hydro plants that may be identified with such processing. In all it is believed in 1943 the total of the estimated 200,000 tons per year of primary product from the hydrocarbon synthesis process as shown in Appendix D might have easily been produced from the tail gases of hydro plants in this manner. This is an additional reason why the importance of the hydrogenation plants in the Axis war effort is greater than reflected by our production estimates for those plants.

B - HYDROCARBON SYNTHESIS (FISCHER-TROPSCH)

The capacities of the plants (in terms of primary product) have been taken at the figures agreed upon with the British last summer, subject to some minor revisions called for by the interpretation of subsequent air coverage, and are shown in Appendix D.

There has been some damage from bombings to the plants in Castrop Rauxel, Holten, Hoesch, Wanne Eickel and Homberg, estimated by Medmenham at a production loss for 1943 of about 40,000 tons -- an estimate which has been adopted for the purposes of this report.

The product distribution has been changed as shown in Appendix E. The main reasons for the different basis for product distribution as compared to that previously used are that there has been an indicated shortage in Germany of diesel oil compared to gasoline and also an indicated large production of synthetic lubricating oils from wax. The end point of the motor gasoline fraction is therefore assumed to have been reduced from 200°C to 160°C. It has furthermore been assumed that the primary product is dewaxed. Of the wax one half is presumably cracked and worked up to lubes, whereas the other half is used for purposes other than liquid fuels (such as fatty acids, etc.) and has, therefore, for the purposes of the present estimates, been left out.

On the above basis, the 1943 production of the hydrocarbon synthesis plants in Axis Europe is estimated as follows:

TABLE V

Estimated production of liquid fuels and lubricants from hydrocarbon synthesis plants in Axis Europe during 1943 (all figures in thousands of metric tons)

	KNOWN PLANTS	"UNKNOWN" PLANTS	TOTAL
Motor gasoline 160°C E.P.	575	85	660
Diesel oil	515	75	590
Lubes	60	10	70
Total liquid fuels and lubes	1,150	170	1,320

*Annual figure reduced by 15,000 tons due to estimated effect of bomb damage

The propylenes and butylenes produced in the Fischer plants are credited separately for the production of octanes. It is known that there is a substantial production of aviation gasoline out of the Ruhr Benzin at Duisburg (Holten). This production is believed to be derived primarily from the alkylation of these olefins.

The production for the first half of 1944 is estimated in Appendix F, without deducting for bombing or other losses, to be at a somewhat higher rate due to estimated completion of extensions of the Castrop Rauxel plant and an assumed higher output for "unknown" plants (300,000 tons of primary product per year instead of 200,000 tons per year) and is as follows:

TABLE VI

Estimated production of liquid fuels and lubricants from hydrocarbon synthesis plants in Axis Europe during the first six months of 1944 (all figures in thousands of metric tons)

	KNOWN PLANTS	"UNKNOWN" PLANTS	TOTAL
Motor gasoline 160°C E.P.	300	65	365
Diesel oil	270	55	325
Lubes	30	5	35
Total liquid fuels and lubes	600	125	725

II - CARBONIZATION INDUSTRY

A - LOW TEMPERATURE CARBONIZATION

The low temperature carbonization of lignite (brown coal) and bituminous coal is the foundation of the German synthetic oil program. Most of the coal hydrogenation plants operate on the feed stock produced by this process and there is an additional production of products by the direct refining of these synthetic crude oils or low temperature tars. The overall production is shown in Appendix G. The production of products from the direct refining of low temperature tars after allowance for the tars consumed as feed stock in hydro plants is as follows. It has been assumed that all the tar produced by the low temperature carbonization of bituminous coal has been consumed as feed stock in the hydrogenation plants.

TABLE VII

Estimated production of liquid fuels by the direct refining of LTC tars in Axis Europe for the year 1943

	Metric Tons
Motor gasoline	50,000
Diesel oil	110,000
Fuel oil	220,000
Total	380,000

Consideration should be given to the possibility that some of the tar fractions are used as raw materials for the chemical industry (fatty acids, etc.) and thus would not enter into the liquid fuels pool, or, again, the wax might be cracked to lubes.

It seems quite probable that the low temperature carbonization of bituminous coal may be undergoing substantial expansion in Upper Silesia because the tar acids that are produced are valuable raw materials for the rapidly expanding chemical industry of that area. It is suggested that the persistent

rumors of new synthetic oil plants in this area, especially at Waldenburg, may prove to refer to low temperature carbonization plants with the product largely consumed either in the chemical industry or as feed stock to the hydro plants. It is noteable in this connection that the Blechhammer North hydro plant which was originally believed to use raw coal as the feed stock is now indicated to be designed for the hydrogenation of tars. At this same installation there is also a very considerable gas plant with very large coal bunkers at the gas plant, which suggests the possibility of a new operation wherein the low temperature carbonization of coal is operated for the production of tar and gas.

B - HIGH TEMPERATURE TARS

It is estimated that the tar production of the Axis powers is about 4,000,000 tons, with the additional recovery of 1 million tons of crude benzol (benzol, toluol, xylenes). It is estimated that after satisfying the requirements of the hydrogenation plants and other chemical and war industries about 3,000,000 tons of H.T. tar and 600,000 tons of benzol are available for the liquid fuels pool. As shown in Appendix H the liquid fuels produced therefrom are estimated as follows:

TABLE VIII

Liquid fuels and lubricants from H. T. carbonization of bituminous coal in Axis Europe in the year 1943 (other than by hydrogenation of H.T. tars)

	Metric Tons
Aviation gasoline	100,000*
Motor gasoline	530,000**
Diesel oil	90,000
Fuel oil	780,000
Total	1,500,000

Another potential supply of liquid fuels from the coking of coal has been considered and assigned entirely to chemical manufacture without any direct credit to the liquid fuel supplies. The additional production referred to is that extracted from coke oven gas, as a by-product from the liquefaction of th gas for the production of hydrogen. Some 75,000 tons a year of gaseous ol ins are thus obtained that may be used to produce either chemicals, lubricating oils or alkylate. In the present estimate these olefins are all credited to the production of glycols or other chemicals and are not included among liquid fuels and lubricants. This is not to say that some of these gaseous olefins do not go into the liquid pool, but such amounts are believed to be small, and in any case offset by known diversions from the liquid fuel pool that have not otherwise been specifically accounted for.

III - HYDROCARBON GASES

The synthetic oil plants of Axis Europe produce large amounts of gaseous hydrocarbons ranging from methane to butanes (C_1 to C_4). A certain part of the butanes, as produced, are incorporated directly in gasoline. The remainder of the gases are available for various purposes, including alkylation for the production of higher octane aviation gasoline components.

As far as the C_1 and C_2 hydrocarbons are concerned, their uses will be mainly as fuel gas or for conversion to hydrogen (either pure for hydrogenation or with carbon monoxide for hydrocarbon synthesis). As mentioned above, however, some industries, notably the coke ovens in the Ruhr, produce and separate an estimated 75,000 tons per year of olefins, including ethylene (C_2), which may be valuable raw materials for further synthesis.

The C_3 and C_4 hydrocarbons also provide effective raw material for synthesis, the products produced therefrom including high octane blending agents, synthetic rubber and numerous chemicals and solvents. They may also prove to have important military uses as propellents, explosives or incendiary or poison gases, either as such or as raw material for their manufacture.

The C_3 and C_4 hydrocarbons are produced by the synthetic plants in substantial quantity -- with an output for 1943 of say 1,500,000 tons being well within the limits of reasonable expectation. Allowing for the C_4 content of the aviation and motor gasoline produced by these plants and further allowing

*Benzol
**Includes 500,000 tons benzol

for the necessary raw materials for octane production, there is an apparent excess of C_3 and C_4 hydrocarbons from the Axis Europe synthetic plants of the order of 1,000,000 tons.

While part of this production is used as bottled gas and for some special domestic and industrial heating and lighting purposes, all such uses together would only account for a few hundred thousand tons per year. It seems unlikely that the Axis would use the remainder of these valuable gases as industrial fuel, and at present we have no satisfactory allocation for them. More precise figures for this excess supply will be available after further work has been done with the samples of captured fuels. It may be observed in this connection that the analyses so far completed make it clear that there was a noteable increase in the alkylate content of the enemy gasoline as of about the middle of 1942.

For the sake of completeness we may add that the synthetic plants are not the only sources of C_3 and C_4 hydrocarbons. It is believed, however, that without too much of an error it can be assumed that production from other sources (natural gasoline and crude oil refineries) is just about sufficient to cover requirements for the normal butane contained in gasoline, and for alkylation feed stock at Ploesti.

HYDROGENATION PLANTS IN AXIS EUROPE

ESTIMATED PRODUCTION IN TERMS OF MOTOR GASOLINE. MONTHLY FIGURES SHOWN AT ANNUAL RATE. ALL FIGURES IN THOUSANDS OF METRIC TONS

	Feed	1943 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Total 1943
A. Bituminous Coal or Tars														
Gelsenberg Hit 12,14 May Hit 21 June	Coal	350	350	350	350	350	350	350	350	350	350	350	350	350
Scholven	Coal	400	400	400	400	400	400	400	400	400	400	400	400	400
Out. – Poelitz Hit May 13, 29, June 20	Tar and Coal	600	600	600	600	600	600	600	600	600	600	600	600	600
Blechhammer N.	Tar	-	-	-	-	-	-	-	-	-	200	200	200	50
Blechhammer S.	Tar	-	-	-	-	-	-	125	250	250	300	300	300	125
Welheim		100	100	100	100	100	100	100	100	100	100	100	100	100 Hit (378A).
Liévin	Coal	10	10	10	10	10	10	10	10	10	10	10	10	10
Béthune	Coal	10	10	10	10	10	10	10	10	10	10	10	10	10
													Subtotal	1,645
B. Brown Coal or Tar														
Boehlen Hit May 12 June 29	L.T.C. Tar	300	300	300	300	300	300	300	300	300	300	300	300	300
Magdeburg " " 28	L.T.C. Tar	250	250	250	250	250	250	250	250	250	250	250	250	250
Zeitz Hit " 12,28	L.T.C. Tar	300	300	300	300	300	300	300	300	300	300	300	300	300
Bruex " " 12	L.T.C. Tar	250	300	350	350	400	400	450	500	550	550	600	700	450
Luena " " 12,28	Coal & L.T.C. Tar	600	600	600	600	600	600	600	600	600	600	600	600	600
Lützkendorf " " 12,28	L.T.C. Tar	125*	125*	125*	125*	125*	125*	125*	125*	125*	125*	125*	125*	125* ← ?
A.G. für Kraft.	L.T.C. Tar	100	100	100	100	100	100	100	100	100	100	100	100	100
Wesseling	Brn. Coal	200	200	200	200	200	200	200	200	200	200	200	200	200
Total		3,595	3,645	3,695	3,695	3,745	3,745	3,920	4,095	4,145	4,395	4,445	4,545	3,970

? → ?

PRODUCT BREAKDOWN (see Appendix B)	Motor Gas. Cap'y	Aviation Gas.	Motor Gas	Diesel Oil**	Lubes**	Total of prods.
Plants sub B (Except Leuna and Lützkendorf)	1,600	-	800	1000	200	2,000
Lützkendorf	125*	-	-	100	25	125
Leuna	600	150	300	50	100	600
Plants sub A	1,645	825	640	-	-	1,465
Total	3,970	975	1,740	1,150	325	4,190

*Assumed to be gas oil and lube only

**Allocation between Lube Oil and Diesel Oil arbitrary

APPENDIX A

PRODUCT BREAKDOWN OF HYDROGENATION PLANTS

I. Bituminous Coal and Bituminous Coal Raw Tar -

Plants operating on these materials show the following relation in production when making either motor spirit exclusively or aviation spirit and motor spirit,

	Motor spirit only	Aviation spirit etc.
Aviation spirit	0	50
Motor spirit	100	39
Total liquid products	100	89

II. Brown Coal and Brown Coal Tar (L.T.C. Tar) -

The comparative yields when making either motor spirit or motor spirit and heavier products: diesel oil and lubricants: show the following relation:

	Motor spirit only	Diesel etc.
Motor spirit 160°C.E.P.	100	50
Diesel oil and lubes	0	75
Total liquid products	100	125

III. When gas oils, diesel oils or middle oils are either converted to motor spirit or aromatized to aviation spirit base stock, the comparative yields are as follows:

	Motor spirit only	Aviation spirit etc.
Aviation spirit	0	37.5
Motor spirit	100	50
Total liquid products	100	87.5

The above formulae are applied as follows: the bituminous coal and bituminous coal tar plants are assumed to be producing aviation spirit, according to Section I above. The production from brown coal or brown coal tar is estimated as follows: the Leuna plant is assumed to be producing 150,000 tons per annum of aviation base stock, according to Section III; while the other brown coal plants* and the balance of the Leuna capacity are producing motor spirit and heavier products according to the formula of Section II. No distinction is made between diesel oil and lube oil from the point of view of yields or capacity.

* except Luetzkendorf which has been put in at 125,000 tons per annum of diesel oil and lubes net.

HYDROGENATION PLANTS IN AXIS EUROPE

Estimated production in terms of motor gasoline capacity.
Monthly figures shown at annual rate. All figures in thousands of metric tons

	Jan.	Feb.	March	April	May	June	First 6 Months '44
A. Bit. Coal or Tars							
Gelsenberg	350	350	350	350	350	350	175
Scholven	400	400	400	400	400	400	200
Poelitz	600	600	600	600	600	600	300
Blechhammer N.	300	400	500	500	500	500	~~225~~ 125
Blechhammer S.	400	500	500	500	500	500	~~240~~ 300
Welheim	100	100	100	100	100	100	50
Liévin	10	10	10	10	10	10	5
Béthune	10	10	10	10	10	10	5
Sub-Total A							1,200
Oswiecim (Auschwitz) Poland							
B. Brown Coal or Tar							
Boehlen	350	350	350	350	350	350	175
Magdeburg	300	300	300	300	300	300	150
Zeitz	400	400	500	500	500	500	230
Bruex	750	750	750	750	750	750	375
Leuna	600	600	600	600	600	600	300
Leutzkendorf	125*	125*	125*	125*	125*	125*	60*
~~A. G. für Kraft.~~	~~100~~	~~100~~	~~100~~	~~100~~	~~100~~	~~100~~	~~50~~
Wesseling	200	200	200	200	200	200	100
Sub-Total B							1,440
Grand Total =							2,640

PRODUCT BREAKDOWN	PRODUCTS: Motor Gasoline Capacity	Aviation Gasoline	Motor	Diesel Oil **	Lubes**	Total
Plants Sub (B) (except Lützkendorf & Leuna)	1,080	-	540	660	150	1,350
Leuna	300	75	150	25	50	300
Lützkendorf	60*			45	15	60
Plants Sub (A)	1,200	600	470	-	-	1,070
Total	2,640	675	1,160	730	215	2,780

*Assumed to be gas oil and lube only.
**Allocation between lube oil and diesel oil arbitrary.

HYDROCARBON SYNTHESIS PLANTS IN AXIS EUROPE

ESTIMATED PRODUCTION IN TERMS OF PRIMARY PRODUCTS (SYNTHETIC CRUDE)
MONTHLY FIGURES SHOWN AT ANNUAL RATE. ALL FIGURES IN THOUSANDS OF METRIC TONS

	1943												
Plant	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total 1943
Holten	130	130	130	130	130	130	130	130	130	130	130	130	130
Castrop Rauxel	100	100	100	100	100	100	100	100	100	100	100	100	100
Hoesch	90	90	90	90	90	90	90	90	90	90	90	90	90
Homberg	190	190	190	190	190	190	190	190	190	190	190	190	190
Krupp (Wanne Eickel)	130	130	130	130	130	130	130	130	130	130	130	130	130
Essener Verein	100	100	100	100	100	100	100	100	100	100	100	100	100
Lutzkendorf	150	150	150	150	150	150	150	150	150	150	150	150	150
Schwarzheide	350	350	350	350	350	350	350	350	350	350	350	350	350
Deschowitz	110	110	110	110	110	110	110	110	110	110	110	110	110
Kuhlmann (Harnes)	30	30	30	30	30	30	30	30	30	30	30	30	30
Total	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380
Estimated loss from bombing													40
Subtotal													1340
"unknown" plants (probably based on hydro tail gases)													200*
Grand Total													1,540

*No attempt has been made at a monthly allocation of this production.

APPENDIX D

1943 PRODUCTION OF HYDROCARBON SYNTHESIS PLANTS IN AXIS EUROPE

(Broken down by products without further processing of wax)

	Low pressure process	Medium pressure process	Average (assuming about 75% M.P. 25% L.P.)		
	% of prim. product.	% of prim. product.	%	Known plants thousands tons	"Unknown" plants thousands tons
C_3+C_4	8	6.5	7.5	100	15.
Motor 160°E.P.	45.*	30.*	40.*	535	80
Diesel	37.*	37.*	37.*	495	74
Lubes	-	-	-	-	-
Wax	10.	26.5	15.	200	30
Total prim. product	100.	100.	99.5	1,330	199
		Dist. loss say .5		10	1
			100.0	1,340	200

1943 PRODUCTION OF HYDROCARBON SYNTHESIS PLANTS

(Assuming cracking of one half of the wax** and utilization of the other half for purposes other than liquid fuel such as e.g. fatty acids, etc.)

	(Without correction for C_4 in Motor Gasoline)	Assuming 5% C_4 in Motor Gasoline		
	% of prim. prod.	% of prim. prod.	Known plants thousands tons	"Unknown" plants thousands tons
C_3+C_4	(8)	(5.25)	(70)	(10)
Motor 160°E.P.	40.75	43	575	85
Diesel	38.5	38.5	515	75
Lubes	4.5	4.5	60	10
Total liquid fuels and lubes (Excl. C_3+C_4)	83.75	86.	1,150	170

*Lower motor gasoline and higher diesel oil content (as compared to figures previously used) due to lower E.P. (160°C. versus 200°C.) of the gasoline and correspondingly lower IBP of diesel oil.
Motor gasoline figure is excluding any C_4 content.

**Assuming conversion as follows:

60%	Lube
20%	D.O.
10%	Motor
6%	C_3+C_4
4%	Ref. gas and loss
100%	

HYDROCARBON SYNTHESIS PLANTS IN AXIS EUROPE

ESTIMATED PRODUCTION IN TERMS OF PRIMARY PRODUCTS (SYNTHETIC CRUDE) MONTHLY FIGURES SHOWN AT ANNUAL RATE. ALL FIGURES IN THOUSANDS OF METRIC TONS

Plant	1944 Jan.	Feb.	Mar.	April	May	June	6 Months 1944
Holten Sterkrade	130	130	130	130	130	130	65
Castrop Rauxel	150	150	150	150	150	150	75
Hoesch	90	90	90	90	90	90	45
Homberg	190	190	190	190	190	190	95
Krupp (Wanne Eickel)	130	130	130	130	130	130	65
Essener Verein	100	100	100	100	100	100	50
Lützkendorf	150	150	150	150	150	150	75
Schwarzheide Ruhland	350	350	350	350	350	350	175
Deschowitz	110	110	110	110	110	110	55
Kuhlmann (Harnes)	30	30	30	30	30	30	15
Total known plants	1430	1430	1430	1430	1430	1430	715
Total "unknown" plants							150

ESTIMATED PRODUCT OUTPUT*
(in thousands of metric tons)

	KNOWN PLANTS	"UNKNOWN" PLANTS	TOTAL
Motor gasoline	307	64.5	371.5
Diesel Oil	275	57.7	332.7
Lubes	32.2	6.8	39.0
Total	614.2	129	743.2**

*See Appendix E for basis of breakdown

**Exclusive of C_3 and C_4 output

ESTIMATED CONTRIBUTION OF L.T.C. INDUSTRY IN AXIS EUROPE TO LIQUID FUELS AND LUBES PRODUCTION IN 1943

	Metric Tons
Total production of L.T.C. tars	3,500,000
Amount used as feed to hydro plants	3,000,000
Balance	500,000

The balance of 500,000 tons as above indicated, is believed to be worked up primarily as fuel, with a product breakdown estimated as follows:

Process	L.T.C. tar	Aviation	Motor	Diesel	Fuel	Total Liquid	Other uses and loss
Distillation	200	-	5	10	110	125	75
Cracking	100	-	15	25	40	80**	20
Solvent extraction	200	-	30	75	70	175	25
Total	500	-	50	110	220	380	120

**Yields as suggested by the British during London meetings (see paragraph 278 of the "Record"). According to a German publication (Vierjahres Plan 1939, page 929) the yields from various treatments of lignite tar (in terms of weight percentage of throughput) are as follows:

	Treatment by distillation (with wax conversion) A	Treatment by distillation (with wax conversion) B	Treatment by partial cracking	Treatment by complete cracking	Treatment by Hydrogenation A	Treatment by Hydrogenation B
Gascline	6	6	10	33-35	80	20
Lubricants	9	9	-	-	-	17.5
Gas Oil	21	35	45-50	-	-	39
Fuel Oil	43	29	10	20-22	-	-
Total Liquids	79	79	65-70	55	80	76.5
Paraffin Wax	-	-	-	-	-	13.5
Pitch	2	2	15-20	30	-	-
Coke for Electrodes	9	9	-	-	-	-
Gas and Losses	10	10	15	15	20	10

ESTIMATED CONTRIBUTION OF H. T. CARBONIZATION INDUSTRY IN AXIS EUROPE TO LIQUID FUELS AND LUBES PRODUCTION IN 1943

(all figures in thousands of metric tons)

	TOTAL	Liquid Fuels					
		Aviation	Motor	Diesel	Fuel	Total Liquids	Other use & Loss
H. T. tars and benzoles	5,000						
From gases							
Benzol*	800	100	500	-	-	600	200
Toluol and xylols	200	-	-	-	-	-	200
From tar							
Direct	3,000	-	30	90	780	900	2,100
To hydro feed and other uses	1,000	-	-	-	-	-	1,000
TOTAL	5,000	100	530	90	780	1,500	

*There is also an estimated production of 75,000 tons annually of olefins (68% of which is extracted from "Ruhr Gas") part of which might be credited to either alkylate or lube oils.