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WAR CABINET

TECHNICAL SUB-COMMITTEE ON AXIS OIL

THE AXIS OIL POSITION IN EUROPE MAY 1943

Offices of the War Cabinet, S.W. 1,
25*th June*, 1943.

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TECHNICAL SUB-COMMITTEE ON AXIS OIL.

The Axis Oil Position in Europe, May 1943.

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REPORT.

1. We now submit our half-yearly report on the Axis oil position in Europe at the end of April 1943. Annex II has been prepared by the Sub-Committee under the Chairmanship of Lieutenant-Colonel Auld. Annexes III and V have been prepared by the Ministry of Economic Warfare, and Annex VI by the Petroleum Board Enemy Oils and Fuels Committee. We wish to confirm and endorse the contents of these Annexes and the conclusions therein reached.

Introductory.

2. From the beginning of the war against Germany until the end of 1942, the consumption of oil in Axis Europe has substantially exceeded production. This has necessitated continuous withdrawal from stocks.

3. On the other hand, loot from the Axis 1940 conquests replenished stocks, and at the time of the German attack on Russia in June 1941 aggregate stocks were probably about the same as they had been in September 1939, though the area these stocks had to cover was much greater.

4. Axis reserves were not depleted to a critical point before the middle of 1942.

Previous Reports.

5. In our last half-yearly report which dealt with the position at the end of November 1942, we pointed out that the enemies' failure to secure the Caucasus oilfields during their Summer campaign had upset their plans. Lack of supplies was making it necessary to cut civil consumption below our estimate of the level required to ensure the degree of distribution efficiency necessary for the maintenance of a maximum war effort.

Not only this, but there was evidence to suggest that the Germans had concluded that the curtailment of civil consumption had reached a point where further reductions would be more harmful to their war effort than restrictions on supplies to the armed forces, and that the latter were, consequently, being cut.

6. In spite of these economies, the depletion of reserves continued and by the end of October 1942 stocks had dropped to a point half a million tons below the figure of 3 million tons which we estimated to be the minimum necessary to ensure efficient distribution.

Intelligence obtained since the date of that Report has confirmed that the position at the end of 1942 was critical.

7. In our Interim Report issued in April 1943 we expressed the opinion that shortage of Oil was still causing the enemy acute anxiety, although some improvement in the stock position had taken place.

We estimated that the position would remain difficult until the new synthetic oil plants came into large-scale production—probably some time after the middle of 1943.

8. We also pointed out that, whether our estimate of the minimum necessary stock was accurate or not, the danger point was, in fact, reached at the time we had expected. Starting with this fresh datum point, deductions from the trend of the Axis stock position can be made with more certainty.

Developments during the six months ending 30th April, 1943.

9. As stated in the same report, we estimate that during the six months ending the 30th April, 1943, total production exceeded consumption by something between 500,000 and 600,000 tons.

10. Thus, by the 30th April, 1943, the stock figure had been restored to the 3 million tons which we estimated to be the minimum necessary to ensure efficient distribution.

11. We summarise in Annex I to this Report the calculations by which these figures are arrived at.

The present position.

12. For the reasons given in Annex I we consider that the most that the Axis can have achieved during the six months ending the 30th April, 1943, will have been to restore reserves to the figure at which they stood at the start of the 1942 campaigning season.

13. The stock position is, however, weaker than these over-all figures suggest, in that there is now a serious shortage of Diesel Oil, as is shown by the laying-up of Diesel ships, even where shipping is urgently required.

14. The supply of Diesel oil has always presented a difficult problem to Germany, but in drawing attention in our previous reports to the flexibility of the Axis Oil Structure, we have expressed the view that, although aggregate stocks might be expected to decline, it was improbable that any particular class of product would show a sufficient drop to cause serious dislocation, so long as the necessary aggregate was maintained.

The recent reports indicating an acute shortage of Diesel Oil do, therefore, suggest that the shortage has been so severe that it has been impossible to adjust production so as to meet the needs in all grades of oil simultaneously.

Comparison with Previous Report.

15. In comparison with the period covered by our previous report, the Oil situation in Europe on the 30th April, 1943, was in some respects more, and in some respects less, favourable to the Axis Powers.

Favourable factors.

16. The favourable factors are :—

(*a*) The line on the Russian front has been shortened. Consumption on that front may, therefore, be less in 1943 than in 1942, especially if the scale of military operations is also less.

(*b*) The output of synthetic oil has been increased and, with the coming into production of large new plants, at least a million tons of additional annual production is in sight. (But see para. 17(*d*) below.)

(*c*) The output of crude oil from the Hungarian fields and from the Vienna Basin has shown a considerable increase during the last few months, and a further expansion may be looked for. (But see para. 17(*c*) below.)

(*d*) Progress has been made in the use of alternative fuels such as producer gas, though only at the expense of some loss in efficiency. Possibilities still exist for development along these lines, although only to a limited extent.

Unfavourable Factors.

17. The unfavourable factors are :—

(*a*) The change for the worse in Germany's strategic position has made it more than ever essential to conserve and build up stocks.

(*b*) There has been a decline in the flexibility of the oil structure as a whole evidenced by the shortage of Diesel Oil.

(*c*) The output of crude oil from the European fields, other than Hungary and the Vienna Basin, is declining. (But see para. 16(*c*) above.)

(*d*) Of the three new large synthetic oil plants under construction, the one which was expected to be the first to come into production (Brux, the construction of which was begun in June 1939), is considerably behind schedule and is unlikely to be in full operation before the beginning of 1944. This *may* justify the inference that the completion of the other plants will be correspondingly retarded. (But see para. 16(*b*) above.)

(*e*) It is now too late in the year for the Germans to have any hope that any fresh oilfields which they might capture in the course of this Summer's campaign would yield them any supplies before the Spring of 1944.

(*f*) Little, if any, further saving in liquid fuels can be looked for through reducing civil consumption, since this has already been cut to an extent which impairs the war effort. (But see para. 5 above.)

Future Trends.

18. Our estimates of the future rate of synthetic oil production are based, in the main, on the results of aerial reconnaissance, and we have hitherto assumed that the first of the two plants under construction at Blechammer would start production in the middle of 1943.

19. If this date were realised, the rate of production of synthetic oil would increase by the end of September 1943 by a million tons a year.

This increased production would permit an increase in civil consumption by the end of the year to the level of the summer of 1941, while covering military consumption at the same rate as in 1942, and at the same time allowing for a gradual build-up of stocks by a further ½ million tons provided that production from existing sources was maintained.

20. If, however, the delay which has been observed in the construction of the Brux plant has been paralleled in the case of the other plants, the increased rate of production would not be achieved before the end of 1943.

In view of the fact that our information on this subject is based almost entirely on the result of aerial reconnaissance of the Synthetic Oil plants, we wish to emphasise the importance which we attach to these reconnaissance flights being carried out at regular intervals.

21. Italy is at present drawing a million tons of oil a year from Roumania. If, therefore, Italy were to drop out of the war, then, so long as Germany retained the ability to control and transport the Roumanian production, her own oil problem would be eased to the important extent of a million tons.

22. If the new synthetic plants do not come into production until some time after the rate of military consumption has reached the 1942 figure and if Italy has remained in the war, Germany's oil structure will be stretched to the utmost.

23. It is clear from current intelligence that Germany regards her oil position with more anxiety than would seem justified from this forecast.

This may be due to : (*a*) anticipation that the completion of the new synthetic plant capacity may be delayed, (*b*) the pressing need to save as much oil as possible now before new military operations force consumption up.

Summary.

(A) During the six months ending the 30th April, 1943, Germany increased her oil stocks by over 500,000 tons, thereby restoring them to the figure which we estimate, to be the minimum necessary to ensure efficient distribution. (Para. 9.)

(B) Our estimates of the Axis minimum oil stocks were made at a time when Germany had the initiative; the loss of it must have increased her minimum stock requirements. (Para. 17 (*a*).)

(C) The present position is uncomfortably tight and will not substantially improve until either the new synthetic oil plants come into large-scale production or Italy goes out of the war. (Paras. 19 and 21.)

(D) The serious shortage of Diesel Oil indicates how difficult the general position is at the present time. (Para. 14.)

(E) The drastic curtailment of civil consumption is directly affecting Germany's war effort. (Para. 4.)

(F) When the new synthetic oil plants come into full production Germany's essential needs should be met. This may happen by the beginning of 1944. (Paras. 19 and 20.)

(G) If Italy goes out of the war, Germany's immediate shortages can be met by using the Roumanian oil at present supplied to Italy. (Para. 21.)

(H) The critical stage in the German oil situation which was previously expected to last only until the middle of 1943, may have been extended by at least three months. (Para 17 (*d*).)

(I) If the new synthetic plants do not come into production until some time after the rate of military consumption has reached the 1942 figure, and if Italy has remained in the war, Germany's oil structure will be stretched to the utmost. (Paras. 21 and 22.)

Conclusion.

The future development of Germany's oil situation depends, in the main, on three factors :—

(*a*) The scale and location of military operations, and the resulting rate of consumption.
(*b*) Whether or not Italy drops out of the war.
(*c*) The dates on which the new synthetic oil plants come into full production.

Deduction.

We should, so far as possible, during the next six months, use every endeavour :—

(*a*) To destroy as much German oil and oil producing plant as possible.
(*b*) To cause the Germans to increase their rate of consumption to the highest possible extent.

Signed on behalf of the Sub-Committee,
H. HARTLEY,
Chairman.

ANNEX I.

STATISTICAL REVIEW OF DEVELOPMENTS BETWEEN THE 1ST NOVEMBER, 1942, AND THE 30TH APRIL, 1943.

1. We have received from the Technical Sub-Committee, under the Chairmanship of Lieutenant-Colonel Auld, a final estimate of production for the period under review. Deducting the corresponding consumption figures, revised in the light of the latest intelligence reports, we arrive at the following picture :—

	Tons.	*Tons.*
Production* (see Annex II)		8,477,000
Less Consumption :—		
(*a*) Civil† (Annex III)	3,587,000	
(*b*) Armed Forces (Annex IV)...	3,885,000	
(*c*) Exports to neutrals	80,000	
		7,552,000
Showing a theoretical Stock increase of		925,000
From this figure we deduct—		
*(*a*) 10 per cent. of estimated synthetic output	241,000	
‡(*b*) For losses by sinkings ...	100,000	
‡(*c*) For losses in Russia and N. Africa	75,000	
		416,000
Giving an estimated net increase in Stock of ...		509,000

* (*a*) The rate of production of crude oil (Annex II) has remained almost unchanged. Reports of very large increases in output in Austria and Hungary have not been completely confirmed, and such increases as have occurred in these areas have been offset by declines in Roumania, Poland and Albania.

(*b*) The Production Sub-Committee has estimated the output of the synthetic oil plants on the assumption that operations have been unaffected by war difficulties or by air attack. We consider that, under existing conditions, this is unlikely to have been the case, and that a ten per cent. reduction in the theoretical output of these plants should be made.

† No allowance has been made for supplies of fuel for agricultural purposes in Occupied Russia.

‡ No account has been taken by the Production Sub-Committee of the losses resulting from the military reverses in Russia and North Africa, and from the sinking of tankers. We have, therefore, made adjustments under both these heads.

ANNEX II.

Report of the Committee on European Axis Oil Production.

Oil Production in Axis Occupied Europe for period the 1st November, 1942, to the 30th April, 1943.

In Appendix A are set out the details of our estimates of the annual rate of production of oil (Primary Finished Products) in Axis occupied Europe for the six months ended the 30th April, 1943, amounting to 16,954 million tons. This total comprises:—

	(Figures for previous half-year in brackets.)
	Thousands of Tons.
1. Crude and Shale oil production ...	8,366 (8,380)
2. Synthetic oil production	4,864 (4,239)
3. Tar oils	1,838 (1,436)
4. Substitute and miscellaneous oils ...	1,886 (1,734)
	16,954 (15,789)

Crude Oil Production.

Hanover Fields.

In 1938 there were 330 wells in the Nienhagen district, the chief field in this area. Photographs taken in 1942 showed at least 123 wells in the northern sector, 23 in the middle-western part and 9 in the new section south of Hanigsen. The cover did not, however, include all the productive areas in the Nienhagen district.

In the new north-east sector there were apparently 20 new wells, with possibly 13 being drilled, and 6 in the south-east sector, with 3 being drilled. Assuming further completions up to the end of 1942, there were probably, by then, 40 new wells completed in the north-east and 10 in the south-east sectors. These wells are estimated to give an average daily production of 10 tons, that is, in total, 500 tons per day. The 330 old wells produced in 1938 only 2½ tons per day. It is, therefore, considered that their current production would not average more than one ton per day, *i.e.*, a total of 330 tons per day.

Thus, the total daily production for the Nienhagen field is estimated at 830 tons per day, equivalent to 302,000 tons per annum. It therefore appears that production has been maintained at about the 1938 level of 310,000 tons, but no definite opinion can be expressed. It is proposed, pending further evidence, to leave the estimate for the whole of the Hanover field at the figure of 450,000 tons per annum, being the same estimate as was taken in our report for the six months ending the 1st November last. It is thought, however, that this figure is more likely to err on the high than the low side.

Reitbrook.

This field had 4 drilling wells in March 1938, 16 at the end of that year and 70 in April 1941. With the 7 drilling outfits reported, each of which is considered capable of drilling one well to 3/4,000 feet depth in two months, 60 new wells could have been drilled in 18 months. Thus in November 1942 there were probably 130 wells. In the light of our knowledge of the earlier development, it is estimated that, allowing for fresh production, the daily average per well is 5 tons, equivalent to an annual production of 240,000 tons.

Heide.

In 1938 there were 15 producing wells. It is estimated that 25,000 tons per annum were produced from an average of 10 wells, which is equivalent to a daily production of approximately 7 tons per well from new wells.

Photographs taken in May, 1943, show that the original oilfield is exhausted as far as surface drilling is concerned. Activity has, however, continued in the new area situated one mile west of Heide. In February last year the photographs showed 17 locations with derricks and 12 locations apparently abandoned; this is an addition of 20 wells in 15 months. The previous deduction that the limits of the field were already defined is confirmed, as drilling has been restricted to the known productive area.

In February, 1942, 3 wells were seen to be drilling. Three drilling outfits could have drilled the additional wells now seen. The number of outfits seems,

however, to have been reduced, as only one drilling well is observed in the latest photographs, although one site may have the drilling gear partly dismantled.

The absence of an increase in activity confirms earlier deductions that the yield of oil obtainable is not large, or greater efforts would be made to exploit it during the present critical period. Some plant construction activity is taking place at Holle, north of Hemmingstedt, which may be preparations for the mining of oil sand.

In the circumstances, production from the Heide area is estimated to be equivalent to 50,000 tons per annum.

Vienna Basin.

In July 1942 the gross production of crude from the Vienna Basin fields was estimated at 740,000 tons for the whole of 1942; in our December report gross production was put at the rate of 850,000 tons per annum for the 6 months ended 31st October, 1942 (*i.e.*, 790,600 tons per annum of refined products).

There have been a number of reports implying large increases in output, but the weight of recent intelligence is that the rate of gross production for the 6 months ended 30th April, 1943, was approximately 850,000 tons per annum. We are, therefore, of the opinion that the estimate for the previous 6 months was on the high side and that the amount of refined products obtained during the 6 months ended 31st October was likely to have been at an annual rate of about 750,000 tons compared with our estimate of 790,000 tons for the 6 months under review.

Czechoslovakia.

The chief source of production is the Gbely field. The German technical press has reported that the Deutsche Erdoel A.G. produced 30,000 tons from this field in 1942 as compared with 24,000 tons in 1940.

A recent report stated that Czechoslovakia is still dependent for oil on other countries as her own crude production is very low. Other intelligence indicates that production is unimportant. It is therefore considered that current production is small and does not exceed 50,000 tons per annum. It may be lower than this level.

West and East Polish Fields.

Crude oil production for 1942 was estimated at 250,000 tons and 380,000 tons per annum for the west and east areas respectively. It is now considered that these figures were on the high side and that in all probability both areas are on the decline. Recent intelligence indicates that there has been no development of new fields and that total Polish production is, in spite of drilling activity in the old fields, only 500,000 tons per annum.

Our estimate for 1943 is 200,000 tons and 300,000 tons for West and East Poland respectively.

France.

No new information has been received to warrant the alteration of our previous estimate of 80,000 tons per annum for production in the Pechelbronn field. No success has been achieved in the development of oil in the St. Gaudens area where it is understood there is now only a limited production of gas.

Hungarian and Croatian Fields.

In our December report we raised our earlier estimate of 1942 production in Hungary from 480,000 to 600,000 tons as information had been received of greater production, particularly from the Lispe oil field. Production is increasing substantially, and the fact that a new refinery is being built in the Lispe area tends to confirm this.

Our estimate at the end of October was 750,000 tons. Assuming an increase of 15 per cent. for the period under review, production for the six months is taken at the rate of 850,000 tons per annum, *i.e.*, 425,000 tons for the half-year. There have been a number of reports that tend to confirm the correctness of this estimate.

Regarding crude oil production in Croatia, this oil is found chiefly in the neighbourhood of the Hungarian border adjoining the Lispe field. Production is not likely to reach substantial proportions, but allowing an increase of 10,000 tons per annum on our previous estimate of 40,000 tons per annum, this would amount to 25,000 tons for the half-year under review.

Italy.

The crude production in the Emilia field is thought to have remained very small. While it is probable that it is below 10,000 tons per annum, the estimate is put at this figure pending further information.

Albania.

About twelve months ago the possiblity was considered that Albanian production might have increased to 250,000 tons per year. Since then, there have been reports of difficulties in production and also of interference by guerrillas. In our December report, our estimate was therefore reduced to 140,000 tons per annum.

Intelligence points to lack of tanker activity across the Adriatic, and recent aerial reconnaissance of Bari refinery shows that this plant was not in operation at the time it was photographed. While the inactivity of the refinery may be only temporary, the inference is that either Albanian crude is being sent to Leghorn refinery (the only other refinery suitable for treating this crude), or production in Albania is not sufficient to keep the Bari plant fully active. The Leghorn refinery is known to be processing Roumanian and Hungarian oil, and it is possible that there might not be sufficient capacity to handle Albanian crude also. Furthermore, the congestion of rail traffic is such that the authorities would possibly not wish to burden the railways with oil traffic to Leghorn.

It is therefore concluded that Albania's production must at the present time be comparatively small, and a figure of 40,000 tons has been taken as the production for the six months under review. It is, however, possible that production for the full year may prove to be at a higher rate.

Roumania.

As the result of a recent detailed study of the Roumanian oil position, production for 1942 is estimated at 5,650,000 tons, and it is expected that production for 1943 will be lower by at least 250,000 tons. Assuming that the decline will be gradual during the year, production for the six months ending the 30th April is taken at 2,750,000 tons.

Occupied Russia.

As a shipment of 1,600 tons of crude oil was reported to have been moved westwards from an unspecified part of Russia in October 1942, it is thought that the Germans may be obtaining some oil from fields in the Romni and Lubni areas (between Kiev and Kharkov), which the Russians had begun to develop before the war.

Current production from these districts is therefore put at a nominal figure of 50,000 tons per annum.

Shale Oil Production.

Estonia.

Oil production from Estonian shale has been reported by a reliable source as 60,000 tons for 1942. If operating conditions are satisfactory, it is considered that production should increase during 1943, and during the six months under review may reach 40,000 tons.

France.

A director of one of the French oil companies reported a few months ago that the shale oil production from Autun had increased by 100 per cent. There is some confirmation of such an increase in the reports received in the middle of 1942 that the Autun refinery was being extended. Presumably this extension was to treat additional production of oil from shale. Recent aerial photographs indicate, however, that the output of the refinery has not been increased since 1937, when it was about 10,000 tons per annum. Our estimate is therefore put at approximately the same figure as given in our previous report, viz., 40,000 tons per annum.

Synthetic Oil Production.

Bergius Hydrogenation Plants.

In accordance with photographic evidence obtained during the past six months, and reports received from various sources, certain amendments to our

previous figures have now been made. Full details of the estimated production at the individual plants are shown in Appendix C. No change has been made in our previous estimate for the French plant.

Fischer Tropsch Plants.

The revised estimates for these plants in Greater Germany are given in Appendix D. As no information has been received regarding the current production of the French plants, the estimates are at the same level as in our previous report.

Miscellaneous.

High Temperature Tar Oils.

In accordance with our last report, we have taken into the production estimates all the fuel oil derived from H.T. tars (*i.e.*, 18·6 per cent.) in each country. Where the quantity available from this source is not as much as the difference between the estimated total consumption of Fuel Oil in the respective countries and the amount of Fuel Oil available from sources other than H.T. Tars, we have taken some of the Pitch from H.T. Tars. The amount of pitch derived from H.T. tars available for use as liquid oil fuel is equivalent to 25 per cent. of the H.T. tars, but we are advised that to make such pitch suitable for use as fuel oil it is necessary to blend it with an equal quantity of creosote/fuel oil. Where there is a deficiency as described above we have, therefore, taken pitch up to a maximum equivalent to the quantities of creosote/fuel oil available from H.T. Tars in the respective countries.

In the case of Greater Germany it is assumed that 400,000 tons per annum of Fuel Oil has been imported from Roumania, and that 50,000 tons per annum Creosote has been used to blend with Diesel oil.

The detailed figures are shown in Appendix E.

Alcohols.

It is assumed (*a*) that motor fuel consumed for civilian and industrial purposes and by the army, except in Russia and Africa, is blended with alcohol, (*b*) that the blend, except in case of France, contains an average of 25 per cent. alcohol, and (*c*) that ethanol is used in preference to methanol. Appendix F shows the amount of ethanol and methanol utilised. It will be noted that there appears to be a potential production of about 1,800,000 tons of methanol that is unused.

Vegetable Oils as Lubricants.

In view of the increased use of vegetable oils as lubricants in countries such as France, the previous estimate under this heading is increased to 100,000 tons per annum.

Regeneration of Used Lubricating Oil.

The total consumption of lubricating oils in Axis countries is about 1,200,000 tons per annum. Increasing attention is being paid to the regeneration of used lubricants. It is therefore considered that an allowance should be made for an overall increase in the use of regenerated oils, which we estimate at 20 per cent. of total consumption, viz., 240,000 tons per annum.

APPENDIX A.

Estimated Production in Terms of a Normal Range of Primary Finished Products.

Average Annual Rate during Period 1st November, 1942–30th April, 1943.

(In Thousands of Metric Tons.)

Source Groups.	Raw Materials.*	Aromatics.	Aviation Petrol.	Motor Petrol.	Kerosene.	Gas/ Diesel Oil.	Aviation and Motor Lubricants.	Other Lubricants.	Fuel Oils, Wax, Asphalt and Pitch.	Loss and Refinery Fuel.	Total Finished Products.	Key.
1. Hanover	450	...	...	45	72	81	67·5 A	67·5	45 Asphalt 36 Wax	36	414	1
2. Reitbrook	240	...	...	12	...	76	80 A	20	54 Asphalt 6 Wax	12	228	2
3. Heide...	50	...	...	2·5	...	16	13	4	11 Asphalt 1 Wax	2·5	47·5	3
4. Vienna Basin	850	...	...	40	...	324	240	120	50 Asphalt 16 Wax	60	790	4
5. Czechoslovakia	50	...	...	2	...	19	14	7	3 Asphalt 1 Wax	4	46	5
6. West Polish Fields	200	...	...	42	42	52	17	17	6 Asphalt 4 Wax	20	180	6
7. East Polish Fields	300	...	...	53	88	70	19	19	9 Asphalt 18 Wax	24	276	7
8. Bergius. Greater Germany—												8
(*a*) On Brown Coal Tar ...	...	...	...	1,293 B	...	...	...	...	...	...	1,293	(*a*)
(*b*) On Coals and Lignite ...	...	...	...	1,409 B	...	...	...	...	...	...	1,409	(*b*)
(*c*) Pitch	...	...	...	15	...	25	...	...	60	...	100	(*c*)
(*d*) Pitch/Creosote	...	...	30	90	...	30	...	...	...	...	150	(*d*)
9. Fischer Tropsch. Greater Germany. (Primary Products)	1,980	...	90	1,190	46	465	24	...	58	107	1,873	9
10. High Temperature Tar. Greater Germany. Bituminous Coal	2,330	...	...	23	...	117 F	...	...	554	...	694	10
11. Low Temperature Tar. Greater Germany—												11
(*a*) Brown Coal	836 C	...	...	...	...	317	...	...	283 75 Wax	...	675	(*a*)
(*b*) Bituminous Coal... ...	200	...	...	10	...	10	...	...	100	...	120	(*b*)

12. Estonian Shale	...	...	...	8	8	32	...		32		...	80	12
13. French Fields	80	...	...	4	16	16	6	10	22		6	74	13
14. French Shale	...	...	...	4	4	...	...	...	32		...	40	14
15. Bergius. France	...	...	...	15	...	...	...	...		...	...	15	15
16. Fischer Tropsch. France... ...	27	...	2	14	...	6	...	...	2		3	24	16
17. Hungarian and Croatian Fields ...	900	...	...	288	206	68	32	98	98		60	840	17
									50	Wax			
18. Italian Fields	10	...	1·5	5	2	1	...	...		...	·5	9·5	18
19. Albanian Fields	80	...	26	11	...	...	16	...	14		13	67	19
20. Rumanian Fields	5,500	...	660	660	754	670	50	70	2,366		270	5,230	20
21. Ukraine Fields	50	...	...	8	14	12	3	3	2	Asphalt	6	44	21
									2	Wax			
22. Vegetable Oils as Lubricants ...	...	...	...	...	...	...	6 D	94		...	...	100	22
23. Regeneration of used Lubricating Oils	...	...	...	...	...	...	...	240		...	...	240	23
24. Substitutes and Miscellaneous. E.—													24
(a) H.T. Tars (excluding Germany)	...	...	...	10	...	34	...	...	269		...	313	(a)
(b) L.T. Tars (excluding Germany)	...	...	...	...	...	17	...	...	15		...	36	(b)
									4	Wax			
(c) Benzol (all countries) ...	...	600	...	...	...	...	...	...		...	...	600	(c)
(d) Bottled Gas (all countries)	...	...	...	430	...	...	...	...		...	...	430	(d)
(e) Ethanol (all countries) ...	...	...	...	414	...	...	...	...		...	...	414	(e)
(f) Methanol (all countries)...	...	...	...	102	...	...	...	...		...	...	102	(f)
Total	...	600	809·5	6,199·5	1,252	2,458	567·5	769·5	4,290		...	16,954	

NOTES.

* Total quantity put through Refineries including Casinghead Gasoline.

A. These amounts may be considered as Aviation grade.
B. These amounts less 10 per cent. processing loss represent the Aviation Petrol yield.
C. The balance of about 1,170,000 tons assumed hydrogenated.
D. 60,000 tons of low viscosity grade could be raised to Aviation quality by the Voltol and Elektrion process.
E. Producer and Town Gas has been deducted from consumption estimates, therefore not shown in this table.
F. Including 50,000 tons Creosote.

APPENDIX B.

ESTIMATED PRODUCTION OF PRIMARY FINISHED PRODUCTS DURING SIX MONTHS ENDED THE 30TH APRIL, 1943, COMPARED WITH ESTIMATES FOR THE PREVIOUS SIX MONTHS.

(Average Annual Rate. (In Thousands of Metric Tons.))

—	Six months to 31st Oct., 1942.		Six months to 30th Apr., 1943.		Change.
1. Crude Oil Production (in terms of refined products)—					
Hanover	414		414		
Reitbrook	284		228		
Heide	47·5		47·5		
Vienna Basin	790·6		790		
Czechoslovakia	46·4		46		
West Poland	225		180		
East Poland	345·8		276		
France	74·4		74		
Hungary and Croatia	600		840		
Italy	10		9·5		
Albania	120		67		
Rumania	5,311		5,230		
Ukraine	...		44		
		8,268·7		8,246	— 22
2. Shale Oil—					
Estonia	80		80		
France	32		40		
		112		120	+ 8
3. Synthetic Oil Production—					
Germany—					
Bergius	2,500		2,952		
Fischer Tropsch	1,280		1,673		
Unknown Plants	420		200		
France—					
Bergius	15		15		
Fischer Tropsch	23·6		24		
		4,238·6		4,804	+ 625
4. Tar Oils—					
H.T. Tars Greater Germany	700		694		
L.T. Tars Greater Germany	355·5		675		
L.T. Tars Greater Germany	90		120		
H.T. Tars Other Countries	254·4		313		
L.T. Tars Other Countries	36		36		
		1,435·9		1,838	+ 402
5. Substitutes and Miscellaneous—					
Benzol	596		600		
Bottled Gas	430		430		
Ethanol	448		414		
Methanol	60		102		
Vegetable Oils	50		100		
Regeneration of Lubricating Oils	150		240		
		1,734		1,886	+ 152
Totals		15,789·2		16,954	+ 1,165

APPENDIX C.

Estimated Synthetic Oil Production in Greater Germany. Six Months ended the 30th April, 1943.

Estimated annual rate of capacity of Bergius Hydrogenation Plants.

(Thousands of Metric Tons.)

Plant.	Raw materials used.(a)	Previous estimate for 1942.	1942.		1943.				Remarks.(b)
			November.	December.	January.	February.	March.	April.	
1. Leuna	B.C. and B.C.T.	400	400	400	400	400	400	400	Increase in carbonising ovens indicates that more brown coal is being processed instead of tar. (February 1943.)
2. Poelitz, Stettin	H.C., P/C, B.C.T.	300	400	400	400	400	400	400	Assuming coal, pitch/creosote and L.T. tar being hydrogenated. (April 1943.)
3. Gelsenkirchen, Ruhr ...	H.C.	325	325	325	325	325	325	325	(June 1942.)
4. Troglitz Zeitz	B.C.T.	320	320	320	320	320	320	320	(March 1942.)
5. Scholven Buer, Ruhr ...	H.C.	250	250	250	350	350	350	350	Two pairs of stalls added to former five pairs. (April 1942.)
6. Bohlen Rotha	B.C.T.	200	200	200	200	200	200	200	New construction in progress, but no apparent increase in output intended. (February 1943.)
7. Wesseling	B.C.	200	200	200	200	200	250	250	One new pair of stalls added to former four pairs. (June 1942.)
8. Magdeburg	B.C.T.	200	300	300	300	300	300	300	A third pair of stalls has been added. (April 1943.)
9. Blechhammer— (a) North	B.C.T.	200	...	...	...	...	...	125	Estimate based on number of stalls and size of gas equipment as compared with Brux. (October 1942.)
(b) South	H.C.	...	...	...	...	...	...	...	Expected to begin production in July 1943. (October 1942.)
10. Brux	B.C.T.	125	125	125	250	250	310	310	(April 1943.)
11. Lutzkendorf Mücheln ...	B.C.T.	125	125	125	125	125	125	125	(February 1943.)
12. Welheim Bottrop, Ruhr (Pottie-Broche)	P.	100	100	100	100	100	100	100	(March 1943.)
Total	...	2,745	2,745	2,745	2,970	2,970	3,080	3,205	(Aircraft for six months, 2,252 tons.)

(a) H.C. = Hard Coal. B.C. = Brown Coal. B.C.T. = Brown Coal Tar. P/C = Pitch Creosote.

(b) Dates are those of latest serial photographs.

APPENDIX D.

Estimated Synthetic Oil Production in Greater Germany. Six Months ended the 30th April, 1943.

Annual rate of capacity of Fischer Tropsch Plants.

(Thousands of Metric Tons.)

Plant.(*a*)	Previous estimate for 1942.	Estimate for 6 months ended 30th April, 1942.	Remarks.(*b*)
1. Ruhland Schwarzheide ...	350	400	Presumed completion of constructional work. (April 1942.)
2. Lutzkendorf Mücheln ...	200	200	(February 1943.)
3. Holten, Ruhr	100	130	Increased gas capacity indicates 30 per cent. greater throughout. Recently damaged by bombing, for which no allowance has been made in this estimate. (March 1943.)
4. Wanne Eickel, Ruhr ...	100	130	A second contact oven house is now known.
5. Rauxel, Ruhr...	100	200	A building under construction when plant was last seen is believed to be a new contact oven house.
6. Dortmund, Ruhr	100	130	The full number of medium pressure ovens is now installed.
7. Homberg, Ruhr	100	200	It is now established that this plant has two rows of ovens, each of 80–100 units. (August 1942.)
8. Kamen Dortmund, Ruhr ...	50	50	(March 1941).
9. Deschowitz.	50	110	New figure based on the first photographic cover. (October 1942.)
Total	1,150	1,550	
(i) Add—15 per cent. for technical improvements		230	
		1,780	
(ii) Add—Allowance for unknown plants ...		200	
		1,980	

(*a*) Raw material is Hard Coal except in case of No. 1 and No. 2 where Brown Coal is used.
(*b*) Dates are those of latest aerial photographs.

APPENDIX E.

Estimated Production from High-Temperature Tars used as Fuel Oils. Six Months ended the 30th April, 1943.

(In Thousands of Metric Tons.)

Country.	Estimated Consumption of Fuel Oils.	Available Mineral Fuel Oil and L.T. Tars, but excluding H.T. Tars.	Deficit or Surplus.	Available from H.T. Tars.		Estimate of Products used.		Total.
				Fuel Oil and Creosote.(a)	Pitch.(b)	Fuel Oil and Creosote.	Pitch.	
Greater Germany	1,802	848	− 554(e)	450(a)	432(c)	400(d)	154	554
France	24	56	+ 32	116	124	92(f)	...	92
Belgium	5	...	− 5	56	60	44(f)	...	44
Holland	10	...	− 10	20	22	16(f)	...	16
Italy	493	14	− 479	48	50	48	48	96
Norway	3	...	− 3	2·4	2	2(f)	1	3
Denmark	5	...	− 5	5	5	5	...	5
Hungary	18	98	+ 80	5	5	4(f)	...	4
Rumania	1,250	2,366	+ 1,116	2·5	2·5	2(f)	...	2
Yugoslavia	20	...	− 20	3·3	3·5	3·3	3·3	6·6
Bulgaria								
Greece								
Occupied Russia	50	...	− 50	...	...	...	...	...
Total	1,878	2,534	+ 656	258·2	274	216·3	52·3	268·6

(a) Assuming all Fuel Oil (18·6 per cent.) and all Creosote (5 per cent.) from H.T. Tars available, except in the case of Greater Germany, where 63,000 tons Fuel Oil and 37,000 tons Creosote are thought to be hydrogenated at Poelitz.
(b) Assuming only 25 per cent. of the 45 per cent. Pitch from H.T. Tars available, the remainder being used for manufacture of Steel, Briquettes and Electrodes.
(c) Assuming 150,000 tons Pitch hydrogenated at Poelitz and Welheim.
(d) Assuming 50,000 tons Creosote blended with Diesel Oil.
(e) After allowing for 400,000 tons Fuel Oil imported from Roumania (based on May–October 1942 reported figures).
(f) Fuel Oil only.

APPENDIX F.

Estimated Amount of Alcohols used as Motor Fuel during Six Months ended the 30th April, 1943.

(Annual rate in Thousands of Metric Tons.)

Country.	Consumption of Motor Fuel.			Alcohol required for 25 per cent. blend.	Ethanol available.	Methanol available or potential.	Estimated Ethanol used.	Estimated Methanol used.	Estimated Ethanol used in previous 6 months.	Estimated Methanol used in previous 6 months.
	Civil.	Army and Todt.	Total.							
Greater Germany	984(*d*)	249	1,233	308	245	1,500	245	63	250	60
France	80	140	220	130(*a*)	100	82	100	30	114	...
Belgium	18	26	44	11	12	148	...(*b*)	...	12	...
Holland	18	30	48	12	12	32	12	...	15	...
Italy	120	56	176	44	110	64	44	...	38	...
Norway	38	64	102	25	3	64	...(*c*)	...	...	...
Denmark	25	4	29	7	3	...	3	...	5	...
Hungary	48	28	76	19	8	13	8	8	12	...
Roumania	140	28	168	42	·5	1	·5	·5	...	...
Yugoslavia	25	70	95	24	2	...	2	...	2	...
Bulgaria										
Greece										
Russia and Finland...	(*c*)	(*c*)	(*c*)							
Total	1,496	695	2,191	622	495·5	1,904	414·5	101·5	448	60

(*a*) Assuming 75 per cent. blend for Civil and 50 per cent. blend for Army and Todt.
(*b*) Assuming benzol and no alcohol used.
(*c*) Assuming no alcohol used.
(*d*) Excluding aero-engine testing.

ANNEX III.

Estimate of Consumption by Civilian and Industrial Users in Axis Europe.

1st November, 1942–*30th April*, 1943.

1. Greater Germany.

The following table shows the average monthly rate of consumption by civilian and industrial users for the six months ending the 30th April, 1943:—

Monthly average of 6 *months.*

(In Thousands of Metric Tons.)

	Motor Spirit, &c.	Gas Diesel.	Kero-sene.	Fuel Oil, &c.	Lub. Oil.	Total.	Average of six months ending 30th Apr. 1942.	1938*
(*a*) Lorries	35	34	...	...	...	69	114	153
(*b*) Motor cars and cycles ...	24	...	...	...	...	24	32	173
(*c*) Omnibuses	14	...	...	...	...	14	17	25
(*d*) Tractors	...	7	1	...	..	8	7	14
(*e*) Industrial Black Oil ...	...	8	...	24	...	32	36	102
(*f*) Bunkers—								
Danube Shipping ...	...	19	...	1	...	20	12·5	22
Inland Shipping ...	...	4	...	1	...	5	4	8
Mercantile Ships ...	...	3	...	12	...	15	25	73
(*g*) Gasoline for test in aero-engines	3	...	...	...	...	3	4	...
(*h*) Kerosene	...	...	8	...	...	8	10	9
(*i*) Lubricating Oils	...	...	...	...	50	50	50	50
(*k*) Asphalt and Wax. ...	...	...	...	28	...	28	41	51
Total	76	75	9	66	50	276	352·5	680

* Monthly average for whole year.

(a) *Lorries.*

It is estimated that, at the end of October 1942, 150,000 lorries were operating on liquid fuels, 24,000 on Diesel fuel and 126,000 on Motor Spirit. The conversion of diesel lorries to producer-gas has not proceeded as rapidly as had been planned (Refer Annex V), and it is estimated that the equivalent of 25 per cent. of the 95,000 lories driven by diesel oil at the commencement of the war are still using this fuel. The remaining 75 per cent. (71,000) are assumed to be run on 30 per cent. diesel oil and 70 per cent. producer gas. Thus the liquid fuel consumption is as follows:—

Diesel oil—	*Tons.*
24,000 lorries at 9 tons per annum	= 18,000 per month
71,000 lorries at 30 per cent. of 9 tons per annum	= 16,000 per month
	34,000 per month

Petrol.

A total of 126,000 lorries consuming 4 tons per annum is equivalent to 42,000 tons per month.

In our August 1942 report it was estimated that the increased use of producer gas was reducing consumption of liquid fuel at the rate of 6,000 tons per month, but there is evidence that the development of producer gas has not been as great as had been expected. In recent months, however, the drive to convert lorries to operate on solid fuels has been intensified. It is therefore estimated that such conversions are now resulting in a cumulative monthly saving of liquid fuels of some 3,000 tons, which is being made almost entirely in respect of petrol. On this assumption the monthly rate of petrol consumption will have been reduced to 27,000 tons by April 1943, and the average rate of consumption for the six months ending April 1943 to approximately 35,000 tons.

It is improbable that the civilian consumption of petrol by lorries will drop below a minimum of 15,000 tons per month as conversions of commercial vehicles

to producer gas and other substitutes will have reached the practical limit. In other words, there will still be a substantial number of commercial vehicles, A.R.P. equipment, &c., which will have to operate on motor spirit, many of them no doubt using locally produced liquid fuels. Evidence in support of this is to be found in the case of Belgium, where " liquid fuels are only granted in so far as they are essential for the bare existence of the population "; while it is probable that conversions to producer gas are still being made, the fact remains that some 33 per cent. of the Belgian lorries in operation last October were running on motor spirit.

When this basic minimum is reached, which would not have been earlier than April, it is likely that such further use of producer gas as may be considered expedient will be applied principally to non-operational military vehicles.

(b) *Motor Cars and Cycles.*

Consumption by motor cars is now restricted to official purposes. Increasing use is being made of Treibgas, but reports indicate that a considerable proportion of cars operating are being run on motor spirit. Any contraction in consumption due to increased restrictions and use of substitute fuels may have been largely offset by emergency transport requirements resulting from air raids. A large number of motor cycles are believed to be in use. Consumption for the period under review is estimated at 24,000 tons per month, or the same figure as at April last year.

(c) *Omnibuses.*

There is little evidence as to how far omnibus services have been curtailed, but in view of the general stringency of supplies it is considered that there will have been about a 20 per cent. reduction compared with the April 1942 estimate.

(d) *Tractors.*

The recent announcement regarding the new composition of diesel oil supports the view that a considerable number of tractors will continue to operate on liquid fuels. As there would have been reduced agricultural activity during the winter months, the average monthly rate has been put at 8,000 tons.

(e) *Industrial Black Oils.*

In view of the general position there has probably been some reduction in fuel oil supplies. In the absence of any definite information a reduction equivalent to 10 per cent. of the April 1942 estimate has been allowed. It is to be expected that an appreciable proportion of these oils will be derived from tar.

(f) *Bunkers.*

Consumption by shipping on the Danube is higher than that during winter of 1942, as the weather has been less severe, but that of the mercantile marine is estimated at 15,000 tons per month, compared with 25,000 tons in 1942. The reduction has been allowed chiefly in respect of the diesel-driven vessels, as substantial evidence shows that such oil has in many cases not been available for motor vehicles.

(g) *Gasoline for Aero-engine Testing.*

It is evident from intelligence received that there has been some reduction in the quantities of fuel used for aero-engine testing purposes. Including the testing of reconditioned engines, consumption is now estimated at 3,000 tons a month.

(h) *Kerosene.*

Consumption during the winter is expected to have averaged at least 8,000 tons a month.

(i) *Lubricating Oil.*

The amount for lubricating oils consumption is the same as that estimated for April 1942. Consumption is more likely to have increased than decreased owing to the deterioration in the quality of some of the grades and the reduced efficiency of mechanical equipment; however, as lubricants are probably being used for abnormally long periods, total consumption, including that of regenerated oils, may still be at about the level of 50,000 tons per month.

(k) *Asphalt and Wax.*

The estimate for asphalt and wax has been reduced to 28,000 tons per month to correspond to the estimated current production of these products.

2. Czechoslovakia.

In view of the known cuts in consumption in Greater Germany, it is reasonable to assume that Czechoslovakian oil rations have also been reduced. As the rate of consumption estimated for April 1942 (17,000 tons) was comparatively small, it is thought that the reduction since this date can have been only slight. Current consumption of all products is therefore put at 16,000 tons per month.

3. Poland and Danzig.

Assuming a reduction similar to that allowed for in Czechoslovakia, *i.e.*, 7½ per cent. of the April 1942 estimate (14,000 tons), current monthly consumption is put at 13,000 tons, the annual rate of consumption by products being: Motor Spirit, 48,000; Kerosene, 36,000; Gas/Diesel oil, 36,000; Fuel oil, 12,000; and Lubricating oil, 24,000 tons.

4. Finland.

Consumption is unlikely to have been reduced much below the low level shown in our previous report as at April 1942 (36,000 tons per annum), as the period under review includes the winter months, when increased Kerosene consumption may have balanced to a large extent the contraction in the use of Motor Spirit. A reasonable estimate to apply to the current period would be at a rate of 32,000 tons per annum in the proportions: Motor Spirit, 12,000; Kerosene, 10,000; Gas/Diesel oil, 5,000; and Lubricating oils, 5,000 tons.

5. Norway.

A reliable source has provided the following consumption figures for 1942:—

(In Metric Tons.)

	Motor Spirit.	Kerosene.	Diesel Oil.	Fuel Oil.	Lubricating Oils.
Wehrmacht and Civil ...	74,125	11,617	88,724	3,591	8,171
Wehrmacht	35,777	694	12,184	84	1,504
Thus Civil was ...	38,348	10,923	76,540	3,507	6,667

Another reliable source reported that in December 1942 consumption was:—

(In Metric Tons.)

	Motor Spirit.	Kerosene.	Diesel Oil.	Fuel Oil.	Lubricating Oils.
Wehrmacht	4,523	98	1,234	15	133
Civil	3,071	1,170	6,352	19	553

As the estimates for the German Army in Norway total about 5,000 tons per month, the figures for the Wehrmacht may be considered to include consumption by the Todt organisation, and possibly also deliveries to the army in Finland made via Norway.

6. Denmark.

At the end of 1942 it was reported that the Germans were still sending to Denmark 800,000 gallons of petrol per month (say, 32,000 tons per annum), which is equivalent to about 10 per cent. of the Danish pre-war consumption. On the assumption that there has been a further decline, we estimate consumption for the current period at 25,000 tons per annum.

Kerosene and Gas/Diesel oil consumption is estimated at 10 per cent. of pre-war level, namely, 9,000 tons and 32,000 tons per annum respectively. Fuel oil is probably at about the same level as in Belgium, namely, 5,000 tons, and Lubricating oil supplies, which were estimated at 7,000 tons in April 1942, have probably fallen to 6,000 tons per month.

7. Belgium.

Supplies of liquid fuel are granted only in so far as they are essential for the bare existence of the population or are of direct or indirect assistance to the German war effort.

According to the *Bulletin de Statistique*, the number of vehicles operating on Petrol was reduced from 22,550 in August 1942 to 20,584 in October, the corresponding figures for those driven by Diesel oil being 2,862 and 2,756 respectively. Little or no liquid fuel is allowed for agricultural tractors. Horses and oxen are used when available.

According to reports which are said to emanate from reliable sources the monthly allocations of motor fuel and gas oil to the civilian population are about 1,500 tons and 1,000 tons respectively. The motor fuel consists of about 80 per cent. benzol.

Fuel oil consumption is believed to be negligible. Kerosene is available in limited quantities and supplies are believed to be at about the same level as in 1941. Lubricating oil supplies are calculated at 15 per cent. of pre-war consumption.

Current estimates, at the annual rate in tons, are therefore as follows:—

Motor fuel	18,000
Kerosene	9,000
Gas oil	12,000
Fuel oil	5,000
Lubricating oil	10,000

8. Holland.

Little information has recently been available upon the oil position in Holland. As the allocation of motor fuel is probably no greater in Holland than in Belgium it is proposed to adopt the same figure as in the case of Belgium, viz., 18,000 tons per annum.

With regard to Kerosene, consumption before the war was about one-quarter million tons per annum, or about ten times greater than that in Belgium. In Belgium the consumption was nearly all domestic, in Holland the offtake, although largely domestic, included 42,000 tons for inland water transport and 7,500 tons for agriculture. Consumption in Holland is therefore likely to be greater than in Belgium and we put the figure at 15,000 tons per annum.

Consumption of Gas/Diesel oil in 1938 (300,000 tons) included about 23,000 tons for fishing vessels and 80,000 tons for inland/coastal bunkering. Ocean bunkers were 200,000 tons Gas/Diesel and 235,000 tons fuel oil. In view of the volume of water traffic, both inland and coastal, that is still in operation, current estimates of Gas/Diesel oil are based on 5 per cent. of 1938 figures for shipping of all types (*i.e.*, 15,000 tons) plus 6,000 tons for fuel for other purposes. Fuel oil consumption is taken at 10,000 tons, which is equivalent to approximately 5 per cent. of the pre-war bunkers. Lubricating oil is estimated at 30 per cent. of the 1938 level, *viz.*, 15,000 tons.

Our estimates are, therefore, Motor Spirit 18,000, Kerosene 15,000, Gas/Diesel oil 21,000. Fuel oil 10,000. and Lubricating oils 15,000 tons per annum.

9. France.

A director of one of the principal oil companies in France affirmed that in September 1942 the authorities were allotting 11,000 tons of oil per month for consumption for the whole of France. This figure is about 25 per cent. of the estimated consumption at the end of 1941, but this quantity evidently does not include the alcohol which is blended in the motor spirit to the extent of 75 per cent. On the assumption that the total civilian consumption has not fallen appreciably below the September level, the current rate of consumption, including that of alcohol, is considered to be about 180,000 tons per annum of which 80,000 tons (20,000 tons petrol, 60,000 tons alcohol) is in respect of automotive fuel. The recent evidence of another French authority on oil confirms that these calculations are approximately correct.

As to Kerosene, some slight decrease in consumption may have taken place since the end of 1941 when it was estimated at 1,500 tons per month, but as the total consumption is small it is felt that it cannot have fallen by more than $33\frac{1}{3}$ per cent. Current consumption is therefore put at 12,000 tons per annum.

Our estimates are, therefore, Motor Fuel 80,000, Kerosene 12,000, Lubricating oil 40,000 tons, leaving 48,000 tons out of the 180,000 to cover Diesel and Fuel oils. It is proposed to allocate this equally between the two products, each of which is, therefore, estimated at 24,000 tons per annum.

10. Hungary.

Hungarian pre-war oil consumption was about 270,000 tons per annum and estimates of pre-war consumption in the present Hungary vary between 390,000 and 450,000 tons per annum.

As in the case of Rumania, civilian consumption is at a much higher relative level than that in most of the other countries of Axis Europe. In the summer of 1942 consumption was reported to be at the rate of 25,000 tons per month, but there is evidence that since then it has been contracted. One report from a reliable source indicates that consumption is now about 20 per cent. of current production, *i.e.*, about 150,000 tons per annum, and another report puts consumption at about 40 per cent. of the pre-war rate, say a maximum of 180,000 tons. A figure of 168,000 tons per annum, equivalent to 14,000 tons per month, is consequently believed to be a reasonable estimate.

The newly acquired territory is largely agricultural so that a considerable proportion of the total current consumption is in respect of tractor fuel, which, before the war, was largely Kerosene. It is, therefore, considered that, of the above total of 168,000 tons, the division is Motor Fuel 48,000, Gas/Diesel oil 30,000, Fuel oil 18,000, Lubricating oils 24,000 and Kerosene 48,000.

11. Italy.

Italian stocks are thought to have been for a long time at an irreducible level. Therefore, recent consumption will not have exceeded current new supplies, which are estimated, as follows:—

	Tons per annum.
Imports from Rumania	1,000,000
Imports from Hungary	12,000
Imports from Germany	144,000
Crude oil from Albania	80,000
Crude oil from Italian fields	10,000
Alcohol, Benzol, and Tar oils	72,000
Total	1,318,000
Consumption by Italian armed forces estimated at approximately	800,000
Leaving	518,000

After allowing for certain refining losses, this would leave not more than about 500,000 tons for civilian consumption.

A well-placed source reported recently that there was a great scarcity of motor spirit in Rome and it is reasonable to assume that this condition prevails over the whole of Italy. The use of Methane gas in motor vehicles is evidently being developed as rapidly as circumstances permit. Liquid fuel consumption by motor vehicles is therefore believed to be at about 10 per cent. of 1938 level, namely, 50,000 tons per annum.

The *Völkischer Beobachter* of the 12th February, 1943, stated that the annual fuel consumption of the 68,500 tractors throughout the country was estimated at 150,000 tons and in addition the 10,000 stationary agricultural engines consumed 20,000 tons per annum. Before the war agricultural tractors were operated mostly on Kerosene, but it is thought that a mixture of motor spirit and Kerosene is now being used. For these calculations it has been assumed that these products are blended in equal proportions. The consumption of liquid motor fuel is, therefore, estimated at 50,000 tons for motor vehicles and 75,000 tons for agricultural tractors, making a total of 125,000 tons per annum.

As regards Kerosene, in addition to the 75,000 tons for agricultural tractors mentioned above, it is thought that 20,000 tons is consumed annually for other purposes. Thus the total Kerosene consumption is estimated at 95,000 tons.

Lubricating oil consumption is estimated at 70,000 tons per annum.

If the estimate of 500,000 tons for consumption of all products is correct, there remains 210,000 tons to cover the supplies of Gas/Diesel oil and Fuel oils. In view of the requirements of coastal vessels, this is arbitrarily divided equally between Gas/Diesel and Fuel oil, or say 100,000 tons Gas/Diesel and 110,000 tons Fuel oil.

The figure of 144,000 tons shown in the above table for imports from Germany is only a tentative figure and it may be that such imports will be found to have been higher. In this event, it is possible that Italian consumption has been more than the half million tons, which is considerably lower than our estimate of 1,123,000 tons for 1941.

12. Rumania.

The fuel oil estimate of 1,250,000 tons is based on an annual rate of 1,375,000 for the months of November and December and a reduction of about 15 per cent. from this figure in respect of the first four months of 1943.

The estimates for the other products have been left unaltered for the period under review, although it is expected that consumption for the whole of 1943 will be reduced as a result of declining production and on account of German demands for additional supplies.

13. Yugoslavia,

14. Greece and

15. Bulgaria.

These estimates are about 50 per cent. lower than the estimates for 1941 and are based on the assumption that the consumption has been cut to almost negligible quantities.

16. Occupied Russia.

No statistics are available upon current consumption in Occupied Russia. Assuming minimum subsistence levels, both industry and agriculture would have to have a certain amount of oil; likewise, road, rail and water transport will involve some consumption. The present rate of consumption is arbitrarily placed at 300,000 tons per annum, as compared with peace-time figures of some seven to nine million tons.

Estimate of Consumption by Civilian and Industrial Users in Axis Europe.

1st November, 1942–30*th April*, 1943.

(Figures at the Annual Rate in Thousands of Metric Tons.)

	Aviation Spirit.	Motor Spirit and Blenders.	Kerosene.	Gas Diesel Oil.	Fuel Oil Asphalt and Wax	Lubricating Oils.	Total A.	Average of 6 months ended 30th April, 1942.	1938 B.	Percentage A, B.
1. Greater Germany	24	912	108	900	792	600	3,336	4,254	8,160	41
2. Czechoslovakia	...	60	12	60	30	30	192	204	408	47
3. German Poland and Danzig	...	48	36	36	12	24	156	168	372	42
4. Finland	...	12	10	5	...	5	32	36	264	12
5. Norway	...	38	11	76	3	7	135	146	576	23
6. Denmark...	...	25	9	32	5	6	77	96	816	9
7. Belgium	...	18	9	12	5	10	54	108	816	7
8. Holland	...	18	15	21	10	15	79	178	1,620	5
9. France	...	80	12	24	24	40	180	600	6,600	3
10. Hungary	...	48	48	30	18	24	168	180	264	63
11. Italy and Albania	5	120	95	100	110	70	500	996	3,420	14
12. Roumania	...	140	305	150	1,250	30	1,875	1,886	2,004	93
13. Yugoslavia	...	25	10	25	20	10	90	132	624	14
14. Greece										
15. Bulgaria										
16. Occupied Russia	...	50	75	100	50	25	300	?	+8,000	4
Total	29	1,594	755	1,571	2,329	896	7,174	8,984	33,944	

ANNEX IV.

Estimate of Consumption by the European Axis Armed Forces.

1st May, 1942, to 30th April, 1943.

(In Thousands of metric tons.)

1942.	*Army.*	*Navy.*	*Air Force.**	*Todt Organisations.*	*Total.*
May	315	205	152	40	712
June	342	205	157	40	744
July	390	205	152	40	787
August ...	405	205	154	40	804
September ...	362	205	148	40	755
October ...	351	205	142	40	738
	2,165	1,230	905	240	4,540
November ...	315	165	153	40	673
December ...	305	165	153	40	663
1943.					
January ...	312	165	154	40	671
February ...	260	165	157	40	622
March ...	303	166	158	40	667
April	225	166	158	40	589
	1,720	992	933	240	3,885
Total for 12 months ...	3,885	2,222	1,838	480	8,425

* These figures include consumption by motor transport.

Total armed forces consumption is lower during the period under review, as compared with the six months ending the 30th October, by 655,000 tons. Army consumption is lower by 445,000 tons; this reduction is principally the result of reduced military activity, the destruction of the Stalingrad army and the shortening of the front. No account, however, has been taken of any losses of supply dumps during the winter retreat in Russia or in North Africa.

Naval consumption has declined by 238,000 tons, this being largely due to the increased use of coal-fired vessels.

Consumption by the Todt Organisation has assumed to have maintained its former level. Nothwithstanding the fact that the transport now used by Todt is largely operated on producer gas, and there has been an increase in the number of purely manual labour employed, it is considered that the activities of Todt have been expanded to an extent that oil consumption has remained at the former level.

ANNEX V.

The Use of Substitute Motor Fuels in Axis Europe.

I.—Conclusions.

1. The shortage of liquid fuel in Axis Europe has resulted in widespread conversions to substitute fuels and especially to producer gas.

2. While the use of producer gas effects an important saving in liquid fuel, it is less efficient. Furthermore, maintenance and the provision of fuel involve increased demands upon materials and labour.

3. In Greater Germany approximately 318,000 civilian vehicles have been converted to use substitute fuels, of which 218,000 operate on producer gas. The consequent saving in liquid fuels is to the order of about one million tons per annum.

4. In the rest of Axis Europe approximately 276,000 vehicles have been converted, representing a saving in liquid fuels of some 700,000 tons per annum.

5. There is scope for further conversions, although it is unlikely that these will be effected either sufficiently rapidly or to a degree that will alleviate the present acute shortage of liquid fuel to any important extent.

II.—Introductory.

Substitute fuels were in use in Europe to a certain extent before the War. While this was more especially the case in France, there were in Germany, in 1938, 21,000 vehicles running on substitute fuels, of which 1,000 were on producer gas.

In Germany the progress of conversions to other fuels than petrol is indicated by the series of decrees that have been promulgated since the beginning of the War. In September 1939, a decree was issued ordering all those vehicles that were still permitted to operate to convert to substitute fuels. This comprehensive decree was later modified, but is a token that the Germans had taken two steps to conserve their liquid fuel supplies within a fortnight of the outbreak of War; they had forbidden all consumption of petrol other than that vitally necessary for the furtherance of the War, and they had announced their intention of making the greatest possible use of substitute fuels.

In June 1940 a subsidy was offered to all who converted their vehicles, but in May 1941 it was announced that no further permits would be issued for the conversion of private cars to wood-gas or any other substitute fuel: permits for conversion were in future only to be granted to commercial vehicles. Evidently difficulties were being encountered in converting transport units with sufficient rapidity.

In May 1942, the direction of the conversion scheme, which had till then been in the hands of General von Schell, was entrusted to Reichsminister Speer, who appointed Dr. Schieber as his deputy with special reference to conversion. There is evidence that just prior to the change in direction, there was dissatisfaction with the progress of conversion and Dr. Schieber's first action was to set up the Zentralstell für Generatoren. From this moment there appears to have been a greater sense of urgency and the types of vehicles to be converted to various forms of substitute fuel were clarified. An appeal was issued to owners to convert vehicles on their own initiative, the offer of subsidies was repeated and an additional inducement was given in the form of an offer that those who so converted their commercial vehicles would get priority when they made application for permission to convert passenger vehicles also.

Finally, due warning was given that those who failed to convert would receive no further supplies of petrol or diesel oil.

III.—Fuels and Applications.

The following are the principal alternative fuels now in use:—

(1) Producer gas, generated from brown coal (bricketted and/or carbonised), wood, peat, charcoal, anthracite and coke.
(2) Propane or Butane (in bottles at low pressure).
(3) Methane or Town gas (in bottles at high pressure or in balloons).
(4) Acetylene.

The applications for which these alternative fuels are used are governed by technical considerations of their suitability, their adaptability to the conditions of use and local supplies of fuel.

Gas.

Gas is used as an alternative fuel in three forms: liquefied at high pressure gaseous at high pressure, and at low pressure. Although conversion to the use of gas necessitates less alteration to the engine than other substitute fuels, specialised ancillary equipment is necessary for the compression and storage of high-pressure gases.

Propane and butane are the most suitable of these fuels, but the demand for these products in the oil industry and for industrial purposes is such that vehicles using these gases have been ordered to change over to producer gas.

Methane from natural sources is being extensively used in Italy. The use of methane from sewage in Germany is localised and the number of vehicles that can be served is comparatively limited.

The use of town gas is likewise confined to localities with a network of refuelling stations, the operating range being restricted by carrying capacity. This gas is being used to a limited extent by public service vehicles operating on fixed routes.

The extent to which gas is being used is not easily estimated; but the total number of vehicles using gas in any form in Germany is less than one-third of the total number of conversions.

The disadvantages and limiting factors in the use of gas are :—

(1) The difficulty of providing in wartime conditions the necessary ancillary equipment, more especially compressor stations and steel bottles.
(2) The carrying capacity of high-pressure gas operated vehicles is reduced by the weight of the bottles to be carried.
(3) The range of vehicles operating on low-pressure gas is limited by the quantity of fuel which can be carried and the range of alll vehicles operating on gas is conditioned by refuelling possibilities which cannot be hastily improvised.

Acetylene.

Acetylene is a less satisfactory fuel and the availability of calcium carbide limits its use. Only in Switzerland, and to some extent in Norway, is it being employed to any extent.

IV.—Producer Gas.

Of the various substitute fuels available, producer gas is the one in most general use. It may be adapted to motor vehicles, agricultural and road tractors, stationary engines and inland water transport.

Fuels.

For producer gas generation the following fuels are in use :—

(1) Brown coal (bricketted and carbonised).
(2) Wood (preferably a hard wood, such as brick or beach).
(3) Charcoal.
(4) Anthracite and coke.
(5) Peat.

In Germany, priority was first given to wood as a fuel, but in July 1942 instructions were given that no more wood generators were to be fitted in the Reich. There is no evidence whether this was due to a shortage of wood supplies or whether it had been decided that wood-burning generators should only be used in the occupied countries to the East where they would become a standard type and where timber supplies are plentiful.

It is apparently intended that the principal fuel in the Reich will be brown coal, either bricketted or carbonised. While the potential supplies of raw material are unlimited, additional bricketting capacity will be necessary to produce fuel of the requisite small size. At the same time experiments are proceeding with a view to the use of hard coal and low-temperature coke. Charcoal, which is the best fuel, is unlikely to be used in Germany owing to difficulties of large-scale manufacture.

The provision of solid fuel for over 200,000 generators represents a task of some magnitude. Whereas the fuels will be used as far as possible within their own zones of production the large quantities required will, nevertheless, impose a greater burden upon transport personnel and facilities than was imposed by the liquid fuels that these products replace. In order to develop the distribution of these solid fuels a company has been formed under the name Generatorkraft A.G., in which the State, timber, coal and oil companies have an interest. In the Rhine district, the Cologne Perlignit Company has been formed to produce generator briquettes from brown coal.

Disadvantages of Producer Gas.

Apart from the abundance of potential fuel supplies, producer has no advantage over liquid fuels and a number of important disadvantages :—

(1) More maintenance work is necessary, a complete overhaul is required twice as frequently as with a petrol engine.
(2) There is loss of carrying capacity if the generator is built on the vehicle; if the generator is carried on a trailer, tyres are needed.
(3) There is a loss of power and speed.
(4) The cumbersome character of the equipment and also fire risks precludes its use for certain purposes.

Labour and Material Requirements.

The use of producer gas not only involves a decrease in efficiency but it also involves additional demands on Axis resources of labour and material.

Taking a unit of 100,000 conversions to producer gas, the steel required would be approximately 10,000 tons, and some 5,000 to 6,000 workers would be needed for manufacture and fitting. Of this labour force about 70 per cent. would be welders.

Producer gas-operated units need more maintenance than petrol-driven vehicles and, if maintenance is insufficient, the engine depreciation rate, the break-down rate and general inefficiency will increase. The added wear and tear upon the enemy's road transport incurred through the use of producer gas will ultimately become a factor of some importance.

Extent of Use of Producer Gas.

Table I indicates the number of vehicles estimated to be operating on substitute fuels in Axis Europe.

Excluding Greater Germany, approximately 276,000 vehicles have been converted. While this represents a saving in liquid fuels of some 700,000 tons per annum, it should not be regarded as such as the Germans would not necessarily have permitted a consumption of petrol for purposes other than the German war effort if alternative fuels had not been available. In these countries producer gas is used for want of liquid fuel and not to save it. Two exceptions are Hungary and Roumania. In Hungary conversion to alternative fuels were only undertaken relatively recently and then only on a limited scale. In Roumania, where petrol rationing has not yet attained any effective degree of severity, the use of producer gas has not yet been reported.

Technical reasons make the conversion of Diesel engines to producer gas one of some difficulty. If no ignition system is installed, a partial conversion is made resulting in a consumption of 30 per cent. Diesel oil, the remainder being producer gas.

There is not sufficient evidence to form any reliable estimate of the quantities of fuel being saved by the use of substitute fuels in stationary engines, in marine engines or barges on inland waterways or in other special applications.

Table II gives an estimate of the number of civilian vehicles in Greater Germany which have been converted and the total savings in liquid fuels on account of the use of substitute fuels. In the absence of evidence as to what proportion of the estimated number of producer gas units have been allotted to different types of vehicle, or as to the horse-power of the converted vehicles, these estimates are necessarily only approximate.

These figures do not take into account the conversion of Wehrmacht and G.A.F. transport. In Norway and in Western Europe a fairly high proportion of the transport vehicles of garrison troops has already been converted and further conversions are being made at a rate that may be to the order of 1,500 units a month.

The fact that military transport is being extensively adapted to producer gas implies that the scope for further conversion to civilian vehicles has become limited. Apart from technical considerations, there will always be a hard core of vehicles which will not be converted to producer gas operation. These include emergency vehicles, such as ambulances, fire-engines, &c., where quick starting and reliability are of first importance. Vehicles used in areas involving fire risks and for the carrying of inflammable goods are also precluded.

While there is scope for further conversions it is unlikely that these will be effected either sufficiently rapidly or to a degree that will alleviate the present acute shortage of liquid fuel to any important extent.

TABLE I.

Position as at May 1943.

Country.	*No. of producer gas units in operation.*	*Total vehicles using substitute fuels.*
Germany	218,000	318,000
Italy	10,000	35,000
France	87,000	110,000
Belgium	10,000	30,000
Denmark	17,500	18,000
Norway	17,000	17,500
Holland	15,300	15,300
Czechoslovakia	4,200	4,200
Remainder	23,000	48,000
Total in Axis Europe	402,000	596,000

TABLE II.

GERMANY.

1942 *Fuel Economies by the use of Substitute Fuels for Civilian Purposes.*

Type.	Approximation of No. of Vehicles now operating.	Per cent. 1938–42.	Per cent. 1938–42 in U.K.	Estimated No. Converted.	Estimated Fuel Saving.	Continued Liquid Fuel Consumption.
Trucks ...	280,000 (petrol)	85	84	192,000	960,000	420,000
	95,000 (diesel)			71,000†	426,000	408,000
Buses ...	14,000	66	99	8,000	104,000	168,000
Cars ...	300,000	20	36	47,000	54,000	288,000
Tractors ...	150,000	...	...	40,000	40,000	96,000
					1,584.000*	1,380,000

* Of this quantity of fuel 430,000 tons is already credited to the Axis among their liquid fuel resources in the form of Bottled Gas in the Auld Production report, and is therefore not an additional saving.

† These vehicles operating on the diesel-cum-gas principle, continue to consume 30 per cent. of former liquid fuel requirements.

NOTES.

1. The total number of road vehicles operating on alternative fuels in Germany is 318,000.
2. Of these 90,000 operate on compressed gas, 10,000 on lower pressure gas and 218,000 on producer gas.
3. The number operating on producer gas is obtained from a survey of the output of generators available to the Germans from their own and occupied countries manufacture and actual fitting of the generator.
4. Lorries have had priority in conversion. Only 1 in 8 of the generators available is assumed to have been fitted to cars.
5. Military vehicles are excluded from these figures.

ANNEX VI.

REPORT ON THE COMPOSITION AND QUALITY OF ENEMY OILS AND FUELS.

Aviation and Motor Petrols.

The chief object of the examination of captured aviation and motor fuels is the determination of the standards maintained by the enemy and the sources of the components used. Up to July 1942 some 70 samples of aviation fuel and 50 samples of motor fuel had been examined, but since that time the additional number of samples has been small. Considerable progress has been made, however, in the methods of testing and the interpretation of the results. The chief advances in these respects have arisen from the examination of aviation fuels by infra-red and ultra-violet absorption spectrography and the carrying out of single-cylinder and full-scale engine tests in British and captured German engines.

The conclusions come to in regard to the quality and potential performance of the enemy petrols are as follows:—

Aviation Fuel.

There are two chief types of G.A.F. operational fuel:—

B.4 Blue Fuel.

This is about 90 octane number (C.F.R. Motor Method) with no exceptional features and contains 5·5 ml. tetraethyl lead per Imperial gallon. It appears to be the principal operational fuel and is of variable composition. Its base is a petroleum spirit similar to Roumanian 73-octane blended with hydro-petrol, iso-octanes, aromatics or hydro-petrol plus aromatics, but not

hydro-petrol and iso-octanes. Typical compositions of the Blue fuel in 1942 were :—

	Per cent.	*Per cent.*
Hydro-petrol	Nil	30–50
Iso-octanes	2-8	Nil
Added aromatics	5-10	5
Petroleum spirit	90	45–65

C. 3 Green Fuel.

This is of about 94 octane number (C.F.R. Motor Method, and also contains 5·5 ml. T.E.L./I.G. It appears to be the G.A.F. fighter grade and is characterized by containing 35–40 per cent. of aromatics added in the form of material containing 60–70 per cent. of aromatics, together with up to 16 per cent. iso-octanes. It contains no regular hydro-petrol. Its average composition is considered to be :—

	Per cent.	
Iso-octanes	16	
Added aromatics	36	(total aromatics, 38 per cent.)
Non-aromatics accompanying added aromatics ...	23	
Petroleum spirit	25	(of high volatility)

When tested by the current British rich mixture methods in comparison with B.A.M. 100-octane fuel, the German fuels rate at 81 for the B. 4 Blue and 110 for the C. 3 Green fuel.

Single-cylinder and full-scale engine tests using simulative Green fuel show that German engines as recent as the BMW. 801.D are not capable of making use of the potential high power output of the C. 3 Green fuel.

Motor Fuel (Petrol).

Samples from Europe, Russia and the Middle East appear to show that the German Army has no general standard for motor gasolines, though it is likely that an octane number of 72–75 is aimed at for fighting vehicles. Other captured motor fuels (including Italian) vary from as low as 47 octane number up to 89. The general range is between 61 and 77.

These gasolines show considerable diversity in composition. Most of them are characterized by an appreciable content of unsaturated hydrocarbons, *i.e.*, of evacked spirit, and a big proportion must be classed as "benzole mixtures" because of their aromatic content of 20 up to 46 per cent. A number of the samples both from the Middle East and Europe contain ethyl alcohol, but methanol has not been identified.

The added aromatics appear to be mainly benzene, which may be synthetic. Tetraethyl lead is present in a large proportion of the samples from the Middle East, and it would seem that in some cases it has been the practice to "lead" and blend poor base stocks in the field to give the standard required for fighting vehicles.

Source of Enemy Aviation Fuel.

Aviation fuel and motor spirit should be taken together in this connection since over half the potential supplies may come from hydrogenation plants which can equally well produce one or the other. Investigation has been largely confined, however, to aviation spirit, and has been by way of hydrocarbon analysis based upon close fractionation and with or without spectrographic study.

The four chief problems have been to determine the content and composition and deduce the possible source of—

(*a*) the hydro-petrol;
(*b*) the iso-octanes;
(*c*) the aromatics, particularly in the Green fuel;
(*d*) the petroleum base spirit.

It is considered that hydro-petrol can be identified and measured by reason of its high ratio of methyl cyclopentane to cyclohexane and its high proportion of branched paraffins to straight chain paraffins. This applies to products of all modifications of medium temperature hydrogenation and to all raw materials.

It is considered possible to distinguish between alkylate and hydroiodimer types of iso-octanes.

It is believed that the nature and possible sources of the aromatics can be indicated. They differ between the Blue fuel and the Green, though recent Blue fuels have a higher aromatic content than previously and appear to be mixed with some aromatics from the "Green" source.

In the case of the Blue fuel the variation in the aromatics content may be due to variation in the composition of the petroleum spirit or to added coal tar products or to hydroforming.

The aromatics of the Green fuel are not added coal tar products neither are they derived from petroleum by extraction, hydrogenation or hydroforming, nor from normal hydrogenation of bituminous material. It has been concluded that the Green fuel aromatics are manufactured by high temperature aromatising bituminous material rich in condensed ring hydrocarbons. Such a product would be of low volatility and contain 60–70 per cent. aromatics of the types recognized.

So far it has not been found possible to distinguish between alternative sources of the petroleum component in enemy fuels. The petroleum may be derived from Rumanian, German, Hungarian or other European crude oil or from American imported or captured stocks.

It must be concluded that there is no individual source of uniform composition of the standard Blue fuel. For the aromatics of the Green fuel (and partly of recent samples of Blue fuel) there are only a limited number of known plants well fitted to their production, though such plant might, of course, have been erected elsewhere.

Diesel Fuels.

Analyses of some 75 diesel fuels have been received since the beginning of 1942. These fuels have come from two main sources :—

(1) From marine craft escaping to or captured and brought to this country—the boats starting from France, Belgium, Holland, Denmark or Norway.

(2) Captured fuels from the Middle East.

The majority of these fuels are of good ignition quality, and would be entirely satisfactory fuels for high-speed diesel engines; the remaining fuels would be considered suitable for stationary or marine diesel engines other than the high-speed type. There is no indication of any depreciation in quality in recent samples. It is to be noted that two-thirds of the samples have Diesel Indices of over 48 and could be used in the highest speed engines for road vehicles. The remaining one-third vary in Diesel Index from 40 to 48 and form good class "marine diesel" fuel. The latter could also be used in many high speed engines which are not particularly sensitive to the ignition quality of the fuel. In this connection it is to be noted that German diesel engines are generally of the less sensitive type.

A number of the samples are characterised by relatively low flash points, indicating the addition of kerosene or the inclusion of a light fraction in the gas oil cut. This would not materially affect performance in engines.

Sulphur contents vary up to about 0·8 per cent., but on the average are on the low side.

The most characteristic constituent of many of the samples—and this is particularly a feature of European samples, although it applies also to some samples from the Middle East—is a small proportion of tar acids, in one case as high as 1·5 per cent., but generally below 0·7 per cent. This would seem to indicate the use of a brown coal distillate at least as a constituent.

No samples of diesel fuel so far examined appear to correspond to straight coal oil or to straight Fischer–Tropsch gas oil. The former have high specific gravity, high sulphur content, and usually high tar acids content, while the latter have low specific gravity, very low sulphur and very high octane numbers.

It is concluded that some fuels are almost certainly of petroleum origin, probably Rumanian; others—and these represent the majority of samples—are probably blends of a coal distillate, possibly hydrogenated, with Fischer–Tropsch gas oil, with or without the addition of petroleum gas oil.

It is thought that one sample (obtained from Stettin) may possibly be a product from the mild hydrogenation of Estonian Shale Oil.

Lubricating Oils.

Judged by the examination of captured material and of samples obtained from other sources, the standard of quality of Axis lubricating oil has been well maintained.

Aviation Oils.

Aviation oils appear to have been kept to pre-war standards, and no changes have been observed which indicate deficiency in any respect. This conclusion is based, however, upon only some two dozen samples since 1941. Amongst them oils of American, Venezuelan, Hanoverian, Rumanian and probably Reitbrook origin have been identified.

The first two sources, which depend upon importation, have not been found to any extent in samples taken since 1940. Since 1941 Rumanian oil has largely been replaced by the Reitbrook type of oil.

Between fifty and sixty per cent. of the aero oils examined since 1941 contain Voltol, but there is little evidence of the use of synthetic oils.

Instructions issued by the Reich Air Ministry on the 31st December, 1941, laid down (1) that certain engines were no longer to be lubricated with Aero Shell Medium (the Voltol blend), and (2) that other types of engine, for which both mineral oils and Voltol mixtures were allowed, were *preferably* to be lubricated with Aero Shell Medium. The effect of the first order (taken with the previous instructions of the 1st September, 1941) is to put all engines using C.3 (green) fuel on to straight mineral lubricating oil. The second instruction indicates that shortage of Voltol was not the reason for the restriction in its application. Presumably the change in policy was due to the occurrence of ring-sticking in the high output engines using Voltol.

In addition to high-grade American oils the Italians continue to use castor-oil for aero lubrication.

Other Service Oils.

Service lubricating oils other than aero oils are also generally of good quality. They include Rumanian, Hanoverian and Reitbrook type oils. In many cases they contain Bright Stock and are solvent-refined and of high Viscosity Index.

Marine Oils.

Marine oils supplied for the use of coastal boats, fishing vessels, &c., have also been kept at a surprisingly high standard, though one or two complaints have been levelled against their performance. Of 26 samples taken from small vessels supplied variously during the last six months in Germany, Denmark, Sweden, Holland, Belgium and France none was found unsuitable for its purpose and most were of high quality. Of two further oils issued as standard products for steam ships, a bearing oil which was complained of as having inferior emulsifying properties was found to be deficient in suitable vegetable oil. A steam cylinder oil, which was also complained of, was found to be of good quality.

As in the case of aero oils, there is little evidence of the use by the Axis of synthetic lubricating oils, though this does not say they are not in use in blended form. A light machine oil taken from a German submarine in 1942 may contain a synthetic oil made by polymerizing unsaturated hydrocarbons.

Lubricating Greases.

A Summary has recently been prepared of the composition and nature of 33 samples of Captured Enemy Lubricating Greases emanating from Aircraft, Armoured Fighting Vehicles, Naval Vessels and Stores. All the samples are of conventional type and within broad limits have their counterparts in our own Service specifications. Such data as are available point to the employment in their manufacture of good quality natural fats, though the possibility of the use of synthetic fatty acids prepared from wax is not excluded.

As far as can be deduced from the analyses the materials are prepared in conventional plant but not with any marked degree of skill, particularly in the Italian products. Moreover, there is no evidence of the application of the more recent developments in Grease Technology, such as the use of soaps of metals other than calcium and sodium, or of high molecular-weight hydrocarbon polymers, &c.

O.R. 5721

SECRET

ESTIMATE OF AXIS OIL CONSUMPTION, PRODUCTION & STOCKS
JANUARY 1941 — APRIL 1943

ANNEX VII

I. DETAILS OF CONSUMPTION

THOUSANDS OF TONS

500
400
300
200
100
0

OCCUPIED EUROPE
GERMAN CIVIL
ARMY
AIR FORCE
NAVY
TODT ORGANISATION

II. TOTAL CONSUMPTION & SUPPLIES

THOUSANDS OF TONS

1700
1600
1500
1400
1300
1200
1100

TOTAL CONSUMPTION
SUPPLIES
LOOT (See Note 2)

III STOCKS

MILLIONS OF TONS

6
5
4
3
2

JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT OCT NOV. DEC. JAN. FEB. MAR APR. MAY JUNE JULY AUG. SEPT OCT. NOV DEC. JAN. FEB. MAR. APR

1941 1942 1943

Army Consumption
Naval "
Air Force "
Todt Organisation Consumption
German Civil "
Occupied Europe "
Total Consumption
Supplies
Loot

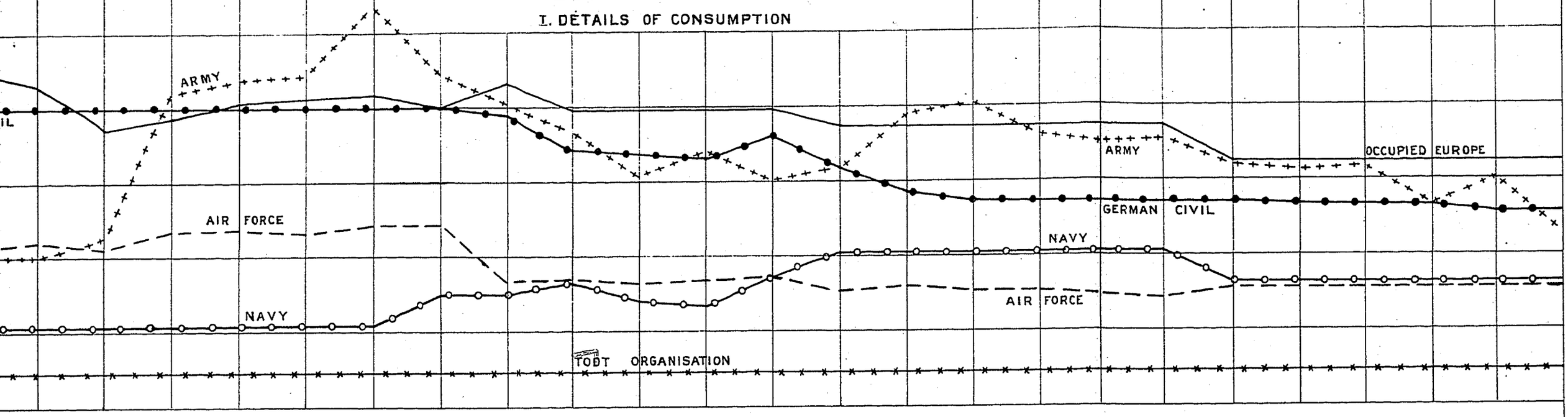
NOTES

1. The monthly estimates of supplies, civil, naval and airforce consumption have been divided equally over periods of either six or twelve months.
2. Represents loot acquired in March, in Bulgaria (10) and in April, in Hungary (75) Greece (25) and Yugoslavia (100)

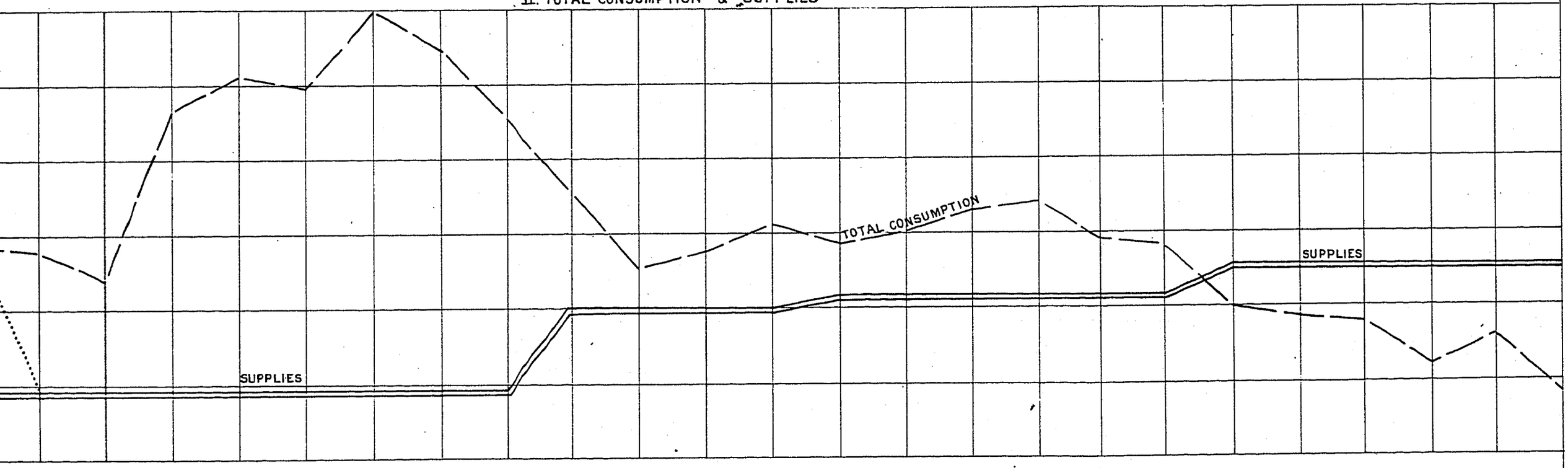
ANNEX VII

ESTIMATE OF AXIS OIL CONSUMPTION, PRODUCTION & STOCKS
JANUARY 1941 — APRIL 1943

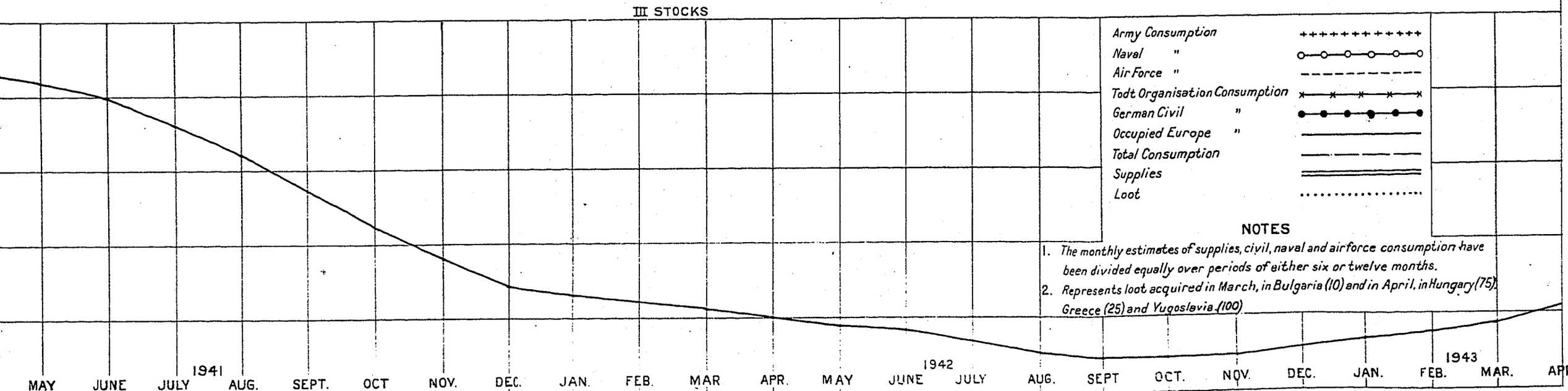
I. DETAILS OF CONSUMPTION



II. TOTAL CONSUMPTION & SUPPLIES



III STOCKS



Army Consumption
Naval "
Air Force "
Todt Organisation Consumption
German Civil "
Occupied Europe "
Total Consumption
Supplies
Loot

NOTES

1. The monthly estimates of supplies, civil, naval and airforce consumption have been divided equally over periods of either six or twelve months.
2. Represents loot acquired in March, in Bulgaria (10) and in April, in Hungary (75) Greece (25) and Yugoslavia (100)