ENEMY OIL COMMITTEE

European Axis Subcommittee

PRELIMINARY REPORT ON TRANSPORTATION OF PETROLEUM AND PRODUCTS IN WESTERN AXIS COUNTRIES

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CONFIDENTIAL

TRANSPORTATION OF PETROLEUM AND PRODUCTS IN WESTERN AXIS COUNTRIES

Part I - Introduction

This report is preliminary, and attempts only to present an overall picture for further analysis. It deals with the movements of volumes of oil, without attempting to trace the classes of products involved.

The area discussed includes all of continental Europe except unoccupied Russia. Areas within national boundaries have been considered as geographic units except in the case of Germany, which has been further subdivided.

It is considered that there can be two main transport movements affecting petroleum: the movement of raw materials to the refining centers, and the distribution of finished products from these centers to the areas of consumption. Table I herewith shows the relation of refining or synthesizing capacity to sources of raw materials, considered by geographic units; from this table it is apparent that only in the case of the Northeast German district (Poelitz, Stettin) is it necessary to go beyond the limits of the geographic unit for raw materials, and only in the case of the Southeast German district (Vienna Basin) is there a surplus of raw materials over local finishing capacity. There is strong reason to suspect that this discrepancy has already been remedied in the Southeast German district, 1/ but coal or oil must be brought in from other districts to supply the Stettin hydrogenation plant. For the purpose of this report the viewpoint is taken that the centers from which distribution occurs are those districts possessing both crude oil and refining capacity, and those districts possessing synthesizing capacity. It is assumed that the local requirements for petroleum products will be satisfied from local sources, where such exist, and that only the surplus after such local withdrawals will be available for wider distribution. Table II shows the production of petroleum products by districts, the amounts necessary for local needs, and the balances remaining after such needs have been met.

In addition to the amounts required for civilian use, great quantities of petroleum products must be moved from the source areas to the areas of military activity. Table III attempts to show the regional distribution of military requirements. In the preparation of this table effort has been made to use generally accepted figures where these could be found, but the details are arbitrary, and it is considered only that they are within the limits of error applicable to the quantitative aspects of the report as a whole.

1/ A refinery with 600,000 tons annual throughput is reported to have been completed near Vienna. O.S.S. report, Doc. Sec. No. 427802.

The transport of petroleum, as considered in this report, involves movements from centers having surpluses, as shown by table II, to those having deficits, as indicated by tables II and III.

The means available for moving petroleum and products consist of pipe lines, railroads, marine tankers, canal barges and highway tank trucks. Each of these means will be considered in detail in the subsequent discussion, with the exception of highway tank trucks. With respect to these latter, it is believed that because of their limited numbers and their high unit fuel consumption, they are of importance only in the local civilian and military distribution of petroleum.

TABLE I

Comparison of Refinery Capacity with Raw Material Sources in Western Axis Europe 1/

Geographic District	Refinery Capacity (Metric Tons/Yr.)	Crude Production (Metric Tons/Yr.)	Source of Materials	Balance Refin.Cap.
Northwest Germany	2,320,000	770,000	Nienhagen, Heide and Reitbrook oil fields	≠ 1,550,000
Southwest Germany	195,000	-	-	≠ 195,000
Central Germany	120,000	-	-	≠ 120,000
Northeast Germany	-	-	-	-
Southeast Germany	376,000	740,000	Vienna Basin oil fields	- 364,000
Western Poland	462,000	250,000	Jaslo district oil fields	≠ 212,000
Eastern Poland	393,000	380,000	Drohobicz district oil fields	≠ 13,000
Czechoslovakia	567,000	20,000	Gbely, Hodonin oil fields	≠ 547,000
Hungary	575,500	480,000	Lispe, Lovaszy oil fields	≠ 95,500
France	7,580,000	80,000	Pechelbronn oil field, Autun sh	≠ 7,500,000
Italy	2,120,000	260,000	Italian and Albanian oil fields	≠ 1,860,000
Jugoslavia	129,500	-	-	≠ 129,500
Belgium	585,000	-	-	≠ 585,000
Holland	680,000	-	-	≠ 680,000
Roumania	9,515,000	5,550,000	Prahova, Dambovita oil fields	≠ 3,965,000
Norway	51,000	-	-	≠ 51,000
Totals	23,668,000	8,530,000		17,138,000

1/ Refinery data from Air Ministry Report, July 1, 1942; production data from Hartley Committee Report, August 15, 1942.

TABLE II

Sources of Finished Petroleum Products in Western Axis Europe 1/
(Figures in Metric Tons/Year)

District	By Crude Refining	By Synthesis	By Substitutes	District Consumption		District Surplus or Deficit
N.W. Germany	718,000	-	226,600	561,460	/	383,140
N.E. Germany	-	300,000	226,600	140,390	/	416,210
Central Germany	-	2,139,000	749,950	701,750	/	2,187,200
S. W. Germany	-	1,398,986	749,950	1,021,989	/	1,123,947
S.E. Germany	688,200	50,000	226,600	381,170	/	583,630
Total Germany	1,406,200	3,887,986	2,179,700	2,806,759	/	4,694,127
Belgium	-	-	110,000	100,737	/	9,263
Bulgaria	-	-	1,000	27,349	-	26,349
Denmark	-	-	13,000	99,260	-	86,260
Esthonia	-	-	40,000	16,362	/	23,638
France	106,400	38,645	300,000	714,569	-	269,524
Greece	-	-	500	54,792	-	54,292
Holland	-	-	70,540	144,918	-	74,378
Hungary	448,800	-	23,000	220,254	/	251,546
Italy	10,000	-	132,000	654,970	-	512,970
Albania	210,000	-	-	10,003	/	199,997
Latvia	-	-	-	13,015	-	13,015
Lithuania	-	-	-	10,831	-	10,831
Norway	-	-	4,000	71,815	-	67,815
Roumania	5,170,000	-	2,000	1,300,655	/	3,871,345
Jugoslavia	-	-	7,000	54,233	-	47,233
Sweden	-	-	-	198,218	-	198,218
Switzerland	-	-	-	126,812	-	126,812
Finland	-	-	-	56,876	-	56,876
Czechoslovakia	18,600	-	-	72,422	-	53,822
Western Poland	225,000	-	-	101,605	/	123,395
Eastern Poland	345,800	-	-	43,545	/	302,255
Totals	7,940,800	3,926,361	2,882,740	6,900,000		7,853,527

1/Production data from Hartley Committee Report, August 15, 1942; consumption data from OPC Report, May 1, 1942.

TABLE III

Allocation of Military Consumption of Petroleum Products
in Western Axis Europe
(Figures in Metric Tons/Year)

District	Navy	Army	Air Force	Total
N. W. Germany	150,000	25,000	200,000	375,000
N. E. Germany	80,000	25,000	-	105,000
Central Germany	-	25,000	50,000	75,000
S. E. Germany	-	25,000	-	25,000
S. W. Germany	-	25,000	50,000	75,000
Holland-Belgium	50,000	50,000	350,000	400,000
Baltic Area	280,000	25,000	200,000	505,000
Western France	560,000	40,000	300,000	900,000
Central Europe	-	25,000	-	25,000
Norway	280,000	25,000	100,000	405,000
Poland	-	25,000	-	25,000
Sicily- N. Africa	150,000	200,000	150,000	500,000
N. and Cent. Italy	300,000	50,000	50,000	400,000
Crete-Dodecanese	90,000	50,000	100,000	240,000
Jugoslavia	50,000	25,000	25,000	100,000
North Russian Front	-	800,000	200,000	1,000,000
Central Russian Front	-	800,000	200,000	1,000,000
South Russian Front	-	1,400,000	300,000	1,700,000
Totals	1,990,000	3,640,000	2,225,000	7,855,000

Part II - Regional Movements of Petroleum

Roumania

This country had an estimated crude oil production during 1942 of 5,550,000 tons. All the important producing fields are within a radius of less than 50 miles from the refinery center at Ploesti, and the crude oil is brought from the fields to the refineries by pipe lines. Roumania's refining capacity is 9,865,000 tons/year, leaving a surplus refining capacity of 3,965,000 tons/year over local crude supplies. The country's minimum domestic consumption for 1942 is estimated at 1,300,000 tons, and the subtraction of this, together with refinery losses, leaves the country with an exportable surplus of 3,871,000 tons/year of petroleum products. Under Roumanian petroleum law, the export of crude petroleum is prohibited, although there is some indication that this has been changed by German influence in recent years. It is estimated that the distribution of the Roumanian petroleum surplus was as follows during the year 1942 2/ (quantities in metric tons):

To:	By Railroad	By Pipe line R.R. and Barge	By Pipe line or R.R. and Tanker	Total
Italy	192,000	681,000	27,000	900,000 3/
Bulgaria	-	26,000	-	26,000
Greece	46,000	-	9,000	55,000
Crete-Dodecanese	-		243,000	243,000
Jugoslavia	31,000	117,000	-	148,000
Russian Front	2,500,000	-	-	2,500,000
Totals	2,768,000	824,000	279,000	3,871,000

1. Internal Roumanian Distribution: This is primarily by railroad tank car, and thereafter by tank truck. Using an average carrying capacity of 14 tons per tank car, and an average turn around of 10 days, some 2,330 tank cars are required for Roumanian internal distribution. This takes into consideration the fact that a fuel oil pipe line of about 120,000 tons/year capacity connects some of the Ploesti refineries with Bucharest. Also of the fact that there are reliable reports that a 12" gas line has recently been completed to connect the Maniesti gas field with Bucharest, to effect an estimated saving of 150,000 tons/year of fuel oil.

2. Shipments to Italy: There are three plausible routes for petroleum shipments from Roumania to Italy:

a. By pipe line to Constanta and by rail to Constanta, thence by tanker through the Bosphorous and the Aegean and Adriatic

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2/ BEW intercept studies suggest that almost no current oil shipments are going to Germany from Roumania.

3/ BEW Report No. 50, Dec. 21, 1942, states that Roumania supplied Italy with this amount during 1942.

seas to Venice, Fiume and Trieste. The combined refinery capacity of these latter ports (1,040,000 tons/yr) is sufficient to handle the indicated quantities if it were desirable to ship crude oil instead of refined products.

As an alternative to loading tankers at Constanta, oil may be sent by pipe line or rail from Ploesti to the Bulgarian ports of Varna or Burghas on the Black sea. Both ports have facilities for tanker loading, and the port of Burghas has been used for this purpose, particularly during 1941.

The railroad from Ploesti to Constanta is double-tracked and it is unlikely that congestion would result even if the entire export to Italy were shipped by rail to Constanta.

The pipe line from Ploesti to Constanta is an 8" kerosene line with a rated capacity of 610,000 tons/year. Since 1941 this line has been used at least occasionally for gasoline, as when the Germans reversed the flow through it to remove gasoline stocks accumulated at Constanta. The main pumping station for the Ploesti-Constanta pipe line is located at Teleajan, 5 kilometers north of the Romano-Americana refinery. There have been reports that the Germans have laid a second 8" line from Ploesti to Constanta. It is known that such a line was planned in 1941, but it was intended to convey Russian crude from Constanta to Ploesti, and it appears doubtful that this project has ever been carried out. 4/

The port of Constanta has 3 oil births capable of accommodating tankers up to 8,000 g.r.t. These facilities are normally used for shipping heavy oils only, and their pumping capacity is about 750,000 tons/month.

The usual route for oil shipped via Bulgarian ports is by rail or pipe line to the Roumanian Danube port of Giurgiu, thence in tank cars it crosses the Danube on a train ferry to the Bulgarian railhead at Ruse (Ruschuk) and continues on the Bulgarian railroads.

The port of Burghas is equipped as an oil-loading port, and Varna was being conditioned for this purpose in 1941. Details as to facilities at either port are not known. The Roumanian Danube ports of Braila and Galati are accessible to ocean going tankers and have rail connections, but neither has pumping facilities for loading oil.

From the foregoing it is apparent that by a maximum use of railroad, pipe line and port facilities, any desired portion of available Roumanian petroleum could be exported from Black sea ports via tanker to the Adriatic and Mediterranean, provided tanker tonnage is available and the Bosphorous remains open to axis ships.

4/ C. Mattingly, verbal information.

At the end of 1942 the axis tanker situation in the Mediterranean appeared as follows: 5/

Tanker tonnage in operation	80,000 g.r.t.
Tanker tonnage under repair	30,000 "
Vichy French tonnage acquired	133,000 "
	243,000 g.r.t.

It is estimated that this tonnage is currently being used as follows:

For Axis forces in North Africa)	50,000 g.r.t.
For Albanian crude transport)	25,000 "
Italian coastal requirements	25,000 "
Reserve for sinkings, etc.	100,000 g.r.t.

There is thus available some 113,000 tons of tanker shipping for the Black sea - Mediterranean run. This fleet is sufficient to haul far more than Italy's currently estimated imports from Roumania, but there is direct evidence that only a small fraction of it is being so used. A study of shipping reports from the Black sea - Mediterranean area indicates that in the period April 1940 - November 1942, only 52,296 g.r.t. of Axis tanker shipping passed through the Bosphorous en route to the Aegean or Mediterranean seas. 6/ Assuming that the carrying capacity of these ships was 20% more than their gross registered tonnage, they could have hauled some 62,000 tons of petroleum from Roumania if they were all fully loaded, or an average of about 3,000 tons/month over the period considered. Most of this oil was carried in 3 tankers regularly assigned to the Black sea-Mediterranean run. Although there is evidence to indicate that not all tanker passages through the Bosphorous were recorded, it is clear that only a relatively small portion of Roumanian oil exports are leaving that country by tanker. About one-fourth of the oil loaded at Black sea ports was discharged at Piraeus, in Greece. On this basis it is concluded that only 3,000 tons/month of petroleum was exported from Roumania by tanker during 1942, and that of this quantity 9,000 tons/year were delivered to Greece and 27,000 tons/year to Italy.

The failure of the Axis to make greater use of tankers as a means for distributing Roumanian oil may be explained by: (1) Until the acquisition of the Vichy French fleet, Axis tanker tonnage in the Mediterranean barely sufficed for requirements in that sea; (2) military dangers in the Black and Mediterranean seas; (3) possible difficulties raised by the Turkish authorities to frequent passages through the Bosphorous, and the fact that ships making that passage can be spotted for later targets.

5/ Estimate by G.R. Paschal, BEW.

6/ MEW tanker movement reports, May 1940 - December 1942.

Despite its current inactivity, the newly acquired Vichy French fleet is an important potential means for transporting oil from Roumania. Assuming an average tanker speed of 8 knots, and with allowance for loading and unloading time, the tanker turn around should be about 12 trips yearly over the 1500 kilometers between Constanta and the Italian Adriatic ports. On this basis the estimated 113,000 tons of available Axis tankers could handle about 1,627,000 tons of petroleum per year.

b. Petroleum may reach Italy from Roumania via pipe line or railroad to Giurgiu, thence via barge on the Danube river to any one of several breaking points, as follows:

Via the Danube to Belgrade, with transfer to railway tank cars at Belgrade;

via the Danube to Belgrade, thence via the Sava river to either Brod, Sisak or Zagreb, depending on the barge draught, with transfer to railway tank cars at any of these points;

via the Danube and Drava river to Osijek, with transfer to rail to Osijek;

via the Danube to Vukovar, with transfer to rail at Vukovar;

via the Danube and Prince Alexander canal, with transfer to rail at Sombor.

There are four pipe lines from Ploesti to Giurgiu: two 9" lines for white products, and a 4" and 6" line for black products. The current capacity of these lines is about 150,000 tons/month, or 1,800,000 tons/year, and this can be increased by faster pumping. The main pumping station for the Giurgiu lines is within the Astra Romana refinery group at Ploesti. It was originally planned to transfer the Giurgiu pumping station to Teleajan, uniting it with the Constanta pumping plant, but as late as 1941 this project had not been accomplished for lack of pumping equipment. 7/

The railway line from Ploesti to Giurgiu is double-tracked throughout, and oil trains are customarily made up of 52 tank cars carrying about 660 tons of petroleum products. As the capacity of the Ploesti - Giurgiu pipe lines is greater than the estimated quantities of oil shipped through Giurgiu, tank car transport between Ploesti and Giurgiu should be of importance chiefly in the winter months.

The harbor of Giurgiu can be used by boats drawing 7' of water, and the Danube channel is maintained at a depth of 10' by constant dredging. The standard Danube tank barge carries about 700 tons of petroleum products, or approximately the equivalent of one 52-car oil train. The size of the barges is limited by the size of the Sip canal at the Iron Gate (Turnul - Severin) and a barge of 700 tons capacity is

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7/ G. Mattingly, verbal information.

about the largest that can pass this point. The minimum depth of the Danube channel in Jugoslavia during low water is about 6'.

Adequate data on present storage and loading facilities at the port of Giurgiu are not available. Before the war oil was loaded on barges by gravity flow, but it is known that the Germans have installed pumps for this purpose and that they have greatly increased the port storage capacity. 8/ As has been noted above, there is a railroad train ferry at Giurgiu which conveys tank cars across the Danube to the Bulgarian railhead at Ruse (Ruschuk).

As a possible supplement to loading barges at Giurgiu, oil may be shipped to the Danube port of Orsova, on the upstream side of the Iron Gate, and there loaded on barges. The loading capacity at this port is about 3 barges per day, or 60,000 tons/month.

The Danube river is closed to navigation in consequence of freezing for an average of 2½ months each year (middle of December to end of February). During this period oil leaving Roumania must be shipped entirely by rail, but it is common practice to accumulate large stocks at Giurgiu during the winter months to be available for rapid loading when the ice breaks in the spring.

Aside from the winter freeze, the only volume restriction on Danube water traffic is the narrow gorge of the Iron Gate (Turnul Severin). At this point the Danube river cuts through the Carpathian mountains, and a canal (Sip Canal) has been blasted through the rapids here. Because of the force of the current, barges going upstream are towed by electric engines on a paralleling railway. Traffic through the Sip Canal is alternately upstream and downstream, and it is estimated that not more than 600,000 tons/month of upstream shipping can be accommodated through these narrows. 9/

Although statistical support is lacking, there is every reason for believing that sufficient oil barges are available on the Danube waterway system to handle all probable requirements. 10/

c. As an alternative to waterway shipments, and during the winter months, oil will be sent by railway tank car direct from Ploesti to Italy. The railroad routes of most importance are:

Ploesti - Bucharest - Velika Kikinda - Kapoevar - Ptuj - Ljubljana - Trieste;

8/ C. Mattingly, verbal information.

9/ American consulate, Istanbul, report dated 11-23-42, Doc. Sec. No. 417787; MEW report on German utilization of Caucasus oil, of April 25, 1942.

10/ MEW report on tied stocks, Autumn, 1941.

Ploesti - Bucharest - Velika Kikinda - Subotica - Vinkovci - Zagreb - Fiume;

Ploesti - Brasov - Arad - Timisioara - Sombor - Zagreb - Fiume.

The two first-mentioned routes are double-tracked throughout, and the third is double-tracked except for the short stretch between Arad and Timisioara. In addition, there are numerous paralleling branch lines which can furnish alternative routes if the main lines are congested or intercepted.

Assuming a 23-day turn around, about 350 tank cars are required to carry Italian imports of Roumanian petroleum during the winter months; intercept studies indicate that Belgrade and Vukovar are currently the most important water-rail transfer points, and assuming a 10-day turn around between these places and Trieste - Fiume - Venice during the remainder of the year, about 1,350 additional tank cars will be required for this haul. A total of some 1,700 tank cars was thus required to move the estimated 1942 Italian imports of Roumanian petroleum.

3. Shipments to Bulgaria: Because of its proximity, it is believed that Roumania supplied all of Bulgaria's estimated 1942 petroleum requirement of 26,000 tons. Alternative transport routes to Bulgaria are:

a. By pipe line or by railway tank car to Giurgiu, there loaded on tank cars and taken across the Danube by train ferry to the Bulgarian railhead at Ruse (Ruschuk) and distributed within Bulgaria by railroad.

b. By rail and pipe line from Ploesti to Constanta, thence by tanker to the Bulgarian ports of Varna and Burghaz, and internal distribution by rail.

In an emergency it would be possible to load barges on the Danube at Giurgiu, Braila or Galati, and tow them down the Danube and along the Black Sea coast to Varna and Burghaz. This route is dangerous for military reasons and because of sudden storms on the Black Sea, but there is some evidence that it may be used occasionally.

The normal route for oil shipments to Bulgaria is (a) above, and it has been discussed in considering shipments to Italy. The Bulgarian railroads are standard gauge, but are all single-tracked and decrepit. The best maintained line in the country is the main Orient Express route from Nis, Jugoslavia, over Sofia and Plovdiv to Edirne and Istanbul. Assuming an average 6-day tank car turn around, only about 40 tank cars would be necessary to handle Bulgaria's estimated 1942 petroleum requirements.

4. Shipments to Greece: As in the case of Bulgaria, it is assumed that because of geographic proximity, the estimated Greek petroleum requirement for 1942, amounting to 55,000 tons, has been supplied by

Roumania. The routes are as follows:

a. By railroad and pipe line to Constanta, thence by tank steamer through the Bosphorous to Piraeus. This route has been discussed in detail in considering shipments from Roumania to Italy, and it is estimated that during 1942 some 9,000 tons of petroleum products moved from Ploesti to Greece in this way.

b. By rail and pipe line from Ploesti to Giurgiu, across the Danube by train ferry to Ruse, and via the Bulgarian railway over Zagorna to Edirne, on the main Greek railway line leading from Edirne via Dedeagach and Xanthe to Salonika and Athens; or from Ruse over the secondary line to Sofia, thence to Nis, Jugoslavia, and via the main railroad line leading southward through Greece to Athens and Piraeus.

The railroads of Greece are nearly all single-tracked and antiquated; only the line from Edirne to Salonika south to Didymatika is double-tracked. Aside from the routes mentioned above, the railways of Greece are narrow-gauged. 11/ Assuming a 14-day tank car turn around, about 125 tank cars were required to handle Roumania's estimated exports of petroleum to Greece during 1942.

5. Shipments to Jugoslavia: Because of the proximity of the two countries and excellent inland waterway transport existing between them, it is believed that all Jugoslavian petroleum requirements during 1942 (estimated 47,000 tons civilian and 100,000 tons military) were met by imports from Roumania. Such shipments would be sent by rail and pipe line to Giurgiu, thence by barge on the Danube, Drava and Sava rivers. Only local distribution within Jugoslavia would require the use of tank cars and tank trucks except during the winter months, when shipments would move by rail over the routes discussed with respect to Italian imports from Roumania.

Assuming a 10-day tank car turn around, about 300 tank cars would be required for the transport of petroleum from Roumania to Jugoslavia during the winter period of middle December to the end of February.

6. Shipments to Crete and the Dodecanese: By virtue of its geographic relationships, Roumania is the logical source from which to supply the military petroleum needs of Crete and the Dodecanese islands, and local reports indicate that this was the case during 1942. 12/ In order of facility, the routes available for this purpose are:

a. By tank car and pipe line from Ploesti to Constanta, alternatively by tank car to Burghaz or Varna, and from any of these ports by tanker through the Bosphorous in the Aegean Sea

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11/ A. Shapiro, BEW Transportation Section, verbal information.
12/ American Consulate, Istanbul, report of November 23, 1942.

to the Dodecanese (the Island of Rhodes) and to the ports of Heraklon or Khania (Suda Bay) in Crete.

b. By tank car or pipe line to Giurgiu, thence from Ruse over the Bulgarian and Greek railway line via Stara Zagora, Edirne, and Xanthe to Saloniki, thence via tanker to the above ports. Alternatively, rail shipments may move from Ruse over Sofiya and Nis to Saloniki.

Although route (a) above is the most efficient, and avoids traffic over the obsolete Bulgarian and Greek railways, observation of tanker passages at Istanbul indicates that it was not being used to any discernable extent during 1942. Local reports state that 1942 petroleum shipments to Crete and the Dodecanese moved over the rail routes indicated in (b) above, and were sent by tanker from Saloniki.

The Bulgarian Railway from Nova Zagorna to Edirne, and the Greek line from Edirne to Saloniki have no parallel lines which can be used to relieve excessive traffic, or as alternatives if the right of way is cut. For the railway haul from Ploesti to Saloniki, using a 14-day tank car turn around, about 625 tank cars are required to carry the estimated quantities of oil used in 1942.

7. Shipments to the Russian Front: An inspection of table III will show that of all the areas having a large surplus of petroleum products, Roumania is best situated from a standpoint of transport routes and geographic proximity to supply the oil needs of the Southern and part of the Central Russian Fronts. It is arbitrarily estimated that a quantity of 2,500,000 tons of Roumanian oil was sent to Russia for military purposes during 1942. The transportation possibilities for these shipments are as follows:

a. By pipe line and rail to Constanta (or Burghaz or Varna), thence by tanker to Odessa, Sevastopol, or Rostov. Distribution within Russia could thereafter be effected by rail from any of these ports, or by barge on the Don, Dniester and Bug rivers.

b. By rail from Ploesti to distribution centers in central and southern Russia, with typical routes as follows:

Ploesti - Buzau - Galati - Tiraspol, with further distribution via numerous parallel lines to Dniepropetrovsk, Stalino and Rostov;

Ploesti - Cernauti - Zhmerinka - Kiev;

Ploesti - Cernauti - Lwow - Tarnopol - Smolensk.

The Roumanian railroads in Bessarabia are single-tracked and decrepit, except insofar as they may have been repaired in recent years. It is also possible that the line from Ploesti via Galati to Tiraspol has been double-tracked in connection with the construction of the new Adolf Hitler bridge across the Danube at Galati. In any case, the

railway routes between Roumania and Russia afford numerous paralleling secondary lines which can be utilized to relieve traffic on main lines.

The logical avenue for transport from Roumania to Southern Russia is via tanker on the Black Sea, from Constanta to rail or barge heads at Odessa, Sevastopol and Rostov, with subsequent distribution by rail and barge. This route is limited for about two and one-half months per year with respect to Rostov because of the freezing over of the straits of Kerch.

Apparently this water route is not being employed, for recent tanker reports state that there is practically no Axis tanker fleet on the Black Sea. Two small tankers of 500 and 800 tons, respectively, were assigned to this service early in 1942, but at last information were tied up in port because of Russian submarine threats.

During 1942, therefore, Axis oil supplies in Russia from Roumanian sources were delivered by rail. Assuming a 24-day tank car turn around, it required about 12,000 tank cars to transport the estimated quantity of 2,500,000 tons.

Hungary

The production of crude oil in this country during 1942 is estimated at 480,000 tons, and was obtained from the Budafa Puszta (Lispe) and Lovaszy oil fields, both near the Jugoslavian border in the southwestern part of the country. Hungary's refineries, with an estimated throughput of 576,000 tons/year, are centered in and around Budapest. The crude oil must therefore be transported a distance of some 225 kilometers from the fields to the refineries. Rail facilities are available for this purpose via the line running from Nagykanisza to Budapest, and it is also reported, with considerable reliability, 13/ that a 9" pipe line has been laid from the oil fields to Budapest. Details as to the capacity of this line are lacking, but from its diameter and the low regional gradient between Budapest and Budafapusta-Lovassy, it appears safe to assume that it could handle several times the currently estimated crude oil production.

After the crude oil has reached Budapest it can either be refined locally or shipped by rail or Danube barge to refinery centers at Vienna and in Germany. Evidence from intercepts indicates that it is nearly all refined locally.

With deductions for refinery losses and Hungary's estimated 1942 internal needs of 220,000 tons of petroleum products, there remains a surplus of 251,000 tons available for distribution beyond the country's borders. Intercept studies suggest that essentially all of this surplus is currently being shipped to Italy. The transportation routes

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13/ E. M. Butterworth, verbal information.

available for the distribution of Hungarian oil are:

1. Internal Distribution: The city of Budapest and its environs contained nearly one-third of Hungary's pre-war population, and the greater part of Hungarian manufacturing is centered here. Probably more than one-half of Hungary's internal consumption of petroleum occurs in the Budapest area, and only the remainder is subject to more than very local distribution. A network of railroad lines radiates from Budapest over the whole country, and the Danube river furnishes an avenue for north-south water transport from Budapest. In the eastern part of the country the Tisza river is also navigable for barges throughout most of its length, and affords a second north-south waterway.

To allow for the available water transport facilities, a short tank car turn around of 5 days may be assumed, in which case about 125 tank cars are required to supply Hungary's internal needs.

2. Shipments to Italy: There are no direct water routes between Budapest and the Italian ports and industrial centers, and shipments of petroleum from Hungary to Italy will almost certainly be by railway tank car. Several alternative routes are available for this purpose:

a. Budapest - Nagykanisza - Ljubljana - Trieste;
b. Budapest - Kaposvar - Zakany - Zagreb - Fiume.

Both of these railroad routes are either double-tracked or have good siding facilities, and there are secondary paralleling routes which can be used to relieve congestion. Assuming a 15-day tank car turn around, some 750 tank cars are required to haul Italian imports of Hungarian petroleum.

Poland

Crude oil production from the west Polish oil fields during 1942 is estimated at 123,000 tons, and from the east Polish fields at 302,000 tons. The refinery capacity of 462,000 tons/year in West Poland, and of 393,000 tons/year in East Poland is in both cases considerably in excess of local production. The country's internal needs during 1942 are estimated at 145,000 tons, leaving, after allowance for refinery losses, a surplus of 426,000 tons/year of refined products available for export.

Oil production in West Poland comes from more than 20 small fields scattered in an east-west line along the foothills of the Carpathian mountains in Southwestern Poland. The refineries are generally located close to a group of producing fields, and the crude oil brought in by horse-drawn tank wagon. To the remoter refineries the crude is shipped by railroad tank car.

In Eastern Poland there are likewise numerous small fields, but

the great bulk of the production comes from the Boryslaw field near Drohobycz. The refinery capacity of Eastern Poland is likewise concentrated at Drohobycz, and the crude brought to the refineries by short pipe lines, or by tank cars. However, there are also refineries in the easternmost Polish producing district of Stanislawow sufficient to handle the production from that area without any considerable transportation.

From a consideration of the areas of demand and the available transport facilities, it is concluded that the distribution of Polish petroleum products during 1942 was as follows:

To	By Railroad
Internal civil needs	145,000 metric tons
Internal military needs	50,000 " "
Central Russian front	200,000 " "
Northern Russian front	176,000 " "
	571,000 metric tons

1. Internal Distribution: The main industrial district of Poland centers around Katowice, in the southwestern corner of the country. Large centers of population and industry are also found at Warsaw, Lwow, Lodz and Lublin.

The only significant inland waterway system in Poland is formed by the Vistula and Bug rivers in the central northwestern part of the country. These rivers are inaccessible from the sources of petroleum products without a considerable preliminary railway haul, and Warsaw and Bydgoscz are the only important industrial centers on this water route. It is therefore probable that internal distribution in Poland is entirely by rail, and as the centers of population and industry are in the western part of the country, oil for internal consumption comes largely from the West Polish production. On this assumption, the principal routes for distribution will be as follows:

Jaslo or Przymsl - Rzeszow - Krakow - Katowice;
Jaslo or Przemysl - Jaroslaw - Lublin - Warsaw;
Drohobycz - Chodorow - Lwow.

There are numerous alternative routes available for effecting internal distribution, and Polish railroads were in relatively good condition in 1939.

2. Internal Military Requirements: The distribution of these will follow essentially the same routes as those described above for internal civilian consumption.

3. Shipments to the Russian Fronts: Like Roumania, Poland has a long common frontier with Russia, and except for supplies sent from Roumania and some of the Baltic ports, all oil shipments to the German military forces in Russia must pass through Poland.

In contrast to the situation with respect to transportation of petroleum for civilian consumption within Poland, the available water routes are of considerable potential significance for shipments to the Russian fronts. The Vistula-Bug waterway is connected by canal with the Oder waterway system of Germany, and thus with the canal network of all Western Europe on the one hand, and via canal through the Pinsk marshes of Western Poland with the Dnieper waterway of Russia on the other hand. It is thus possible for barges of moderate draught to go from the Baltic or North seas to the Black Sea. Although it is considered unlikely that significant quantities of oil of Polish origin is shipped to Russia via water, the existence of a barge route linking eastern and western Europe deserves emphasis, and there is evidence 14/ that current goods movement over this waterway is heavy.

The shipments of Polish oil for military use on the Russian front, as here postulated, will supplement the Roumanian shipments sufficiently to cover all the needs of the Central Russian front, and will afford part of the requirements for the Northern Russian front. The main routes available for such shipments are:

a. By rail from Drohobycz and Jaslo to Warsaw, thence via barge on the Vistula and Bug rivers to Brzesc, thence by canal to Pinsk, and via the Pripyet river to military railheads on the Dnieper river.

b. By rail over a variety of routes, of which the following appear most important:

Drohobycz - Lwow - Tarnopol - Borosten - Kiev;
Drohobycz - Chodorow - Tarnopol - Korosten - Orsha - Smolensk;
Jaslo - Jaroslaw - Lublin - Brzesc - Minsk - Borisov - Orsha - Smolensk.

Because route (a) above would require several transhipments from rail to water, and because of the long immobilization of the comparatively small quantities of oil handled, it is assumed that shipments of Polish oil to Russia are made by rail. The lines involved are, so far as known, all single-tracked, but there are many paralleling lines affording alternative routes.

Assuming an average 20-day turn around, some 1,700 tank cars are required for shipping Polish oil to the military distribution centers in Russia.

Southeastern Germany

The oil fields of the Vienna Basin are the principal source of oil in Southeastern Germany. It is estimated that in 1942 the finished products available from refining local crude oil and from synthetic plants within the district amounted to 738,000 tons, to which may be

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14/ MEW Economic Intelligence Report, January 15, 1943.

added an estimated production of 227,000 tons of substitute fuels. The estimated local consumption of petroleum products during 1942 is 381,000 tons, leaving a surplus local production of 584,000 tons available for wider distribution.

The oil fields of the Vienna Basin are approximately 40 kms. north-northeast of the refinery centers around Vienna and at Bratislava. It is believed that the crude oil is transported from the fields to Vienna by pipe line. Such a pipe line was being planned in 1939, but no details of its completion or capacity are available. Crude oil sent to Bratislava for refining would travel from Vienna by barge on the Danube.

The centers of synthetic oil production in Southeastern Germany are in the industrial triangle bounded by Gleiwitz, Odertal (Deschowitz-Beuthen) and Cosel. Although the estimated 1942 production from these plants is small, great potential hydrogenation capacity is under construction in this area. Raw materials will be provided by bituminous coal from the adjacent fields in Silesia, Poland and Czechoslovakia.

It is believed that the distribution of refined products from the Southeastern German district will be approximately as follows: (in metric tons/year)

To	Via Railroad	Via Barge and R. R.	Total
Internal consumption	32,000	349,000	381,000
Local military needs	25,000	-	25,000
Central Europe military	25,000		25,000
Southwestern Germany	-	464,000	464,000
Italy	-	69,000	69,000
	82,000	882,000	964,000

1. Internal Distribution: The principal centers of consumption in the Southeast German district are the Vienna metropolitan area and the Eastern Silesia industrial district from Breslau southeast to Gleiwitz and Odertal. The oil needs of this latter area during 1942 probably surpassed local production of substitutes and synthetics, and some oil may have moved into it from the Vienna-Bratislava refining center. On this basis the main routes for the internal distribution of petroleum within the Southeastern German district were as follows:

a. Via the Danube by barge from Vienna or Bratislava, thence via the March river canal to Odertal, with local distribution by rail or tank trucks.

b. From Vienna via the rail route: Vienna - Breclav - Prerau - Mährisch Ostrau - Hindenburg;

c. Via Danube barge to Linz, with farther Austrian distribution over the local railway net.

The Danube ports of Vienna and Bratislava are equipped as oil ports, with adequate storage and pumping facilities. The port at Bratislava has storage for about 90,000 tons of petroleum products, and pumping equipment to handle about 100,000 tons per month. 15/ Equipment at Vienna is on a much larger scale, although not known in detail.

The canalization of the March (Morava) river to form a link between the Danube and Oder waterways had only begun in 1939, but in view of the importance of this water route, and the absence of natural obstacles, it may reasonably be assumed that this work was completed by 1942. As originally planned, the canal would accomodate barges with a maximum capacity of 400 tons. The Danube and its tributaries rarely freeze over for as much as a month in Central Europe and Southern Germany, so that the water route is normally usable at least 11 months of the year.

Assuming a tank car turn around of 7 days for the 31,764 tons of petroleum products estimated as distributed entirely by rail, and one of 4 days for the local distribution of the 349,000 tons whose main movement will be by water, a total of about 310 tank cars are required for internal distribution in the Southeast German district.

2. Local and Central European Military Requirements: A total of 50,000 tons of petroleum is allotted for consumption in military training and by defense organizations in Southeastern Germany, Slovakia and Bohemia. Because of the priority rating of such supplies, and the relatively small quantities going to any single area, it is believed they are forwarded entirely by rail. Using an average 7-day tank car turn around, about 50 tank cars would be required for the annual distribution of the estimated military requirements within the district.

3. Shipments to Southwestern Germany: After subtraction of the local civilian and military needs, the Southeastern German district had, in 1942, an estimated surplus of 534,000 tons of petroleum products available for wider distribution. From a consideration of the over-all picture in Axis Europe, and because of the excellent water transport between the two areas, it is concluded that all of this surplus will be sent to the Southwestern German district for farther distribution. The routes available for this shipment are:

a. By barge on the Danube from Vienna and Bratislava to Passau, Regensburg, Ulm or Mainz, depending on the size of the barge used;

b. By railroad, over the routes:
Vienna - Linz - Salzburg - Rosenheim - Munich;
Vienna - Linz - Passau - Munich - Ulm - Karlsruhe;
Vienna - Linz - Regensburg - Nürnberg - Frankfurt.

Danube barges of 700 tons capacity can ascend the river as far

15/ Confidential report of interview with recently returned informant Doc. Sec. #425184.

as Regensburg, which is the main breaking point for the transfer to railroad of water-borne goods. A similar breaking point with oil transfer facilities exists at Passau. Barges of 400 tons maximum capacity can ascend the Danube as far as Ulm, with transfer to rail at that point. Barges of 400 tons maximum capacity can also pass through the canal connecting the Danube and Main rivers, which leaves the Danube some 50 kilometers upstream from Regensburg, and passing via Nürnberg enters the Main at Bamberg. Once such barges have entered the Main, they may continue on the Rhine waterway system to almost any desired point in Western Germany, the Low Countries and Northern France.

The railroad routes noted above are the most direct of a large number of alternative lines, except for the stretch Vienna-Linz, which affords the only direct link with Southwestern Germany. It is a double-tracked main line, but there are no alternative routes except those involving a large detour.

The Danube and Rhine waterways in southern Germany are open practically all of the year, and it is to be expected that maximum use is made of them, particularly as much of the subsequent secondary distribution of the products moved can also be effected by water. The entire estimated quantity of oil moving from Southeast to Southwest Germany is thus believed to move by water.

3. Shipments to Italy: It is estimated that 69,325 tons of petroleum products were shipped to Italy from the Southeastern German district during 1942, primarily to satisfy military needs. There are two routes available for such shipments:

a. By rail over the route

Vienna - Linz - Salzburg - Innsbruck - Brenner Pass - Verona;

b. By rail and water, using Danube barges to Linz, thence via route (a) above.

Because of the excellent connections of the Vienna refineries with the Danube, it is believed that route (b) is used almost exclusively. The railway haul from Linz through the Brenner Pass is over a steeply graded, mountainous route, and although the distance is only a little more than 300 kilometers, a tank car turn around of 10 days seems probable. On this assumption, about 140 tank cars annually were required to haul the quantity indicated.

Central Germany

The production of petroleum products in the Central German district is entirely by the synthesis or hydrogenation of local coals. An estimated 2,139,000 tons of finished products were made in the district during 1942. After allowance for a production of substitute fuels estimated at 750,000 tons, and deducting an estimated local

consumption of 702,000 tons, there were 2,187,000 tons of petroleum products available for distribution beyond the district in 1942. It is estimated that these were handled as follows:

To	By Railroad	By Barge	By R. R. and Barge	Total
Local civilian needs	-	-	702,000	702,000
Local military needs	75,000	-	-	75,000
Czechoslovakia	-	-	54,000	54,000
Northeast Germany	-	1,273,000	-	1,273,000
Northwest Germany	-	551,000	-	551,000
Southwest Germany	-	234,000	-	234,000
	75,000	2,058,000	756,000	2,889,000

1. Local Civilian Consumption: The Central German District possesses excellent inland waterway facilities in the form of the Mittelland Canal and the Elbe and Saale rivers. Although it is believed that a maximum use is made of these water routes, particularly in supplying the larger cities, much of the final distribution will have to be by rail or tank truck.

The Central German district likewise possesses a dense network of multi-tracked railroads, and there is no basis for citing particular rail routes as especially significant in the distribution of petroleum products. Typical rail routes are:

Merseburg (Leuna) - Halle - Wittenberg - Berlin;

Bohlen Rotha - Leipzig - Dessau - Berlin;

Ruhland-Schwarzheide - Elstwerda - Baruth - Berlin.

With respect to water routes it is possible to be more definite:

a. Products from the Leuna plant will move by barge up the Seale river to the Elbe, thence via the Elbe to its junction with the Mittelland Canal, on which they can move either east or west across all Germany; or shipments may continue on the Elbe to Northwest Germany.

b. Products from the plant at Troglitz-Zeitz will require to be carried 38 kms by rail or truck, to Merseburg, whence they can continue by route (a) above.

c. Shipments from the Brüx plant must move by rail or truck some 40 kms. eastward to the Elbe river port of Aussig, at which place they can be loaded on barges and reach any point on the Elbe and Mittelland canal system.

d. The output of the plant at Bohlen Rotha can reach the Saale river via a 40 km. rail or truck haul, and thereafter move by barge up the Saale to the Elbe and wider distribution.

e. Products originating at Lützendorf-Mücheln require only 30 kms. of rail or truck transport to reach the Saale river at either Halle or Merseburg.

f. The output of the plants at Ruhland-Schwarzheide must be moved by rail or truck about 50 kms. to reach the Elbe river at either Meissen or Riesa.

To allow for the extensive facilities for distribution of petroleum by water within the Central German district, the tank car turn around may be assumed as 5 days, in which case about 500 tank cars per year are required for distribution of the estimated local requirements.

2. Local Military Requirements: It is assumed that 75,000 tons of petroleum products were required for military purposes in the Central German district during 1942. It is likewise assumed that military distribution was effected by rail. On the assumption of a 6-day tank car turn around, about 90 tank cars were required for this purpose.

3. Shipments to Czechoslovakia: Because of the geographic and water transport relations between Czechoslovakia and Central Germany it is believed that Czechoslovakian internal requirements, estimated at 53,000 tons during 1942, were supplied from Central Germany. The primary routes for such supply are:

a. By rail for an average distance of 25 miles from Brüx, Bohlen Rotha or Ruhland-Schwarzheide to the Elbe river, thence via barge down the Elbe to its junction with the Moldau (Vltava) and on the Moldau to Prague, with farther distribution in Czechoslovakia by rail.

b. By rail from Troglitz-Zeitz to Leuna, and by barge from Leuna via the Saale river to the Elbe river, thence over route (a) above.

c. By rail over the general routes

Leipzig - Dresden - Bodenbach - Prague;

Leipzig - Plauen - Eger - Pilsen.

The main rail routes for distribution within Czechoslovakia are:

Prague - Kolin - Pardubice - Brno - Bratislava;

Prague - Kolin - Pardubice - Prerau - Morava Ostrava;

Prague - Tabor - Budweis.

The above railway lines, both in Germany and in Czechoslovakia, are double-tracked main routes. There are numerous parallel branch lines by which the same distribution can be effected, except for the

stretch Dresden - Bodenbach - Aussig on the road to Prague, which passes through the Elbe river gorge in the Erzgebirge mountains. A very large detour would be required if this stretch were intercepted.

Assuming an average tank car turn around of 7 days, about 75 tank cars are required for the distribution of Czechoslovakia's internal oil requirements.

4. Shipments to Northeast Germany: It is estimated that a quantity of 1,273,000 tons of oil supplies for civil and military needs moved from Central to Northeastern Germany for farther distribution during 1942.

Numerous main railway lines connect Central and Northeastern Germany, but it is probable that the shipments here considered were effected by the available inland waterways. Although the water routes may freeze over for a month or more during each year, shipments could be proportionally increased during the remainder of the year to permit moving the entire quantity by water. The important routes are:

a. From Troglitz-Zeitz and Leuna via the Saale river to the Elbe river, thence up the Elbe to its junction with the Mittelland Canal, thence eastward on the Mittelland canal system to the Oder river and northward on the Oder to Stettin.

b. From Lützendorf-Mücheln, Ruhland Schwarzheide, Bohlen Rotha or Brüx by rail to the nearest Elbe port, thence over route (a) above.

5. Shipments to Northwest Germany: It is estimated that during 1942 some 551,000 tons of petroleum products moved from the Central to the Northwestern German district for farther distribution from the latter area. Although there are numerous main railway lines linking the two areas, it is believed that oil shipments were essentially over the excellent water routes available:

a. By barge from Merseburg (Leuna and Troglitz-Zeitz plants) via the Saale river to the Elbe river, thence up the Elbe to Hamburg;

b. Via route (a) to the Mittelland Canal at Magdeburg, thence westward on the Mittelland Canal to connections with the Weser river (Bremen) at Minden, or with the Ems river and Rhine waterway near Rhiene;

c. If rail shipments were made, representative routes from Ruhland Schwarzheide, Lützendorf-Mücheln, Bohlen Rotha, Leuna or Troglitz-Zeitz are:

Halle - Dessau - Magdeburg - Hannover - Bremen
Leipzig - Magdeburg - Wittenberg - Hamburg.

6. Shipments to Southwest Germany: It is estimated that during 1942 some 234,000 tons of petroleum products moved from the Central to the Southwestern German district for farther distribution. There are very good waterways available for such shipments, and barges from Central Germany can continue without transhipment to any desired region in Western Germany, the Low Countries or Northern France; it is therefore believed that the water route was used to the exclusion of others for making shipments from Central to Western Germany. However, representative rail routes are also noted below.

a. The water route is via barge on the Elbe or Saale-Elbe rivers, depending on the plant of origin, to the Mittelland Canal at Magdeburg, thence westward on the Mittelland Canal to its junction with the Hms waterway near Rheine, thence southward to the Rhine river and farther distribution.

b. Representative rail routes for shipments from Southeastern to Southwestern Germany are:

Leipzig - Erfurt - Eisenach - Fulda - Frankfurt - Mainz;
Halle - Nordhausen - Kassel - Marburg - Giessen-Koblenz.

The railroad routes, as in the case of those previously considered within Germany, are multi-tracked main freight lines, and are supplemented by numerous parallel routes.

Southwestern German District

Petroleum products in the Southwestern German district come entirely from synthetic plants working local coals. It is estimated that an annual quantity of 1,399,000 tons is so produced; after allowing for the production of substitute fuels, and deducting local consumption estimated at 1,022,000 tons during 1942, there is left a quantity of 1,124,000 tons for distribution outside of the district.

Because of the geographic and transportation relationships between Southwestern Germany and the heavy deficit areas of western Europe, it is believed that products from other areas are shipped into the district for forwarding, as follows: From the Central German district, 234,000 tons; from the Southwest German district, 464,000 tons. The routing of these shipments has already been discussed, and when they are added to the local surplus a total of 1,822,000 tons of petroleum products become available for distribution from the Southwest German district. It is believed these will be distributed as follows: (metric tons/year)

To	By Rail	By Barge	By Barge and R.R.	By Barge and Tanker	Total
Local military	75,000	-	-	-	75,000
French civil	115,000	60,000	85,000	-	260,000
French military	150,000	76,000	114,000	560,000	900,000
Holland civil	-	74,000	-	-	74,000
Belgium-Holland military	-	400,000	-	-	400,000
Switzerland	-	-	127,000	-	127,000
Italy	-	-	-	-	60,000
	60,000	-	-	-	
	400,000	610,000	326,000	560,000	1,836,000

1. Internal Distribution: All the hydrogenation and synthetic plants in the Southwestern German district are located directly on the Rhine waterway system, with the exception of the plant under construction at Ludwigshafen, whose potential has not been considered in this report. Despite the available water transport, local distribution must be in large part by tank car and tank truck. To compensate for the quantities moved by water and truck, a short tank car turn around of 4 days may be assumed, in which case an annual number of 800 tank cars will be required to distribute the 1,021,389 tons of oil required within the district.

It is assumed that the estimated 75,000 tons of oil required for local military use was distributed entirely by rail. On the preceding assumptions, about 60 tank cars were used for this purpose during 1942.

2. Shipments to France: It is estimated that France needed to import a total of 1,160,000 tons of petroleum products for civilian and military purposes during 1942. The greater part of the quantity allocated for civilian consumption was used in the industrial districts of Northern France, and of the amounts allocated for military use, it is estimated that 560,000 tons were distributed to the ports of Western France for naval consumption.

The available water routes for the distribution of civil and military (except naval) oil supplies from Southwestern Germany to Northern France are:

a. By barge from Rhine ports up the Rhine to Strasbourg, thence via the French canal system over Nancy and Chalons to Paris and canal ports of Northern France.

b. By barge up the Rhine to the Rhine canal near Basel, thence via the French canal system to Mulhouse, Dijon and Lyon.

c. By barge down the Rhine to Nijmegen, in Holland, thence via the Dutch and Belgian canal system over Liege to Namur and connections with the canal system of Northern France.

Of the above routes, that headed (c) presumably carries the greatest volume of traffic, and (a) the least, owing to the fact that only

small barges can negotiate the canal connecting Strasbourg with the Rhine.

Despite the variety of the available water routes, all of them involve long and circuitous hauls from the production centers of Southwestern Germany to the principal civilian and military consumption centers in France. It is therefore estimated that two-thirds of the shipments to France for other than naval requirements will be by rail, for which representative routes are:

Dusseldorf - Aachen - Liege - St. Quentin - Paris;

Dortmund - Gelsenkirchen - Venlo - Eindhoven - Brussels - Lille;

Köln - Aachen - Liege - St. Quentin;

Ludwigshafen - Metz - Chalons - Paris.

All of the above are multi-tracked freight routes, and there are other parallel routes available. The railroad routing is controlled chiefly by the fact that there are bridges over the Rhine only at Duisburg, Düsseldorf, Köln, Koblenz and Mainz. The distance from the Ruhr production centers to consumption centers in Northern France averages about 300 kms. Assuming a 10-day tank car turn around, about 530 tank cars are required to handle the 265,000 tons of oil estimated as moving to Northern France by rail.

The civil and non-naval military oil needs of Central and Southern France are estimated at 199,000 tons. These quantities may be shipped from Southwestern German Rhine ports by rail and water, for which purpose the most direct routes are:

a. Via Rhine barge to near Basel, thence via canal over Mulhouse and Besancon to the Rhone river and via the latter to Lyon. From Lyon distribution by rail southward to Marseille and westward to Bordeaux and Nantes;

b. By barge on the Rhine river to Coblenz, thence by rail over the route

Coblenz - Luxemburg - Chalons - Paris - Tours - Bordeaux.

The above are only typical of many routes for rail distribution within central and Southern France. Assuming an average tank car turn around of 14 days, about 550 tank cars were required for effecting distribution in Central and Southern France.

For the distribution of naval requirements along the west coast of France, it is believed that full use will be made of the available tanker fleet in the North Sea. The principal restriction on this method of distribution are the military dangers of the tanker passage through the Straits of Dover. However, by putting into the numerous available ports along the route during the daytime, this risk could be

minimized, and there is evidence of a sufficient number of tanker loadings in Dutch and Belgian ports to cover the indicated oil movement. The most direct route for this purpose is:

> By barge on the Rhine from the Ruhr area to Rotterdam, or via the Rhine and Dutch and Belgian canals to Antwerp, with tanker loading at either Rotterdam or Antwerp; thence via the English channel and the Bay of Biscay to L'Orient, St. Nazaire and Bordeaux.

To allow for the very slow passage through the English channel, a low tanker turn around of three weeks over the average 500 mile route may be assumed. On this basis no more than seven 5,000-ton tankers would be required to move the indicated 560,000 tons/year of oil.

3. Shipments to Holland and Belgium: After allowing for the Belgian production of substitute fuels, which some is 9,000 tons/year greater than the country's estimated consumption of all petroleum products, it is estimated that a total of 474,000 tons of oil will be required for military and civil needs in the low Countries. Both Holland and Belgium are at the distributional head of the Rhine waterway system, and it is highly probable that shipments to them follow the routes:

a. From Ruhr sources via the Rhine river to the Dutch canal system;

b. From Ruhr sources via the Rhine to the English channel, thence through water inlets in the Rhine delta to Antwerp and the Belgian canal system;

c. Via the Rhine river to Nijmegen, thence via Dutch and Belgian canals over Liege and Namur to the east Belgian canal system.

A network of canals connecting with the Rhine waterway covers Holland and Belgium, so that even every local distribution in these countries can be effected by barge.

4. Shipments to Switzerland: It is estimated that Switzerland consumed 127,000 tons of petroleum products during 1942, all of which were received from Germany or from German-controlled countries. The Southwest German district is so closely linked to Switzerland by both rail and water routes that it is here assumed that all oil supplies to Switzerland were shipped from this source. The routes available are:

a. By barge from Ruhr sources via the Rhine river to Basel, with farther distribution within Switzerland by rail;

b. By rail over the route

> Gelsenkirchen - Duisburg - Köln - Mainz - Karlsruhe - Basel.

It is believed that route (a) will be used almost exclusively in shipments to Switzerland. For internal distribution within Switzerland a 5-day tank car turn around may be assumed, in which case about 125 tank cars were required during 1942.

5. Shipments to Italy: For shipments to Italy from Southwest Germany there are several routes available:

a. By barge from Ruhr ports via the Rhine river to Basel, thence via railroad over the route leading to Lucerne and through the St. Gotthard tunnel to Milano;

b. By route (a) above, thence over the railroad route Basel - Bern - Simplon Tunnel - Milano.

An estimated quantity of 60,000 tons of oil reached Italy from Germany over the above routes during 1942. BEW intercept studies afford some confirmation both of the quantities and the routes noted. Assuming a 12-day tank car turn around, about 150 tank cars per year were required to effect this shipment:

Northeast German District

The only known source of oil products in the Northeast German district, aside from local production of substitute fuels, is the hydrogenation plant at Poelitz (Stettin). This is the only known hydrogenation plant in Germany which is situated a considerable distance from any source of raw materials. In order of proximity, raw materials for the Stettin plant may be derived from (1) the central German coal fields around Halle, and moved by rail or canal a distance of about 275 kilometers to Stettin; (2) the coal fields of Silesia, with rail or canal transport a distance of about 500 kilometers to Stettin; (3) the oil shale deposits of Esthonia, with marine transport on the Baltic Sea for a distance of about 1,000 kilometers; (4) the Roumanian oil fields, via canal or canal and rail combinations a distance of over 1600 kilometers to Stettin. With the exception of the marine haul for Esthonian shale oil, all of the routes above have been previously discussed in considering oil movements.

The production of the Poelitz oil plant during 1942 is estimated at 300,000 tons of finished products; in addition, it has been estimated above that 1,273,000 tons of oil were shipped from the Central German district to the Northeast German district for farther distribution. With allowance for the local production of substitute fuels, and with deduction for estimated 1942 consumption within the district, there is available a quantity of 1,689,000 tons of petroleum products for shipment beyond the borders of the district. To this may be added the Esthonian surplus production of shale oil, estimated at 24,000 tons in 1942, whose distribution may be considered identical with parts of that from the Northeast German district. It is estimated that the distribution from the Northeast German district is as follows: (in metric tons/year)

To	By Railroad	By Tanker and R. R.	Total
Local military needs	105,000	-	105,000
Baltic military area	-	505,000	505,000
North Russian front	-	824,000	824,000
Lithuania	-	11,000	11,000
Latvia	-	13,000	13,000
Finland	-	57,000	57,000
Sweden	-	198,000	198,000
	105,000	1,608,000	1,713,000

1. Internal Distribution: The only water route of importance in the Northeast German district is afforded by the north-south Oder river. Distribution of oil products within the district will therefore be chiefly by rail and tank truck. Assuming an average 5-day tank car turn around, 240 tank cars will be required for the distribution of the estimated 245,000 tons annual consumption of oil for civil and military purposes within the district.

2. Shipments to the Baltic military area: It is estimated that 505,000 tons of petroleum products were required for naval, army and air force consumption in the Baltic area during 1942. The probable routes for the distribution of these supplies are:

a. By tanker from Stettin to Gdynia, Königsberg, Riga and Talinn;

b. By rail from Stettin to Rostock or Gdynia, thence by tanker as in route (a) above;

c. By rail over either of the following routes:

Stettin - Bydgoszcz - Insterburg - Kaunas - Riga - Talinn;

Stettin - Marienburg - Königsberg - Kaunas - Riga - Talinn.

It is estimated 16/ that at the end of 1942 Germany had available a tanker fleet of 880,000 g.r.t. in northern waters, of which 230,000 g.r.t. were vessels of 1,000 g.r.t. or over. Swedish tanker tonnage could add an additional 30,000 g.r.t. to this total. Assuming an average 15-day tanker turn around, this fleet would be capable of hauling some 6,500,000 tons of oil annually, a quantity far in excess of Germany's requirements for marine distribution.

The railroad facilities in Lithuania, Latvia and Esthonia involve single-tracked lines and generally decrepit equipment. It is therefore believed that Germany will make full use of the excellent tanker routes available for distributing oil for civil and military needs in the Baltic Sea area.

16/ Estimate by G. R. Paschal, BEW Transport Section.

3. Shipments to the Northern Russian Front: An estimated quantity of 505,000 tons of oil moved from the Northeast German district to the north Russian front during 1942. It is believed that the transport routes employed are:

a. By tanker from Stettin or Rostock to Riga, thence by rail over the general route Riga - Dvinsk - Vitebsk;

b. By tanker from Stettin or Rostock to Talinn, thence by rail over the general route Talinn - Idritsa - Velikie Luki.

Assuming an average 8-day tank car turn around from the ports to the military distribution centers on the North Russian front, some 800 tank cars were required for the indicated rail haul.

4. Lithuania: This country's estimated petroleum allotment during 1942 is the nearly negligible figure of 11,000 tons. The most economical route for its shipment is:

By tanker from Stettin to Königsberg, thence by rail over the route Königsberg - Insterburg - Kaunas.

Assuming a 6-day tank car turn around, about 13 cars were required to effect internal distribution within Lithuania.

5. Shipments to Latvia and Finland: The civil consumption in Latvia during 1942 is estimated at 13,000 tons, and that of Finland at 57,000 tons. Shipments to these countries have the following main routes available:

a. By tanker from Stettin to Riga, with internal distribution in Latvia by rail;

b. By tanker from Stettin or Rostock to Helsinki, with farther distribution in Finland by rail;

c. By tanker from Stettin or Rostock through the Kattegat, thence along the Norwegian coast and around the North Cape to Petsamo.

Routes (a) and (b) above appear from tanker movement studies to be regularly employed. There is also evidence that route (c), which is long and involves considerable military hasard, is being used for the shipment of military supplies. However, the quantity of oil involved in this latter case is small, as seems evident from the conclusion that a tanker tonnage of not more than 3,000 g.r.t. was used on this run during 1942.

Assuming that Latvian and Finnish internal distribution permit a 5-day tank car turn around, not more than 60 tank cars were required for this purpose during 1942.

6. Shipments to Sweden: An estimated 198,000 tons of petroleum

products were consumed by Sweden during 1942, all of which is here assumed to have been imported from the Northeast German district. The available supply routes are:

a. By rail, via the line Stettin - Pasewalk - Sassnitz - Trälleborg; this route employs the train ferry across the Baltic between Sassnitz, Germany and Trälleborg, Sweden;

b. By tanker from Stettin to Stockholm, Karlskrona, Malmö or Göteborg, and distribution by rail within Sweden.

Route (b) above affords the most economical use of transport facilities, and is probably most employed. Assuming a 7-day tank car turn around within Sweden, about 275 tank cars were required for local distribution within the country.

Northwest German District

The source of petroleum products in the Northwest German district is by refining the crude oil produced in the Reitbrook, Nienhagen and numerous smaller oil fields, all of which are within a relatively short rail or canal haul of the refinery centers at Hamburg, Hannover and adjacent areas in Northwest Germany. It is estimated that 718,000 tons of petroleum products were produced within the district during 1942, and an additional 551,000 tons were shipped in from the Central German district, as discussed above, for farther distribution from Northwest Germany. After allowance for the local production of substitute fuels, and with deduction of the estimated local consumption of 561,000 tons/year, there remained a total of 934,000 tons of oil available for wider distribution. It is believed that this quantity was handled as follows:

To	By R. R. and Barge	By R. R. and Tanker	Total
Local military needs	375,000	-	375,000
Norway military needs	-	405,000	405,000
Norway civil	-	68,000	68,000
Denmark civil	-	86,000	86,000
	375,000	559,000	934,000

1. Distribution of local Requirements: The Northwest German district possesses a network of multi-tracked railroads, and a very good canal system involving the Elbe, Weser and Ems rivers, which are linked together by the Mittelland canal. To allow for a maximum use of water routes in the local distribution of oil, a tank car turn around of 4 days is assumed, in which case 730 tank cars are required to handle the 960,000 tons/year of oil for civil and military needs within the district.

2. Norwegian civilian requirements for petroleum during 1942 are

estimated at 68,000 tons, and a total of 405,000 tons is allotted for military requirements during this period. The larger part of the military shipments will consist of fuel oil for naval bases in western Norway, and aviation gasoline, also chiefly to destinations in Southern and Western Norway. The most economical route for these shipments is:

> By barge on the Mittelland canal to the Elbe or Weser rivers, thence to Hamburg or Bremen, with tanker loadings at these ports. Thereafter by tanker through the Kiel canal and the Kattegat to Oslo, or to the Atlantic ports of Bergen, Trondhjem, etc.

Assuming an average tanker turn around of three weeks, not more than 20,000 g.r.t. of tanker shipping would be required to supply the indicated civil and military oil needs of Norway. As Norwegian oil requirements are chiefly centered in areas within trucking distance of seaports, it is assumed that tank car distribution within the country will permit a 4-day turn around, in which case about 375 tank cars are required.

3. Shipments to Denmark: The Danish internal consumption of petroleum products during 1942 is estimated at 86,000 tons. The probable sources of this supply are refineries at Hamburg or Hannover, or shipments to Bremen and Hamburg from the Central German district. The important routes for deliveries of oil to Denmark from the Northwest German district are:

a. By tanker from Bremen or Hamburg through the Kiel canal to Danish Kattegat ports such as Fredericia, Aarhus or Copenhagen;

b. By rail from Bremen or Hamburg via the route

Hamburg - Neumunster - Kolding - Odense - Copenhagen.

c. By rail and rail-ferry via the route

Hamburg - Lübeck - Rostock - Gedser - Copenhagen.

The rail routes are multi-tracked main lines. Route (b) involves crossing the Little Belt bridge between Jutland and Fyn Island, and a rail ferry crossing between Nyborg, on Fyn Island, and Korsor, on Sjaelland island.

Because of the generally assumed strained condition of the railway lines in western Europe, it is highly probable that distribution of oil to Denmark is effected through the excellent water connections afforded by route (a) above.

Assuming an average 4-day tank car turn around, some 65 tank cars are required for the local distribution of petroleum products within Denmark.

Italy

Italy's internal production of crude oil from numerous small fields bordering the Po valley in the northern part of the country, amounts after refining to the small figure of 10,000 tons/year of petroleum products. However, Italy refines the production from the Devoli field in Albania by hydrogenating it at plants in Bari and Livorno (Leghorn), by this means adding a further internal supply of 200,000 tons/year of petroleum products.

The Albanian production is sent by pipe line from the producing ares in the south-central part of the country a distance of 74 kilometers to the harbor at Valona, where it is loaded on tankers and taken to Bari or Livorno. The pipe line has a diameter of 200 mm. (about 8") and can handle 2,500,000 tons/year of oil, or more if the pumping rate is increased.

The harbor at Valona has two underground storage tanks capable of containing about 4,500 tons each of oil, and has two tanker births. Oil is loaded from tanks to tankers by gravity flow, and ships can be loaded at the rate of 800 tons/hour.

Italy's civilian consumption of oil during 1942 is estimated at 655,000 tons, and an estimated 900,000 tons additionally is required for military purposes within the country and in the North African war theater. After allowance for domestic production of crude oil and substitute fuels, and for Albanian imports, Italy had a deficit of 1,280,000 tons in its liquid fuel requirements for 1942. As has been indicated earlier, this deficit is assumed to have been met by the following imports:

From	Metric tons/year
Roumania	900,000
Hungary	251,000
Southwest Germany	60,000
Southeast Germany	69,000
	1,280,000

Italian supplies from Hungary and Roumania, amounting to 1,151,000 tons/year, may be viewed as becoming available at Fiume or Trieste. Their farther distribution from these ports can be effected most economically by tanker, for which typical routes are:

Fiume - Bari - Catania - Libyan ports;
Trieste - Bari - Naples - Livorno - Genoa.

It may be assumed that the bulk of the Italian military requirements in Italy, Sicily and North Africa will be supplied by these or similar routes. The average tanker haul for this purpose is about 1700 kilometers, and with an average tanker speed of 8 knots, the tanker turn around may be estimated at about 4 weeks, in which case it

will require some 60,000 g.r.t. of tanker shipping to handle the estimated annual water-borne supplies of 1,151,000 tons.

The oil imports from Germany may be assumed as becoming available at Milano and Verona. For the farther distribution of these, and for the local distribution of oil for civilian consumption within Italy, railway tank cars will be employed, with the following as typical routes:

a. Verona - Bologna - Rimini - Ancona - Foggia - Bari - Brindisi;

b. Milano - Bologna - Firenze - Rome;

c. Milano - Genoa - Pisa - Livorno - Rome - Naples - Reggio Calabria.

Route (a) above involves a double-tracked, electrified line as far as Ancona; thereafter the route is largely single-tracked and steam powered. Route (b) is a double-tracked, electrified line throughout. Route (c) is double-tracked and electrified from Milano to south of Salerno; for the remaining approximately 200 kilometers to Reggio Calabria it is a single-tracked electric line.

The railroads on the island of Sicily are all single-tracked and steam powered, with narrow-gauged secondary routes.

Assuming an average 7-day tank car turn around for the internal distribution of Italian petroleum requirements, some 900 tank cars are required for the purpose.

Estimates of Tank Car Requirements for Distribution of Petroleum in Axis Europe

Estimate of Tank Cars Available Before the War		M. E. W. Tied Stock Report, Autumn, 1941		Present Report	
Country	Tank Cars	Service	Tank Cars	Service	Tank Cars
Germany	20,000	Roumania-Germany	10,750	Roumania internal	2,550
Czechoslovakia	1,500	Roumania-Italy	5,040	Roumania-Italy	1,700
Austria	1,500	German Danube ports	4,770	Roumania-Greece	950
Poland	3,000	Danube ports-Italy	1,660	Roumania-Jugoslavia	300
Italy	2,000	For German production	10,200	Roumania-Russia	12,000
France	15,000	Italy internal	3,700	Hungary internal	125
Belgium	2,400	Roumania		Hungary-Italy	750
Holland	500	Internal	2,370	Poland internal	400
Hungary	700	Ploesti-Giurgiu	1,130	Poland-Russia	1,700
Roumania	10,000	Military supplies	6,420	S. E. Germany internal	360
Jugoslavia	380	Germany-Russia	7,560	S. E. Germany-Italy	140
Denmark	300	Germany-France	2,030	Central Germany internal	590
Bulgaria	150	France internal	3,520	Cent. Germany-Czechoslovakia	75
Greece	80	Balkans		Southwest Germany internal	800
	57,510	Bulgaria	230	S.W. Germany-France	1,080
		Greece	940	S.W. Germany-Switz., Italy	275
		Jugoslavia	180	Northeast Germany internal	240
			60,450	N.E. Germany-Russia	800
				N.E. Germany-Baltic States	350
				Northwest Germany internal	730
				N.W. Germany-Scandinavia	440
				N.W. Germany-Italy	900
					25,183