

PETROLEUM BOARD

ENEMY OILS AND FUELS COMMITTEE

RESULTS OF EXAMINATION OF

ENEMY LUBRICATING OILS

FOURTH SUMMARY

TO

31ST AUGUST 1943

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The examination of the oils described in this report was carried out in the following Laboratories:

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London Passenger Transport Board, Chiswick
Petroleum Board, Vauxhall
Shell Marketing Co., Ltd., Fulham
Vacuum Oil Company, Ltd., Wandsworth

PETROLEUM BOARD ENEMY OILS AND FUELS COMMITTEE

EXAMINATION OF SAMPLES OF ENEMY LUBRICATING OILS

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LUBRICATING OILS FROM GERMAN AERO-ENGINES

Since the preparation of the third report, 19 samples of German aero-engine oils have been received for analysis in the period September, 1942 - August, 1943. Of those samples, 5 were captured in dumps in North Africa and one came from Sweden. The remaining 13 oils including one from Russia are all used oils excepting one taken from a Heinkel. (see Tables I and II for data)

SUMMARY

1. About 30% of the oils are compounded with Voltol or Elektrion.
2. The average viscosity of the oils at 210°F. is slightly higher than before and so is the viscosity index.
3. The straight mineral oils are principally high quality oils of the solvent treated type. Certain oils captured in North Africa may consist of synthetic oils. The mineral oil components of the Voltolized oils are of the high sulphur (Reitbrook) type.
4. There is no indication that phosphorus or chlorine-containing additives are being used in German Aero oils.

Composition of the Oils

Six of the oils, i.e. about 30%, contain Voltol, but one of the six compounded oils has only a small Voltol content corresponding with about 1% fatty oil (AIR.204). The latter oil is the only instance since the second summary (October, 1941) in which a German aero-engine oil has shown a small Voltol content, i.e. less than saponification value of 7. It is probable that the occurrence of compounded oils with less than the usual Voltol content arises from mixing of mineral and voltolized oils in service, a practice which the Germans appear to have discontinued since 1941, judging from the samples received.

Regarding the use of aviation oils instructions were issued by the Reich Air Ministry in December, 1941, to the effect (1) that certain engines were no longer to be lubricated with oil containing Voltol (used in the grade known as AeroShell Medium), and (2) that other types of engine for which both mineral oils and Voltol mixtures were allowed, were preferably to be lubricated with the voltolized oil. The effect of the first instruction was to cause all engines using G.3 (green) fuel to be lubricated with straight mineral oil (known as Rotring or Intava 100). The second instruction indicated that shortage of Voltol was not the reason for the restriction in its application. It is possible that the incidence of piston ring-sticking in high duty engines caused Voltolized oil to be rejected for these units, since it is known that high temperature ring-sticking is hastened by the presence of Voltol.

An order dated 11.8.41. captured from the Germans in North Africa made a distinction between oils known as Intava 100 and Rotring, terms which were originally synonymous. The order stated that the former oil may no longer be used for B.M.W.132 and Bramo 323 engines. Both these types of engine were scheduled to use Rotring oil. No samples of oil have been obtained from B.M.W.132 and Bramo, so the significance of the difference between Intava 100 and Rotring Oils has remained unknown to the Committee. Included in the oils dealt with in this report are five samples, captured in North Africa, which bear the designation "Rotring" and reference numbers such as L.45 and M.45M. One of these oils, sample L.3, is similar to many previous German aero oils of the solvent refined type, but the other four oils (AIR.295, 6 and 7 and 310),

although of the same viscosity grade have low specific gravities (.870 - .875), viscosity indices of 105, a low sulphur content (about 0.16%), and low coke values indicating the absence of Bright stock. The B.A.M. oxidation test has been carried out on two of the oils and the results give a high coke increment and viscosity ratio for oils of this class. Excepting the sulphur content, which is rather high, these physical and chemical properties are generally consistent with the assumption that the oils consist essentially of "synthetic" materials, i.e. oils made by the polymerization in presence of $AlCl_3$ of unsaturated hydrocarbons of appropriate boiling range. Examination of the oils for the presence of high viscosity hydrocarbon polymers of the polyisobutene type by addition of precipitating solvents gave negative results. Specimens of AIR.295, 6 and 7 have been sent to the U.S.A. via the U.S. Embassy so that the views of American petroleum technicians on the nature of the "Rotring" oils may be obtained.

Properties of the Oils

The oil AIR.179 from Sweden is low in viscosity for a German aircraft oil. Its properties indicate that it is probably a basic mineral oil distillate of the Reithrook type, used for blending with Voltol to produce AeroShell Medium.

All the oils are again of "100" grade (D.T.D.472B) their average viscosity is about 21.5 cs. at 210°F. or 104 secs. Saybolt Universal. This is slightly higher than the average of previous captured German aero oils, which was 96 secs. Saybolt Universal, but the increase is not sufficiently great to indicate that the Germans have changed the viscosity grade of their aviation oils.

The average Viscosity Index of the oils, excepting AIR.179, is 96 which is higher than the average of previous reports (93). The lowest viscosity indices, viz. 84, 85 and 86 are shown by three Voltol blends.

Origin of the Oils

The nature of four of the "Rotring" oils captured in North Africa (AIR.295, 6 and 7 and AIR.310) has already been discussed and it has been suggested that these oils consist largely of synthetic material.

The only oil obtained from a fighter, AIR.190, from a F.W.190, is a solvent-refined oil. Other mineral oils of the solvent-refined type came from Dornier and Junkers 88 bombers, samples AIR.214, 235, 277, 284 and 286. Two of these oils have low sulphur contents 0.2 - 0.35% and specific gravities of .893 - .896. The other three mineral oils have sulphur contents of 0.5 - 0.6% and specific gravities from .888 - .890. Since the viscosity indices of the three latter oils are at least as high as those of the two former oils, it seems that the Germans are solvent refining at least two different crudes to make 100 V.I. mineral aero oils. The low specific gravity combined with low sulphur content of the F.W.190 oil (AIR.190) suggests that three different crudes may be employed in the solvent extraction plants. The mineral oil sample, AIR.204, which appears to contain a trace of Voltol is of the higher sulphur (0.6%) type and is solvent refined. In view of the presence of Voltol, it is not safe to draw conclusions regarding its origin from the specific gravity. The "Rotring" oil L.3 (AIR 294) is probably solvent-refined.

The five Voltolized oils all contain more than 1% sulphur and their mineral oil component is probably of Reithrook origin. The saponification values of the Voltolized oils (excluding AIR.204) vary from 4.5 to 14.9, corresponding with fatty oil contents of about 2.5 - 7.5% of the total oil, or 7.5 - 22.5% Voltolized material.

No evidence was found of the presence of phosphorus or chlorine compounds in the oils.

Most of the used oils are in fairly good condition, although AIR.204 had a sediment (insoluble in petroleum ether) of 1.6% and an ash content of 0.6%. AIR.173 and 286 also had ash contents of about 0.5 - 0.7%. The high ash contents are largely due to the presence of lead from the fuel.

GERMAN AERO OILS

	AIR 173	AIR 174	AIR 179	AIR 190	AIR 194	AIR 204	AIR 208
AIRCRAFT, ENGINE, AND DATE AND PLACE OF CRASH.	Ju. 88. 29-4-42. Crockey Hill, York. (From un- damaged tank). (Used Oil)	Ju. 88. 29-4-42. Crockey Hill, York. (From dam- aged tank). (Used Oil)	Sweden via M.E.W. rec'd June, 1942. (Unused)	F.W.190. BMW.80D. 23-6-42. Pembrey. (Used Oil)	Heinkel. Aug., 1942. "Aviation Waste Oil" taken after forced landing ex Russia. (Used Oil)	Ju. 88. Novr., 1942. (Used Oil)	Ju. 88. June 2113 3-7-42. Baumber, near Newark. (Used Oil)
<u>Oil as Received.</u>							
Diluent %v.	2.8	2.8	-	4.8	8	2.0	4
Red. I @ 140°F.	285	285	266	-	-	-	-
Insol. in Pot. Ethor, %w.	0.48	0.35	-	1.12	nil	1.62	< 0.01
" " Benzol, %w.	0.44	0.23	-	-	-	-	-
Neut. value, mgms.KOH/gm. oil.	0.6	0.6	-	-	-	-	0.1
Ash, sulphated %w.	0.52	0.30	0.03	0.29	nil	0.63	0.04
Load in ash.	Present	Present	-	-	-	Present	-
Water, %v.	0.1	0.1	-	-	-	-	-
Phosphorous, %w.	-	-	None	Nil	-	-	Nil
Chlorine, %w.	-	-	None	Nil	-	-	Nil
<u>Oil after Removal of Diluent and Filtration.</u>							
Spec. Gravity, 60°F./60°F.	.925	.925	.917 ²	.884	.917	.900	.913
Pour point, °F.	-10	-10	10 ²	-	-	-	-10
Viscosity cs. @ 70°F.	-	-	- ²	-	-	-	-
100°F.	308	309	226 ²	298	273.5	310	275.7
210°F.	20.65	20.4	15.2 ²	22.04	19.0	21.6	20.33
Saybolt Universal @ 210°F.	95	93	78 ²	106	94	104	98
Viscosity Index	86	84	65 ²	98	84	94	93
Sap. value, mgm.KOH/gm. oil	7.6	7.4	1.6 ²	0.5	14.9	2.3	4.5
Neut. value, mgm.KOH/gm. oil	-	-	-	-	-	-	-
Sulphur, %w.	1.2	1.2	1.3 ²	0.3	1.22	0.6	1.2
<u>Recovered Mineral Oil.</u>							
Specific Gravity, 60°F./ 60°F.	.918	.920	-	-	.912	.898	-
Pour point, °F.	-	-	-	-	-	-	-
Viscosity cs. @ 100°F.	218.5	245.7	-	-	188	306	187.1
210°F.	14.1	15.45	-	-	12.85	21.6	13.91
Saybolt Universal @ 210°F.	65	68	-	-	69.5	104	-
Viscosity Index	52	57	-	-	69	95	71
Coke Value (Ramsbottom)	0.35	0.30	0.20 ²	0.4 ¹	-	0.41	0.44
Refractive Index ^D ₂₀	1.500	1.500	-	-	-	-	-
Sulphur, %w.	1.15	1.2	-	-	-	-	-
<u>Unused Oil: B.A.M. Oxidation Test.</u>							
Coke No. increment	-	-	-	-	-	-	-
Viscosity Ratio	-	-	-	-	-	-	-

MAN AERO OILS FROM EUROPE.

AIR 208	AIR 214	AIR 219	AIR 229	AIR 235	AIR 277	AIR 284	AIR 286
Ju. 88. Jumo 211J. 3-7-42. Baumber, near Newark.	Do. 217E/4. BMW. 801. 26-10-42. Rochford.	He. 111. 9-6-42. 6 miles north of L.G. 60. (N. Africa:)	Comper Swift Pobjoy 'R'. 7-12-42. Hythe, Hants.	Do. 217E2.. BMW. 801A2. 7-2-43. Wroxhall, I.O.W.	Do. 217E4 BMW. 801A. 15-4-43. Nr. Clacton. (Used oil from pool on ground)	Ju. 88. Jumo 211.J1. 14-5-43. Nr. Bury St. Edmund's.	Ju. 88. 9-5-43. Dyco, Aberdeen.
(Used Oil)	(Used Oil)	(Unused Oil)	(Used Oil)	(Used Oil)		(Used Oil)	(Used Oil)
4	1	-	< 0.5	2	0.8	1.0	3.2
< 0.01	0.015	-	0.20	0.27	1.15	337 0.28	277 1.12
0.1	-	-	-	-	-	-	-
0.04	0.038	-	0.11	0.13	0.42	0.08	0.67
-	Mainly lead	-	Present	Present	Present	Present	Present
Nil	-	-	-	-	-	-	-
Nil	-	-	-	-	-	-	-
.913	.893	.918 ²	.913	0.889	.896	.888	.890
-10	-5	15 ²	-10	-10	-5	-20	-10
275.7	304.8	969 ²	300.2	278.1	284.1	293.1	307.4
20.33	22.5	275 ² 18.7 ²	21.19	22.03	20.9	22.31	22.64
98	109	92 ²	103	108	101	107	109
93	98	85 ²	92	103	95	100	98
4.5	1	8.42	1.5	0.4	0.6	1.2	1.1
-	-	-	-	-	-	-	-
1.2	0.35	1.07 ²	0.95	0.55	0.2	0.6	0.5
-	-	-	-	-	-	-	-
187.1	-	142.7	-	-	-	-	-
13.91	-	11.1	-	-	-	-	-
-	-	63	-	-	-	-	-
71	-	57	-	-	-	-	-
0.44 ¹	-	0.22 ² (Conradson)	0.78 ¹	0.42 ¹	0.38 ¹	0.39 ¹	0.41 ¹
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

TABLE I. contd.

GERMAN AERO OILS FROM EUROPE.

	AIR 173	AIR 174	AIR 179	AIR 190	AIR 194	AIR 204	AIR 208	AIR 214	AIR 219	AIR 229	AIR 235	AIR 277	AIR 284	AIR 286
AIRCRAFT, ENGINE, AND DATE AND PLACE OF CRASH.	Ju. 88. 29-4-42. Crockey Hill, York. (From un- damaged tank). (Used Oil)	Ju. 88. 29-4-42. Crockey Hill, York. (From dam- aged tank). (Used Oil)	Sweden via M.E.W. rec'd June, 1942. (Unused)	F.W.190. HEW.80D. 23-6-42. Pombrey. (Used Oil)	Heinkel. Aug., 1942. "Aviation Waste Oil" taken after forced landing ex Russia. (Used Oil)	Ju. 88. Novr., 1942. (Used Oil)	Ju. 88. Juno 211J. 3-7-42. Baumber, near Newark. (Used Oil)	Do.217E/4. HEW.80L. 26-10-42. Rochford. (Used Oil)	Ho.111. 9-6-42. 6 miles north of L.G.60. (N. Africa?) (Unused Oil)	Comper Swift Pobjoy 'R'. 7-12-42. Hytho, Hants. (Used Oil)	Do.217E2. HEW.80L.2. 7-2-43. Hroxhall, I.O.W. (Used Oil)	Do.217E4. HEW.80L. 15-4-43. Mr. Clacton. (Used oil from pool on ground) (Used Oil)	Ju. 88. Juno 211.Jl. 14-5-43. Mr. Bury St. Edmund's. (Used Oil)	Ju. 88. 9-5-43. Dyce, Aberdeen. (Used Oil)
Fatty Acids.														
Melting Point °C.	48.5	44				42.5	40		42					
Iodine Value	63	63				52	65		37.6					
Nature of fatty acids	Voltol	Voltol	Probably none, but sample too small for detailed exam.	-	Voltol	Trace Voltol ?	Voltol	None	Voltol	None	None	None	None	None

1. After removal of diluent and filtration.
2. On oil as received.

TABLE II
GERMAN AERO ENGINE OILS FROM NORTH AFRICA

Sample No.	AIR 294 L.3	AIR 295 L.4	AIR 296 L.5	AIR 297 L.6	AIR 310
Date (Lab.report)	25.3.43.	25.3.43.	25.3.43.	25.3.43.	June, 1943
Name	Oel Rotring L.45 (unused)	Oel Rotring L.45 M. (unused)	Rotring or Rr. (unused)	Rotring M.45 M. (unused)	Rotring L.45 ex Mersa Matruh district (unused)
Specific gravity, 60°F./60°F.	.893	.875	.874	.873	.874
Pour Point, °F.	-	-	-	-	5
Viscosity Red.I @ 140°F.	320	350	350	342	-
200°F.	-	-	-	-	-
cs.100°F.	-	268.5	269.5	270.2	274.8
" 210°F.	-	21.97	22.03	22.06	22.63
Viscosity Index	98	105	105	105	106
Neut. Value, mgms.KOH/gm.oil	Nil	-	-	-	-
Coke value, Conradson	0.5	0.16	-	-	0.28 *
Ash, sulphated %w.	Nil	Nil	-	-	-
Flash point P.M. (closed), °F.	445	405	405	405	465 (open)
Sulphur, %w,	-	0.18	-	-	-
<u>B.A.M. Oxidation Test</u>					
Coke No.increment		1.01			0.96
Viscosity ratio		2.05			1.66
* Ramsbottom coke					
The results on AIR.310 were obtained by the A.I.D.					

ITALIAN AERO-ENGINE OILS FROM NORTH AFRICA

From September, 1942, to August, 1943, nine unused Italian mineral aero oil samples have been captured in addition to a number of castor oils used for aircraft engines. (See Table III for data).

Summary

1. The oils vary in viscosity from below 100 to above 120 grade.
2. All the oils are of good quality with Viscosity Indices in the range 77 to 103.
3. The oils are generally of the Pennsylvanian or solvent-refined types, containing Bright Stock. They are mostly of U.S. origin.

Composition and Properties of the Oils.

Two of the oils, AIR.315 and MISC.26, are 120 grade (DTD.472C); four oils, AIR.271, 272, 273 and MECH.222, are 100 grade (DTD.472B); two oils, AIR.224 and 301 are more viscous than 120 grade, and one oil, AIR.293, is a light or 80-90 grade.

The oils, which are all unused and uncompounded, are of high quality, with Viscosity Indices in the range 90-103 excepting one which has a Viscosity Index of 77.

AIR.224 is solvent refined. The remainder of the oils are of Pennsylvanian type or are blends of Bright Stock with good quality distillates, including solvent-treated oils.

The American origin of several of the oils is confirmed by the markings on the containers.

ENEMY LUBRICATING OILS (MECH. SAMPLES) FROM EUROPE AND
MIDDLE EAST.

SUMMARY:

Since the issue of the Second Summary of Enemy Lubricants from Europe and the Middle East a total of sixty-six samples of enemy lubricating oils from sources other than aircraft and ships have come to hand. The data obtained from their examination are collected in seven tables appended hereto, the samples being classified as follows:-

Unused Engine Oils - Fighting Vehicle types	-	Table III
Used Engine Oils from Fighting Vehicles	-	" IV
Unused Engine Oils supplied for Civilian Purposes	-	" V
Used Engine Oils from German non-fighting vehicles	-	" VI
Used Transmission Oils from Fighting Vehicles	-	" VII
Unused Oils suitable as Transmission Lubricants	-	" VIII
Miscellaneous Lubricating Oils	-	" IX

The samples appearing in each table are briefly commented upon and certain general conclusions are summarised below:-

Engine Oils - Fighting Vehicles.

(1) The engine oil normally used in German A.F.Vs. is the "Sonder-Motoren" grade. This is a solvent refined distillate, possibly from German crudes, blended with Bright Stock and is of high V.I. It varies somewhat in make up, while its viscosity limits are a little wide, but within the S.A.E.40 range. Motoren Einheits is of similar quality but of lower viscosity; the one sample from Europe was of considerably lower pour point than those from M.E. Neither grade is compounded nor are additives of the phosphorus, chlorine and nitrogen types present.

(2) The used oils varied considerably in the extent to which they were contaminated. Six of the eight appeared to be Sonder-Motoren Oil; of the remaining two one was possibly of Russian origin and the other either the Einheits grade or British M.160.

Engine Oils - Other Vehicles.

(3) The engine oils supplied for civilian vehicles are not up to the standard of the Sonder and Einheits grades but are nevertheless of reasonably good quality and again may be derived from German crude with added Bright Stock. One may have contained a small proportion of vegetable oil; the others were uncompounded. A used oil from a German Diesel-engined chassis was of similar grade to Sonder-Motoren but of higher viscosity.

Transmission Oils - Fighting Vehicles.

(4) Information in respect of transmission oils is derived mainly from captured vehicles, samples from these sources being much more numerous than from captured stocks.

The oils are classified into three groups representing, asphaltic base, mixed base and paraffinic base, respectively. The first group includes oils of two viscosity grades; apart from one doubtful example they are uncompounded. The second group comprises three or perhaps four viscosity grades and provides also examples of four compounded lubricants, two with a sulphurised fatty oil, one with a normal fatty oil and the fourth with Voltol, the last mentioned lubricant being from a German lorry. The paraffinic oils probably represented one grade

only and were from a German armoured car. Apart from this example it is evident that there is very little standardisation of transmission lubricants by the enemy.

(5) The unused transmission oils call for little comment except to mention that an Italian grade of asphaltic base contained some 7% of fatty oil.

Miscellaneous Lubricating Oils.

(6) The miscellaneous lubricating oils comprise thirteen from Middle East and nine from Europe.

(7) At least six were probably of Roumanian origin, three being machine oils, two were possibly I.C. engine lubricants and one a marine engine oil base. Three samples were of American origin, their precise purpose being unknown though one was a cylinder oil. Another sample, possibly of American origin, appeared to be an aero engine oil. One each were probably from Reitbrook and Austrian crudes respectively, the former being an engine oil and the latter a superheat steam cylinder oil. One sample was genuine castor oil.

(8) The remaining nine included a transformer oil which may have been partly of synthotic origin; a naphthenic oil - Bright Stock blend, purpose unknown; three dark cylinder oils, probably of partial coal tar origin and a lighter oil of the same type; a light spindle oil and two lubricants probably intended for geared turbines.

ENGINE OILS - FIGHTING VEHICLES

Table III contains particulars of six unused engine oils representing grades which are believed to be employed in German tanks. MECH.51 and 294 are described as Sonder-Motoren-Oel and though both are solvent refined distillates, possibly from German crudes, blended with Bright Stock, they differ in regard to the proportion of the latter and also in respect of viscosity; a similar difference was noted between samples of this grade discussed in the Second Summary of Enemy Lubricants for Europe and Middle East to 31.8.42. MECH.256, described merely as Motorenöl is closely analogous to MECH.51. MECH.287 may also be Sonder-Motoren-Oel, but if so, indicates a change in make up, being of lower V.I. and higher sulphur than the others.

The one sample, MECH.279, described as Motoren Einheits Oel, is a solvent refined distillate but differs from previous samples (MECH.93, 94 and 99 - Second Summary) in being of lower V.I. and much lower pour point. The latter is probably to be connected with the origin of the sample which appeared to be Europe (?France), whereas the earlier ones were from M.E. MECH.303 may also be of the Einheits grade but was evidently not produced from the same source as MECH.279. None of the samples showed evidence of compounding, nor were additives of the phosphorus, chlorine and nitrogen types present.

Table IV gives particulars of eight samples of used engine oils taken by D.T.D. from captured German armoured fighting vehicles; three originated from Russia and five from M.E. The oils, which were from petrol engines represented various degrees of usage, MECH.109 and 269 being in very bad condition; MECH.186 was heavily contaminated with sea water and corrosion products resulting therefrom; the remaining five exhibited from light to moderate contamination.

The origin of the samples cannot be vouched for, since certain of the vehicles appeared to have been run after capture and the engine bases may therefore have been re-filled and topped up with British or Russian lubricants. Thus, MECH.149 which is of a viscosity suitable for air-cooled engines, may possibly be of Russian origin. MECH.140 was of lower viscosity than any of the others and though the oil might have been Motoren Einheits, its characteristics are also analogous to those of the W.D. M.160 grade.

The remaining six samples, MECH.109, 148, 186, 187, 197 and 269 are of a generally similar character as will be seen from the following synopsis:-

Specific Gravity ranged from	0.886 - 0.900
Redwood viscosity	
at 140°F. ...	" " 205-237 secs.
Viscosity Index	" " 92-99
Sulphur	" " 0.24 - 0.39%

Addition agents were absent and evidence of compounding was negative. It would seem reasonable to conclude that the original oils were of the Sonder-Motoren grade as represented by those included in Table III.

ENGINE OILS - OTHER VEHICLES.

Table V contains particulars of four unused engine oils, three of which were supplied for civilian purposes, while the fourth would be expected to have a similar application.

MECH.49 and 50, representing automobile oil in use in Sweden in May 1942 are analogous; both are refined distillates, possibly from Reitbrook crude, the former being blended with residual oil, though this constituent appears to be absent from MECH.50, the high

V.I. of which is difficult to explain; both were uncompounded and free from additives.

MECH.243, representing oil supplied to Trondheim in February 1943, is a machine oil of medium V.I. and high sulphur content; it contained some residual material or added Bright Stock and was possibly derived from Reitbrook crude. Some 5% of fixed oil, probably of vegetable origin, was present, but this may have been due to contamination; the general absence of compounding in enemy engine oils lends support to this supposition.

MECH.264, representing oil manufactured in Belgium, was a refined product of medium V.I. and low sulphur content.

Table VI comprises two used engine oils from German vehicles. MECH.107 is a high speed Diesel engine lubricant, the only example so far encountered; it exhibited fairly heavy contamination with suspended matter. The original oil was a high grade solvent refined product probably derived from indigenous German crude and may have been slightly compounded. It was of somewhat heavier viscosity than the oil employed by the Germans for petrol-engined A.F.Vs.

MECH.119A was in fair condition and when new was a solvent refined distillate of medium V.I. and sulphur content, possibly derived from German crude.

TRANSMISSION OILS - FIGHTING VEHICLES.

Twenty samples of used transmission oils taken by D.T.D. from captured German armoured vehicles have been examined since the last Summary was compiled. Like the used engine oils their origin cannot be vouched for though the possibility of contamination by admixture with British or Russian oils is obviously less remote. It is somewhat difficult to assess the extent to which the characteristics of the oils may have been modified as a result of use, but in view of the number concerned and the relative paucity of samples of unused German transmission oils, the used oils are regarded as giving a fairly reliable indication of the types of transmission lubricants employed by the enemy.

Particulars of the used samples are collected in Table VII which for convenience includes also data in respect of an oil from a German lorry. The samples from German A.F.Vs. comprise two each from Pz.Kw.I, Pz.Kw.IV, PK2"22" and Czech tanks, three from Pz.Kw.II tanks, four from Pz.Kw.III tanks and five from 8-wheeled armoured cars. None of the oils was excessively contaminated with suspended matter though they had doubtless suffered some deterioration due to oxidation.

The oils fall into three main Groups -

(i) MECH.110, 111, 142, 153, 154, 198 and 199, are of asphaltic base and of medium V.I.; four are of high viscosity (738-893 Redwood secs. at 140°F.), and the remainder of medium viscosity. Judging from their sulphur contents MECH.110, 111 and 142 were not derived from the same source as the others. MECH.111 may have been slightly compounded but the remainder were almost certainly not so.

(ii) MECH.141, 146, 147, 150, 151, 268, 270, 272 (and also the mineral oil from 119B) are from mixed type crudes, are of medium V.I. and from their sulphur contents are of varied origin. Their viscosities range from 205-763 Redwood secs. at 140°F. and three or perhaps four different viscosity gradings are represented. MECH.146 and 147 are apparently compounded with a sulphurised fatty oil, while this may possibly have been the case with MECH.151, though presence of active sulphur was not proved; MECH.268 is probably compounded with a fatty oil; MECH.119B, from a German lorry, is apparently blended with Voltol and provides the only example of the use of this material by

the enemy in an automobile lubricant.

(iii) MECH.152, 188, 189, 144 and 145 were uncompounded oils of high V.I., medium viscosity and low sulphur content. They would appear to have been prepared from paraffinic crude and MECH.189 may have been of Pennsylvanian origin. They were employed as lubricant for gearbox, transfer box and rear axle in German 8-wheeled armoured cars.

Apart from the five oils included in Group (iii), transmission lubricants for German tanks do not appear to be at all closely standardised. Various examples of this statement are apparent in Table VII, the best being provided by MECH.268 and 270, which are gearbox oils from the same type of tank Pz.Kw.I; MECH.268 possessed a viscosity of 299 Redwood secs. at 140°F., whereas the corresponding viscosity for MECH.270 was 763 secs.

Table VIII includes four unused oils of types which would be suitable for use as transmission lubricants, though only two of them - MECH.293 and 295 - Getribe Oel - are definitely described as such. The former is a gear oil of the residual type, though its relatively high V.I. associated with high specific gravity presents an anomaly. Apart from this the lubricant is analogous to the used oils MECH.110, 111 and 142 previously discussed. MECH.295 is of much lower viscosity and is probably a blend of distillate oil with Bright Stock; used oils MECH.150 and 268 already mentioned, seem to be of similar type, though both are of higher sulphur content than MECH.295.

MECH.258 appears to be an Italian grade of transmission lubricant and is probably a blend of distillate oil and Bright Stock and is of good quality. MECH.259, also Italian, is a heavy residual oil containing nearly 7% of fatty oil.

MISCELLANEOUS LUBRICATING OILS.

Table IX contains particulars of twenty-one unused oils which cannot be definitely classified as either engine or transmission lubricants. They represent a variety of types and grades and in the main must be summarised individually. MECH.53 obtained from Brest is possibly an engine oil; it may have been derived from Reitbrook crude and probably contains Bright Stock; its saponification value suggests that it is a reclaimed product. MECH.190 and 191, from Middle East, are probably Roumanian distillates, the former containing some Bright Stock; there is indication that both have been subjected to only limited refining; MECH.190 may be an I.C. engine lubricant and MECH.191 a machine oil. MECH.208 is described as an Italian transformer oil; its characteristics indicate either particularly good dewaxing of a distillate from American or German crude, or that it is partly, at least, of synthetic origin.

Three Italian oils - MECH.209, 210 and 212, are of high quality and are likely to be of American origin; the first two are similar to samples described in the previous Summary, while the third is a cylinder oil and would be suitable as a transmission lubricant. MECH.211, also an Italian grade, is a blend of naphthenic oil with Bright Stock. MECH.213 and 214, again Italian, are probably SO₂ refined Roumanian distillates, containing no Bright Stock; the former may be a heavy engine oil and the latter a machine oil; both are of low V.I. MECH.216, described merely as 'captured oil' is of high V.I. and would appear to be a solvent refined oil blended with Bright Stock and may be of American origin; it is probably an aero engine oil.

MECH.260 is a German lubricant, reported to be superheat steam cylinder oil donated to the Turkish Railway Commission. Its properties, together with other information available suggest that it may be a de-asphaltised residuum from Austrian crude.

MECH.261, 2 and 5 representing lubricants manufactured in Belgium for the Germans are dark cylinder oils of high gravity, high sulphur and low V.I. MECH.263, also of Belgium manufacture, is of the same type and though of a viscosity suitable for I.C. engine lubrication can hardly have been intended for this purpose. The characteristics of all four of these oils point to a partial coal tar origin, this being particularly likely in the case of MECH.263 which is of unusually high specific gravity.

MECH.284 from Stettin is a conventionally refined naphthenic distillate similar to that produced from Roumanian non-paraffinous crude and might be intended as a base for preparation of marine engine oils. MECH.291, from France, is also a distillate, probably of Roumanian origin; it could be described as a light machine oil. MECH.289, also from France is a light spindle oil of medium V.I.

MECH.332 and 333 are Italian oils and are probably intended for the same purpose which from the description of MECH.333 may be lubrication of geared turbines. They are medium viscosity machine oils of relatively high V.I.

Finally, MECH.215 (not included in the tabulation) represented a genuine castor oil captured in M.E.

UNUSED ENGINE OILS - FIGHTING VEHICLE GRADES.

MECH. NOS.	51	256	279	287	294	303
Date of report	20. 8.42.	17. 5.43.	12. 7.43.	16. 7.43.	22. 7.43.	19. 8.43.
Origin	M.E. (30. 5.42)	M.E. Tripoli 10. 2.43.	M.E.W. (23. 4.43)	N.A. (Souasse)	M.E.	M.E. (Mersa Matruh prior to 23. 3.43).
Source or description	Sonder Motoren- Oil, T, Wifo.	Motorenöl Tr.	Motoren Einheits Oil (Huile Auto).	Wifo.	Sonder Motoren-Oil T, Wifo.	"M"
Used or Unused	Unused	Unused	Unused	Unused	Unused	Unused
Oil as received:						
Specific Gravity at 60°F.	0.885	0.885	0.903	0.898	0.895	0.906
<u>Viscosity</u>						
Redwood nos. @ 140°F.	202	225	173	233	242	162
(Saybolt) secs @ 100°F.	667	840	589	822	815	-
" secs. @ 210°F.	72.5	81.7	64	78	79	-
Kinematic Viscosity at 100°F. cs.	144.3	181.9	127.6	177.8	176.1	-
at 210°F. cs.	13.79	16.15	11.47	15.22	15.38	-
Viscosity Index	99	99	81	93	95	88
Pour Point - °F.	- 5	- 5	- 20	5	10	-
Saponification Value mg. KOH/gm.	0.3	0.6	Below 0.2	0.15	1.2	-
Sulphur - %	0.22	0.30	0.7	0.6	0.3	0.25
Ash - %	Trace	-	0.01	Below 0.01	0.01	Negl.
Ash (sulphated) - %	-	0.02	-	-	-	-
Ramsbottom Coke No.	0.33	0.38	0.20	0.52	0.51	0.13
Examination of Saponi- diable Matter	-	-	-	-	-	-
Addition Agents	-	-	-	-	-	-
Phosphorus, Chlorine and Nitrogen absent.						-

ENGINE OILS FROM CAPTURED GERMAN FIGHTING
VEHICLES.

MECH. NO. Date of report Origin Source	109 7.10.42 D.T.D.) 23.6.42) German tank Pz.Kw.III ex Russia.	140 19. 1.42 D.T.D.) 13.8.42) Latest German Pz.Kw.III tank captured in Libya - April 1942.	148 4. 3.43. D.T.D.) 25.8.42) "PKZ.22 Russian"	149 21. 4.43 D.T.D.) 25.8.42) Czech Light Tank.	186 21. 4.43 D.T.D.) 10.8.42) German 8- wheeled Fighter Vehicle.	187 21. 4.43 D.T.D.) 10.8.42) A.C. Command Vehicle.	197 29. 3.43 D.T.D.) 26.11.42) German Pz.Kw.IV (Libya) Tank.	269 10. 8.43 D.T.D.) 12.4.43.) German Tank Pz.Kw.I Commanders (ex M.E.)
Used or Unused	Used	Used	Used	Used	Used *	Used	Used	Used
<u>Oil as Received</u>								
Total suspended matter (insol. in benzene) - %	1.68	0.31	0.61	0.23	-	0.31	0.19	1.46
Asphaltenes (insol. in I.P. spirit) %	0.21	0.03	0.05	0.01	-	0.03	0.01	0.03
Insoluble in Petroleum Ether - %	-	-	-	-	-	-	-	-
Water - %	Nil	Nil	Nil	0.3	5.0	1.8	Trace	Nil
Ash (on Petroleum Ether Insoluble)	-	-	-	-	-	-	-	-
Ash (Sulphated) - %	1.09	0.35	0.38	0.13	-	0.29	0.41	1.24
Ash - %	-	-	-	-	0.73	-	-	-
Composition of Ash								
Acid Insoluble - %	3	21	10	14	(MgO 49%)	13	30	18.5
Copper, tin and lead oxides - %	-	14	-	-	(NaCl 19%)	-	-	-
Lead as PbSO ₄ - %	54	-	-	-	(Fe ₂ O ₃ 21%)	-	-	14
Remainder of Ash	Iron and copper oxides.	Mainly iron oxide.	Mainly iron oxide.	Mainly iron oxide.	(+Al ₂ O ₃)	Mainly iron oxide.	Mainly iron oxide.	Mainly iron oxide.
Diluent - %	1.7	13.9	4.1	1.7	1.6	10.3	6.2	8.0
Addition Agents	Phosphorus and chlorine absent	-	...Phosphorus and chlorine absent....		
<u>After Removal of suspended matter and diluent</u>								
Specific Gravity at 60°F.	0.897	0.886	0.892	0.904	0.886	0.900 (approx.)	0.892	0.889
Viscosity at 140°F. (Redwood) secs.	205.5	164	208	434	237	205 (approx.)	222	208
" " 100°F. (Saybolt) "	710	540	685	1830	820	-	745	-
" " 210°F. (") "	72.5	63.5	73.5	115.5	78	-	77	-
Kinematic Viscosity at 100°F. - cs.	154	113.9	155.5	384	175	-	160	154
" " 210°F. - cs.	13.5	11.1	14.0	23.4	15.2	-	14.75	14.0
Viscosity Index	92	89	94	84	94	-	99	95
Flash Point - Open ... °F.	-	-	445	535	-	-	445	410
Pour Point - °F.	Below -5	10	Below 0	10	-	-	10	Below 10
Acidity - mg.KOH/gm.	0.5	0.1	0.4	0.05	-	0.2	0.1	0.3
Saponification Value - mg.KOH/gm.	2.6	0.6	0.7	0.2	0.8	-	1.2	2.7
Asphaltenes (insol. in I.P.Spirit) - %	0.02	Nil	0.01	Nil	-	0.013	0.01	Below 0.01
Sulphur - %	0.33	0.23	0.38	0.12	-	0.24	0.39	0.26
Ash (sulphated) - %	-	-	-	-	-	-	-	0.03
Ramsbottom Coke No.	-	-	-	-	-	-	-	0.69
Refractive Index at 20°C.	1.4923	1.4913	1.4903	1.4975	1.4910	-	1.4912	1.4876
Examination of Saponifiable Matter	Petroleum origin.	-	-	-	-	-	-	-

* Contained
60% watery
sludge; oil
layer
examined.

TABLE V
UNUSED ENGINE OILS - EMPLOYED IN CIVILIAN SERVICE

MECH. NO.	49	50	243	264
Date of Report	24.8.42	24.8.42	16.4.43.	2.6.43
Origin	M.E.W.	M.E.W.	M.E.W.	M.E.W.
Source or Description	Lubricating Oils for motor cars obtained in Sweden during May, 1942.		Lub. oil supplied to all I.C. vehicles Trondheim Feb. 1943	Oil manufactured in Belgium for the Germans. Probably unused (after dehydration and filtration.)
Used or Unused	Unused	Unused	Unused	
Oil as received:-				Mineral Oil
Specific Gravity at 60°F.	0.902	0.909	0.920	0.918
Viscosity at 140°F. (Redw.) secs.	131	159	150	164
at 100°F. Saybolt secs.	424	530	499	554
" 210°F. Saybolt secs.	56.7	63.7	59	63
Kinematic Viscosity at 100°F. cs.	92.5	115	109.12	119.8
" 210°F. cs.	9.4	11.3	10.02	11.15
Viscosity Index	83	91	74	83
Pour Point - °F.	-5	-5	0	15
Saponification Value mg. KOH/gm.	1.0	2.4	10	2.0
Sulphur - %	0.7	1.2	1.8	0.55
Ash - %	0.02	0.04	-	-
Ash (sulphated) - %	-	-	0.015	Below 0.01
Ramsbottom Coke No.	0.41	0.26	0.41	0.52
Examination of Saponifiable Matter	-	-	Free and combined F.A. - 4.7%. Probably of vegetable origin.	-
Addition Agents	None	None	Phosphorus, chlorine and nitrogen absent.	Phosphorus, chlorine and nitrogen absent.

TABLE VI

USED ENGINE OILS FROM GERMAN VEHICLES

MECH NO.....	107	119A
Date of report.....	15.9.42	19.9.42
Origin	M.E.	M.E.W.
Source	1.6.42. German 4-cyl. Mercedes-Benz Diesel chassis	German lorry entered from Occupied France.
Used or Unused	Used	Used
<u>Oils as received.</u>		
Insoluble in Petroleum Ether %	1.2	0.25
Ash (on Pot.Ether Insoluble) %	0.2	0.15
Diluent %	Trace	6
	After removal of diluent & filtration	Recovered mineral oil
		Filtered oil
		Recovered mineral oil
Specific Gravity at 60°F.	0.891	0.891
Viscosity at 100°F.Saybolt secs.	900	924
" " 210°F. " "	85	87.1
Kinematic Viscosity at 100°F. cs.	195	200
" " " 210°F. "	16.85	17.35
Viscosity Index	100	100
Saponification Value - mg.KOH/gm.	4.5	3.5
Sulphur %	0.47	0.61

TABLE VII

USED TRANSMISSION OILS FROM GERMAN FIGHTING VEHICLES

MECH NO. Date of report Origin Source	110 7.10.42 D.T.D. 23.6.42 Gearbox. German tank Pz.Kw.III ex Russia	111 7.10.42 D.T.D. 23.6.42 Final Drive. Pz.Kw.III tank cap- tured in Libya April 1942	141 19.1.43 D.T.D. 13.8.42 Gearbox. Pz.Kw.III tank cap- tured in Libya April 1942	142 19.1.43 D.T.D. 13.8.42 Final Drive. Pz.Kw.III tank cap- tured in Libya April 1942	146 4.3.43 D.T.D. 25.8.43 Bevel box. "PKZ22 Russian"	147 4.3.43 D.T.D. 25.8.43 Gearbox "PKZ22 Russian"	150 21.3.43 D.T.D. 25.8.43 Bevel box. Czech Light Tank	151 21.3.43 D.T.D. 25.8.43 Gearbox. Czech Light Tank	152 21.3.43 D.T.D. 25.8.42 Gearbox German 8-wheeled A.C. Type -	188 21.3.43 D.T.D. 10.8.42 Gearbox Type - Fighter	189 21.3.43 D.T.D. 10.8.42 Axle Oil	145 21.3.43 D.T.D. 25.8.42 Transfer Box German 8-wheeled A.C. Type -	155 21.3.43 D.T.D. 25.8.42 Type -
Used or Unused	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used	Used
Oil as received:													
Total suspended matter (insol. in benzene) %	0.30	0.23	0.07	0.09	0.2	0.1	0.18	0.53	0.23	0.22	0.34	0.43	0.35
Asphaltenes (insol. in I.P. spirit) %	-	-	0.68	3.80	0.12	0.13	0.28	0.27	0.05	0.05	0.38	0.45	0.90
Water %	3.0	Nil	0.13	Nil	0.1	Nil	Nil	Nil	Nil	Trace	0.2	0.15	Trace
Ash %	0.22	0.17	0.02	0.03	0.13 *	0.05 *	0.07	0.31	0.12	0.11	0.17	0.13	0.16
Composition of Ash				Mainly	Iron	Oxide							
Acid Insoluble %	Present	Present	-	-	-	-	9	10	10	14	8	8	9 1/2
Remainder of Ash	Mainly Iron Oxide	Mainly Iron Oxide	-	-	-	-			Mainly	Iron Oxide			
Addition Agents	Phosphorus and Chlorine Absent				Phosphorus and chlorine absent. See below		Phosphorus, chlorine and active sulphur absent.		Phosphorus and chlorine absent				
After removal of suspended matter:													
Specific Gravity at 60 F.	0.943	0.940	0.920	0.943	0.928	0.931	0.930	0.924	0.907	0.908	0.899	0.905	0.900
Viscosity at 140 F. (Redw.) secs.	760	600	418	738	374	398	257	205	433	428	388	438	417
" " 200 F. " "	169	143.5	110.5	166	102.5	108.5	76.5	67.5	119.5	117	111	123	117
Kinematic Viscosity at 100 F. cs.	-	-	380	775	320	346	217	165	-	-	-	-	-
" " 210 F. cs.	-	-	22.0	32.6	20.4	21.7	14.85	12.4	-	-	-	-	-
Viscosity Index	50 (approx)	65 (approx)	75	69	80	82	65	63	92	88	92	96	94
Flash Point - Open °F.	420	415	435	405	425	445	405	420	445	-	-	430	445
Pour Point °F.	20	20	15	20	5	0	Below 5	Below 5	15	20	30	15	20
Acidity - mg.KOH/gm.	1.4	1.2	0.4	0.5	0.5	0.7	0.9	0.7	0.7	0.8	1.0	0.8	1.2
Saponification Value - mg.KOH/gm	8.7	6.6	4.6	9.2	15.3	16.6	5.6	5.3	2.5	2.0	2.0	2.5	2.0
Asphaltenes (insol. in I.P. spirit)	2.46	1.50	0.58	3.50	0.03	0.02	0.05	0.12	0.003	0.004	0.06	0.10	0.12
Sulphur %	0.83	0.84	0.66	0.80	1.57	1.48	1.20	1.62	0.54	0.48	0.50	0.40	0.43
Examination of Saponifiable Matter	Acids probably of petroleum origin	Slight evidence of fatty acids	Acids of petroleum origin	-	Crystalline acids isolated. M.P. 33 C. (Sulphurised fatty oil present)		Extracted acids considered to be of petroleum origin		-	-	-	-	-

* Sulphated Ash.

CONTD.

TABLE VII

USED TRANSMISSION OILS FROM GERMAN FIGHTING VEHICLES

MECH NO. Date of report Origin Source	153 21.3.43 D.T.D. 25.8.42 Gear and bevel boxes. Pz.Kw.II tank	154 21.3.43 D.T.D. 25.8.42 Final Drive. Pz.Kw.II tank	198 30.3.43 D.T.D. 26.11.42 Gearbox German Pz.Kw.IV tank.	199 30.3.43 D.T.D. 26.11.42 Final Drive. (Libya)	268 10.8.43 D.T.D. 12.4.43 Gearbox German tank Pz.Kw.I ex M.E.	270 10.8.43 D.T.D. 12.4.43 Gearbox German tank Pz.Kw.I Commanders ex M.E.	272 10.8.43 D.T.D. 12.4.43 Gearbox German tank Pz.Kw.II	119B 19.11.42 M.E.W. German lorry entered from Occupied France.
Used or Unused	Used	Used	Used	Used	Used	Used	Used	Used
Oil as received:								
Total Suspended Matter (Insol. in benzene) %	0.26	0.39	0.31	0.29	0.03	0.19	0.12)	1.4
Asphaltenes (insol. in I.P. spirit) %	3.89	2.76	2.02	1.86	0.19	0.58	0.54)	-
Water %	Nil	Nil	Nil	Trace	Negl.	Negl.	Negl.	1.4
Ash %	0.19	0.28	0.23	0.21	0.02	0.08	0.15	-
Composition of Ash					Mainly iron oxide.			
Acid Insoluble %	21	30	23	6.5	-	46	37.5	-
Remainder of Ash	Mainly Iron Oxide		Oxides of iron, copper and tin.		-	Oxides of iron, copper and tin.		-
Addition Agents	Phosphorus, Chlorine and active sulphur absent.		Phosphorus and chlorine absent.		Phosphorus, chlorine and Active Sulphur absent.			-
After removal of suspended matter:								Recovered Oil.
Specific Gravity at 60°F	0.947	0.945	0.956	0.958	0.933	0.923	0.926	0.954 (0.925)
Viscosity at 140°F. (Redw.) - secs.	506	454	893	888	299	763	730	-
" " 200°F. (") - "	126.5	113.5	191.5	190.5	86	171	169	-
" " 100°F. (Saybolt) "	-	-	-	-	-	-	-	998 (763)
" " 210°F. (") "	-	-	-	-	-	-	-	92.4 (74.7)
Kinematic Viscosity at 100°F. cs.	-	-	-	-	255	795	725	216 (165)
" " " 210°F. cs.	-	-	-	-	16.8	34.0	33.8	18.6 (14.2)
Viscosity Index	-	-	-	-	70	74	81	103 75.3
Flash Point (Open) °F.	410	430	440	450	430	475	440	-
Pour Point °F.	10	5	20	20	Below 15	20	15	-
Acidity - mg.KOH/gm.	1.0	0.6	1.1	1.0	0.7	0.6	0.9	-
Saponification Value-mg.KOH/gm.	5.5	4.6	8.3	9.3	9.0	6.0	7.0	24.5
Asphaltenes (insol. in I.P. spirit) %	3.54	2.55	2.09	1.95	0.14	0.50	0.45	-
Sulphur %	1.32	1.31	1.51	1.49	1.24	0.77	0.48	2.61
Examination of Saponifiable Matter	-	-	Acids considered to be of petroleum origin.		Fatty oil probably present but not proved.	Fatty oil unlikely to be present.	Fatty oil very unlikely to be present.	Apparently blended with Voltol.

TABLE VIII

UNUSED OILS OF TYPES SUITABLE FOR USE AS TRANSMISSION LUBRICANTS.

Mech. No. Date of report. Origin. Description.	258 19.3.43. M.E. Ultra-Denso A.N.I.C. R.E.	259 19.3.43. M.E. Special Oil Soc. Lubrific Cingolio Lubrivite Genova R.E.	293 22.7.43. M.E. Getrieboel Vario Rex Getriebe.	295 22.7.43. M.E. Getrieboel Wifo.
Used or Unused.	Unused.	Unused.	Unused.	Unused.
Oil as received:				
Specific Gravity at 60°F	0.922	0.962	0.947	0.930
Viscosity at 140° F. Rodwood secs.	-	-	656	282
" " 100° F. Saybolt secs.	-	-	3100	1108
" " 210° F. " "	-	-	149	82
Kinematic Viscosity at 100°F. ... cs.	439	1750	670.3	239.4
" " " 210°F. ... cs.	23.7	43.0	31.81	16.25
Viscosity Index	72	34	79	71
Flash Point - Open ... °F.	475	495	375	-
Pour Point ... °F.	Below 15	30	30	15
Acidity - mg.KOH/gm.	Negl.	2.2	-	-
Saponification Value - mg.KOH/gm.	2	12	4.5	2.7
Sulphur %	-	-	0.85	0.9
Ash %	-	-	0.11	0.02
Ramsbottom Coke No.	-	-	4.22	1.57
Conradson Carbon ... %	1.12	3.4	-	-
Examination of Saponifiable Matter	-	6.95%) Fatty Oil)	-	-
Addition Agents	-	-	Chlorine, phosphorus and nitrogen absent.	

MISCELLANEOUS LUBRICATING OILS.

MERCH. NO.	190	191	53	208	209	210	212	211	213	214	216
Date of Report	12.9.42	12.9.42	5.10.42	4.12.42	4.12.42	4.12.42	4.12.42	4.12.42	4.12.42	4.12.42	12.2.42
Origin	M.E.	M.E.	M.E.W.	M.E.	M.E.	M.E.	M.E.	M.E.	M.E.	M.E.	M.E.
Description	Enemy Lubricating Oil Drum marked No.170	Drum marked R-Marina	Huile Provenant de l'arsenal de Brest.	Olivo Isolante R.A.per transforma- tori od interruttori.	Olivo Minerale Denso.	Olivo Minerale Denso III Clarenty Refined oils.	Olivo Minerale Denso II.	Olivo Minerale Extra Denso.	Olivo Minerale Semi- Denso.	Olivo Minerale Fluido R.A. Silbo. Genoa.	Captured Oil.
Used or Unused	Unused	Unused	Unused	Unused	Unused	Unused	Unused	Unused	Unused	Unused	Unused
Oil as received -											
Specific Gravity at 60°F.	0.918	0.933	0.909	0.877	0.894	0.894	0.897	0.912	0.921	0.916	0.893
Viscosity at 100°F. (Redwood) secs.	-	-	-	-	-	2167	1150	-	-	-	-
" " 140°F. " "	-	-	165	-	336	626	332	-	-	-	342
" " 212°F. " "	-	-	-	-	86	130	84	-	-	-	-
" " 100°F. (Saybolt) secs.	-	-	566	-	-	-	-	-	-	-	1233
" " 210°F. " "	-	-	63.1	-	-	-	-	-	-	-	101.7
Kinematic Viscosity at 100°F. cs.	119.9	87.1	122.5	12.59	-	-	-	453	211.1	96.3	267
" " 210°F. " "	9.28	7.4	11.1	2.78	-	-	-	24.5	13.2	8.4	20.98
Viscosity Index	36	18.5	79.6	88	-	94	85	74	36	36	100
Flash Point - Open	415	395	-	315	-	-	505	490	475	420	-
Pour Point	Below 15	30	-	Below -30'	-	Below 15	Below 15	Below 15	Below 15	Below 15	10
Acidity - mg.KOH/gm.	Negligible	0.04	-	Nil	-	Negl.	Negl.	Negl.	Negl.	Negl.	Below 0.05
Saponification Value - mg.KOH/gm.	0.55	0.92	3.9	"	-	0.56	Nil.	Nil.	Nil.	Nil.	Nil.
Asphaltenes (insol. in I.P. spirit)	-	-	-	-	-	-	-	-	-	-	-
Sulphur	-	-	1.39	-	-	-	-	-	-	-	0.35
Ash	-	-	0.01	-	-	-	-	-	-	-	Below 0.01
Ramsbottom Coke No.	-	-	0.46	-	-	-	-	-	-	-	0.70
Conradson Carbon	0.26	0.04	-	0.2	-	1.1	0.81	0.89	0.20	Negl.	-
Addition Agents	-	-	-	-	-	-	-	-	-	-	Nitrogen, chlorine, phosphorus & sulphur negative.

MISCELLANEOUS LUBRICATING OILS.

MECH. NO. Date of report Origin Description	260 29. 5.42 M.E.W. German Super-heat steam cylinder oil donated to Turkey 1942.	284 31. 5.42 M.E.W. "MaskinOil- Destilat" (Stettin) Reported originated Rumania.	261 2. 6.43 M.E.W. Oil manu- factured in Belgium for the Germans.	262 2. 6.43 M.E.W. Oil manu- factured in Belgium for the Germans.	265 2. 6.43. M.E.W. Oil manu- factured in Belgium for the Germans.	263 2. 6.43. M.E.W. Oil manu- factured in Belgium for the Germans.	291 12. 7.43 M.E.W. Huile de Graissage F.N. (Herstal)	332 12. 7.43 M.E. Italian Lubricants ex Asmara. Olio Fluide.	333 12. 7.43 M.E. Olio Turboline.	289 23. 7.42 M.E.W. Coupago F.N. Herstal Nov. 42.
Used or Unused	Unused	Unused	Probably Unused.	Probably Used * (after dehydration & filtration)	Probably Unused.	Probably Unused.	Unused.	Unused	Unused	Unused
Oil as received -										
Specific Gravity at 60°F.	0.970	0.955	0.959	0.951	0.965	0.971	0.913	0.915	0.913	0.884
Viscosity										
Redwood secs. @ 100°F.	-	920	-	-	-	-	-	-	-	-
" Redwood secs. @ 140°F.	2269	219	816	757	1091	164	101	-	-	44
" Redwood secs. @ 200°F.	-	66	-	-	-	-	-	-	-	-
" Saybolt secs. @ 100°F.	-	-	4161	4137	6557	612	-	-	-	76
" Saybolt secs. @ 210°F.	-	-	150	152	173	58	-	-	-	36
Kinematic Viscosity										
at 100°F. cs.	3897	-	900.6	895.4	1419	132.3	-	88.4	78	14.71
" at 210°F. cs.	62.82	-	32.06	32.48	37.1	9.72	-	8.7	8.4	3.12
Viscosity Index	22	Below 0	51	54	27	32	-	80	82	74
Flash Point - Open - °F.	576	-	-	-	-	-	-	415	395	-
Pour Point °F.	50	About 10	30	30	35	0	-	Below 15	Below 15	Approx. 40
Acidity - mg. KOH/gm.	-	0.5	-	-	-	-	-	0.05	0.06	-
Saponification Value) (mg. KOH/gm.)	-	-	0.6	4.3	0.6	0.6	-	0.9	0.7	0.1
Asphaltenes (insol. in I.P. spirit)	0.06	-	0.18	0.07	0.19	0.20	-	-	-	-
Sulphur %	1.2	-	1.85	2.2	2.45	2.3	0.65	0.40	0.8	0.55
Ash %	-	-	-	-	-	Below 0.01	-	-	-	Below 0.01
Ash (Sulphated) %	-	-	Below 0.01	Below 0.01	Below 0.01	-	-	-	-	-
Ramsbottom Coke No.	-	-	2.65	-	2.6	2.0	-	-	-	-
Conradson Carbon %	5.4	0.36	-	-	-	-	-	0.09	0.20	-
Addition Agents	-	-	Chlorine, Phosphorus & Nitrogen absent.	Chlorine, Phosphorus & Nitrogen absent.	Chlorine, Phosphorus & Nitrogen absent.	Chlorine, Phosphorus & Nitrogen absent.	-	-	(Steam Emulsion No. -710 secs.)	Chlorine, Nitrogen & Phosphorus absent.

* Brown water
in oil emul-
sion with
separated
water (as
received).

ENEMY LUBRICATING OILS (MARINE SAMPLES)

Since the issue of the Third Summary on Enemy Lubricating Oils a further total of 60 Marine samples have been reported upon. These are tabulated in the following Summary under the headings:

	<u>No. of Samples</u>	<u>Table</u>
High Speed Diesel Oils	43	X
Heavy Cylinder and Gear Oils	3	XI
Marine Steam Engine Oils	3	XII
Miscellaneous Marine Lubricants	7	XIII
Samples of Analysed in Norway	4	XIV

Of these the most important both in numbers and significance are the diesel oils acquired from captured fishing boats and escape boats. All the oils in this class have been taken from vessels sailing from north European ports. Only one marine sample has been obtained from an Italian source.

High Speed Diesel Oils

Most of the samples examined have had the advantage of being unused. They are all satisfactory for the purpose intended and indeed, judging by the modern outlook on the requirements of lubricating oil for high speed and medium speed diesels, they may generally be described as good class oils.

MAR.113, an oil from the Naval Stores at Gdynia, which has a viscosity index of 80 and may have been derived from Hanover type oil, and MAR.72, which has a viscosity index of 103 and is likely to be a solvent refined oil from indigenous German crude oil, are the only oils having a viscosity index higher than 75. Eighty per cent. of the remainder fall within the V.I. range 50 - 75 and may consequently be regarded as likely to be reasonably detergent in nature. It is to be noted that MAR.72 is the highest viscosity oil examined and it may have been originally intended for another purpose. It would probably conform, in fact, to an "80-second" aircraft oil.

In actual viscosity the oils fall into three groups, of which the largest is a medium class comprising two-thirds of the samples and having viscosities around 60-seconds Saybolt at 210°F. A heavier class ranges from 70 to 75 seconds, whilst three samples are in a very light class and have viscosities about 52 seconds Saybolt at 210°F. These last named oils are obviously intended for vessels operating in Arctic waters. They have pour points of -15 to -10°F. and contain no Bright Stock.

Of the medium and heavy medium viscosity oils over eighty per cent. may be regarded as containing Bright Stock.

Whatever the viscosity index the oils are all well dewaxed. The highest pour point is 20 F. and the lowest -15°F. but the bulk range between -5 F. and + 5°F.

Judging by their appearance, neutralization and saponification values and ash content, the oils are all well-refined. The conclusion has been drawn that those which are wholly distillates are of Rumanian non-paraffinous origin either conventionally or sulphur dioxide refined, whilst those containing Bright Stock are similar distillates blended with cylinder stock or residuum from indigenous German crude oils, probably Hanover or Reitbrook.

Enemy Lubricating Oils (Marine Samples) (Cont'd).

The viscosity classes are quite well marked, so that it seems probable production specifications may have been drawn up on a viscosity basis. Arbitrarily described as light, medium and heavy medium, they would appear in general to have the following approximate characteristics:

	<u>Light</u>	<u>Medium</u>	<u>Heavy Medium</u>
Viscosity, S.U., at 210°F.	52"	60"	75"
Viscosity Index.....	Less than 50	50 - 75	Less than 75
Pour Point.....	-15°F.	0°F.	10°F.
Carbon Residue,			
Ramsbottom.....	0.20	0.35	0.45

Heavy Cylinder and Gear Oils

The purpose of these samples is not entirely clear. MAR.114 may be an uncompounded steam cylinder oil. MAR.156 is of similar nature and might also have been regarded as a steam cylinder oil though a good deal lower in viscosity. It was taken however from a diesel vessel having a normal type engine oil (MAR.165) and must therefore be regarded as a gear or heavy general purpose oil.

The Italian oil, MAR.119, is a high grade solvent refined heavy diesel lubricating oil and is probably of American origin. It would be suitable for the cylinders of the main engines of large diesel driven ships.

Marine Steam Cylinder Oils

MAR.94, taken from a Swedish tanker chartered by the Germans, is a conventional marine engine oil compounded with a high proportion (about 15%) of blown rape seed oil.

MAR.120 and MAR.121 are interesting as being stated to represent the quality generally made available for German shipping. The heavier oil, used for steam cylinders, is compounded with 4% rape oil; the lighter, used for lubricating reciprocating parts, is compounded with 5% Sunflower oil.

The analysis of the steam cylinder oil shows it to be of good class though rather lower in viscosity than recommended for British Services. The extent of compounding is that normally used in steam cylinder oils, but is not strictly necessary. The corresponding British Service grade is uncompounded.

MAR.121, on the other hand, is of poor quality. It appears to be the type known as Romanian OO containing about 5% of fatty oil. This quantity of fatty oil is insufficient to ensure good emulsification of bearings, guides, etc., particularly with salt water. Corresponding British oils would contain up to 20% of blown rape seed oil.

Both these oils had been complained of by the Norwegian engineers sailing the vessel for the Germans, and the complaint regarding MAR.121 appears to be justified.

Miscellaneous Marine Lubricants.

These call for no special remarks.

Samples Analysed in Norway

The four analyses of marine lubricating oil in this group represent oils imported into Norway from Germany and as such warrant special consideration. Unfortunately the data are insufficient for full identification, but it appears that MAR.105 and probably also MAR.104, is unrefined Romanian distillate oil. None of the oils is compounded.

HIGH SPEED DIESEL OILS.

Sample No. Date of Report Description	MAR.53 15. 9.42. Unused lub. oil from Reserve Drum	MAR.57 15. 9.42. Unused lub. oil.	MAR.58 15. 9.42. Unused lub. oil (printed Societe Anonyme des Huiles Cila - Paris).	MAR.61 11.12.42. Unused lub. oil	MAR.63 11.12.42. Unused lub. oil	MAR.65 11.12.42. Unused lub. oil	MAR.67 11.12.42. Unused lub. oil	MAR.69 11.12.42. Unused lub. oil	MAR.72 11.12.42. Unused lub. oil	MAR.74 11.12.42. Unused lub. oil	MAR.77(A) 11.12.42. Unused lub. oil	MAR.77(B) 11.12.42. Unused lub. oil.
Type of Vessel	German fish- ing, of about 11 tons regd. wt.; arrived at a harbour on the S.Coast 8th June. Understood vessel sailed from Newport.	18 ft. half-decked sailing, of the type used for mackerelling. Engine, 1-cyl. marked "Motour C.L.Concord" on base. Solox carburettor marked "26 M.B.". Spark plug marked "Ideal Standard B.T.E. - S.G.D.G.". Engine appeared to be of approx. 7 h.p.		Motor fishing, "Maritana" fuelled at Esjberg.	Motor fishing, "Evy" fuelled at Esjberg.	Motor fishing, "Tinno" fuelled at Esjberg.	Motor fishing, "Gurli" fuelled at Esjberg.	Motor fishing, "Chr.Smed" fuelled at Esjberg.	Motor fishing, "Alico" fuelled at Esjberg.	Motor fishing, "Risagor" fuelled at Esjberg.	Motor fishing, "Smant" (1935 6 h.p. Whickman (?) engine.) Last fuelled in Bergen area.	Motor fishing, "Smant"
Received through	M.E.W.	Security, Plymouth.	 Security, GrantonSecurity, Larwick.....	
Origin	Probably Rumanian.	Probably from indigenous German crude oil. Appears to contain Bright Stock.	Uncertain. May also be derived from German crude. Appears to contain Bright Stock.	Probably SO ₂ refined Ru- manian Dis- tillate blended with varying pro- portions of Bright Stock.	Indigenous German oil.	Suspected to be made from Reitbrook crude.	Probably SO ₂ refined Ru- manian Dis- tillate blended with varying pro- portions of Bright Stock.	Probably SO ₂ refined Ru- manian Dis- tillate blended with varying pro- portions of Bright Stock.	Probably derived from a German crude by solvent refining.	Probably SO ₂ refined Ru- manian Dis- tillate blended with varying pro- portions of Bright Stock.	SO ₂ refined Rumanian.	SO ₂ refined Rumanian.
Size of Sample (Approx.)	8-oz-	1-gln.	1-qt.									
Appearance				Clear dark red	Clear dark red	Clear dark red	Clear very dark red	Clear very dark red	Clear dark red	Clear dark red	Clear pale	Clear pale
Colour				Dark green	Green	Green	Green	Dark green	Green	Blue	Slight green	Slight green
Bloom												
Specific Gravity	0.937	0.908	0.931	0.922	0.914	0.920	0.925	0.924	0.895	0.927	0.919	0.919
Viscosity:												
Kinematic @ 100°F (C.S.)	169	191	260	106.9	115.3	121.1	133.2	166.4	161.2	190.4	98.8	98.04
" 140°F "	44.3	58.2	68	35.37	38.3	39.2	40.65	49.05	55.4	53.55	30.55	30.55
" 210°F "	10.0	14.35	14.6	9.28	10.28	10.21	10.22	11.87	15.28	12.45	7.99	8.06
Saybolt " 100°F (Soes)	780	882	1201	488	529	556	611	763	739	873	448	446
" 210°F "	59.2	75.2	76.2	56	60	60	60	65	78	68	52	52
Redwood " 140°F "	182	238	344	145	157	161	166	201	227	219	127	127
Viscosity Index	Of the order of -10	74	34.4	57	71	62	46	50	103	41	22	27
Ash	-	0.004%	Nil	Less than 0.01%	Less than 0.01%	Less than 0.01%	Less than 0.01%	Less than 0.01%	Less than 0.01%	Less than 0.01%	Less than 0.01%	Less than 0.01%
Pour Point	5°F	5°F	0°F	0°F	5°F	20°F	5°F	5°F	5°F	0°F	- 15°F	- 15°F
Sulphur	0.54%	0.87%	2.44%	0.4%	0.65%	1.0%	0.15%	0.35%	0.5%	0.45%	0.2%	0.25%
Saponification Value (mg.KOH/gr.)	0	0.8	0.3	1.1	0.1	0.4	0.5	1.5	0.1	0.5	0.2	0.3
Additives	Nil	Nil	Nil	-	-	-	-	-	-	-	-	-
Ramsbottom Coke Number	0.17	0.28	0.32	0.48	0.41	0.28	0.44	0.39	0.37 This sample was examined further for the presence of a V.I. dopo su h as polyiso- butylene but none was detected.	0.37	0.17	0.18

TABLE X.
HIGH SPEED DIESEL OILS.

Sample No. Date of Report Description	MAR. 78 24-11-42 Neuer Maschinöl	MAR. 80 19-1-43 Lub. Oil extracted from a 50-gln. drum of oil marked KRIEGSMARINENWERF, WILHELMSHAVEN, washed ashore in the vicinity of the river mouth, Ognore-by-Sea, nr. Porthcawl, Glam., which was salvaged at 0815/23/10/42 and conveyed to Naval Base, Cardiff.	MAR. 81 19-1-43	MAR. 84 15-4-43 Unused Lub. Oil	MAR. 87 21. 1.43. Unused lubricating oil supplied to a Dutch ship (under 200 tons) at Delfzijl in the middle of October.	MAR. 102 21-1-43
Type of Vessel	German Merchant (s.s. "Norden") 21-9-42			Auxiliary Fishing Ketch D.3139 ("Belle Brotagne"). Port of Registry - Douarnenez. Gross Tonnage 138. Vessel arrived in Barrow from overseas 18-8-42.		
Received through	M.E.W.	Admiralty, N.I.D.7.		Admiralty, N.I.D.7.	Ministry of Economic Warfare.	
Origin	May be blend of acid refined Rumanian distillate with residual oil from German crude.	May consist of a mixture of indigenous German oil and SO ₂ -treated Rumanian distillate. <u>Preliminary tests showed that these samples were identical so they were bulked for examination.</u>		From gravity and low pour point appears to be a Rumanian distillate oil but the substantial carbon residue seems to indicate that it has been blended with residual stock to achieve the required viscosity.	Straight mineral general purpose materials likely to have been prepared by conventional methods from indigenous German crude.	
Size of Sample	5-oz.			350 c.cs.	100 mls.	120 mls.
Appearance	An opaque dark red oil with a dark green bloom, smelling strongly of acetic acid and contaminated with water.	Opaque red oil containing water.		A pale clear oil.		
Specific Gravity	-	-		0.913	0.9210	0.9213
Colour, A.S.T.M.	-	-		-	5	4½
Pour Point	-	-		-15°F.	10°F.	10°F.
Viscosity:						
Kinematic @ 100°F, C.S.	-	-		129	128.2	136.2
" 140°F, "	-	-		-	41	43
" 210°F, "	-	-		10.2	10.76	10.88
Redwood 1 " 140°F, Socs.	-	-		163	168	176
Saybolt Universal " 100°F, "	-	-		595	596	629
" 210°F, "	-	-		60	62	62.3
Viscosity Index	-	-		52	66	60
Ash	-	-		Trace only	0.009%	0.007%
Water Content	-	0.5%		-	-	-
Neutralisation Value (mg.KOH/gm.)	-	-		0.09	-	-
Saponification Value (mg.KOH/gm.)	-	-		2.5	0.85	0.55
Sulphur Content	-	-		0.73%	1.22%	1.32%
Additives	-	-		Absent	Absent	Absent
Carbon Residue, Conradson	-	-		0.55%	-	-
" " Ramsbottom	-	-		0.52%	0.30%	0.30%
After drying and filtration:						
Specific Gravity	0.929	0.919				
	S.U. Rod. 1. C.S.	S.U. Rod. 1. C.S.				
Viscosity @ 100°F.	600" - 130.6	911" - 197.2				
@ 140°F.	- 41.38	- 60.5				
@ 210°F.	61" - 10.59	75" - 14.41				
Viscosity Index	59	71				
Ash	0.04% (essentially iron oxide)	-				
Ash (sulphated)	-	Loss than 0.01%				
Pour Point	70°F.	+15°F.				
Neutralisation Value (mg.KOH/gm.)	-	Loss than 0.05				
Saponification Value (mg.KOH/gm.)	1.0	0.5				
Sulphur Content	0.7%	0.65%				
Carbon Residue, Conradson	-	0.63				
" " Ramsbottom	0.64	-				
Additives	Absent	Absent				
Refractive Index at 20°C.	-	1.51005				
Sodium D Line	-	-				

T A B L E X
HIGH SPEED DIESEL OILS

Sample No. Date of Report Description	MAR.90 22.1.43 Unused lub.oil obtained from spare on board.	MAR.91 22.1.43 Used lub.oil as drawn from sump of engine.	MAR.96 27.1.43 Lub.oil	MAR.98 27.1.43 Lub.oil	MAR.107 20.4.43 Lub.oil (Slightly used)	MAR.109 20.4.43 Lub.oil (unused)	MAR.111 20.4.43 Oil (unused)
Type of Vessel	Dutch motor fishing, "Frans Hals" (HS.126) which arrived at Ramsgate 2.10.42 from Flushing.	Dutch motor fishing, "Frans Hals" (HS.126) which arrived at Ramsgate 2.10.42 from Flushing.	Motor, "Dagnar" which arrived at Grimsby from the Continent on 19.11.42. Said to be seine-net fish- ing vessel from Denmark.	Motor, "Valib" which arrived at Grimsby from the Con- tinent on 19.11.42. Said to be seine-net fish- ing vessel from Denmark.	Danish motor, "Veno" which escaped from Denmark and arrived at Grimsby 25.1.43.	Danish motor, "Vestfart" which arrived at Grimsby from Denmark 25.1.43.	French lugger at Salcombe on 7.2.43.
Received through	Admiralty N.I.D.7	Admiralty N.I.D.7	M.E.W.	M.E.W.	M.E.W.	M.E.W.	M.E.W.
Origin	Appear to consist of the high sulphur type oils which we associate with Reitbrook lubricating oils.		May be derived from indigenous German crude oil by convention- al refining methods or by blends of residual oils from such source with SO ₂ -treated Ruman- ian distillate. It seems likely that the German oil used is of the highly sulphurous or Reit- brook type.		Low pour point and Viscosity Index may indi- cate its being a blend of Ru- manian distill- ate with de- waxed paraffinic residual oil.		Low pour point and Viscosity Index may indi- cate its being a blend of Rumanian dis- tillate with dewaxed para- ffinic residual oil.
Size of Sample.....Approx. Appearance.....	Clear dark red oil with green bloom	Used oil con- taining a con- siderable quan- tity of carbon- aceous material in suspension.	1-pt. Cloudy dark red oils apparently unused but containing water.	1-pt.	1-pt. Cloudy red oil with dark green bloom. Odour of used oil.	1-pt. Cloudy red oil with dark green bloom.	4-oz. Cloudy red oil with de- posit and odour of Terpenes (Proba- bly bottle con- tamination).
Specific Gravity.....	0.919	-	0.918	0.918	-	-	-
Viscosity							
Kinematic @ 100°F....C.s....	156.8	-	191.6	172.2	-	-	-
" 140°F.... "	46.81	-	58	53	-	-	-
" 210°F.... "	11.82	-	13.97	13.17	-	-	-
Redwood 1 " 140°F...Secs.....	192	-	237	217	-	-	-
Saybolt Unit " 100°F... "	718	-	884	795	-	-	-

versal " 210°F... "	65	-	73.4	70.4	-	-	-
Viscosity Index.....	58	-	69	70	-	-	-
Diluent (Diesel).....	-	2%	-	-	Approx. 1%	-	-
Sediment Insoluble in 60/80°C.	-	-	-	-	0.66%	-	-
Petroleum Ether.....	-	-	-	-	-	-	-
Sediment insoluble in I.P.Spirit...	-	1.44%	-	-	-	-	-
Pour Point (A.S.T.M.).....max.	5°F.	-	0°F.	+10°F.	-	-	-
.....	0.02%	0.28%	less than	less than	-	-	-
Nature of Ash.....	Essentially	Essentially	0.01%	0.01%	-	-	-
	iron oxido	iron oxide	-	-	-	-	-
Water.....	-	-	less than	0.15%	-	-	-
	-	-	0.1%	-	-	-	-
Neutralization Value(mg.KOH/gm.)...	-	-	less than 0.05	0.1	-	-	-
Saponification Value(mg.KOH/gm.)...	0.1	-	0	0	-	-	-
Sulphur.....	0.95%	-	0.7%	0.95%	-	-	-
Additives.....	Absent	-	Absent	Absent	-	-	-
Ramsbottom Coke No.....	0.36	-	0.54	0.57	-	-	-
Oil after removal of diluent and filtration.							
Appearance.....		Clear dark red oil with slight dark green bloom					
		0.914					
Specific Gravity		Red. 1 0. s.					
Viscosity @ 140°F.....		191" 46.48					
		10°F.					
Pour Point.....		0.13%					
Sediment insoluble in I.P.Spirit...		0.02%					
Ash.....		Essentially					
		iron oxide					
Nature of Ash.....		1.0%					
Sulphur.....		0.8					
Saponification Value(mg.KOH/gm.)...							
Oil after removal of water and filtration							
Specific Gravity.....				0.921	0.916	0.904	
Pour Point				-10°F.	5°F.	0°F.	
Viscosity:							
Kinematic @ 100°F.....C.s.				134.0	140.9	158.3	
" 140°F..... "				41.1	43.3	49.6	
" 210°F..... "				10.50	10.95	12.70	
Redwood 1 " 140°F.....Secs.				168	178	203	
Saybolt Univer-" 100°F..... "				619	651	731	
sal " 210°F.				61	62	68	
				53	56	74	
Viscosity Index.....				0.05%	0.03%	0.07%	
Ash.....				Essentially	Essentially	Essentially	
Nature of Ash.....				iron oxide	iron oxide	iron oxide	
				0.55%	0.40%	0.35%	
Sulphur.....				0.7	0.1	0.8	
Saponification Value (mg.KOH/gm.)...				Absent	Absent	Absent	
Additives.....				0.43	0.24	0.33	
Ramsbottom Coke No.							

TABLE X.
HIGH SPEED DIESEL OILS.

Sample No. Date of Report Description	MAR-113 31.5.43 Machine Oil (on label "No.1 P.5/8411") said to have been taken from the Naval Stores at Gdynia.	MAR-116 31.5.43 Lub.Oil	MAR-124 31.5.43 Lub.Oil	MAR-133 12.7.43 Oil (Used)	MAR-136 12.7.43 Unused Oil thought to have come from a German merchant ship in northern waters.	MAR-142 12.7.43 Unused Oil Source unknown, but thought to have come from a German merchant vessel in northern waters	MAR-145 15.7.43 Lubricating oil obtained in a German Baltic Port in February 1943.	MAR-148 23.7.43 Lub.Oil
Type of Vessel	Swedish, "T.B.IV", chartered by the German Navy.	French auxiliary, which arrived from France at Plymouth on 8.3.43.	Danish motor fishing, "Lorley" which recently arrived from Denmark.	27-ton Coastal, which arrived from Norway on 13.3.43.				Fishing, which arrived in this country from Denmark on 19.4.43.
Received through	M.E.W.	M.E.W.	M.E.W.	M.E.W.	M.E.W.	M.E.W.	M.E.W.	M.E.W.
Origin	? Possibly an acid refined oil from the Hanover fields.	May be an SO ₂ refined Rumanian oil.	May have been prepared from a Rumanian dis- tillate and residual oil.	May have been of similar nature to MAR-136 and 142 though the lower sulphur content might indicate a larger proportion of oil from German crude.	Of similar type and likely to be largely produced from conventionally refined German indigenous crudes. The rather lower V.I. and higher Specific Gravity of MAR-142, combined with the rather lower Coke No., suggests blending with a proportion of Rumanian distillate.		May be a blend of SO ₂ - refined Rumanian con- taining some Bright Stock.	May consist of a mixture of SO ₂ - treated Rumanian with a high sulphur residue such as that from Roitbrook crude
Size of SampleApprox. Appearance	50 mls. Dark red oil with green bloom	1-pt. Red oil with light green bloom	1-pt. Cloudy red oil with heavy green bloom	400 ccs. Used oil containing carbonaceous material.	½-pt. Clear dark red oil with green bloom.	100 mls. Clear red oil with green bloom.	2-oz. Light red oil with green bloom (contaminated with water probably from bottle container).	1-qt. Dark red oil with green bloom.
Specific Gravity	0.908	0.899	0.931	0.916	0.915	0.920	0.921	0.923
Viscosity								
Kinematic								
@ 100°F, C.S.	173.2	119.8	123.1	130.4	99.10	88.61	131.1	166.5
" 140°F, "	55.3	39.4	38.7	41.05	34.75	29.53	40.9	49.11
" 210°F, "	13.85	10.46	9.80	11.05	9.38	8.33	10.82	11.91
Redwood 1	226	161	159	168	140	123	168	201
Saybolt Universal	800	554	569	602	459	410	606	771
" 100°F, "	73	60	58	62	56	53	62	66
" 210°F, "	80	70	48	69	72	58	64	51
Viscosity Index	-	-	-	-	-	-	-	-
Ash	-	-	-	Less than 0.01%	Less than 0.01%	Less than 0.05%	0.01%	0.01%
Nature of Ash	-	-	-	-	-	Essentially iron oxide.	-	-
Ash (sulphated)	0.03%	0.01%	Less than 0.01%	-	-	-	-	Essentially iron oxide
Diluent (Diesel)	-	-	-	Nil	-	-	-	-
Sediment insoluble in 60/80°C Petroleum Ether	-	-	-	0.35%	-	-	-	-
Pour Point	10°F	5°F	-5°F	0°F	0°F	-10°F	0°F	20°F
Neutralization Value (mg.KOH/gm.)	0.05	0.05	-	-	-	-	-	-
Saponification Value (mg.KOH/gm.)	0.1	0.1	0.3	2.4	Less than 0.2	0.3	Less than 0.1	Less than 0.1
Sulphur	0.7%	0.3%	0.35%	0.6%	1.35%	1.2%	0.6%	0.7%
Additives	-	-	Absent	-	Absent	Absent	Absent	Absent
Ramsbottom Coke No.	0.44	0.17	0.40	-	0.36	0.24	0.45	0.43
	This contains residual oil.	This is a dis- tillate oil.						

TABLE X
HIGH SPEED DIESEL OILS

Sample No. Date of Report Description	MAR.152 22.7.42 Slightly used oil brought from Cherbourg	MAR.156 19.8.43 (L.11) Kriegs- marine W.W. (embossed) ZdmT Alexander	MAR.157 19.8.43 (L.12) Kriegs- marine W.W. (embossed) Zdm6 K.M.	MAR.161 19.7.43 Lub.oil thought to have been obtained at Delfzijl in April 1943	MAR.163 4.8.43 Lub.Oil re- ceived from Sweden and sup- posed to have originated from a Dutch steamer which went to Sweden. (Unused)	MAR.165 4.8.43 Lub. Oil (on label: "Erling") (Unused)	MAR.167 4.8.43 Lub. Oil (Unused)	MAR.168 4.8.43 Lub. Oil (Unused)
Type of Vessel Received through Origin	French motor, "St.Sophie" M.E.W.	M.E.W. Appears to be an acid-refined oil make from German crude.	M.E.W.	M.E.W. Might consist of Conventionally- refined indigenous German crude from the Hanover or Reitbrook fields and containing a substantial quantity of "Bright Stock" or residual material.	M.E.W.	Fishing, from Denmark M.E.W.	Fishing, from Denmark M.E.W.	Fishing, from Denmark M.E.W.
Size of Sample Approx. Appearance	$\frac{1}{2}$ -pt. Cloudy light red oil having odour of terpenes (bottle contami- nation?). Red- brown deposit. 0.911	$\frac{1}{2}$ -gln. Dark red oil with bluish- green bloom	$\frac{1}{2}$ -gln. Dark red oil with heavy green bloom	$\frac{1}{2}$ -pt. Opaque red oil with medium green bloom	8-oz. Dark red oil, medium green bloom	1-pt. Dark red oil, medium green bloom	$\frac{1}{2}$ -pt. Dark red oil, dark green bloom	$\frac{1}{2}$ -pt. Dark red oil, bluish-green bloom
Specific Gravity	0.911	-	-	0.916	0.915	0.928	0.922	0.922
Viscosity:								
Kinematic	@ 100°F, C.s.	-	-	128.7	101.2	120.4	129.7	122.1
" 140°F, "	33.50	-	-	40.3	33.8	37.8	39.8	39.1
" 210°F, "	-	-	-	10.48	9.45	10.01	10.10	10.25
Redwood 1	" 140°F, Secs.	138	-	165	139	155	163	160
Saybolt Universal	" 100°F, "	-	-	595	467.5	556	599	564
" 210°F, "	-	-	-	60.5	56.9	58.8	59.2	59.7
Viscosity Index	-	-	-	59	71	58	48	62
Diluent (Diesel)	1%	-	-	-	-	-	-	-
Insoluble in 60/80°C Petroleum Ether	0.40%	-	-	-	-	-	-	-
Nature of 60/80°C insoluble matter	General debris (silica, glass, oxide scale, fibre, wood) not associ- ated with oil, pro- bably bottle or barrel contamination.	-	-	-	-	-	-	-
Ash	0.18%	-	-	0.01%	0.01%	0.01%	Less than 0.01%	0.01%
Nature of Ash	Iron oxide, silica, glass	-	-	-	-	-	-	-
Sulphur	0.8%	0.95%	0.65%	0.85%	1.45%	0.6%	0.9%	0.7%
Pour Point	-5°F	-	-	5°F	0°F	-5°F	0°F	5°F
Saponification Value (mg.KOH/gm.)	2.0	-	-	0.4	0.3	0.4	0.2	0.2
Additives	-	-	-	Nitrogen and phos- phorus - absent. Sulphur and Chlor- ine (faint trace) - present.	Absent	Absent	Absent	Absent
Ramsbottom Coke No.....	-	-	-	0.40	0.38	0.32	0.33	0.39

TABLE X.
HIGH SPEED DIESEL OILS

Sample No. Date of Report Description	MAR.179 4.8.43. Lubricating oil drawn from cylindrical reserve lubricating oil drum.	MAR.184 10.8.43. Lubricating Oil
Type of Vessel	Motor Cabin Day Cruiser which reached a Scottish Port on 30.5.43. ex Norway. Engine: "Wickmann" single-cylinder semi-diesel (hot bulb) by M.Halderson & Son, Rubbestadnes - 7 h.p. Dry sump type. Lubrication by Manzel (American) force feed lubricator giving complete circulation back to lub.oil service tank.	Auxiliary "St.Yves" which arrived from Franco on 15th June.
Received through Origin	Security, Scotland	N.E.W. Probably represents a solvent refined distillate possibly of Rumanian origin.
Size of Sample Approx. Appearance	2-glns. Dark oil with dark green bloom	$\frac{1}{2}$ -gln. Very slightly opaque red oil with green bloom.
Colour (Union) Specific Gravity	- 0.923	$4\frac{1}{2}$ Minus (N Minus) 0.900
Viscosity: Kinematic @ 100°F, c.s. " 140°F, " " 210°F, " Redwood 1 " 140°F, Secs. Saybolt Universal " 100°F, " " 210°F, "	114.1 35.8 9.37 147 527 56.7 48	114.5 37.9 10.30 156 529 60 73
Viscosity Index	-	Nil
Diluent (Gasoline)	-	200°F
Flash Point, P.M., Closed Open Fire	- - -	445°F 505°F
Ash	Less than 0.01%	Less than 0.01%
Water Content	-	0.05%
Pour Point	- 5°F	0°F (max.)
Sulphur	1.1%	0.25%
Saponification Value (mg.KOH/gm.)	0.1	0.16
Additives	Absent	Absent
Ramsbottom Coke No.	0.28	0.17

TABLE XI.
HEAVY CYLINDER AND GEAR OILS.

<p>SAMPLE No. Date of Report Description</p> <p>Type of Vossol</p>	<p>MAR.114 31.5.43. Cylinder Oil (on label "No.2 P.5./8411") said to have been taken from the Naval Stores at Gdynia.</p> <p>Swedish, "T.B.IV", chartered by the German Navy. M.E.W.</p>	<p>MAR.119 17.5.43. Italian Lub. Oil - Tripoli 8.2.43. - in 200 litre brls. Mark- ings: Vacno Marine Oil AA. Vacuum Oil Co.,S.A.I. Genova. Prodotto della Raffineria di Napoli.</p> <p>M.E.W.</p>	<p>MAR.166 4.8.43. Heavy Lub. Oil (on label: "Erling").</p> <p>Fishing, from Denmark. M.E.W.</p>
<p>Origin</p> <p>Size of Sample Approx...</p> <p>Appearance</p> <p>Specific Gravity</p> <p>Colour (Union)</p> <p>Viscosity:</p> <p> Kinematic @ 100°F C.s..</p> <p> @ 140°F "</p> <p> @ 210°F "</p> <p> Redwood 1 @ 140°F Secs.</p> <p> Saybolt Univorsal @ 100°F "</p> <p> @ 210°F "</p> <p>Viscosity Index</p> <p>Ash</p> <p>Ash (sulphated)</p> <p>Pour Point</p> <p>Neutralisation Value (mg.KOH/gm.)</p> <p>Saponification Value (mg.KOH/gm.)</p> <p>Sulphur</p> <p>Additives</p> <p>Ramsbottom Coke No.</p>	<p>May contain Reithbrook oil.</p> <p>50 mls.</p> <p>Dark oil with heavy dark green bloom.</p> <p>0.948</p> <p>-</p> <p>1,266</p> <p>255.5</p> <p>40.23</p> <p>1,035</p> <p>5,849</p> <p>187</p> <p>57</p> <p>-</p> <p>0.03%</p> <p>30°F</p> <p>0.20</p> <p>0.3</p> <p>1.8%</p> <p>-</p> <p>1.98</p> <p>This is a residual oil.</p>	<p>Consists largely of solvent- refined oil probably of American origin.</p> <p>½-gln.</p> <p>Dark red oil with heavy green bloom.</p> <p>0.895</p> <p>Darker than 8(R)</p> <p>356.7</p> <p>105.3</p> <p>23.62</p> <p>427</p> <p>1,648</p> <p>112.9</p> <p>92</p> <p>-</p> <p>Loss than 0.01%.</p> <p>20°F</p> <p>-</p> <p>0.6</p> <p>0.15%</p> <p>Absent</p> <p>0.50</p>	<p>1-pt.</p> <p>Dark oil, dark green bloom.</p> <p>0.955</p> <p>-</p> <p>818.9</p> <p>177.5</p> <p>30.25</p> <p>719</p> <p>3,783</p> <p>142</p> <p>50</p> <p>0.03%</p> <p>-</p> <p>30°F</p> <p>-</p> <p>0.5</p> <p>2.8%</p> <p>Absent</p> <p>1.97</p>

TABLE XII

MARINE STEAM ENGINE OILS

Sample No. Date of Report Description	MAR.94 15.4.43 Unused lubricating oil.	MAR.120 29.4.43 German Oil as used for lubricating cylinders of triple expansion Marine Engine - 29.3.43. These oils are stated to represent the quality made available at the moment for the maintenance of German shipping.	MAR.121 29.4.43 German Oil as used for hand lubrication of reciprocating parts of triple expansion Marine Engine - 29.3.43.
Type of Vessel	Small Swedish Tanker chartered by the Germans.	Norwegian, sailing for the Germans	Norwegian, sailing for the Germans.
Received through	M.E.W.	M.E.W.	M.E.W.
Size of Sample (Approx.)	250 ccs.	-	-
Specific Gravity	0.951	0.918	0.930
Colour	-	Dark Green Cylinder	Dark with greenish sheen
Pour Point	+ 15°F.	45°F.	30°F.
Flash Point, open	-	500°F.	420°F.
Flash Point, closed	-	465°F.	395°F.
Viscosity:	178.4	-	-
Kinematic @ 100°F... C.s.	13.25	-	612
Redwood @ 100°F... Secs.	-	1266	188
140°F... "	218	382	63.6
200°F... "	-	111	-
Saybolt Universal @ 100°F... "	824	-	-
210°F... "	71	-	-
Viscosity Index	66.5	-	-
Compound	15.0%	4.0%	5.3%
Nature of Compound	Blown Rape	Possibly Rape Oil	Probably Sunflower Oil
Ash	Trace only	-	-
Saponification Value (mg.KOH/gm.)..	29.6	-	0.056
Neutralization Value (mg.KOH/gm.)..	-	0.280	-
Sulphur	0.34%	-	-
Additives	Absent	-	-
Conradson Carbon Residue	0.63%	-	-
Ramsbottom " "	0.55%	Nil	Nil
Asphaltenes	-	1.4644	1.4720
Refractive Index of F.A's @ 40°C...	-	72	150
Iodine Value of F.A's	-	-	-
Mineral Oil after removal of Saponifiable Content	0.944	-	-
Specific Gravity	+ 20°F.	-	-
Pour Point	-	-	-
Viscosity:	170	-	-
Kinematic @ 100°F... C.s.	10.25	-	-
210°F... "	785	-	-
Saybolt Universal @ 100°F... Secs.	60	-	-
210°F... "	Zero	-	-
Viscosity Index	-	-	-

MISCELLANEOUS MARINE LUBRICANTS

Sample No. Date of Report Description	MAR.146 23.7.43 Lub. Oil obtained in March. May have been taken on board at Hamburg.	MAR.154A 23.7.43 "Tallow and Soap"	MAR.154B 23.7.43	MAR.155 22.7.43 "Cleaning Material" (on tin: Schleifmasse Blitz Kornug G) brought from Cherbourg.	MAR.173 4.8.43 Light Lub. Oil (Unused)	MAR.177 4.8.43 Lub. Oil drained from mechanical force feed lubricator.	MAR.178 4.8.43 Contents of reserve lubricating oil drum.
Type of Vessel	German coal-burning cargo (s.s. "HAGA") operating in Northern waters.	French motor "ST. SOPHIE"	French motor "ST. SOPHIE"	French motor "ST. SOPHIE"	Fishing, from Denmark	Motor Cabin Day Cruiser which reached a Scottish Port on 30.5.43 ex Norway. Engine: "Wickmann" single-cylinder semi-diesel (hot bulb) by M. Haldorsen & Son, Rubbestadnes - 7 h.p. Dry sump type. Lubrication by Manzel (American) force feed lubricator giving complete circulation back to lub. oil service tank.	
Received through	M.E.W.	M.E.W.	M.E.W.	M.E.W.	M.E.W.	Security, Scotland.	Security, Scotland.
Origin	"	"	"	"	Rapo Oil	"	"
Size of Sample.....Approx.	1-pt.	"	"	"	1-pt.	1-pt.	1-pt.
Appearance.....	Cloudy red oil with dark green bloom and some black deposit.	White, salve-like consistency with an unpleasant odour.	Yellow, fairly firm with a distinct odour of mutton tallow.	This cleaning mater- ial is a typical polish of the abrasive type consisting of car- borundum, earth filler and a soluble oil. "Kornug G" in the title of the material apparently refers to the grading of the carborun- dum in this particular sample.	Pale oil.	Cloudy dark oil with slight dark green bloom. Contains small amount of sedi- ment consisting mainly of rust particles and water droplets.	Cloudy dark oil with slight dark green bloom. Contains trace of sediment consisting of rust particles and a white mush of water droplets. Smells of spirit.
Specific Gravity.....	0.896	-	-	-	0.915	0.906	0.905
Viscosity:	-	-	-	-	-	-	-
Kinematic @ 100°F.....C.S.	-	-	-	-	23.84	30.8	29.6
140°F....."	6.80	-	-	-	-	-	-
210°F....."	-	-	-	-	100	128	123
Redwood 1 @ 140°F.....Secs	43	-	-	-	-	-	-
Flash Point, P.M., Closed.....	295°F.	-	-	-	-	-	-
Open.....	315°F.	-	-	-	-	-	-
Fire.....	350°F.	-	-	-	-	-	-
Diluent:	-	-	-	-	-	-	Nil
Gasoline.....	-	-	-	-	-	Nil	Nil
Diesel.....	30%	-	-	-	-	-	-
Insoluble in 60/80°C Petroleum Ether	0.13%	-	-	-	-	-	-
Nature of 60/80°C Insoluble Matter	Carbonaceous material	-	-	-	-	-	-
Sediment insoluble in 60/80°C Petroleum Ether.....	-	-	-	-	-	0.02%	0.03%
Ash.....	0.03%	0.61%	0.05%	-	0.01%	0.02%	0.02%
Nature of Ash.....	Essentially iron oxide	Mainly sodium sul- phate with some potassium sulphate.	-	-	-	Essentially ferric oxide.	Essentially ferric oxide.
Pour Point.....	-15°F.	-	-	-	0°F.	-10°F.	0°F.
Sulphur.....	0.65%	-	-	-	-	0.45%	0.45%
Saponification Value (mg.KOH/gm.)..	1.1	181	197	-	172.5	0.3	0.4
Setting Point (rotating bulb thermometer).....	-	27-29°C.	35°C.	-	-	-	-
Refractive Index @ 60°C.....	-	1.4485	1.4485	-	-	-	-
Acid Value (mg.KOH/gm.).....	-	1.1	1.9	-	-	-	-
Additives.....	-	-	-	-	Absent	-	-

Sample No. Date of Report Description	MAR.146 23.7.43 Lub. Oil obtained in March. May have been taken on board Hamburg.	MAR.154A 23.7.43 "Tallow and Soap"	MAR.154B 23.7.43	MAR.155 22.7.43 "Cleaning Material" (on tin: Schleifmasse Blitz Kornug G) brought from Cherbourg.	MAR.173 4.8.43 Light Lub. Oil (Unused)	MAR.177 4.8.43 Lab. Oil drained from mechanical force feed lubricator.	MAR.178 4.8.43 Contents of reserve lubricating oil drum.
<p><u>Properties of Fatty Acids</u></p> <p>Appearance White micro-crystalline solid with distinct "rancid vegetable" odour. 34°C. 1.4385 42 Probably mixed fats</p> <p>Setting Point White crystalline solid with "stearic" "mutton" odour. 44°C. 1.4390 38 Mutton tallow</p> <p>Refractive Index @ 60°C 1.4385</p> <p>Iodine Value 42</p> <p>Nature of Fat Probably mixed fats</p>							
<p><u>Oil after removal of diluent and sediment</u></p> <p>Appearance Clear dark red oil with dark green bloom.</p> <p>Specific Gravity 0.902</p> <p>Viscosity @ 100°F. S.U. Red.1 C.S. 101" - 20.85</p> <p>140°F. - 49" 9.1</p> <p>210°F. 38" - 3.56</p> <p>Viscosity Index 21</p> <p>Pour Test 35°F.</p>							
<p><u>Diluent</u></p> <p>Appearance Clear pale oil, odour of sweet gas oil.</p> <p>Specific Gravity 0.880</p> <p>Viscosity @ 140°F Red.1 C.S. 37" 4.5</p> <p>The vapours evolved during the determination of the open flash point of this oil had an odour resembling that of kerosine heavy ends.</p>							
<p>MAR.173 proved to be a fatty oil and was further examined as follows:</p> <p>Neutralization Value (mg.KOH/gm.) 0.04</p> <p>Iodine Value 110</p> <p>Refractive Index @ 60°C. 1.4584</p> <p>Unsaponifiable Matter .. 1.2%</p> <p>Total free and combined fatty acids 94.5%</p>							
<p><u>Properties of Fatty Acids</u></p> <p>Melting Point 16°C.</p> <p>Iodine Value 107</p> <p>Refractive Index @ 60°C. 1.4497</p> <p>Nature of Fatty Acids .. Derived from rape.</p>							

TABLE XIV

SAMPLES ANALYSED IN NORWAY

Sample No. Date of Report No. of Report Description	MAR.103 8.10.42 S/1328 "Marine Oil 1609"	MAR.104 8.10.42 S/1328 "Marine Oil No. 9 Vallo"	MAR.105 8.10.42 S/1328 "Marine Oil 8" (Date of analysis 14.9.42)	MAR.106 8.10.42 S/1328 "Marine refined 4/50"
Ex Steamer	"Desdemona" 25.8.42	-	-	"Desdemona" 25.8.42
Received through Ministry of Economic Warfare			
Origin		Probably unrefined Rumanian oil	Unrefined asphaltic Rumanian oil (distillate)	
Specific Gravity	0.935	0.943	0.946	0.934
Flash Point o.d. Marcusson	200°C.	200°C.	205°C.	205°C.
Viscosity @ 20°C.	-	-	7.64° Engler	-
50°C.	10.15° Engler	9.19° Engler	-	4.42° Engler
100°C.	1.9° "	1.81° "	1.68° "	1.51° "
Fatty Oil Content	0	0	0	0
Water	0	0	0	0
Pour Point	- 18°C.	- 18°C.	- 30°C.	- 18°C.
Acid Value (mg.KOH/gm.)	0.28	1.12	0.56	0.1
Colour in cylinder with diameter 4 cm.	Black (tinge of green)	Black	Black (tinge of green). The oil emulsifies with water somewhat better than MAR.103	Orange

The Director of Intelligence,
Air Ministry (A.I.2.(g)),
King Charles Street,
S.W.1.

12th November 1943

SECRET

Sample No. AIR 334

Starting Spirit ex Me.108 B.1, F8 + CA, Argus AS 10, R.1, Engine No. 4462131, shot down at Ford 11.9.43. Plane from Chatoaubrun, France. Tank from which sample taken undamaged.

Analysis by The Petroleum Board, Vauxhall

Size of Sample	Approx.	150 mls.
Specific Gravity7560
Colour		Blue
Distillation - I.B.P.		65°C
Recovery at 80°C		6%
100°C		43%
105°C		52%
140°C		90%
150°C		93 $\frac{1}{2}$ %
F.B.P.		162°C
Total Recovery		97%
Residue		1%
Freezing Point		Below -60°C
Total Sulphur		0.01%
Bromine Number		1.0
Aniline Point Before Sulphonation		43.8°C
Aniline Point After Sulphonation.		55.4°C
Aromatics		11.6%

This is actually less volatile than the normal German blue fuel. It is most probably weathered so no useful conclusions can be drawn from this sample.

S.J.M.Auld
for The Petroleum Board

The Petroleum Board,
Shell-Mex House,
W.C.2.

The Director of Intelligence,
Air Ministry (A.I.2.(g)),
Whitehall, S.W.1.

SECRET

1st November 1943

Samples Nos. AIR 337, AIR 338, AIR 339, and MECH.386, MECH.387, MECH.388, MECH.389, MECH.390 (received through Allied Force Headquarters, Petroleum Section)

AIR 337 - AeroShell ex Marseilles. AIR 338 - AeroShell 100. AIR 339 - Rotring.-
MECH.386 - Motoren Oel. MECH.387 - Dentoline Getrieboel. MECH.388 - Getrieboel. MECH.389 - Lub.Oil (unlabelled). MECH.390 - Lub.Oil (unlabelled)

Analyses by Shell Marketing Co., Ltd., Fulham

Various samples of enemy lubricating oils, all representing unused oils from North Africa, have been submitted to the following limited examination:

	<u>AIR 337</u>	<u>AIR 338</u>	<u>AIR 339</u>	<u>MECH.386</u>	<u>MECH.387</u>	<u>MECH.388</u>	<u>MECH.389</u>	<u>MECH.390</u>
Appearance	Clear red oil, pale green bloom	Clear red oil, pale green bloom	Clear light red oil, pale blue- green bloom	Clear red oil, dark green bloom	Dark oil, very dark green bloom	Dark red oil, dark green bloom	Dark red oil, very dark green bloom	Light red oil, pale blue bloom
Specific Gravity	0.893	0.890	0.897	0.885	0.929	0.924	0.880	0.885
Viscosity:								
Kinematic	@ 100°F, C.s.	-	253.7	177.1	-	-	-	-
	" 140°F, "	82.64	-	-	64.65	84.78	82.60	85.90
	" 210°F, "	-	19.23	15.40	-	-	-	-
Redwood 1	" 140°F, Socs.	335	-	-	262	344	335	348
Saybolt Universal	" 100°F, "	-	1,171	820	-	-	-	-
	" 210°F, "	-	94	79	-	-	-	-
Viscosity Index	-	-	93	95	-	-	-	-
Pour Point	-	-	5°F	-	-	-	-	-
Saponification Value (mg.KOH/gm.)	0.1	0.1	-	0.4	3.5	0.6	0.3	0.1
Sulphur	-	-	0.55%	-	-	-	-	-
Ramsbottom Coke No.	-	-	0.20	-	-	-	-	-

The results on AIR 337 and AIR 338 indicate that these are normal samples of AeroShell 100. MECH.387 and MECH.388 are mixed base or asphaltic type low viscosity gear oils, and the former oil contains a small proportion of fatty material. MECH.389 and MECH.390 are apparently uncompounded aviation oils.

AIR 339 and MECH.386 are solvent-refined oils. AIR 339 may contain less Bright Stock than the pre-war proprietary grade or be especially highly refined, probably the former. It is likely to be derived from indigenous German crude. MECH.386 is similar to previous samples of Sponder Motoren Oel received from North Africa.

The Petroleum Board,
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