SECRET

EMBASSY OF THE UNITED STATES OF AMERICA

ECONOMIC WARFARE DIVISION
Enemy Objectives Unit

14 November 1944

GERMAN AVIATION FUELS

SUMMARY and CONCLUSIONS

1. Maintenance of the recent low level of German gasoline output through repeated heavy bomber attacks on producing plants should continue to limit severely the overall activity of the G.A.F. Progressive deterioration in the performance of fighters dependent on high-quality aviation fuels may be expected. It should be noted that:

(a) An appreciable number of s.e.f. aircraft have been derated to operate on 87/91 octane Blue (bomber) fuel, with consequent reductions in efficiency and performance. Such conversions appear to have been the result of a stringent, long-run shortage of 100-octane Green fuel.

(b) The monthly allocation of gasoline to the G.A.F. was cut, during September 1944, to about 45,000 tons. This was roughly 25% of the allocations made prior to the strategic bomber offensive against oil.

(c) The base stocks of gasoline contained in recently captured aviation fuel specimens have been of lower octane rating. To compensate for this deficiency, higher proportions of tetra-ethyl-lead and aromatics have been employed to raise the final octane ratings to proper performance levels.

2. The new jet and rocket fighters do not require high-grade aviation gasoline:

(a) The Me 262 uses "aircraft diesel" fuel, which should be available in sufficient quantities to meet requirements.

(b) The Me 163 does not operate on an oil product.

(c) The AR 234 and He 280, twin-engine fighters, use low-grade gasoline. Their activity may be restricted due to over-riding Army demands for motor transport fuel.

3. General intelligence indicates that a major factor restricting GAF activity during the past six months has been the strategic bomber offensive directed against German oil plants. It should be stressed, however, that there is not yet sufficient direct evidence -- such as a large number of captured fuel specimens or enemy documents -- to permit definitive conclusions as to the future to be drawn.

4. Despite the limit on overall G.A.F. activity imposed by inadequate fuel allocations, fighter sorties may be increased at the expense of other G.A.F. operations. Moreover, while lower performance qualities would handicap the ability of conventional German fighter aircraft to resist strategic bomber attacks, ground force support would not be appreciably affected thereby.

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TYPES OF FUEL IN USE BY GAF

5. The following table indicates the types of fuel regularly used by GAF combat aircraft:

Fuel Required	A/C Type	Aircraft
C-3 Green, 95/100 octane gasoline	s.e.f.	Me 109 (DB 605 engine) FW 190 (BMW 801-D engine)
	t.e.f.	Me 410 (DB 603-G engine)
B-4 Blue, 87/91 octane gasoline	s.e.f.	Me 109 (DB 601 engine) FW 190 (BMW 801-D engine) Ju 87
	t.e.f.	Me 410 (DB 603 engines) He 219 Do 335
	t.e.b.	Do 217 Ju 188 Ju 88 (Jumo 211 or 213 engines) He 111 Do 215 He 177
Low-grade motor transport gasoline	t.e.f.	AR 234 (BMW 003 jet units) He 280 (" " " ")
DK-1 aircraft diesel fuel	t.e.f. t.e.b.	Me 262 (Jumo 004 jet units) Ju 88 (Jumo 207)
Hydrogen Peroxide mixture	s.e.f.	Me 163 (Walter liquid rocket)

Only three operational or semi-operational types are thus known to be equipped with engines requiring 100 octane gasoline. All are fighter aircraft currently comprising the largest proportion of GAF defensive strength. The new jet and rocket fighters do not use this premium quality fuel.

AVIATION GASOLINE

6. According to the Allied estimates of recent German oil production, the strategic attacks had imposed an 80% cut in gasoline output by September [illegible]. September gasoline production was 107,000 tons. During October there was some recuperation. ECU/EWD estimates that monthly allocations to the GAF fell from 180,000 tons per month prior to the oil offensive to perhaps 45,000 tons during September.

7. According to the technical intelligence records of A.I.2(g), Crash Intelligence officers have in recent months examined an appreciable number of FW 190 aircraft fitted with BMW 801-D engines derated to operate on 87 octane Blue fuel. This has not been a factory conversion, but one which took place at squadron and group echelons. (Appendix A). Fuel sample Air 399, an 88 octane Blue gasoline, was obtained in summer 1944 from an Me 109G-6 with DB 605 engine, a type originally designed to operate on 100-octane Green. This Blue fuel was, moreover, considerably below normal Blue standards (Appendix B).

8. This sample was obtained months before the oil offensive reached its peak in September, but is the latest available. It is presumably indicative of a downward trend in quality which may have developed still further in recent months.

9. Such derating of 100-octane engines was no doubt prompted by tactical shortages of Green fuel. It probably occurred, however, only with the realization that adequate supplies could not be expected in the future.

10. The latest available specimen of Green fuel (Appendix C) proved generally similar to earlier samples. This fuel was obtained from a jettisoned tank in summer 1944, and may well have been manufactured prior to the commencement of the strategic oil attacks. The base stock was apparently low in tetra-ethyl-lead susceptibility, and therefore contained somewhat more T.E.L. than earlier samples. The finished product, however, adequately fulfilled normal Green standards. More recent specimens are required to determine whether qualitative deterioration has occurred in the limited quantities of this fuel still available.

LOW-GRADE GASOLINES

11. The AR 234 and He 280, twin-engine fighters, use low-grade motor transport fuel. They will not be affected by any quality deterioration suffered by high-test gasolines. Overriding army demands for L.T. fuel, however, ~~are likely to~~ might limit the activity of these 2nd priority fighter types.

AIRCRAFT DIESEL FUEL

12. The most recent sample of "Flugdiesel Triebstoffe" was obtained in April 1944, one month before the inauguration of the strategic bombing offensive. Even this early sample (Air 391, Appendix D) showed certain qualitative changes, among them a cetane number (anti-knock rating) considerably below the norm for K-1 aircraft diesel fuel. This fuel was of petroleum origin, whereas the excellent quality K-1 fuels previously examined were generally blends of Fischer Tropsch volatile oil and brown coal tar distillate in roughly equal proportions.

13. Even if the qualitative changes noted in this sample prove typical, they will not significantly affect the performance of the He 262 jet fighter. Cetane number is not a relevant consideration with a jet-type engine.

14. Despite the sharp cut in diesel oil production inflicted by the strategic oil attacks, and the likelihood that a low level of production will be maintained, it cannot be expected that any curtailment of He 262 activity will be achieved thereby. Alternative uses of diesel fuel are generally lower in priority than, for example, the alternative uses of high-quality gasolines. The consumption of the He 262 is perhaps one ton per sortie. 70,000 tons of gas/diesel oil were manufactured in German Europe during September, the month during which the peak results of the oil offensive were achieved.

THE FUTURE

15. This winter, the effectiveness of continued attacks on oil plants in Germany will be hampered by poorer operational weather than that which prevailed over Europe from May to September 1944. While it is theoretically feasible to drive gasoline output below the record month of September 1944 (20% of normal), it is not expected that this will be achieved. On the basis of the scale of attack exerted during October, and the results obtained, gasoline output is likely to rise to perhaps 160,000 tons per month later this winter. This figure is roughly 30% of the pre-raid norm.

16. Final decisions concerning allocation of this limited gasoline output will depend on the extent of the land fighting against the Germans on all fronts, and the consequent Army and Air Force demands for motor fuel. Non-military gasoline consumption is insignificant. There can be little doubt, however, that virtually all strategic stocks of gasoline have now been consumed. Future overall consumption will be largely determined by the current output.

17. Recent GAF consumption has been estimated at 45,000 tons per month, as follows:

Fighters	7,000
Bombers, Coastal, Recce....	11,000
Transport & Communications.	14,000
Experimental	2,000
Training	11,000
	45,000 tons of gasoline per month.

Maintenance of the recent low level of GAF activity will thus require 1/4 to 1/3 of estimated winter gasoline production. Within this allocation, however, it will be observed that fighter activity might be very substantially increased if GAF consumption for other purposes were reduced. It does not seem likely that the overall GAF allocation will be significantly increased in the face of Army demands.

18. There has been a recent movement of GAF fighter squadrons from Central Germany to the Western Front. The strategic mission of the GAF may be changing and more effort may be devoted to close support of ground forces. This emphasis on ground support, by which the GAF could avoid the aerial combat in which it has been outmatched, is a reasonable expectation.

19. Maintenance of the oil offensive will nevertheless accomplish the primary purpose for which it was begun: a reduction in the tactical and supply mobility of the German army such that, when mobile warfare is imposed, the enemy's fighting ability will be critically weakened. This was the case in France.

MLK/bg
14 November 1944
(60 copies)

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APPENDIX "A"

FUEL CONSUMPTION DATA

CURRENT OPERATIONAL & SEMI-OPERATIONAL A/C OF THE G.A.F.

Engine(s)	Aircraft	Remarks
BMW 003	He 280	Twin-unit jet. Aircraft believed still non-operational. Reports indicate fuel to be low grade motor gasoline, with probable fuel consumption similar to that of Me 262.
BMW 003	Ar 234	Twin-unit jet. Aircraft operational or approaching operational status. Reports indicate fuel is low grade motor gasoline, with probable fuel consumption similar to that of Me 262.
BMW 801-D	Fw 190	Single-engine. Most of these aircraft use this later model engine which requires C-3 100 octane gasoline. A number of these, however, have in recent months been observed to have been derated at Squadron echelon for employment of B-4 87 octane gasoline. Maximum fuel consumption at take-off is 120 gal. per hr., minimum 60 gal. per hr.
BMW 801	Do 217	Twin engine. Uses B-4 87 octane gasoline, with approximately same fuel consumption as above, per engine.
BMW 801	Ju 188	Twin engine. Uses B-4 87 octane gasoline, with approximately same fuel consumption per engine as single-engined Fw 190.
DB 601	Me 109 (older type)	Single engine. Uses B-4 87 octane gasoline. Maximum fuel consumption at Takeoff is 100 gal. per hr., minimum 45 gal. per hr.
DB 601	Do 215	Twin engine. Uses B-4 87 octane gasoline. Fuel consumption per engine same as above older type Me 109.
DB 603	Me 410	Twin engine. Uses B-4 87 octane gasoline. Maximum fuel consumption per engine at take-off is 125 gal. per hr. (The newer version of this unit, the DB 603-G, is designed for a 100-octane requirement, and this engine is growing more extensively used by operational aircraft.)
DB 603	He 219	Twin engine. Same as Me 410.
DB 603	Do 335	Twin engine. Believed same as Me 410.
DB 605	Me 109	Single-engine. Uses C-3 100 octane fuel. Maximum consumption at takeoff is 110 gal. per hr.; mean consumption 80 gal. per hr.

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Engine(s)	Aircraft	Remarks
DB 610	He 177	Two pairs of coupled 601-type engines. Uses B-4 87 octane gasoline. Maximum fuel consumption per pair of coupled engines is 200 gal. per hr. at take-off, minimum 90 gal. per hr.
Ju 004	Me 262	Twin-unit. No fuel specimens have been captured, but one crashed E/A yielded skin fragment bearing a painted yellow triangle on which was inscribed "Flugdiesel Triebstoff". Maximum fuel consumption per jet unit at maximum thrust at sea level is approximately 325 gal. per hr., or 650 gal. per hr. for each E/A of this type. Fuel consumption is reduced to about half this amount at 40,000 ft. There are well in excess of 200 of these aircraft.
Ju 207	Ju 88	Twin engine. Uses DK-1 aircraft diesel fuel. Mean consumption per engine is 35 gal. per engine.
Ju 211	Ju 88 (normal)	Twin engine. Uses B-4 87 octane gasoline. Maximum fuel consumption per engine at take-off is 95 gal. per hr., and minimum of 50 gal. per hr.
Ju 211	He 111	Twin engine. Uses B-4 87 octane gasoline. Consumption approximately same as Ju 88 (normal).
Ju 211	Ju 87	Single engine dive bomber now being introduced as a night fighter. Uses B-4 87 octane gasoline. Consumption approximately same as single engine of Ju 88 (normal).
Ju 213	Ju 88 (special)	Twin engine. Uses B-4 87 octane gasoline. Maximum fuel consumption per engine is 130 gal. per hr., minimum 45 gal. per hr.
Walter	Me 163	Single liquid rocket unit. Fuel is not oil product, but is hydrogen peroxide, using a potassium permanganate detonator.

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Appendix B

B-4 "BLUE" AVIATION GASOLINE
Specifications of Recent Samples

	SAMPLE AIR 362	SAMPLE AIR 683	SAMPLE AIR 365	SAMPLE AIR 377	SAMPLE AIR 389	SAMPLE AIR 399
Specific Gravity	0.7407	0.735	0.7408	0.7422	0.735	0.7576
Colour	Blue	Blue	Blue	Blue	Blue	Blue
Distillation: I.B.P.	45° C.	45° C.	44° C.	44° C.	45° C.	66° C.
Recovery @ 75°	22%	25%	22%	23%	23%	2½%
100°	54½%	55%	54½%	55%	55%	42½%
150°	96%	96%	96%	95%	(80%@140°C.)	93½%
F.B.P.	158°C.	159°C.	160° C.	165°C.	140°C.	162°C.
Residue	1%	1%	1%	1%	-	-
Freezing Point	Below-60°C.	Below-60°C.	Below-60°C.	-60°C.	-	-
Vapour Pressure (lb./sq. in.)	6.4	5.6	5.7	5.9	-	-
Gum Content (mg./100 ml.)	0.8	0.6	0.6	0.4	-	-
Sulphur Content	0.009%	0.003%	0.005%	0.004%	-	0.01%
Tetraethyllead (ml./I.Gal.)	5.51	5.45	5.52	5.44	Present	7.0
Octane Number	91	91	90½	91	-	88
Octane No. of Base Fuel	71	72	73	71	-	68
REMARKS:	Typical Blue; sample from Do217M with DB603 engines shot down 25 Feb.44	Sample from Ju88 Apr. 1944; lower aromatics than usual for Blue	Typical Blue; sample from Do217M with DB603 A-2 engines shot down 24 Feb.44	Typical Blue; from Ju88 A-4 with Jumo 211 J-1 engines shot down 19 Apr. 44.	From Denmark; sample very small but seems typical Blue, 1944.	Results of tests abnormal, although sample obtained 31 Jul. 44 probably weathered. In any case, the naphthene content of 62.2% is much higher than for Blue fuels previously reported. From Me 109 G-6 with DB 605 A engine.

APPENDIX C
C-3 GREEN GASOLINE
SPECIFICATIONS OF RECENT SAMPLES

	SAMPLE AIR 345	SAMPLE AIR 396
Specific Gravity	0.7748	0.7763
Colour	Green, cloudy	Green
Distillation: I.B.P.	52° C.	50° C.
Recovery @ 75°C	9%	9%
100°C.	39%	35%
150°C.	86%	85%
F.B.P.	175° C.	177° C.
Residue	2% (partly solid due presence rubber)	1%
Freezing Point	Bel.-60° C.	-
Vapour Pressure (lb./sq.in.)	2.3	-
Gum Content (mg./100 ml.)	2.78 (Rubbery matter)	1.4
Sulphur Content	0.02%	0.02%
Tetrathyllead (Ml./I.Gal.)	5.83	5.96
Octane Number (Octane No. of Base Fuel	(Not Determined due to rubber) 83½	95 82
REMARKS:	Sample was a weathered Green fuel; from Ju 188 E-1 with BMW 801 G-2 engines shot down 1 Nov. 43.	Sample generally similar to Green. Has higher lead and aromatics content than usual for this type. From jettisoned tank, Normandy, Summer 1944.

APPENDIX D
FLUGDIESEL TRIEBSTOFFE K-1
SPECIFICATIONS OF RECENT SAMPLES

	SAMPLE AIR 332	SAMPLE AIR 352	SAMPLE AIR 361	SAMPLE AIR 391
Specific Gravity	-	-	0.8165	0.870
Colour (N.P.A.)	-	-	-	1-1½
Distill: IBP-	-	-	152° C.	211°C.
FBP			354° C.	369°C.
Residue	-	-	1½%	1%
Flash Point (Closed)	-	-	-	208° F.
Pour Point	-	-	-55°C. (Cold Test	0°.F.
Sulphur Content	0.61%	0.55%	0.57%	0.08%
Ash	-	-	-	Trace
Carbon Residue	-	-	-	Trace
Diesel Index	60.5	60.2	-	47
Octane Number	57	58	-	47
REMARKS:	High sulphur precludes presence hydrog. brown coal distillate. It is probable blend of volatile Fischer-Tropsche oil and brown coal tar distillate. Anomolous characteristics do not indicate presence of petroleum in appreciable proportions.	Probably is equal proportions of Fischer-Tropsch oil and brown coal distillate; excellent quality suitable for low temperature high altitude performance.		Average ignition quality; probably of petroleum origin but may have some synthetic material. Tests differ from previous samples of K-1.