PROJECT TED No. PTR - 1107

REPORT OF COMPARATIVE COMBAT EVALUATION OF FOCKE-WULF 190-A/4 AIRPLANE

References: (a) BuAer Ltr., AER-E-11-JFS, dated 17 January 1944.
(b) BuAer Conf. Ltr., AER-E-11-JFS, C04181, dated 17 February 1944.
(c) BuAer Conf. Ltr., AER-E-11-JFS, C04990, dated 26 February 1944.

1. In accordance with the references, comparative combat evaluation tests of the FW-190-A/4 Airplane have been completed and are reported on herein. The comparisons were made with new production models of the F4U-1 and F6F-3 airplanes, loaded to gross weights of 11988 pounds and 12,406 pounds, respectively. The FW-190 was loaded to a gross weight of 8,690 pounds. The previous flight time of the FW-190 was unknown. All loads used were "standard overload fighter" weights, as indicated in enclosure (1).

2. Prior to the comparative tests the FW-190 was stripped and painted with standard smooth camouflage finish, and the pilots were familiarized with the airplane. Airspeed indicators in all three airplanes were calibrated and loads were checked.

3. The program for tests was essentially as outlined in reference (c), enclosure (2) being the schedule used. As suggested in reference (a), the data obtained was of a qualitative rather than a quantitative nature. Power settings used are included in enclosure (3). Results of the comparative tests are discussed below.

a. RATE OF CLIMB - Rates of climb were compared at rated powers for indicated airspeeds of 140, 160, 180 and 200 knots, at altitudes of 200, 5,000, 10,000, 15,000, 20,000, and 25,000 feet. The FW-190 and F4U-1 showed superiority in climb over the F6F-3 at all speeds and altitudes except at 140 knots below 15,000 feet, where the FW-190 and the F6F-3 were about equal.

At 140 knots the F4U-1 showed slight superiority over the FW-190 up to 20,000 feet. At 25,000 feet the two airplanes were about even.

At 160 knots the FW-190 showed superiority in climb over the F4U-1 at all altitudes, the greatest advantage being at about 15,000 feet.

At 180 knots the FW-190 showed marked superiority over the F4U-1 up to 10,000 feet, above which altitude its superiority decreased to only a slight advantage at 25,000 feet.

At 200 knots the FW-190 showed marked superiority over the F4U-1 up to 10,000 feet, above which altitude its advantage decreased to an equal rate of climb at 25,000 feet.

The best climbing speeds of the F4U-1, F6F-3, and FW-190 were found to be 135 knots, 130 knots, and 160 knots, respectively.

b. HORIZONTAL SPEEDS - Tests of horizontal speeds were made at altitudes of 200, 5,000, 10,000, 15,000, 20,000, and 25,000 feet. The speed runs were made at each altitude for periods of two minutes at full available power, the F4U-1 and F6F-3 using War Emergency Power. At all altitudes the F6F-3 was slower than the F4U-1. At 200 feet the F6F-3 was equal to the FW-190. Above that altitude the FW-190 showed an advantage over the F6F-3. At 200 feet the F4U-1 was twenty-five (25) knots faster than the FW-190, at 15,000 feet the speeds were equal, and at 25,000 feet the FW-190 was six (6) knots faster than the F4U-1. It should be noted that the runs were for only two minutes, during which time full speed was probably not developed, but which serve for the purpose of comparison. Sample speed figures for altitudes are as follows (True Airspeed):

Std. Alt.	FW-190	F4U-1	F6F-3
200 ft.	290 (334)	315 (363)	290 (334)
5,000 "	310 (357)	314 (362)	305 (351)
10,000 "	310 (357)	320 (369)	302 (348)
15,000 "	335 (386)	335 (386)	320 (369)
20,000 "	348 (401)	343 (395)	331 (381)
25,000 "	356 (410)	350 (403)	339 (391)

Knots (M.P.H.)

c. HORIZONTAL ACCELERATIONS - Tests of horizontal accelerations were made at altitudes of 200, 5,000, 10,000, 15,000, 20,000, and 25,000 feet, and for initial indicated airspeeds of 140, 160, 180 and 200 knots. Accelerations were determined by flying in line at the predetermined initial speed and applying full power simultaneously in all three airplanes. It should be noted that application of full power in the FW-190 was much easier than in the other airplanes due to the fact that it was necessary to use only the throttle control. Relative accelerations, for all speeds over 160 knots, showed both the F4U-1 and FW-190 to be slightly superior to the F6F-3, and showed the F4U-1 to be slightly superior to the FW-190 up to 15,000 feet, above which altitude the FW-190 had a slight advantage. At speeds less than 160 knots the F6F-3 and FW-190 were equal.

d. RATES OF ROLL - Results of comparative tests of rates of roll showed the FW-190 and the F4U-1 to be superior to the F6F-3. The FW-190 and F4U-1 were found to be about equal in rate of roll. It should be noted that the F4U-1 was equipped with mechanically linked boost tab ailerons. The FW-190 rolls with extreme ease, showing no excessive stick forces or tendencies to drop its nose.

e. TURNING CIRCLES - Results of comparative tests of turning characteristics showed the F4U-1 and F6F-3 to be far superior to the FW-190. Both the F6F and F4U could follow the FW-190 in turns with ease at any speed, but the FW-190 could not follow either of the other two airplanes. The FW-190, when in a tight turn to the left and near the stalling speed, exhibits a tendency to reverse aileron control and stall without warning. Similarly, when turning to the right it tends to drop the right wing and nose, diving as a result.

From a head-on meeting with the FW-190 both the F4U-1 and F6F-3 could be directly behind the FW-190 in one turn. From a position directly behind it was possible to turn inside the FW-190 and be directly behind again in about three turns.

f. MANEUVERABILITY - The F4U-1 and F6F-3 were found to be much more maneuverable than the FW-190. No maneuvers could be done in the FW-190 which could not be followed by both the F4U-1 and F6F-3.

It was found that the FW-190 requires a much greater radius in which to loop than do either the F4U-1 or F6F-3, and tends to stall sharply when trying to follow the F4U-1 or F6F-3 in a loop.

In zooms after dives the FW-190, F4U-1 and F6F-3 were found to be about equal.

The FW-190 stalls with very little warning, but recovers easily.

Formation flying was extremely difficult with the FW-190 because of the lack of fine power plant control.

g. STABILITY AND CONTROLABILITY IN DIVES - In general, stability and controlability of the FW-190 in dives were satisfactory. However, at diving speeds above 350 knots, indicated, vibrations were felt and control forces became noticeable. In no case did control forces become objectionable. Diving restrictions indicated by a captured document, and as posted on the airspeed indicator in the airplane, were as follows:

466 m.p.h. (ind.)	below 10,000 feet
426 m.p.h. (ind.)	10,000 feet to 16,500 feet
360 m.p.h. (ind.)	16,500 feet to 25,000 feet

The above mentioned vibrations and control forces were noted when these restrictions were exceeded.

h. CONTROL FORCES AND REVERSAL POINTS - The control forces in the FW-190 were generally extremely light. Slight stabilizer trim adjustments were required with changes in speed. The only trim controllable in flight is a moveable horizontal stabilizer. No controllable trim tabs are provided. However, the FW-190 does not have objectionable characteristics without them. Control forces became noticeable, but not objectionable at high speeds. The only reversal was found to be an aileron reversal in a tight turn to the left.

i. ANGLES OF VISION - Forward vision from the FW-190 is blanked off to some extent, due to the fact that the cockpit greenhouse rises only about six inches above the cowling contour. Forward vision from the F4U-1 and F6F-3 is considered to be better than from the FW-190

In the FW-190 the pilot sits rather low with respect to the wing, but the downward vision blanked out by the small wing is not excessive. Downward vision from the FW-190, F4U-1 and F6F-3 is con-

sidered to be about the same.

The molded canopy of the FW-190 allows good rear vision. There was no rear-view mirror in the FW-190 tested, but it was felt that one would be desireable. Rear vision from the FW-190 was considered, however, to be better than from the F4U-1 or F6F-3.

There was no gun-sight mounted in the FW-190 tested and its effect on vision is unknown.

j. GENERAL CHARACTERISTICS IN MOCK COMBAT - The FW-190 is a very simple airplane to fly in combat, and seems to be designed for pilot convenience. It has a no-warning stall which tends to reduce its efficiency in combat against airplanes which can force it to fly near the stalling speed. In general it is considered to be an excellent interceptor-type airplane which is at a disadvantage against airplanes designed for the purpose of "in-fighting". Below are discussed some of the salient features of the FW-190.

One throttle lever controls propellor pitch, manifold pressure, mixture, magneto timing, and throttle setting, making operation comparatively simple.

Propellor pitch can be controlled manually by means of a button on the throttle lever. Mixture changes automatically at 2100 r.p.m.

Stabilizer trim, flaps, and landing gear are controlled electrically by conveniently placed push-buttons.

The pilot sits with his legs extended forward and high. This position is excellent from the standpoint of resisting blackout.

The cockpit is rather cramped in comparison with the F4U-1 and F6F-3. Otherwise it is extremely simple and convenient.

Blower changes automatically at 10,000 feet.

k. GENERAL OPINION OF PILOTS AS TO RELATIVE MERTIS OF FW-190, F4U-1, AND F6F-3.

The general opinion of the pilots who made the comparative tests is that the FW-190 is an extremely simple airplane to fly and is designed for pilot convenience, but is not equal to the F4U-1 or F6F-3 in combat. The simplicity of the cockpit in the FW-190 was in contrast to the cockpits in the F4U-1 and F6F-3. However, it is felt that although more automatic features are provided in the FW-190, less direct control over variable settings is provided and the pilot has, as a result, less actual control over the engine performance. All the pilots agreed that the F4U-1 and F6F-3 would be preferred in actual combat operations.

l. SUGGESTED TACTICS TO BE USED AGAINST THE FW-190 BY THE F4U-1 AND F6F-3.

In view of the fact that the FW-190 can outrun the F4U-1 and F6F-3 in a 160 knot, or faster climb, the best solution in offense is for the F4U-1 and F6F-3 to get the FW-190 to close with them so that

advantage can be taken of their superior maneuverability, provided, of course, that any initial advantage in altitude is not sacrificed merely for the sake of closing. When being attacked from astern, the FW-190 can be expected to roll and dive out from the attack.

If attacked by the FW-190, the F4U-1 and F6F-3 can evade by the use of tight turns. When followed by the FW-190 the F4U and F6F can evade by the use of tight loops. If the FW-190 attempts to follow the other airplanes in tight loops it stalls out.

In general, whenever the hit-and-run technique cannot be employed, the F4U and F6F should make every effort to close with the FW-190, in both offense and defense.

4. In order to evaluate properly the results of the comparative tests herein reported the following items should be noted:

The FW-190-A/4 tested had been employed by the Germans as a converted fighter-bomber, and was not the standard fighter version of the FW-190. In order to have the airplane at the standard fighter weight for the type it was necessary to ballast with lead weights. The standard useful load and fighter gross weight information used was obtained from a captured handbook for the type.

On three attempts to reach service ceiling with the FW-190 all power was lost abruptly at about 33,000 feet. The cause was unknown.

The F4U used was overheating at high power output throughout the tests. This was attributed to a too lean mixture.

The F4U-1 used was equipped with the factory installed propellor with type 6525-21 blade. Installation of the F6F type propellor with 6501A-0 blades, as it is understood is being installed at modification centers, would improve the comparative performance of the F4U-1 over that which was obtained in these tests.

Some rough running was experienced with the FW-190 which was apparently caused by fouling of the spark plugs at low R.P.M.

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Encls:
(1) Loading Schedule For Comparative Test (1 page).
(2) Program of Comparative Tests (2 pages).
(3) Power Settings for Comparative Tests (1 page).

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Loading Schedule For Comparative Test

FW-190-A/4 CEE #2900

Basic Weight	6716.5 pounds
Fuel - 140 gallons	840
Oil - 11 gallons	81.5
Armament -	
2 MG 151/20	196
Ammo. 2 x 250 rnds.	250
2 MG 17/7.9	56
Ammo. 2 x 900 rnds	256
Pilot & Chute	200
Radio -	
Our installation	90
Estimated remains old installation	20
Oxygen -	
Our installation	19
Enemy equipment removed	-35
TOTAL AS FLOWN	8690 pounds

F4U-1 #49832

Basic Weight	9196.9 pounds
Fuel - Main tank, 230 gallons	1380
Oil - 20 gallons	150
Armament	
6 .50 cal. guns	356.1
Ammo. - 2350 rnds	705
Pilot & chute	200
TOTAL AS FLOWN	11988 pounds

F6F-3 #42150

Basic Weight -	9509.9
Fuel - 250 gallons	1500
Oil - 16 gallons	120
Armament	
6 .50 cal. guns	356.1
Ammo. 2400 rnds	720
Pilot & chute	200
TOTAL AS FLOWN	12406 pounds

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Enclosure (1)

One of One.

PROGRAM OF COMPARATIVE TESTS - FW-190-A/4

At 200 ft. ALTITUDE: -

1. Acceleration to Vmax from 200 knots, IAS.
2. Two-minute full power Vmax.
3. One-minute climb at 140, 160, 180, 200 knots, IAS.

At 5,000 ft. ALTITUDE: -

1. Acceleration to Vmax from 180 knots, IAS.
2. Two-minute full power Vmax.
3. One-minute climb at 140, 160, 180, 200 knots, IAS.
4. Push-over dive to 1,000 feet.

At 10,000 ft. ALTITUDE: -

1. Acceleration to Vmax from 160 knots, IAS.
2. Two minute full power Vmax.
3. One-minute climb at 140, 160, 180, 200 knots, IAS.
4. Push-over dive to 5,000 feet.
5. Rolls - low and high speed - level, climbing, and diving.
6. Turns at 140, 160, 180, 200 knots - same and opposite course.
7. Check control forces in 4, 5, 6, above.
8. Mock combat, maneuverability.

At 15,000 ft. ALTITUDE: -

1. Acceleration to Vmax from 140 knots, IAS.
2. Two-minute full power Vmax.
3. One-minute climb at 140, 160, 180, 200 knots, IAS.
4. Turns at low and high speeds, same and opposite course.

At 20,000 ft. ALTITUDE: -

1. Acceleration to Vmax from 140 knots, IAS.
2. Two-minute full power Vmax.
3. One-minute climb at 140, 160, 180, 200 knots, IAS.

At 25,000 ft. ALTITUDE: -

1. Acceleration to Vmax from 140 knots, IAS.
2. Two-minute full power Vmax.
3. One-minute climb at 140, 160, 180, 200 knots, IAS.

GENERAL: -

1. Vision from FW-190.
2. General characteristics, and pilot's opinions on relative merits of FW-190, F4U, and F6F.

POWER SETTINGS FOR COMPARATIVE TESTS

		(Ata.)	MP	(Water Inject)	RPM
FW-190-A/4					
	Take-off & Vmax only	(1.42)	42.4"		2700
	Climb and Combat	(1.35)	40.4"		2450
F4U-1					
	Take-off & Vmax only	Neut.	53.0"	(57.5)	2700
	(water injection for Vmax	Low	54.5"	(59.0)	2700
		High	51.5"	(59.5)	2700
	Climb and Combat				
		Neut.	43.5"		2550
		Low	47.5"		2550
		High	48.0"		2550
F6F-3					
	Take-off & Vmax only	Neut.	54.0"	(60.0)	2700
		Low	56.0	(60.0)	2700
	(water injection for Vmax)	High	54.0	(60.0)	2700
	Climb and Combat	Neut.	46.0"		2550
		Low	51.0"		2550
		High	50.5"		2550