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FLIGHT TEST
U. S. NAVAL AIR STATION
PATUXENT RIVER, MD.

FINAL FLIGHT REPORT

of

PRODUCTION INSPECTION TRIALS
(TED NO. BIS 2116)

on

MODEL F6F-3 AIRPLANE NO. 25892
(Contract NOa(s) 90071)

held

1 JUNE 1943 to 17 SEPTEMBER 1944

by

FLIGHT TEST

for

BOARD OF INSPECTION AND SURVEY

at

U. S. NAVAL AIR STATION
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BIS 2116 - F6F-3 No. 25892
3/4 Right Front View

Photo PTR 13647
9-28-44

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OFFICIAL NAVY PHOTOGRAPH
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REFERENCES

(a) BuAer conf. ltr. Aer-E-211-JCM C12494 dated 26 Jan 1944.
(b) BuSandA NOa(s) 90071 of 23 May 1942.
(c) BuSandA NOa(s) 88263 of 30 June 1941.
(d) BuAer conf. ltr. Aer-E-211-JCM C22554 dated 21 Aug 1944.
(e) BuSandA Change Order NOa(s) 90071 (SPM6), dated 29 Dec 1942.
(f) SD-286-1A, Detail Specification for model F6F-3 airplane, dated 8 Aug 1941.
(g) Power Curves for model R-2800-10 Engines, AEL Proj. 3911 Naval Aircraft Factory.
(h) NAS conf. ltr. NA83 VF6F-3 BIS 2116 (FT) (44056) dated 7 Apr 1944.
(i) FT Memo. NA83 VF6F-3 (FT) (44017), for VF Design Desk, dated 14 Feb 1944.
(j) BuAer conf. ltr. Aer-E-211-RJ C-90071 C11926, dated 8 Jun 1943.
(k) BuAer conf. ltr. Aer-E-211-RJ C-90071 C14761, dated 13 Jul 1943.
(l) FT Memo. NA83 VF6F-3 for VF Design Desk, dated 29 Jul 1943.
(m) FT Memo. NA83 VF6F-3 for VF Design Desk, dated 25 Aug 1943.
(n) BuAer conf. ltr. Aer-E-211-RJ C-90071 C17360, dated 13 Aug 1943.
(o) FT Memo. NA83 VF6F-3 (FT) (44) for VF Design Desk, dated 30 Aug 1943.
(p) NAS, Patuxent River ltr. NA83, VF6F-3 (FT) (88) dated 1 Feb 1944.

INTRODUCTION - Paragraph (1) of reference (a) stated that model F6F-3, airplane No. 25892 was to be used for purposes of conducting production inspection trials. Paragraph (2) of reference (a) authorized the substitution of additional aircraft, procured under reference (b), in place of F6F-3 airplane No. 25892 for purposes of facilitating the conduct of these trials. In view of this, the performance and flight characteristics of the subject airplane as submitted in this report are, in reality, a summary of test results obtained on various representative model F6F-3 airplanes, including the model XF6F-3 airplane No. 02982, procured under reference (c). Reference (d) recommended that performance of the F6F-3 be based on that obtained on the XF6F-3 provided the Board of Inspection and Survey considered the data directly applicable. Except for minor changes, the XF6F-3 airplane was identical to the production airplanes of reference (b) as modified by reference (e).

The model F6F-3 airplane was designed and constructed by the Grumman Aircraft Engineering Corporation, Bethpage, New York, in general accordance with reference (f), and is a single-engine, single-place, landplane fighter for use aboard aircraft carriers. The airplane is equipped with a Pratt and Whitney model R-2800-10 two-stage supercharged engine and a Hamilton Standard, constant-speed, three-blade propeller of 13'1" diameter, blade design No. 6501A-0, in lieu of the Government furnished XR-2600-16 engine and Curtiss Electric propeller originally specified.

Prior to flight testing the model XF6F-3 airplane, minor modifications were incorporated which included removal of the propeller spinner, installation of streamline gun blast tube fairings, installation of new type landing gear fairings, and painting the airplane with non-specular paint. Enclosed photographs of model F6F-3 airplane No. 25892 are representative of the external configuration of the model XF6F-3 airplane No. 02982, except that the gun blast tube fairings have been removed and a bomb rack installed on the lower right wing panel-inboard.

PURPOSE OF TESTS - The purpose of the tests conducted by Flight Test on the model F6F-3 airplane in accordance with reference (a) was to determine the following:

(a) Performance and flight characteristics.
(b) General suitability for service use as a fighter airplane.

METHOD OF TEST - Engine powers developed during the subject trials were based on AEL Power Curves, contained in reference (g), for the Pratt and Whitney R-2800-10 engine.

The loading condition of model XF6F-3 airplane No. 02982 when flown during these trials is summarized as follows:

Weight and Balance Summary

Loading	"Normal" Fighter	"Overload" Fighter
Par. from Detail Spec.....	104a	104c
Gross wt.-lbs.....	11,364	12,153
Useful load-lbs.....	2,463	3,252
Useful load-% gross wt.....	21.7	26.8
Weight empty-lbs.....	8,901	8,901
Wing loading-lbs. per sq. ft.....	34.0	36.4
Take-off power loading-lbs per BHP	5.7	6.1
Center of gravity location-% MAC:		
Wheels up.....	25.6	26.1
Wheels down.....	23.3	23.8
Detailed useful load:		
Pilot-lbs.....	200	200
Fuel:		
Main-gal.....	107	175
Reserve-gal.....	75	75
Oil-gal.....	13	16
Trapped fuel and oil-lbs.....	92.5	92.5
Fixed wing guns installation-lbs.....	401.7 (6-50 cal.)	401.7 (6-50 cal.)
.50 cal. ammun.-rds.....	1200	2400
Gun sight-lbs.....	5.6	5.6
Navigating equip-lbs.....	3.3	3.3
Oxygen equip.-lbs.....	27.5	27.5
Pyrotechnics-lbs.....	11.8	11.8
Gun camera-lbs.....	4.2	4.2
Life raft (seat type) lbs....	14.	14.
Radio-lbs.....	145.5	145.5
Emergency equip-lbs.....	8.7	8.7

RESULTS OF TEST

A. Performance (as a "normal" loaded fighter) - Comparative military power performance figures on model F6F-3 airplane No. 04934 were obtained from reference (h), a report on flight test of water injection equipment.

Airplane Number	02982	02982	04934
Gross Weight	11,364	11,364	11,573
Power	Normal	Military	Military
1. Maximum Speed (high blower):			
Brake horsepower.....	1550	1650	1650
Airplane critical alt.-ft.	23,700	22,300	22,300
Maximum speed at ACA-MPH..	373.5	377.5	377.5
2. Service Ceiling-ft.....	38,400	38,900	37,800
3. Maximum rate of climb at sea level - FPM.....	2500	3120	3070

Airplane Number	02982
Gross Weight	11,364
4. Stalling speed at sea level:	
Clean condition-power on-MPH...	91.5
Clean condition-power off-MPH..	93.5
Landing condition-power on-MPH.	76.0
Landing condition-power off-MPH	80.0

Airplane Number	02982	02982	04934
Gross Weight	11,364	12,153	11,573
5. Take-off data:(Full flap)			
Distance in no wind-ft...	565	655	605
Distance in 25 knot wind-ft.....	255	310	270
Take-off speed - MPH.....	83.0	85.5	81.5

B. Flight Characteristics

Longitudinal stability of the airplane loaded either as a normal or overload fighter was found to be positive in all flight conditions except the high power climb in the landing condition where stability became neutral to slightly negative. Elevator control forces were normal.

Lateral stability was positive in all conditions. Aileron control was found to be adequate but control forces fairly high.

Directional stability was positive in all conditions. Rudder control was considered adequate but marginal in high power climbs at low speeds. Rudder trim effectiveness was not sufficient to trim in the high power climb.

Stalling characteristics were found to be good in both the clean and landing conditions, with and without power. There was ample evidence of the approaching stall in the form of buffeting and stick displacement. Rolling tendencies after the stall were mild.

All maneuvers expected of the type, except spins were satisfactorily performed during the trials. However, no unusual tendencies to enter unintentional spins were observed.

C. Miscellaneous Tests

1. Reference (i) is a preliminary report on take-off tests on the F6F-3, airplane No. 25892, using "JATO" units manufactured by the Aero Jet Engineering Co., Pasadena, Calif. The jet installation consisted of two units, each delivering a 1000 lb. thrust of 8 seconds duration. The results of these tests are briefly summarized in the following table:

Loading	"Overload" Fighter	1-1000-lb. Bomb	2-1000-lb. Bomb	2-1000-lb. Bombs & 150 gal. Drop Tank
Gross weight-lbs.	12,234	13,269	14,298	15,285
Take-off speed-MPH.....	82.5	90.5	95.0	98.0
Take-off distance in zero wind,ft.	455	585	660	760
Take-off distance in 25-knot wind, ft.....	205	290	340	400

The reduction in take-off distance in a 25 knot wind obtained by using the jet units is considerable. Based on previous tests of model F6F-3 airplanes without jet units the percent reduction is as follows: overload fighter, 35.9%; 1-1000 lb. bomb, 36.3%; 2-1000 lb. bombs, 46.9%; 2-1000 lb. bombs and

150 gal. drop tank, 49.1%.

2. Reference (j) stated that the contractor was modifying the droppable fuel tank provisions on one F6F-3 to provide for an alternative installation of either a 1000 lb. AN-M65 bomb or MK 13-2 torpedo. Reference (j) also requested flight and take-off performance characteristics with these alternative loadings. In compliance with this request, the following data are submitted on model F6F-3 airplane No. 09039, in the overload fighter condition.

Take-off data - Full flap (1000-lb. bomb or torpedo installed on airplane centerline)

(a) Loading

	1-1000-lb. Bomb	Torpedo
Gross weight - lbs.....	13,198	14,001
Take-off speed, MPH.....	89.5	94.0
Take-off distance, zero wind-ft.....	925	1140
Take-off distance, 25 knot wind - ft.....	450	580

(b) Stalling Speeds at Sea Level:

Condition	Clean	1-1000-lb. Bomb	Torpedo
Gross weight.....	12,198	13,198	14,001
Center of gravity locations:			
Landing gear extended.	24.3	---	25
Landing gear retracted	26.5	---	26.8
Stalling Speeds:			
Clean condition-power on-MPH.....	98.0	102.0	104.5
Clean condition-power off-MPH.....	101.3	104.0	109.5
Landing condition-power on-MPH.....	80.4	84.5	87.0
Landing condition-power off-MPH.....	84.9	88.0	91.0

3. Reference (k) requested trials, as outlined in reference (j), be extended to include similar additional tests using the model F6F-3 airplane No. 25890, provided with an off center bomb rack (1-1000-lb.) which permitted the droppable fuel tank to be carried simultaneously. Reference (1) is a preliminary report on the brief stability, control and performance tests conducted on this airplane; however, only the performance data have been summarized and resubmitted in this report:

(a) Take-off Distances:

	Bomb Only GR.WT.=13,151	Bomb + 150 gal. Tank GR.WT. = 14,155
Take-off speed, MPH....	89.5	95.0
Take-off distance in zero wind, ft.....	890	1230
Take-off distance in a 25 knot wind, ft.....	435	630

(b) Stalling Speeds at sea level:

	Bomb Only GR. WT. = 13,151	Bomb + Tank GR.WT. = 14,155
Clean condition-power on-MPH.....	101.5	106.0
Clean condition-power off-MPH.....	106.0	110.0
Landing condition-power on-MPH.....	81.5	83.0
Landing condition-power off-MPH.....	88.0	92.0

4. Reference (k) also requested the differential in stalling speeds between airplanes equipped and not equipped with blast tube fairings. These data were previously reported in reference (m), and are summarized below:

Stalling Speeds at Sea Level:

Condition	Fairings No. 07746 GR.WT.= 12,225 lbs.	No Fairings No. 25890 GR.WT. = 12,151 lbs.	Differential
Clean condition-power on-MPH.....	96.0	101.5	+ 4.5
Clean condition-power off-MPH.....	98.5	103.0	+ 4.5

Landing condition-power on-MPH.....	77.0	82.0	+ 5.0
Landing condition-power off-MPH.....	83.5	85.5	+ 2.0

5. Flight tests, including performance, flight and take-off characteristics, with various combinations of bombs, with and without the droppable fuel tank were requested in reference (n) on the F6F-3 airplane No. 25890. Reference (o) is a preliminary report on this request and is the source from which the performance data, summarized below, was taken. The F6F-3 used during the tests had provisions for two off center bomb rack installations capable of carrying 2-1000-lb. 2-500-lbs., or 2-1000-lb. bombs in addition to the droppable fuel tank.

(a) Stalling speeds for various loading conditions were determined as indicated:

	2-1000-lb. Bombs GR.WT. = 14,211	2-1000-lb Bombs & Tank GR.WT. = 15,237
Clean condition-power on-MPH.	107.0	113.0
Clean condition-power off-MPH.....	111.0	115.0
Landing condition-power on-MPH	88.5	90.0
Landing condition-power off-MPH.....	93.5	95.0

(b) Take-off Data:

	2-1000-lb. Bombs GR.WT. = 14,211	2-1000-lb. Bombs + Tank GR.WT. - 15,237
Take-off speed, MPH.....	95.0	98.0
Take-off distance in zero wind, ft.....	1250	1495
Take-off distance in 25 knot wind, ft.....	640	785

Enclosure (2) contains a cruising chart for model F6F-3 airplanes based on the results of Miscellaneous Tests Nos. 1 and 5.

6. Rates of roll were measured under various operating conditions, with the following representative values:

* 90° Roll

Condition	IAS -KTS	Rate of Roll Degrees Per Second Left	Right	Stick Force - Full Deflection - lbs. Left	Right
Landing	90	21.5	30	10	17
Clean	150	45.0	45.0	14	19
Clean	200	45.0	53.0	25	28
Clean	250	47.5	45.0	--	--

* Note: TIMES were measured from the instant the ailerons were deflected in level flight to the time when the airplane had rolled 90°. The rates given thus are average for a 90° roll and include the effect of starting.

** Maximum Rate of Roll

Condition	IAS -KTS	TAS - MPH	Degrees Timed	Rate of Roll Degrees Per Second Left	Right	Pb/2V Left	Pb/2V Right
Landing	90	132.8	90	28	36	.054	.07
Clean	150	221	90	45	56	.051	.064
Clean	200	292	270	69	67	.060	.058
Clean	250	361	270	64	69	.045	.049

** Note: The rates of roll represent approximately the steady rate of roll at full aileron deflection and do not include the effect of starting and stopping the roll. The expression Pb/2V is a measure of aileron effectiveness where P is the rate of roll-radians/sec., b the span-feet, and V the true airspeed-feet/sec.

7. Evaluation of the fuel pressure using unheated fuel was made during a normal power climb from 7,000 feet to 30,000 feet altitude. At commencement of the climb, the tank pressurizing system and auxiliary fuel pump were off. Observed data during the climb and other pertinent information are summarized below:

ALT. Feet	OAT °C	CAT °C	MAP "Hg.	IAS Knots	CYL. HEAD °C	OIL °C	Fuel Pressure PSI
7,000	8.5	28	40	140	230	88	16
10,000	7.5	34	48	140	250	95	17
14,500	.5	32	51.0	140	230	95	14-16 (fuel pressure fluctuating; auxiliary fuel pump turned "on", resulting in fuel pressure increase to a steady 20 psi; oil and cowl flaps "closed".)
18,000	-5.5	28	44	140	230	95	20
21,000	-12.5	31	48	140	220	91	19
24,000	-17.5	29	44	140	230	90	18-19 (Fuel pressure fluctuating.)
26,000	-21.5	27	41	135	230	90	18-19
27,000	-24.5	24	37	135	230	91	20 (fuel tank pressurizing valve "on", resulting in fuel pressure increase to steady 20 psi.)

29,000 - Feet altitude - pressurizing valve turned "off"; fuel pressure was then 18-19 psi fluctuating.

30,000 - Feet altitude - pressurizing valve again turned "on"; auxiliary fuel pump turned "off", with fuel pressure then remaining steady at 17 psi. With pressurizing system and auxiliary fuel pump switched "off", the fuel pressure dropped to 8-9 psi fluctuating. The climb was terminated at this altitude because of the engine cutting-out due to faulty ignition - magnetos not pressurized.

From these data, it is apparent that the fuel pressurizing system adequately maintains the required pressure at high altitudes except in the vicinity of the high and low blower criticals where auxiliary fuel pump boost is needed because of the greater power output. However, the pressure boost by the auxiliary pump, as is, is excessive (20 psi) and would seemingly indicate that the desirable auxiliary fuel pump be controlled by a three-position switch; a "boost" position for use in conjunction with the pressurizing system; an "emergency" position in the event of complete failure of the engine driven fuel pump or the pressurizing system or both; and an "off" position.

8. Carbon monoxide concentrations measured on airplane No. 25892 for various flight conditions are summarized below. Excessive contamination was present during a military power, level speed run where it amounted to .012%.

Carbon monoxide enters the cockpit from the lower rear and is diulted sufficiently at the knee and nose level to be within acceptable limits. The above excessive reading was reduced to an acceptable amount by sealing the places of entrance in the cockpit after bulkhead. It is to be noted that this particular airplane has been flown considerably and would conceivably have a greater cockpit carbon monoxide contamination because of service deterioration than a relatively new one.

Flight Condition	IAS -KTS	RPM	MAP "Hg.	Carbon Monoxide Percentage Concentration At Nose	At Knee	Diluter-Demand Oxygen Inlet
Climb	145	2550	45	.004	.004	.007
Climb	130	2700	40	.002	.002	---
Climb	145	2700	53	.002	.001	.004
Level	250	2700	53	.006	.004	.012

9. Figure (4) of Performance Characteristics is a curve showing angle of climb and dive versus true airspeed as obtained on F6F-3, airplane No. 25892. Both climbs and dives were made with the airplane in the clean condition, with the engine operated at 2700 RPM and 53.5" Hg. manifold pressure, delieverying approximately 1735 horsepower.

10. Temperature surveys were conducted on the model XF6F-3 airplane and results forwarded to the Bureau of Aeronautics by reference (p). Engine cooling characteristics were found to be generally satisfactory except that excessive "oil-in" temperatures were encountered, that temperature being 14°C over the limit in a military power climb.

11. Considerable difficulty was experienced with the engine cutting out when throttled down from either normal or military power in high blower. As the manifold pressure was reduced at constant RPM, engine surging and intermittent cutting out took place when the manifold pressure reached a critical value, (32 inches Hg. at 24,000 feet altitude) the engine cutting out completely as the manifold pressure was reduced further. It was found that satisfactory engine operation could be restored either by reducing the RPM or changing to alternate air without lowering the RPM. The critical manifold pressure at which this condition started was found to be a function of RPM, altitude, outside air temperature and also air speed to a minor degree. Increased air temperatures seemed to lower the critical manifold pressur whereas higher RPM, altitude, and greater airspeeds caused the surging to start at higher manifold pressures.

CONCLUSIONS - The model F6F-3 airplane was found to be satisfactory for service use as a fighter airplane except for defects noted under Recommendations.

RECOMMENDATIONS - 1. As a result of the trials, changes in the model F6F-3 airplane are recommended and summarized below with responsibility for incorporation indicated as follows:

C - Contractor responsibility
G - Government responsibility

(a) Necessary changes, considered essential to obtain a satisfactory combat aircraft. These changes should be incorporated on delivered aircraft as soon as practicable.

1. Provide satisfactory oil cooling. - C

2. Investigate rough and irregular engine operation. - C

3. Improve engine cowl flap operation so that port and starboard sections operate together. - C

4. Reduce excessive change in directional trim with change in speed and/or power. - C

(b) Desirable changes which will enhance the aircraft's efficiency. These changes should be incorporated when practicable and should be considered for any redesign or future construction.

1. Replace separate oil temperature, oil pressure, and fuel pressure gauges with single engine unit gauges. - C

2. Provide flap position indicator for oil and intercooler flaps. - C

3. Provide auxiliary fuel pump controlled by a three-position switch: "BOOST" - "EMERGENCY" - "OFF". - C

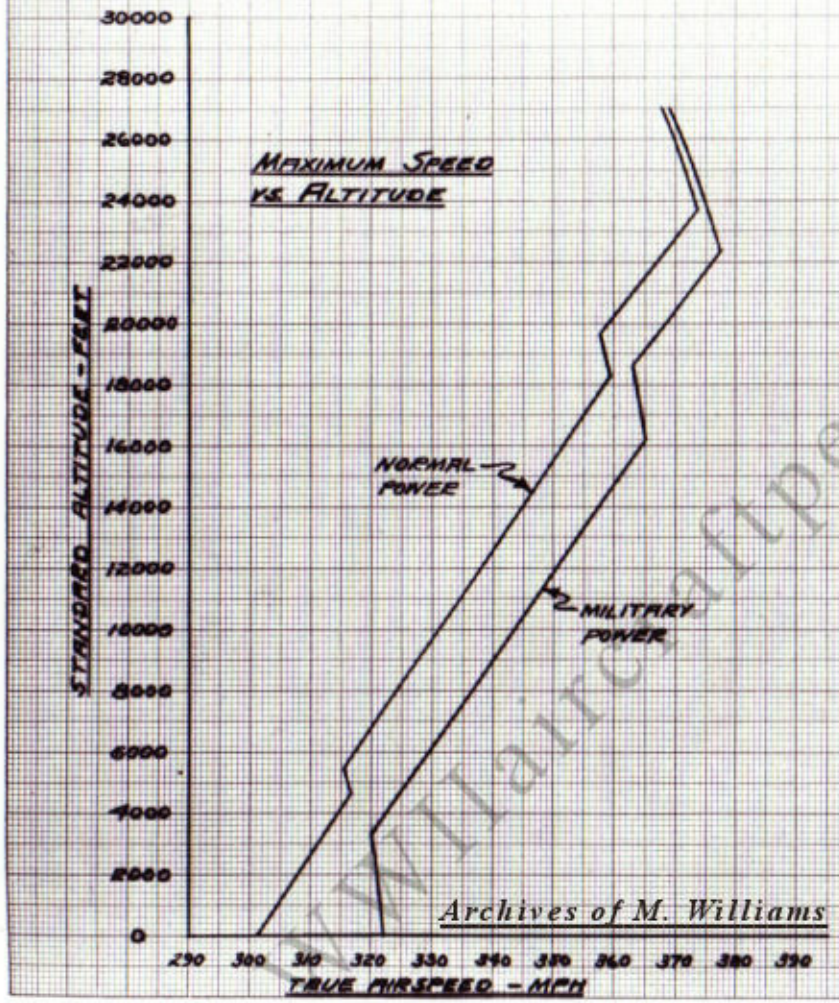
4. Improve aileron effectiveness so as to increase rate of roll. Paragraph (F-8) of Navy Aeronautical Specification SR-119 requires that lateral control be sufficient to give a wing-tip helix angle equal to or greater than 0.08. Paragraph (6) of Miscellaneous Tests, a part of this report, shows that the maximum Pb/2V obtained on model F6F-3 airplane number 25892 was 0.07. - C

5. Reduce objectionable cockpit noise. - C

Encl: (HW)
1. Five (5) Performance Curves, photo PTR 1262, 1263, 1264, 14042, and PTXT 234.
2. Twenty-four (24) Photographs, photo PTR 13655, 13648, 13646, 13652, 13651, 13654, 13653, 13650, 13644, 13645, 12932, 12931, 12930, 12926, 12925, 12924, 12923, 12928, 12927, 13395, 13391, 13392, 12929, 12933.

MODEL XF6F-3, AIRPLANE No. 02982
PERFORMANCE CHARACTERISTICS
Normal Fighter, Gross Weight = 11,364 Lbs.

PHOTO FTR 1262
REC. 11-23-43



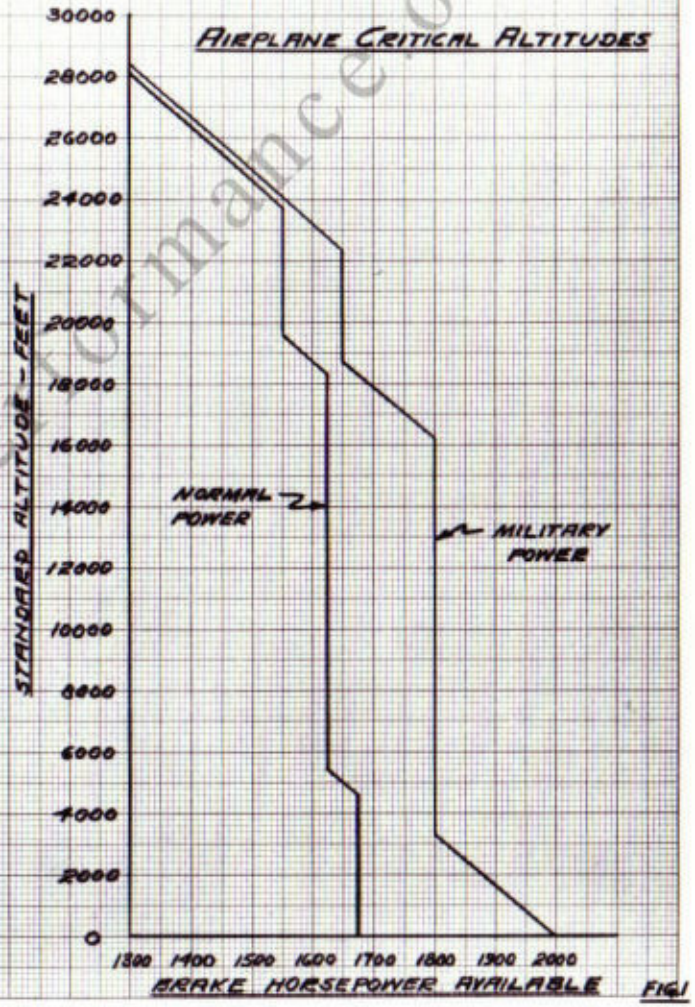
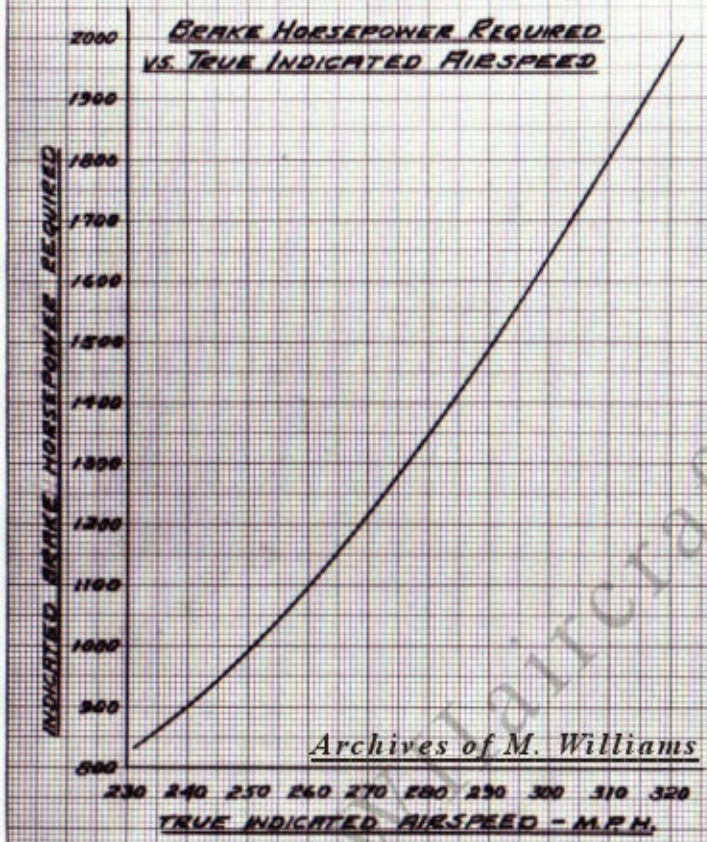


FIG 1

PHOTO FTR 1263
R.E.B. 11-23-43

MODEL XF6F-3, AIRPLANE No. 02982
PERFORMANCE CHARACTERISTICS
NORMAL FIGHTER, GROSS WEIGHT = 11,364 LBS.



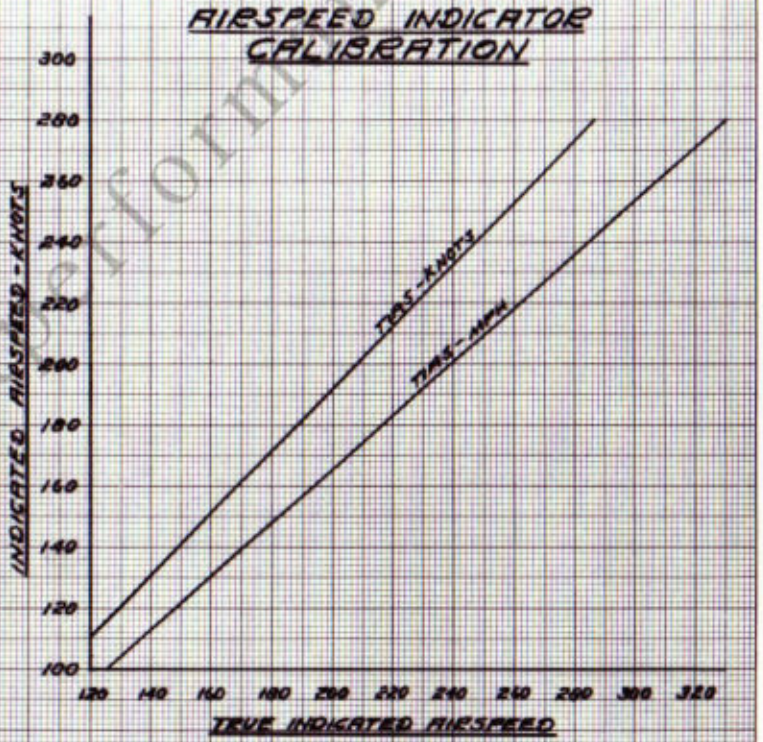


FIG. 2

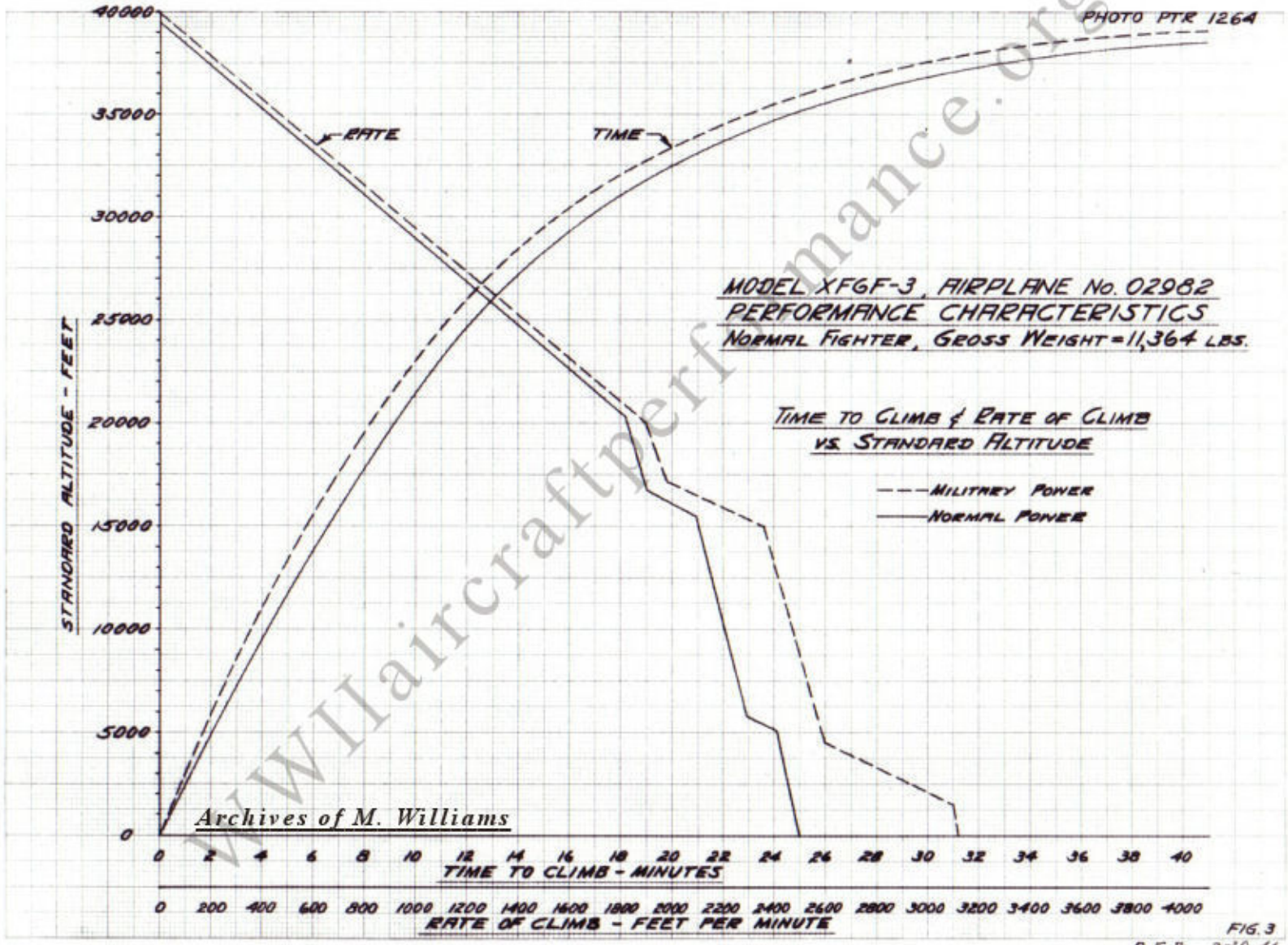


FIG. 3
P.E.B. 3-20-44

PHOTO PTR 14042

MODEL F6F-3, AIRPLANE NO. 25892
PERFORMANCE CHARACTERISTICS
OVERLOAD FIGHTER GROSS WEIGHT = 12,267 LBS.

1735 BRAKE HORSEPOWER - 10,000 FT DENSITY ALTITUDE

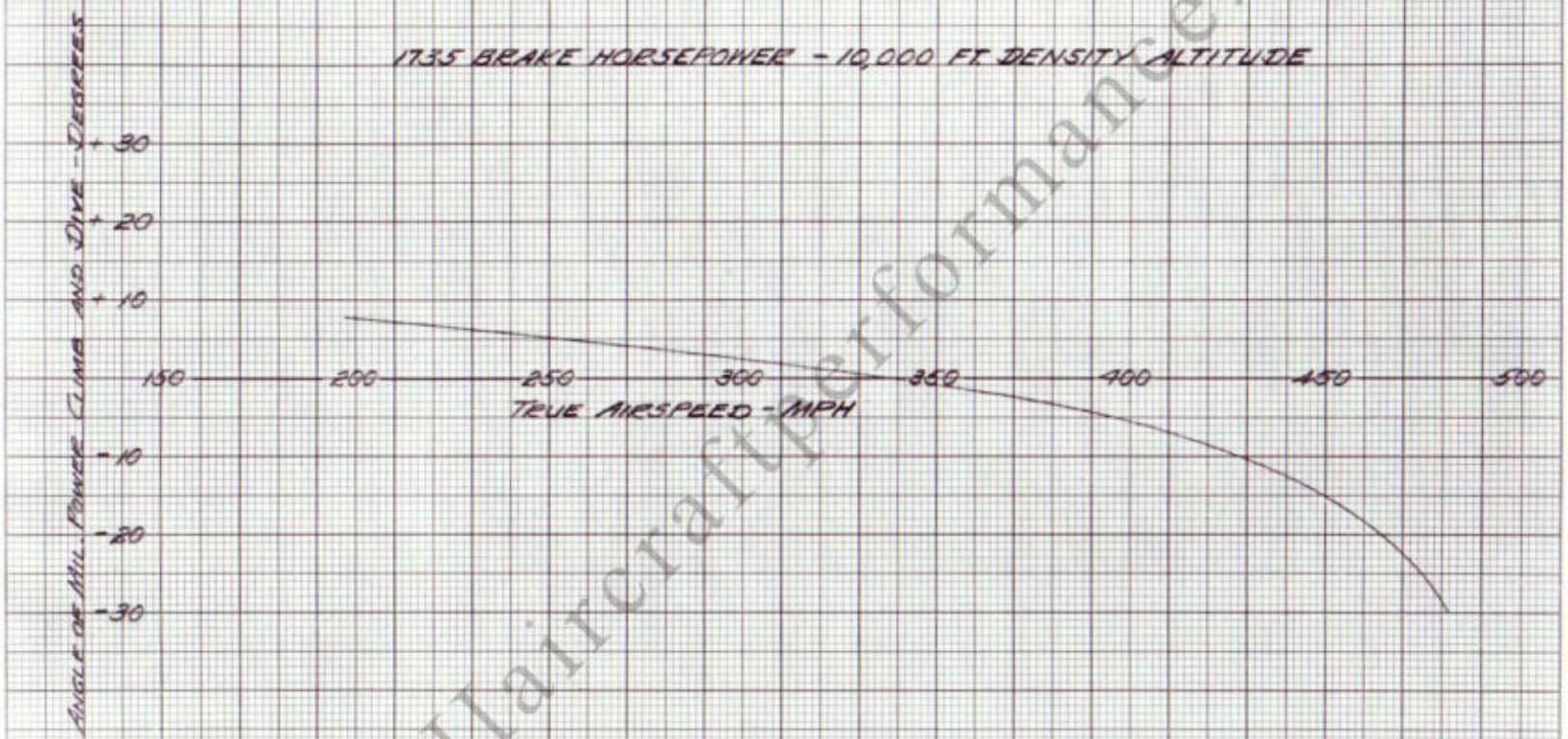


FIG 4