CONFIDENTIAL

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

FINAL FLIGHT REPORT

of

PRODUCTION INSPECTION TRIALS
(TED NO. BIS 2122)

on

MODEL FG-1A AIRPLANE NO. 14575
(CONTRACT NOa(s)-1871)
(FORMERLY NOS 99529)

held

3 MARCH 1944 to 9 OCTOBER 1944

by

FLIGHT TEST

at

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

for

BOARD OF INSPECTION AND SURVEY

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REFERENCES

(a) BuAer conf. ltr. Aer-E-211-RJ (C-99529) to Pres., Insurv dated 25 June 1943.
(b) SD-305-1, Detail Specification for model FG-1 Airplane, dated 14 Feb 1942.
(c) Contract NOa(s)-1871, dated 16 Oct 1944 for model FG-1 Airplanes.
(d) Contract NOs 99529, dated 18 June 1942 for model FG-1 Airplanes.
(e) Recommended Changes in the model FG-1, -1A Airplane Items 1 to 15, dated 12 May 1944 to 29 Sept 1944.
(f) CNO 27TWX1345 April 1944.
(g) NA83/VFG-1A BIS 2122 MJR/vba (FT) Spdltr., dated 15 July 1944.
(h) Power Curves for R-2800-8 engine, AEL Project No. 3911.
(i) Flight Test, NAS, Patuxent River, Md., Final Report on Temperature Survey for model FG-1 Airplanes, dated 2 Jan 1945.

BIS 2122 - FG-1 No. 13623
3/4 Right Front View

Photo PTR 4519
3-15-44

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BIS 2122 - FG-1A No. 14062
3/4 Right Front View

Photo PTR 8752
6-15-44

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BIS 2122 - FG-1A No. 14575
3/4 Right View

Photo PTR 14057
10-10-44

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NOT TO BE USED FOR PUBLICATION

INTRODUCTION - Production Inspection Trials on the model FG-1 airplane as requested in reference (a) were initiated 3 March 1944. The model FG-1 airplane manufactured by the Goodyear Aircraft Corporation in accordance with reference (b) is essentially the same as the model F4U-1 airplane designed and manufactured by the United Aircraft Corporation (Chance Vought Aircraft Division). The subject airplane is a single-engine, single-seat landplane fighter for use aboard aircraft carriers and was procured under Contract NOa(s)-1871, reference (c), formerly Contract NOs 99529, reference (d), as Ammended, Supplemented, and Restated.

Numerous difficulties were encountered during the testing of the first and second model FG-1 airplanes procured for the subject trials, which before final completion necessitated the testing of three model FG-1 airplanes. Since these three airplanes differed somewhat in external configuration and because the first two airplanes tested were found deficient, a brief historical resume of each airplane is given in chronological order of testing.

1. Model FG-1 airplane No. 13623 - Flight Tests commenced on this airplane 3 March 1944 were discontinued 10 May 1944 due to unsatisfactory handling characteristics in the nature of excessive aileron control forces and unusually high aileron tab angles for trim. Items 1 and 2 of reference (e) briefly state the unacceptable conditions encountered and the unsuccessful measures taken to correct these deficiencies. An enclosed photograph shows the external configuration of this airplane which had a "built-up" high tail wheel fork, arresting hook installation, spoiler on right wing, blast tube openings smoothly taped over, and electrical leads for temporarily installed test instruments securely taped to the accessory cowling on the right side of the fuselage. The engine installed was a Pratt and Whitney model R-2800-8 equipped with a 3-blade Hamilton Standard constant-speed hydromatic-control propeller of blade No. 6525 A-21 and 13'4" diameter.

2. Model FG-1A airplane No. 14062 - Reference (f) authorized the replacement of model FG-1 airplane No. 13623 with another model FG-1 for continuance of the subject trials. In May, 1944, model FG-1A airplane No. 14062 was received at NAS, Patuxent River, Md. for this purpose. This airplane differed from airplane No. 13623 in the following respects:

(a) Arresting hook was removed.
(b) Wing folding gear was removed.
(c) Bombing window removed and replaced with aluminum skin.
(d) Wing walk replaced by a wing walk of different material.
(e) VHF mast installed directly aft of the cockpit canopy.
(f) Pratt and Whitney model R-2800-8 engine changed to Nash-Kelvinator R-2800-8W.

Insofar as handling characteristics and control were concerned, model FG-1A airplane No. 14062 was a decided improvement over airplane No. 13623 and was used for the stability evaluations later reported upon in this report. However, other deficiencies such as unusually bad engine-propeller vibrations between 1950 and 1500 RPM, tail wheel shimmy, trimming and rigging discrepancies, and excessive cylinder head temperatures were encountered at the outset of the test program and were reported by reference (g). Reference (g) also requested that another model FG-1A airplane be provided for the Production Inspection Trials inasmuch as excessive cylinder head temperatures on airplane No. 14062 prevented performance evaluation in high and low blower auxiliary stages. In compliance with this request, model FG-1A airplane No. 14575, was diverted from the Air Ferry Squadron 2, Columbus, Ohio, departing from there for NAS, Patuxent River, Md. 20 August 1944.

3. Model FG-1A airplane No. 14575 - This airplane, having the new dark blue, high-gloss painted finish, appeared to be in excellent condition and had superior workmanship as compared with the two previous models tested. Trim and control were much improved. In addition, the engine and propeller combination exhibited smooth running qualities through a range of 1100 to 2700 RPM, with no particular rough spots noted. From the outset airplane No. 14575 represented a substantial improvement over the other models tested, performing satisfactorily throughout the remainder of the trials. The external configuration of airplane No. 14575 during performance evaluation flights conformed to the following:

(a) Gun blast tube openings and shell ejection chutes were faired over with tape.
(b) A spoiler was installed on the right wing leading edge just outboard the gun blast tubes.

(c) The tail wheel fork was the "high" type.
(d) A retractable mast for the ZB-1 radio equipment and an IFF stationary mast were installed on the bottom side of the fuselage. The VHF mast was installed aft of the cockpit canopy; the standard radio aerial mast was installed forward of the cockpit windshield, to the right.
(e) Electrical leads for temporarily installed test instruments which extended externally from the accessory compartment to the cockpit were enclosed in an aluminum housing (See enclosed photograph of No. 14575).
(f) Entire arresting hook assembly was removed and the bottom tail cone smoothly faired over.
(g) An outside air temperature gauge, electrical resistance type, was installed on the underside of the right wing panel.

The Nash Kelvinator model R-2800-8W engine installed on the model FG-1A airplane No. 14575 has the following military and normal power ratings:

Military Power

2000 BHP @ 2700 RPM - 1,700 ft. altitude
1800 BHP @ 2700 RPM - 15,700 ft.
1650 BHP @ 2700 RPM - 21,000 ft.

Normal Power

1675 BHP @ 2550 RPM - 5,500 ft. altitude
1625 BHP @ 2500 RPM - 16,500 ft.
1550 BHP @ 2550 RPM - 21,700 ft.

Take-off Power

2000 BHP @ 2700 RPM@ 54" Hg. MAP

The propeller was a three-blade Hamilton Standard constant-speed hydromatic-control of 13'4" diameter (hub design No. 23E50-495, blade design No. 6525 A-21), having a pitch setting of 12° - 54° @ 72".

PURPOSE OF TEST - The purpose of the tests as conducted by Flight Test on the model FG-1A airplane in accordance with reference (a) was to determine the following:

(a) Performance and flight characteristics.
(b) General suitability for service use as a carrier and land-based fighter.

METHOD OF TEST - Engine powers developed throughout the subject trials were based on torquemeter readings unless otherwise noted.

Instrumentation was made for purposes of observing the carburetor air temperature and outside air temperature during performance evaluation flights.

A temperature survey was conducted on the engine of airplane No. 14575 by means of a specially installed Brown Recorder.

The following Weight and Balance summary shows the condition of airplane No. 14575 as flown during the performance phase of the trials.

Weight and Balance Summary: "Overload" Fighter less wing tank fuel

Loading

Par. from Detail Spec.....	104c modified
Gross weight - lbs.....	12,057
Useful load - lbs.....	3,288
Useful load - % gross weight.....	27.3
Weight empty - lbs.....	8,769
Wing loading - lbs. per sq. ft.....	38.4
Take-off power loading - lbs. per sq. ft.....	6.0
Center of gravity location - % MAC:	
Wheels retracted.....	31.9
Wheels extended.....	30.7
Detailed useful load:	
Pilot - lbs.....	200
Fuel (main-257 gals.) - lbs.....	1,422
Oil (20 gals.) - lbs.....	150
Trapped fuel and oil - lbs.....	111
Anti-detonant fluid (10 gals.) - lbs....	78
Wing guns (6-.50 cal.) & installation - lbs.....	396
.50 cal. ammunition (2400 rds.) - lbs...	720

Radio - lbs	152
Navigating equipment - lbs	4
Emergency kit - lbs	13
Pyrotechnics - lbs	4
Life raft - lbs	14
Oxygen - lbs	24

RESULTS OF TEST

A. Performance (As an "overload" fighter less wing tank fuel)

Model FG-1A Airplane No. 14575

1. Maximum speed (high blower)

Power	Normal	Military	Combat
Brake horsepower	1495	1640	2000
Airplane critical alt.-ft	23,300	22,300	18,000
Maximum speed at ACA - MPH	390.0	393.0	406.0
2. Service ceiling - ft	37,000	37,000	37,000
3. Maximum rate of climb at sea level - FPM	2160	3120	3450

Model FG-1A Airplane No. 14062

4. Minimum speed at sea level:	
Clean condition - power on - MPH	96.0
Clean condition - power off - MPH	98.0
Landing condition - power on - MPH	76.0
Landing condition - power off - MPH	83.5
5. Take-off data (full flap):	
* Brake Horsepower (actual)	1940
Take-off speed - MPH	83.0
Take-off distance - no wind - ft	720
Take-off distance - 25 knot wind - ft	325

Engine Data	Airplane Configuration
RPM = 2700	Cowl flaps - 3/4 open
MAP = 53.5	Intercooler - closed
CAT = 27°C	Oil cooler - open
OAT = 23°C	Cockpit hood - open

* Note: On basis of AEL Power Curves - reference (h).

B. Flight Characteristics - A discussion of stability and stalling characteristics of model FG-1A airplane No. 14062, the second of three airplanes tested during the production inspection trials, is summarized below. At a gross weight of 11,950 lbs., the airplane center-of-gravity location was 32.5% MAC (landing gear retracted) and 31.2% MAC (landing gear extended). A bungee spring, operative only when the tail wheel is down, was installed in this airplane, which by exerting a forward force on the control stick induced longitudinal stability in the landing condition.

1. Longitudinal stability - During high power climbs, clean condition, with the airplane trimmed at an indicated airspeed of 150 MPH, the angle of attack was increased until the airspeed dropped to an indicated 125 MPH. Release of the stick then resulted in the airplane becoming increasingly tail heavy, with airspeed dropping accordingly, indicating negative static stability. Upon decreasing the angle of attack from the initial trimmed angle for climb, with airspeed increasing to an indicated 180 MPH, the airplane exhibited positive static stability at release of the stick but dynamic instability. The condition of longitudinal instability during high power climbs as described here is similar to that shown by model F4U-1 and F3A-1 airplanes at the same approximate gross weight and center-of-gravity location.

   In high speed level flight, clean condition, the airplane possessed static stability but marginal dynamic stability, with very little damping of the pitching oscillations after three complete cycles.

   During cruise speed level runs, low power glides, and power-off glides, clean condition, static and dynamic stability was positive. Dynamic oscillations were practically damped out after two to three cycles.

   In simulated carrier approaches, landing condition, at indicated airspeeds of 90 MPH, the airplane was statically stable but displayed marginal dynamic stability tendencies when momentarily disturbed from trim. Although oscillations were of relatively small amplitude, there was no appreciable damping after two complete cycles.

The airplane was both statically and dynamically stable in high power climbs and power-off glides in the landing condition, static stability being very pronounced in power-off glides.

Elevator forces required for speed disturbance from trim speeds were extremely light for all speeds and powers in both landing and clean condition. However, in change of power from any one condition of flight to another, elevator forces were quite high and became excessive during power-off glides, landing condition, where 20° nose up trim tab was required for minimum speed of 110 MPH indicated. In this respect, it is believed that the bungee spring which imposes a downward force on the elevators, with extended tail wheel, was too strong in this installation.

The summary of recorded stick positions given below indicates the degree of elevator movement and required stick forces with change of airspeed in a given condition of flight.

Condition	From	To	Difference	Stick Force - lbs.
Clean 75% Power	Level flight 4 7/8"	Minimum V 5 5/8	6/8"	10
Clean Power Off	Dive at Vmax level 4 3/4"	Vstall plus 40 knots 5 3/4"	1"	12
Clean Power Off	Vstall plus 40 knots 5 3/4"	Vstall 7 1/2"	1 3/4"	5
Glide at 100 knots	Clean condition 6"	Landing Condition 6"	0	20 (wheels down) 18 (flaps 50° down)
Landing Condition Power On	Vstall plus 30 knots 5 3/4"	Vstall plus 20 knots 6"	1/4"	0
Landing Condition Power On	Vstall plus 10 knots 6"	Vstall 6"	0	0

Landing Condition Power Off	Vstall plus 50 knots 5 3/4"	Vstall 5 3/4"	0	2.5
Ground	Full Fwd. 6.5"	Full back 22 3/8"	15 7/8"	22

2. Lateral stability - Airplane No. 14062 was laterally stable throughout various speed and power combinations, both in the clean and landing conditions. However, in the carrier approach lateral stability appeared somewhat weak: gentle to sharp turns, with ailerons free, were normal under all conditions investigated except in the carrier approach where response was slow but positive. Aileron forces, stick fixed, were either low or moderate in yawed flight up to full rudder. Recoveries from rolls due to full rudder yaws were satisfactory, but recovery was sluggish from a right bank resulting from right rudder yaw in the landing condition, power on.

3. Directional stability - Aileron turns, rudder free, were satisfactory in military climbs, clean condition; however, in sharp turns (45° bank) to the left, slight adverse yaw was perceptible. In Vmax and cruise runs, clean condition, gentle to sharp aileron turns, with rudder free, were normal, but during glides response was sluggish.

Stability was noticeably weak in simulated carrier approaches. At indicated airspeeds of 90 MPH, required trim tab settings were from 15° - 20° right rudder; consequently, with little or no available control tab remaining, control was undesirably poor and necessitated considerable use of right rudder. Model FG-1A airplane No. 14062 was not as stable directionally in the carrier approach as a model F4U-1 airplane, especially in right turns.

Rudder forces in right rudder yaw during climbs in the carrier approach and during glides, landing condition, were very low.

Recovery after level yaw, rudder free, was satisfactory in various power and speed conditions.

4. Stall characteristics were investigated under the various flight conditions as summarized below:

Condition	Power	Stall Warning	Stall & Recovery
Clean	2150 RPM @ 18" Hg. MAP	Stick buffeting 3-4 MPH above stall	Falls straight ahead and then to right - loses about 300 ft. - recovers easily
Clean	Throttle closed	Similar to above	Falls off to right - recovers easily
Landing	2250 RPM @ 22" Hg. MAP	Little or no warning	Falls off to left - Uncomfortable, almost 90° roll before recovery - loses 600 ft.
Landing	Throttle closed	Little warning	Falls off to right - recovery similar to recovery in landing condition plus power but less violent in stall.

C. Miscellaneous Tests - 1. The following tables showing rates of roll and required stick forces, using fully deflected ailerons were measured on airplane No. 14062 and are believed representative of any production model FG-1A airplane. Neutral rudder was maintained except for momentary use in keeping the ball centered.

Rates of Steady Roll Through 360°

Condition	IAS MPH	Rate of Roll Degrees per sec. Left	Right	Stick Force pounds Left	Right	*Pb/2V Left	Right
Clean	170	74	74	22	22	.09	.09
Clean	200	78.3	85.2	25	28	.081	.088
Clean	220	81.8	88.5	30	32	.076	.083
Clean	240	88.5	85.7	34	36	.076	.073
Clean	260	85.7	88.5	34	36	.067	.070
Clean	280	91.6	----	38	36	.061	----
Clean	300	87.2	----	42	40	.059	----

* P = radians per second
b = wing span - ft.
V = true air speed - feet per second

Rates of Steady Roll Through 90°

Condition	IAS MPH	Rate of Roll Degrees per sec. Left	Right	Stick Force Left	Right	Pb/2V Left	Right
Landing	110	36	36	12	10	.070	.070
Landing	120	41	40	14	10	.072	.070

2. Oil Pressure In Push Over - The oil pressure was observed to drop during negative accelerations, recovering only when positive acceleration was applied. In level flight at 2150 RPM and a manifold pressure of 28" Hg., the oil pressure was 90 psi; however, as negative acceleration was applied (push over), the oil pressure dropped to 30 psi, remaining at this value until recovery (positive acceleration) was made. During inverted flight, the oil pressure decreased to 20 psi and would, in all probability, have dropped to zero pressure had inverted flight been continued.

3. Angles of climb and dive are plotted in the form of a curve, showing flight angle versus airspeed, and are contained in enclosure 2 as Figure 4 of Performance Characteristics.

4. Excessive carbon monoxide concentrations were found in model FG-1A airplane No. 13623 and No. 14062 during Surveys as prescribed by Navy Aeronautical Specifications SR-93A. Test results showing the excessive concentrations were submitted earlier during the test program as Item No. 2 (airplane No. 13623) and Item No. 5 (airplane No. 14062) of reference (e). The following descriptive information, giving the percentage concentration at various places within the cockpit under different operating conditions, was taken from Item No. 5. Both the cockpit ventilator and hatch were closed while any one reading was being taken.

Military power climb with cockpit closed:

(a)	At pilot's nose.....	.027%
(b)	At pilot's knees.....	.024%
(c)	At diluter-demand oxygen inlet.....	* .066%

*Note: Reading obtained after recheck - previously reported in Item No. 5 as .040% (limit of CO indicator gauge)

Military power level flight: (a) At pilot's nose.....	.018%
Cruise 70% power: (a) At diluter-demand oxygen inlet.....	.012%
Military power level flight: (a) At cockpit heater outlet, with heater on.....	.040% (limit of CO indicator gauge)

5. An attempt to conduct a temperature survey on model FG-1A airplane No. 14062 was discontinued soon after commencement of the survey because of engine cooling deficiencies. Item No. 11 of reference (e), a trouble report on unsatisfactory cooling of the engine installed on this airplane, contained factual data showing the extent to which cylinder head temperatures exceeded prescribed operating limits. As previously mentioned in this report, model FG-1A airplane No. 14062 was replaced by model FG-1A airplane No. 14575 for continuance of temperature surveys in addition to performance evaluation. Excessive temperatures were recorded during the final survey and reported in reference (i), from which the following discussion was taken:

(a) During a military power, auto-rich climb with oil cooler one-half open at sea level and full open at 25,600 feet, the oil temperature exceeded the 80°C limit and continued rising to a maximum of 92°C at 23,800 feet and at 30,900 feet.

(b) During a military power, high blower, auto-lean run in level flight at 21,900 feet, number 4 cylinder reached 262°C, 2° over the allowable limit.

(c) An attempt to run the ground run with cowl flaps closed was discontinued when at 1400 RPM with the wind on the port beam, cylinder number 7 and elbows number 3 and 15 exceeded the allowable limits.

6. Cabin sealing was satisfactory on the subject airplane, with no apparent leakage after hose testing with water.

7. The fuel filling rate was 32 gallons per minute which is within the required rate of 30 - 50 gallons per minute.

8. Actual clearance between the ground and the flaps in the full down position was 14 inches, the minimum allowable being 11 inches.

DISCUSSION - Figure No. 2 of Performance Curves is a graphical presentation of the manifold pressures, horsepowers developed, and speeds obtained at various altitudes in normal, military, and combat powers on model FG-1A airplane No. 14575. It is to be noted that all part-throttle performance was that obtained with the engine operated at constant manifold pressure, i.e., the current rated manifold pressure for respective blowers at various powers as indicated on these curves. It is for this reason that the critical altitudes are based on engine rated manifold pressures rather than on engine power ratings. Horsepowers developed are based on torquemeter readings and are corrected for temperature variations from standard conditions.

In determining steady rates of roll using fully deflected ailerons, the rolls were started from a 60° bank opposite to the intended roll; hence, the time for a 90° roll was measured from the instant the gyro horizon passed through 30° on one side to the time it passed through 60° on the other side. The times recorded, therefore, represent approximately the maximum steady rate of roll and do not show the effect of starting and stopping. Stick forces required to hold the controls fully deflected were obtained from a control force indicator held between the pilot's hand and stick.

CONCLUSIONS

1. Model FG-1 airplane No. 13623 exhibited unacceptable flight characteristics in view of excessively high stick forces and unsatisfactory trim.

2. Flight characteristics of model FG-1A airplane No. 14062 were acceptable but inferior to the flight characteristics possessed by similar model F4U-1A airplanes. This airplane was found unacceptable, however, because of extreme engine cooling deficiencies though, in this respect, subsequent temperature surveys on airplane No. 14575 would seem to indicate that airplane No. 14062 was an isolated case.

3. Model FG-1A airplane No. 14575 was a decided improvement over the other two models tested, exhibiting satisfactory performance and flight characteristics, and was concluded to be the equivalent of any similar model F4U-1A airplane.

4. As a result of the production inspection trials on airplane No. 14575, the model FG-1A airplane was found acceptable for service use as a fighter airplane except for a number of defects as listed under recommendations. Attention is invited to the fact that satisfactory completion of the demonstration by the contractor pursuant to paragraph (ii-a) of section 7, reference (c), has not been fulfilled as of this date.

RECOMMENDATIONS - As a result of these trials, changes in the model FG-1A have been recommended and submitted in reference (e). These and other recommendations are 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. Reduce to a safe minimum the carbon monoxide concentration in the airplane cockpit. -C

2. Provide more serviceable exhaust stacks and exhaust stack securing bolts. -C

3. Improve engine cooling. -C

4. Improve oil cooling. -C

5. Reduce aileron forces to design limit and rig airplanes to trim less than three degrees wing heavy at 200 knots indicated. (Only airplane No. 14575, the last of the three model FG-1A's tested, met these requirements.) -C

6. Rig landing flaps to fair with wing and desist from trimming airplanes by drooping inboard landing flaps. -C

7. Improve sealing of wing fuel tanks. -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. Install a separate switch to insure that the water injection system is inoperative when the throttle is advanced to the full open position and water injection is not desired. -C

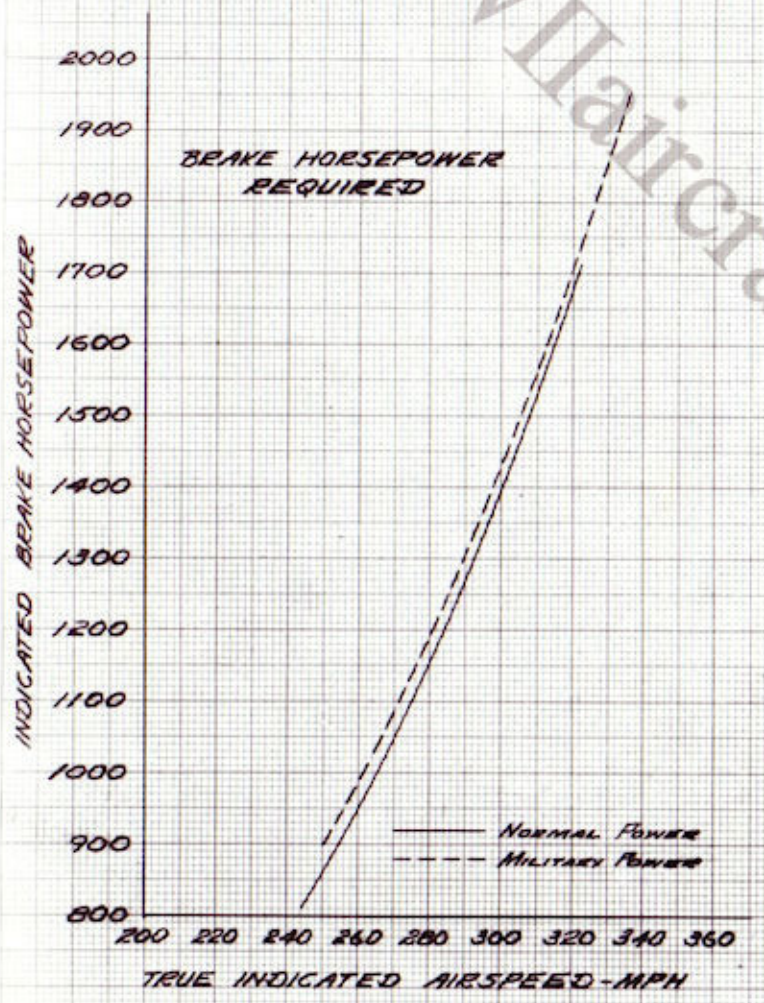
2. Modify safety-wire stop on the throttle control to prevent the sharp ends of the safety wire cutting the pilot's hand as the throttle is moved back and forth. -C

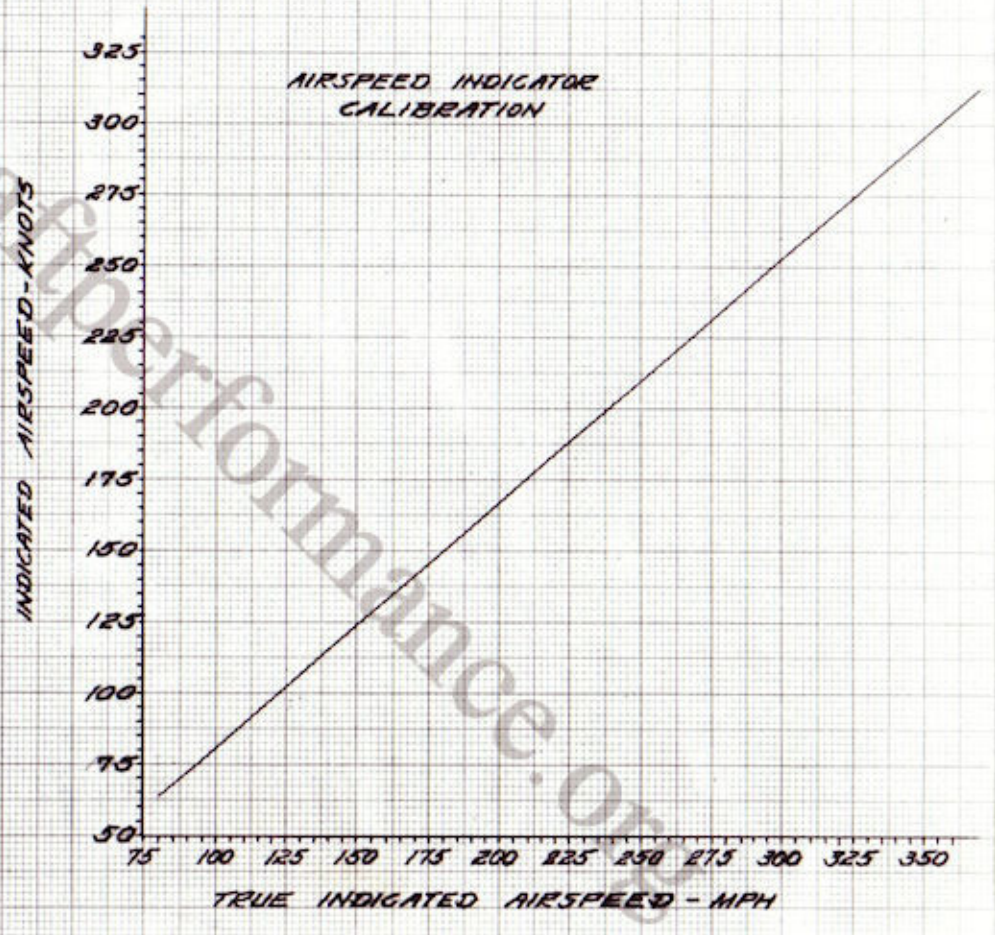
3. Eliminate excessive vibration or "shimmy" in the tail wheel assembly which develops when the tail wheel is unlocked at any speed in excess of slow taxiing speed. This recommendation applies only to the old type tail wheel yoke modified by the interposition of a 6" bracket, bolted to the regular tail wheel yoke, for the purpose of raising the tail to the height of the current production F4U-1A airplanes. -C

Encl: (HW)
1. Four (4) Performance Curves, Photo PTR Nos. 16701, 16702, 16703, and 16704.
2. Twenty (20) Photographs, Photo PTR Nos. 8748, 8750, 8751, 8749, 8747, 8054, 8157, 8156, 8063, 8064, 8060, 8061, 4854, 4855, 8057, 8059, 8058, 8055, 4917, and 8089.

MODEL F6-1A AIRPLANE NO. 14575
PERFORMANCE CHARACTERISTICS
OVERLOAD FIGHTER GROSS WEIGHT = 12057 LBS.

PHOTO PTR 16701





R&B 12-6-44

FIG. 1

PHOTO PTR 16792

MODEL FG-1A AIRPLANE NO. 14575
PERFORMANCE CHARACTERISTICS
OVERLOAD FIGHTER GROSS WEIGHT = 12057 LBS.

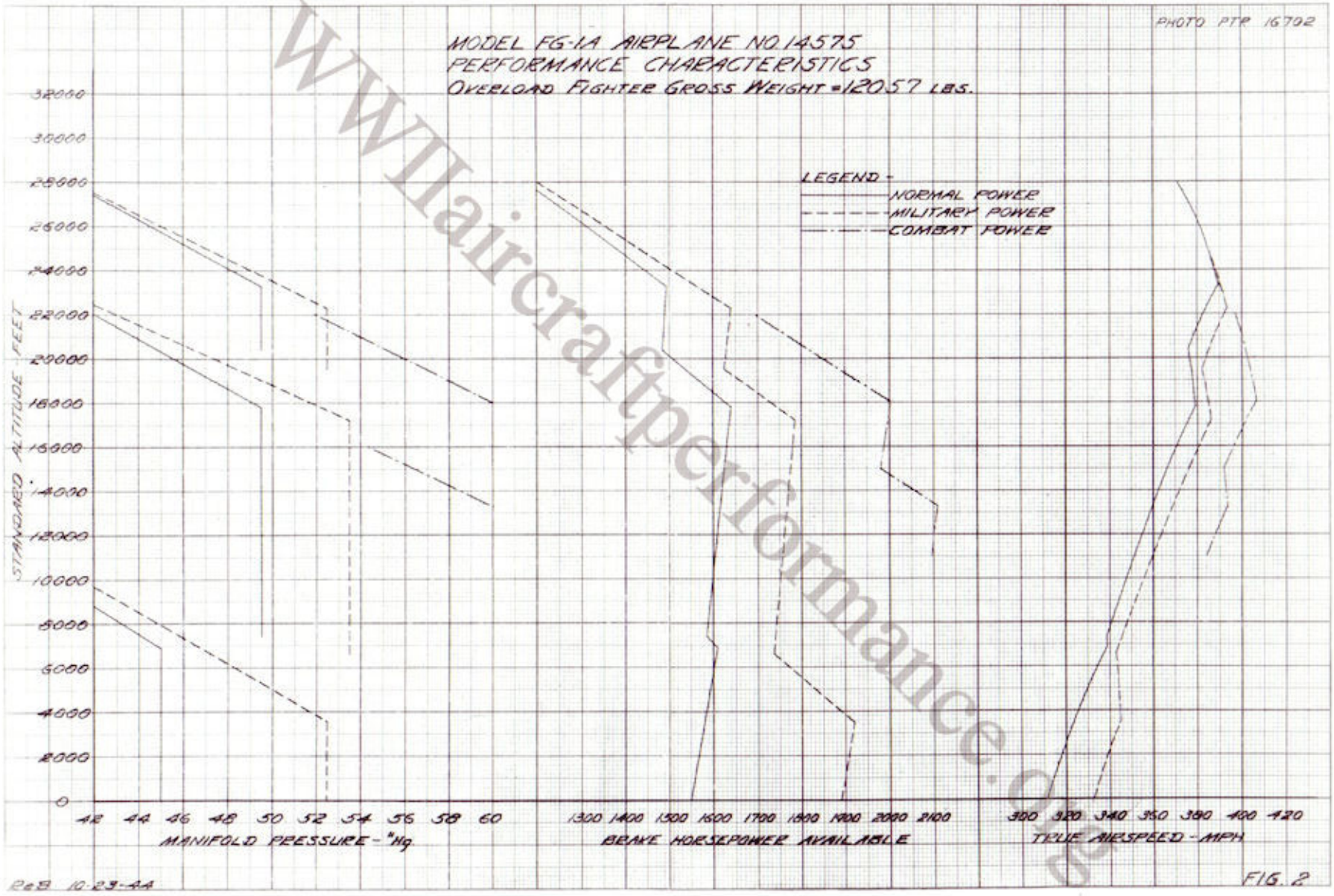


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FIG. 2

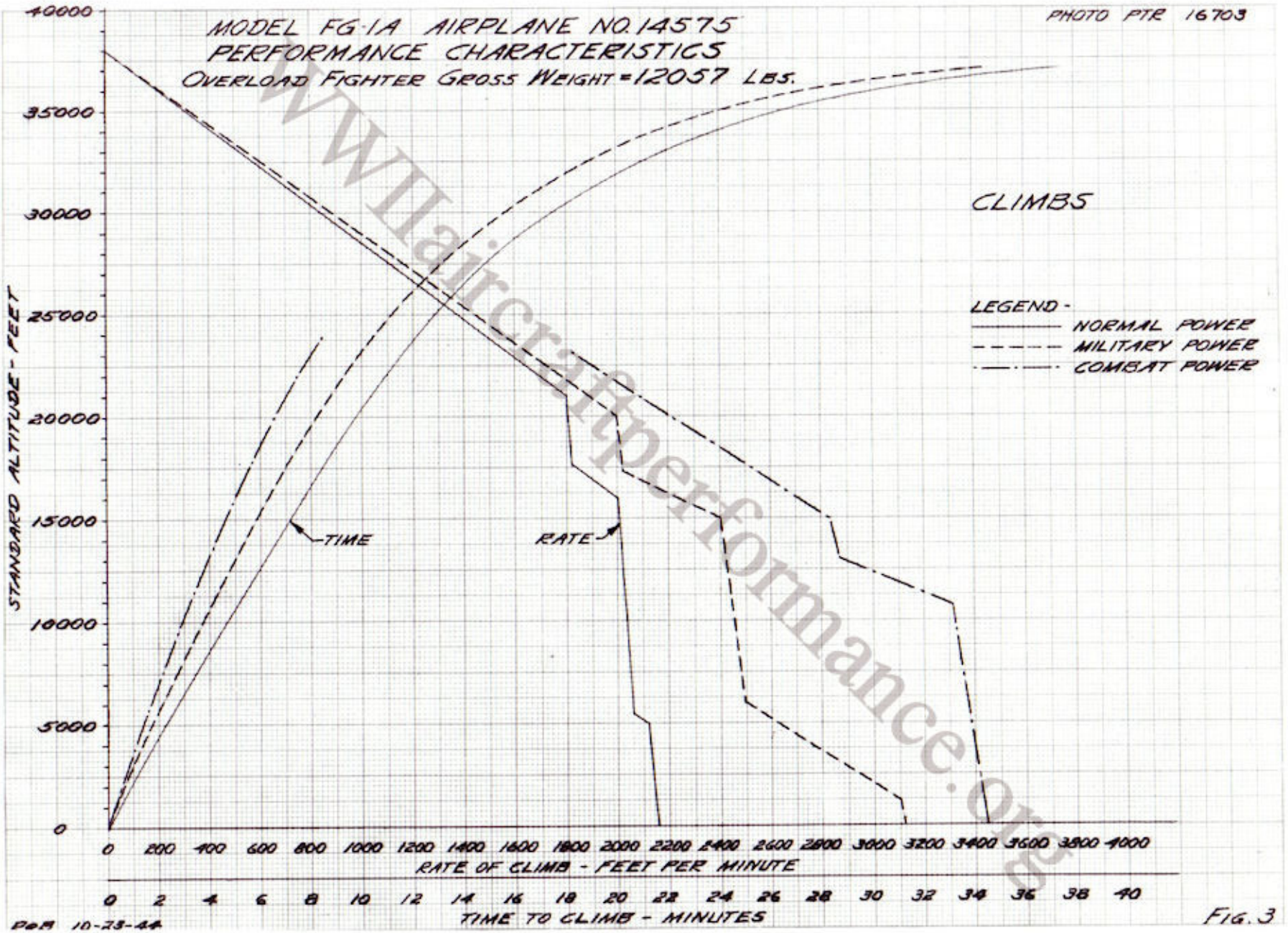

FIG. 3

MODEL FG-1A AIRPLANE NO. 14575
PERFORMANCE CHARACTERISTICS
OVERLOAD FIGHTER GROSS WEIGHT = 12057 LBS.

PHOTO PTR 16704

ANGLE OF CLIMB AND DIVE VERSUS TRUE AIRSPEED
1650 BRAKE HORSEPOWER - 10,500 FT. DENSITY ALT.

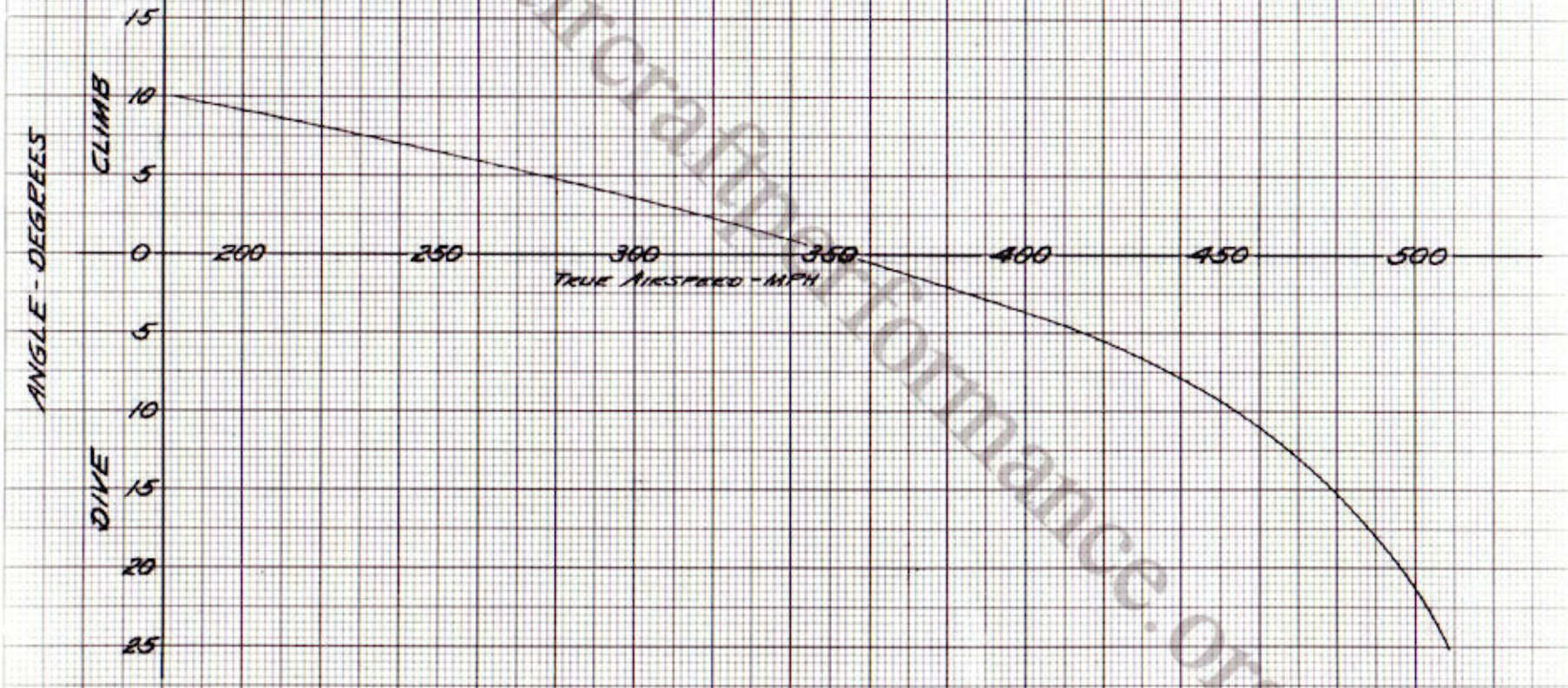

FIG. 4