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HECTOGRAPH

FINAL REPORT

OF

PRODUCTION INSPECTION TRIALS

ON

MODEL F4F-3 AIRPLANES NOS. 1845, 1848 and 1851
(Contract NOs-68219)

HELD

AUGUST 20, 1940 to DECEMBER 23, 1940

BY

BOARD OF INSPECTION AND SURVEY

AT

NAVAL AIR STATION, ANACOSTIA, D. C.

AND

NAVAL AIRCRAFT FACTORY, PHILADELPHIA, PA.

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Original to: Department (Judge Advocate General)
Via: Chief of the Bureau of Aeronautics
Copies to: Chief of Naval Operations 1
Bureau of Aeronautics ..... 4 (1) ✓
(1 copy with 39 additional photographs)
Naval Air Station, Anacostia, D.C. 4
Naval Aircraft Factory, Philadelphia 1

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NAVY DEPARTMENT
BOARD OF INSPECTION AND SURVEY
WASHINGTON

MGH
VF4F-3/F8-2(158-S)
Serial 1321
CONFIDENTIAL

January 23, 1941

From: Board of Inspection and Survey.
To: Secretary of the Navy (Judge Advocate General).
Via: Chief of the Bureau of Aeronautics.

Subject: Contract 68219 - Model F4F-3 Airplane - Production Inspection Trials - Final Report of.

Reference:
(a) Judge Advocate General of the Navy letter VF4F-3/F8-2(400105)P dated January 10, 1940. (Copy appended, marked "A").
(b) Bu.Aero.conf.letter Aer-E-211-GF C-68219 of January 2, 1940. (Copy appended, marked "B").
(c) Bu.Aero.conf.letter Aer-E-211-GF C-68219 of January 22, 1940. (Copy appended, marked "C").
(d) Bu.Aero.conf.letter Aer-E-211-GF C-68219 of February 5, 1940. (Copy appended, marked "D").
(e) Bu.Aero.conf.letter Aer-E-211-GF C-68219 of October 30, 1940. (Copy appended, marked "E").
(f) Grumman Aircraft Eng.Corp.letter #4829 of August 19, 1940 with INA Bethpage 1st End. C-68219/F8(321-41) of August 20, 1940.
(g) Bu.S&A letter NOs-68219 SPM of December 30, 1940.
(h) Bu.Aero.letter Aer-E-271-AMP C-68219 of April 27, 1940.
(i) Bu.Aero.letter Aer-E-271-AMP C-68219 of June 6, 1940.
(j) NAS Anacostia conf.report VF4F-3/NA6 Ser. #40124 of September 13, 1940.
(k) Grumman Aircraft Eng.Corp.conf.letter #5052 and INA Bethpage conf.1st end. C-68219/F8 (1106-41) both dated November 27, 1940.
(l) SD-235-3, Detail Specification for Model F4F-3 airplane dated August 29, 1939.
(m) Grumman Aircraft Eng.Corp. report No. 1448B dated February 23, 1940.

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(n) Grumman Aircraft Eng.Corp.report No. 1448F dated November 18, 1940.
(o) NAF conf.report on S.E.U. Test No. 39-10 dated January 6, 1941.
(p) NAF conf.report No. AML 13037-41 of September 12, 1940.
(q) Bu.Aero.letter Aer-E-422-MN/4-26 C-68219 of April 12, 1940.
(r) Bu.Aero.letter Aer-E-471-ETC VF4F3/F23 C-68226 of December 13, 1940.
(s) Bd.I&S conf. letter VF4F-3/F8-2(116-S) Serial 0821 of January 16, 1941.

Enclosure: (F) Set of eight (8) photographs of model F4F-3 airplanes Nos. 1845 and 1848.
(G) Set of two (2) performance charts.

1. In accordance with the references, production inspection trials have been conducted on the model F4F-3 airplane, using serial numbers 1845, 1848, and 1851 for this purpose. All trials having been completed, this, the final report, is submitted.

2. The model F4F-3 airplane was designed as a single-engine single seat landplane fighter for use aboard aircraft carriers. The airplane is generally similar to the model XF4F-3 airplane and is the production model of the latter. It is designed to take off from the deck of an aircraft carrier with or without the aid of a catapult and land on the carrier deck in an arresting gear or for operation from an ordinary landing field. Changes recommended as a result of trials of the model XF4F-3 airplane have been incorporated, where applicable, in the model F4F-3 airplane. F4F-3 airplanes Nos. 1844 and 1845 were equipped for the installation of two .30 caliber synchronized guns and two .50 caliber wing guns. Nos. 1846 and 1847 were converted to model XF4F-5 airplanes by change No. J of contract NOs-68219 and a separate report will be made on these airplanes. Airplanes Nos. 1848 and 1851, by the incorporation of modifications arranged for under contract NOs-68219, were equipped to carry four .50 caliber wing guns and were supplied with armor protection and a stronger landing gear or their equivalent in ballast. Airplane No. 1848

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was used in the trials at Anacostia, while No. 1851 was delivered to Philadelphia for carrier acceptability and vibration tests. Photographs in enclosure (F) show airplanes Nos. 1845 and 1848 as flown during the trials.

3. The preliminary demonstration of the model F4F-3 airplane was carried out before the Inspector of Naval Aircraft, Bethpage, Long Island, using airplanes Nos. 1844 and 1845. The report of the preliminary demonstration was forwarded to the Bureau of Aeronautics by reference (f), the endorsement stating, "The preliminary demonstration as conducted on the subject airplane was considered satisfactory in all respects".

4. Contract NOs-68219, dated August 8, 1939, states that the airplane shall be delivered, set up and ready for flight, at the Naval Air Station, Anacostia, D.C., within 120 days after date of contract but not before acceptance of Items 1 and 2(a), and not before delivery of Item 2(b). Model F4F-3 airplane No. 1845, designated Item 3(a) of the contract in place of No. 1844 by reference (g), was delivered at the Naval Air Station, Anacostia, on August 20, 1940, 378 days after date of contract. Acceptance of Items 1 and 2(a) of contract NOs-68219 was indicated by references (h) and (i), dated April 27, 1940 and June 6, 1940, respectively, which state that the Bureau of Aeronautics considers the requirements of the items fulfilled. It is understood that item 2(b), the airplane structure for static test, was delivered to the Naval Aircraft Factory, Philadelphia, Pa., in December, 1939.

5. Final demonstration of model F4F-3 airplane No. 1845 was carried out at the Naval Proving Ground, Dahlgren, Virginia, on August 22-23 and September 3-4, 1940. Report of this demonstration was made to the Bureau of Aeronautics by reference (j). In addition to the preliminary demonstration referred to in paragraph 3 and the final demonstration, a special demonstration of model F4F-3 airplane No. 1848 was carried out by the contractor. This consisted of two dives and pull-outs with the airplane carrying a gross load corresponding to the normal fighter condition, with all changes incorporated, exclusive of protection, but with mock up armor installed. The report of this special demonstration was forwarded to the Bureau of Aeronautics by reference (k).

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6. The Board met to conduct trials on the model F4F-3 airplane at the Naval Air Station, Anacostia, D. C., on August 20, 1940.

Present: Commander G. R. Henderson, U.S.N.

7. The Board was assisted during the trials by personnel of the Naval Air Station, Anacostia, D. C., and the Naval Aircraft Factory, Philadelphia.

8. The model F4F-3 airplane, as a carrier landplane under all load conditions specified in reference (1), substituted for Specification SD-112-15 by reference (c), and in all respects, was found to be satisfactory for service use as a fighter, except for a number of items covered below by comment and recommendations.

9. The model F4F-3 airplane, under all load conditions specified in reference (1), was found to be in correct flying balance, controllable and positively stable in the air about each of the three major axes, with free and locked longitudinal, lateral, and directional controls, except that with free controls the airplane was longitudinally unstable in the following conditions of flight:

(a) Landing condition with power on.
(b) Full power climb.
(c) Maximum speed (nearly neutral).

10. The model F4F-3 airplane, under all load conditions specified in reference (1), was found to be controllable and stable on the ground with the following exceptions:

(a) The brakes were not satisfactory for full load conditions.
(b) The airplane lacked adequate lateral stability under certain conditions.

11. The model F4F-3 airplane, under all load conditions specified in reference (1), was found to be satisfactory for service use in taking off from and landing on a carrier, with the exception of items covered by recommendations in paragraph 24.

12. Contract NOs-68219 states that the weight empty of the model F4F-3 airplane as defined in SD-112-15, paragraph 105a, will not exceed 4867 pounds. Changes through No. K increased the weight empty guarantee by 164 and 258 pounds for airplanes Nos. 1845 and 1848, to 5031 and 5125 pounds, respectively. Reference (m) gives the weight empty of F4F-3 airplane No. 1844 as 4926 pounds including 28.2 pounds overweight of government furnished material. Assuming that F4F-3 airplane No. 1845 is identical in weight empty, the above figures result in the airplane being 133.2 pounds under the guarantee. Reference (n) gives the weight empty of F4F-3 airplane No. 1848 as 5300 pounds including 31 pounds underweight of government furnished material. In addition to the authorized changes up to and including No. K, an increase in the weight empty allowance of 278 pounds has been requested in various letters from the contractor. Using these figures and the original guaranteed weight empty, F4F-3 airplane No. 1848 was 103 pounds under the guarantee. The weights empty of F4F-3 airplanes Nos. 1845 and 1848, as determined at Anacostia, were 4988 and 5238 pounds, respectively.

13. The performance data pertaining to the model F4F-3 airplanes as fighters, with useful load specified in paragraph 104a of reference (1), are compared with the guarantees, as revised by changes Nos. B to F, inclusive, as stated in reference (c), as follows:

	Actual		Guaranteed
Airplane No.	1845	1848	
Full load weight (lbs.)	6260	7065	-
Center of gravity location (% M.A.C.)	26.1	28.2	-
Maximum speed at airplane critical altitude (m.p.h.)	331	330*	Not less than 350
Minimum speed without power at sea level (m.p.h.)	70	81	Not more than 69.5
Service ceiling, starting with normal load (ft.)	38200	37000*	Not less than 34300
Take-off distance in a 25-knot wind (ft.)	171	194	Not more than 190

*With weight at start of flight of 7300 pounds.

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14. The performance guarantees were made with the understanding that the R-1830-76 engine furnished by the Government would deliver 1000 BHP at 2550 RPM at 19000 feet altitude and at sea level and 1200 BHP at 2700 RPM for take-off purposes, using 3-blade constant speed controllable pitch propeller described in reference (1), and that the engines would be operated with domestic aviation gasoline of 100 octane number. The power developed was derived from torque meter indications from which the airplane critical altitude under standard conditions was found to be 21,100 feet. The maximum speed given above in paragraph 13 has been corrected to standard conditions at the airplane critical altitude. During the trials the F4F-3 airplanes were equipped with the specified type propellers and used domestic aviation gasoline of 100 octane number.

15. The actual maximum speeds attained in level flight by the F4F-3 airplanes were as follows:

Airplane No.	1845	1848
Speed (m.p.h.)	331	331
Pressure altitude (ft.)	22000	21000
Density altitude (ft.)	23250	21300
Horsepower developed	944	981

16. Arresting, night flying and catapult tests were conducted with model F4F-3 airplane No. 1851 at the Naval Aircraft Factory, Philadelphia. The results are reported in reference (o) from which excerpts are quoted, as follows:

(a) "The subject airplane meets the current specifications and is considered satisfactory for carrier operations including arrested landings".

(b) "This airplane is considered satisfactory for catapult operations providing recommended change is made to prevent contact between bottom of fuselage structure aft of tail wheel and the 'Catapult Hold Back and Release Unit'". (Recommendation is made in paragraph 24).

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17. In accordance with reference (d), vibration tests were conducted by the Naval Aircraft Factory on model F4F-3 airplane No. 1851. Flight tests only were conducted since the airplane was assumed to be similar, with the exception of the power plant, to the model XF4F-5 airplane upon which a complete survey was conducted and reported on by reference (p). The tests conducted indicated that the vibration characteristics of the model F4F-3 airplane were entirely satisfactory.

18. Considerable difficulty was encountered with the power plants in model F4F-3 airplanes No. 1845 and 1848. Both engines were rough at full throttle in neutral blower. This roughness became noticeable when manifold pressures exceeded 38 inches of mercury at 2500 r.p.m., and it occurred with all spark plugs used (Aero LS1AB and LS1AD types with gap settings of .012", .014", and .015"). The roughness was decreased by increasing r.p.m. to 2640. It should be noted that operation in neutral is relatively short since the supercharger control is usually shifted to "low blower" at 4500 feet. In attempted climbs to service ceiling five magneto failures were had due to shortcircuiting through the distributor rotor at pressure altitudes around 32,000 feet. An improved rotor was supplied and while this difficulty was overcome, faulty engine operation occurred between 32000 and 34000 feet apparently due to shorts in the spark plugs. With gap settings in Aero LS1AB plugs reduced to .014", satisfactory operation was maintained to slightly over 37000 feet.

19. Power plant temperature surveys showed cylinder temperatures to be excessive. Investigations are now underway which are expected to result in adequate cooling of the power plant.

20. All maneuvers required by the demonstration or expected of the type were performed during the trials. Recoveries from ten (10) turn spins were accomplished within two turns. Recoveries from inverted two (2) turn spins were effected in 1/4 to 1/2 turn with about 1500 feet loss in altitude before resuming level flight after the dive. Loss of altitude after a stall without power was found to be around 400 feet.

21. Armament tests were conducted on the two model F4F-3 airplanes at Anacostia. Airplane No. 1845 was equipped with two .30 caliber fuselage synchronized guns and two .50 caliber wing

guns. 100 rounds were fired on the ground from each of the guns. 1300 rounds were fired in flight from the .30 caliber guns. Results were satisfactory except that some difficulty was experienced with the left gun in commencing fire under acceleration apparently due to the failure of the solenoid to extract the plunger from the cam follower of the impulse generator. 2020 rounds were fired in flight from the two .50 caliber wing guns. Poor results were obtained in firing the wing guns at accelerations as low as 2g, believed due to friction at the mouth of the ammunition box. Installation of a large diameter roller to eliminate friction failed to improve gun operation. Installation of stronger driving springs were tried but these did not produce satisfactory results. As a result of discussion with the Bureau of Ordnance and Army technical personnel it was decided that improper timing of the guns was the cause of the gun failures. The guns were correctly timed and tested in flight in F4F-3 airplane No. 1848 which had four .50 caliber wing guns and no fuselage guns. Full ammunition allowances of 450 rounds were fired satisfactorily from each of the guns in flight maneuvers and in addition 550 rounds were fired above 30,000 feet at temperatures of minus 40 to 45 degrees Centigrade and during accelerations between 3 and 4g reached in sharp turns.

22. Bombs were released in flight from F4F-3 airplane No. 1845, as follows:

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Drop	Angle of Dive	I.A.S. (knots)	Remarks
1	70°	320	Mk.VII water-fillable bomb filled with water dropped from right side (Wt. 49½#). Tail vane dented under surface of wing.
2	80°	360	Mk.VII ballasted to 113# released from left side. Did not touch wing.
3	65°	330	Mk.IV, service type, sand-loaded to 116#, dropped from right side. Did not touch wing.
4	80°	340	Same as above but dropped from left side - did not touch wing.
5	80°	370	Dahlgren type "preventer" of .039 sheet installed on each rack. Two Mk. VII water-fillable bombs (39# each) dropped in salvo. Neither bomb struck wing but preventer on right side carried away after bombs were released. "Preventer" made of too light material.

23. Additional inspections and tests were carried out on the model F4F-3 airplane which are commented on as follows:

(a) Reference (q) indicated that comments of the trial board were desired on the question of additional bracing of the oil "out" line mentioned on page 57 of the Power Plant Inspection Report for Model F4F-3 Airplane, dated April 2, 1940. No difficulty was encountered with this line during trials and the installation appears to be satisfactory.

(b) Carbon monoxide tests conducted with the airplane as originally delivered showed excessive concentrations in various locations. After final modifications by the contractor the carbon monoxide content was below the allowable limit.

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(c) The stalling speed with minimum power for horizontal flight in the landing condition was approximately 8 mph below the stalling speed without power.

(d) The effect of the installation of the Mark III, Mod. 4 telescope sight on maximum speed was checked. From the results it is considered that the maximum speed with the sight installed is about 1/2 mph less than when the sight is not installed.

(e) The maximum speed with the four wing gun openings uncovered and guns installed as shown in enclosure (F) was found to be about 3 mph less than with gun covers installed.

(f) Reference (r) requests that an F4F-3 airplane be made available for propeller vibration tests. This will be handled by the Naval Air Station, Anacostia.

(g) Complete installation and inspection of GF radio equipment was carried out. Reports thereon have been forwarded to the Bureau of Aeronautics by reference (s).

(h) The position of the cowl flaps did not appear to affect the stall characteristics of the airplane.

24. Modifications in the model F4F-3 airplane which are considered necessary or desirable are covered below by recommendations, necessity and responsibility for incorporation being indicated as follows:

N - Necessary.
D - Desirable.
C - Contractor's responsibility.
G - Government's responsibility.

(a) General

(1) Improve longitudinal stability with free controls. See paragraph 9. DC

(2) Reduce carbon monoxide to acceptable values. NC
This has been done in No. 1845

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(3) Provide adequate cockpit ventilation. NC

(4) Eliminate possibility of moving fuel valve when operating flap controls. NC

(5) Provide means which will operate wing flaps at all altitudes. NC

(6) Improve lateral stability on the ground. DC

(7) Eliminate excessive draft in the cockpit with hood open. NC

(8) Eliminate high pitched note due to vibration of hood. NC

(b) Structure

(1) Improve brakes and reduce throw of brake pedals. NC

(2) Provide adequate strength and rigidity in cabin enclosure. NC

(3) Improve latches on movable hood eliminating extra latch on left side. NC

(4) Provide more durable tail wheel. NC

(5) Improve cowl flap control. NC

(6) Provide adequate strength and rigidity in ammunition box covers. NC

(7) Eliminate hinged doors at bottom of ejected link chute on right side. NC

(8) Eliminate binding or excessive friction in tab controls at low temperatures. NC
Rudder tab corrected by removing grease.

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(9) Provide leading edge covers for wing guns which can be fired through. For inboard guns streamline for high angle of attack. For outboard guns flush with leading edge. DC

(10) Improve fit of movable hood. NC

(11) Provide adequate strength and rigidity in cowling to eliminate distortion and cracking reported in reference (j). NC

(12) Provide landing gear retracting chains of adequate strength. NC

(c) Power Plant

(1) Make changes to give proper functioning of power plant, correcting:

(a) Roughness in neutral at full power.

(b) Rough operation in high blower at high altitudes when not at or near full throttle.

(c) Defective magnetos.

(d) Spark plug malfunctioning.

(2) Provide adequate cooling of cylinder heads and bases. NC

(3) Provide a satisfactory fuel quantity gauge for emergency fuel tank. DC.

(d) Fixed Equipment

(1) Eliminate interference between cockpit ventilator and right .30 caliber gun charging handle. NC

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(2) Provide outside air temperature gauge with low temperature range to -60°C. DG

(3) Move microphone holder to position on shelf outboard of radio receiver tuner. NC
Done on test airplane No. 1848.

(4) Eliminate interference between fire extinguisher handle and air temperature gauge. NC

(5) Eliminate interference with battery switch when operating cowl flaps. NC

(6) Make changes recommended in reference (o) as follows:

(A) Part V - page 16

1. Change location of arresting hook operating handle to preclude possibility of fouling pilot's arm on executing "cut signal".

2. Change specifications of hook as suggested in H2 and 4 of discussion. Refer to NAF Conf. ltr. VX4D4/VF4F-3/F8(15659) dated 31 December 1940.

3. Install approach lights on under side of left horizontal stabilizer as suggested in F-8 of discussion.

4. Enlarge and reverse barrier hooks mentioned in discussion C-5.

5. Increase size of dashpot holding bolt to avoid a possible failure.

6. Include in maintenance manual proper compressions for tail wheel strut.

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(B) Part VII - page 23

C-5

It is recommended that the point of the attachment of the "Catapult Hold Back and Release Unit" to the tail release shackle on the rear landing gear structure be lowered to a position not higher than the center of the tail wheel.

It is further recommended that the clearance between the low rear point of the fuselage structure and the deck, when the rear landing gear is fully bottomed, be increased by at least one inch.

An alternate recommendation, more acceptable from the operations standpoint is to provide a tail release shackle at the lower after end of the fuselage tail cone. If this is done, the present clearance between the low rear point of the fuselage structure and the deck with the landing gear bottomed will be satisfactory.

(e) Useful Load

(1) Provide stainless steel roller about 2-3/4" diameter for each wing gun ammunition box to guide belt into the feed chute.

(2) Provide means of removing barrel and barrel extension of two outboard guns for servicing without removing gun receivers from their mounts.

(3) Provide means of installing camera gun.

(4) Provide means of boresighting camera gun.

(5) Provide means of bore sighting guns to positions required in specifications.

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25. Model F4F-3 airplane No. 1845 fulfilled the contract guarantees of weight empty, service ceiling, and take-off; substantially met the guarantee of minimum speed without power; and failed to comply with the maximum speed guarantee. The performance characteristics of the model F4F-3 airplane under the two conditions in which tested are shown in enclosure (G).

26. The Board recommends that the model F4F-3 airplane, with modifications incorporated correcting the defects covered by recommendations in paragraph 24, be considered acceptable as a service type for use aboard aircraft carriers at gross weights up to 7480 pounds.

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Model F4F-3 -
No. 1845

AN-55836
9-19-40

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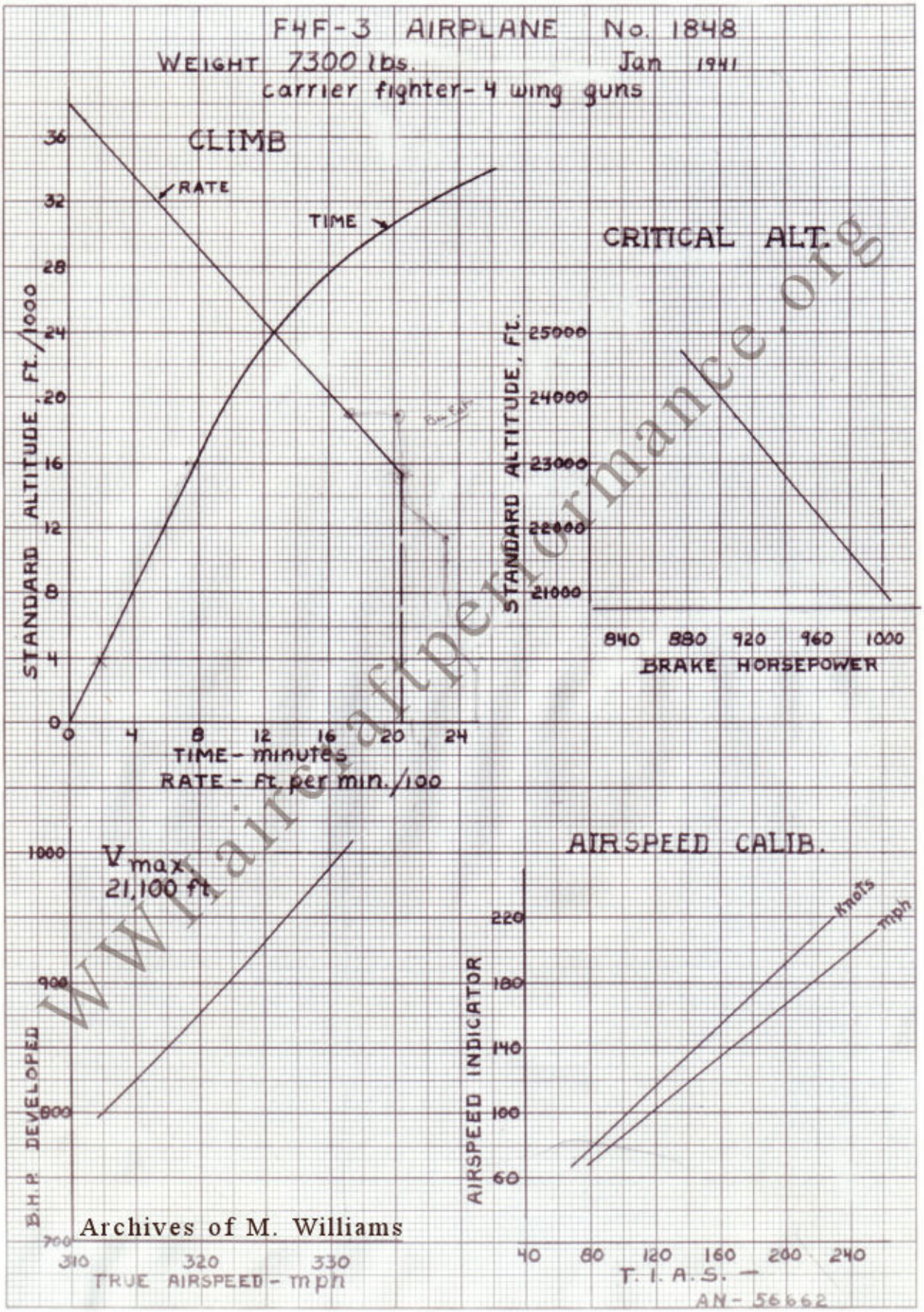

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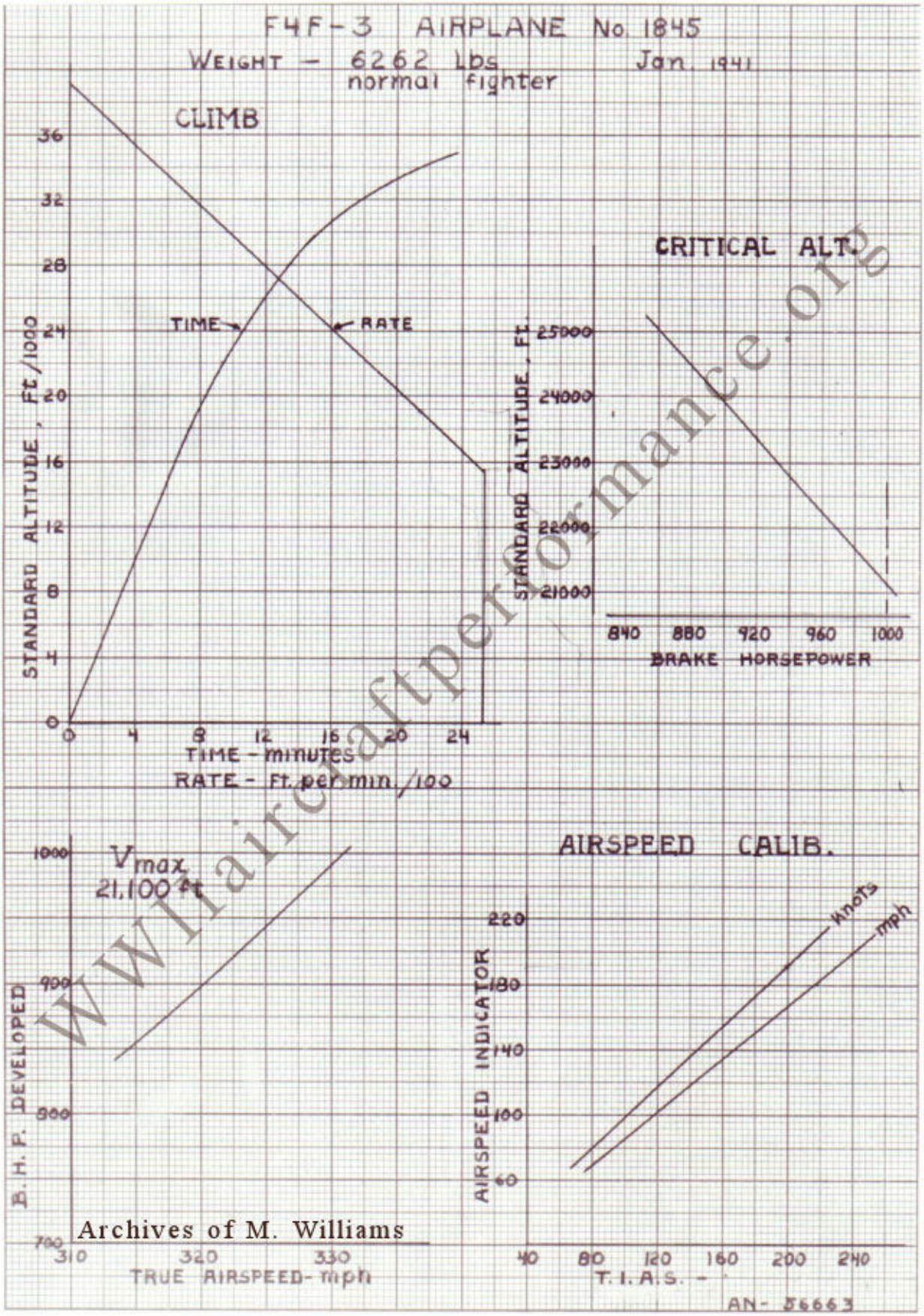

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