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

# FINAL FLIGHT REPORT

of

SERVICE ACCEPTANCE TRIALS
(TED NO. BIS 2143)

on

MODEL XF7F-1 AIRPLANE
(Contract NOa(s)-645)

held

9 DECEMBER 1943 to 15 APRIL 1945

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-JMC, C-NOa(s)-645 C28180, dated 3 Dec 1943.

(b) BuAer conf. ltr. Aer-E-211-DA, C-NOa(s)-645, C29314, dated 17 Dec 1943.

(c) BuAer conf. ltr. Aer-E-211-JCM, C14505, dated 1 June 1944.

(d) BuAer conf. memo. Aer-E-11-WES, dated 22 June 1944.

(e) BuAer ltr. Aer-E-11-LWC, 138698, dated 9 Aug 1944.

(f) BuAer msg. 09TWX1549 Sept 1944.

(g) BuAer conf. spdltr. Aer-E-413-CCS, C28899 dated 23 Oct 1943.

(h) BuAer msg. 152354 Dec 1944.

(i) BuAer msg. 150105 Feb 1945.

(j) NAS Patuxent River conf. memo. NA83 VXF7F-1 (FT) (150) dated 10 Dec 1943.

(k) NAS Patuxent River conf. report NA83, VXF7F-1 (FT) (44001) dated 8 Jan 1944.

(l) NAS Patuxent River conf. prelim. report NA83/44158 VF7F-1/BIS 2143 FEE/vba (FT) dated 7 Aug. 1944.

(m) NAS Patuxent River conf. spdltr. NA83/SL 60-44 VF7F-1 BIS 2143 dated 9 Sept 1944.

(n) NAS Patuxent River conf. spdltr. NA83/SL 64-44 VF7F-1 BIS 2143 dated 15 Sept 1944.

(o) NAS Patuxent River conf. spdltr. NA83/SL 72-44 VF7F-1 BIS 2143 CFK/vba (FT) dated 10 Oct 1944.

(p) NAS Patuxent River restr. spdltr. NA83/SL 79-44 VF7F-1 BIS 2143 NEH/vba (FT) dated 27 Oct 1944.

(q) NAS Patuxent River conf. spdltr. NA83/SL 77-44 VF7F-1 BIS 2143 CFK/vba (FT) dated 28 Oct 1944.


Model F7F-1 No. 80262 3/4 right front clean

Photo PTR 22532 4-6-45

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(r) NAS Patuxent River conf. spdltr. NA83/SL 13-45 VF7F-1 BIS 2143 NEH/vba (FT) dated 1 Feb 1945.

(s) NAS Patuxent River msg 160019 March 1945.

(t) NAS Patuxent River conf. spdltr. NA83/SL 37-45 VXF7F-1 BIS 2143 CFK/vba (FT) dated 19 April 1945.

(u) NAS Patuxent River restr. report NA83/VF7F-1/BIS 2143 PTH/mbw (FT) ser. 996 dated 16 May 1945.

(v) SD-294-1A, Detail Spec. for model XF7F-1 airplane, dated 12 March 1943.

(w) SD-294-1B, Detail Spec. for model F7F-1 airplane, dated 20 Oct 1944.

(x) BuAer conf. spdltr. Aer-E-11-LWC, 189755, dated 6 Nov 1944.

(y) BuAer conf. ltr. Aer-E-211-JCM, C05076, dated 19 Feb. 1945.

(z) BuAer msg. 02TWX1748 Oct 1944.

(aa) BuAer msg. 212118 Dec 1944.

(ab) NAS Patuxent River Recommended Change or Report of Trouble on model F7F-1 airplane NOS. 80262 and 80263, Items No. 1 to No. 43, dated 15 Sept 1944 to 18 May 1945.

(ac) BuAer restr. msg. 071850 Feb 1945.

(ad) BuAer restr. msg. 170343 Feb 1945.

(ae) BuAer conf. ltr. Aer-E-211-JCM C05077 dated 19 Feb 1945.

(af) BuAer conf. memo. Aer-E-11-LWC, C19838, dated 24 July 1944.

(ag) BuAer Change Request Aer-E-11-LWC, dated 22 Aug 1944.

(ah) NAS Patuxent River conf. spdltr. NA83/SL 61-44 VF7F-1 BIS 2143 dated 9 Sept 1944.

(ai) BuAer msg. 12TWX 2143 Oct 1944.

(aj) NAS Patuxent River conf. memo. NA83/44219 VF7F CTB/alw (FT) dated 30 Sept 1944.

(ak) BuAer spdltr. Aer-E-422-EAM 176485 dated 13 Oct 1944.

(al) NAS Patuxent Recommended Change or Report of Trouble on model F7F-1 airplane No. 80260, Items No. 1 to No. 24 dated 4 Aug 1944.

(am) NAS Patuxent River msg. 121913 Feb 1945.

(an) Contract NOa(s)-645 dated 4 June 1943.

(ao) Pratt & Whitney R-2800-27 Engine Calibration Curves T-775 and T-776, dated 5 Aug. 1941 and 15 Aug 1941.

(ap) Grumman AEC Weight & Balance Report No. 2637D dated 12 April 1944.

(aq) NAMC Philadelphia Prelim. Report No. 3 on Project TED No. NAM-04103 dated 6 June 1944.

(ar) NAMC Philadelphia Prelim. Report No. 8 on Project TED No. NAM-04103 dated 5 Jan 1945.

(as) NAMC Philadelphia Prelim. Report No. 9 on Project TED No. NAM-04103 dated 1 Mar 1945.

(at) NAS Patuxent River Recommended Change or Report of Trouble on model XF7F-1 airplane No. 03549, Items No. 1 to No. 12, dated 7 Jan to 14 Jan 1944.

(au) NAS Patuxent River Recommended Change or Report of Trouble on model F7F-1 Airplane No. 80281, Item No. 1 dated 10 Nov 1944.

(av) NAS Patuxent River conf. spdltr. NA83/SL 71-44 VF7F-1 BIS 2143 NEH/vba (FT) dated 10 Oct 1944.

## INTRODUCTION

1. Reference (a) established this project and requested brief evaluation of the first model XF7F-1 airplane No. 03549, to consist of inspections and tests of the fixed gun installation. Reference (b) requested that the evaluation be extended to include brief tests of the performance, stability, controllability and take-off characteristics of the airplane. Reference (c) outlined a complete program for Service Acceptance trials which was to include fuel consumption tests, performance tests with and without water injection, flame damping tests, performance tests with droppable tanks installed, and release tests of droppable tanks. Reference (d) allocated the two model XF7F-1 airplanes and the first seven model F7F-1 airplanes for the test program, of which model F7F-1 airplanes No. 80260, No. 80262, No. 80263, and No. 80266 were used by Flight Test. Additional tests were requested in reference (e), (f), (g), (h) and (i). Preliminary data obtained during the trials were reported in references (j) to (u), inclusive.

Model XF7F-1 airplane No. 03549 was the first experimental airplane. It was designed according to reference (v) by the Grumman Aircraft Engineering Corp., Bethpage, N.Y., as a twin-engine, single-seat, tricycle-landing gear, landplane fighter for shipboard operation. It was powered by Pratt and Whitney model R-2800-27 ("B" Series) engines, which were not used thereafter in either the second model XF7F-1 or the model F7F airplanes. For this reason the data reported on this airplane in reference (j) and reference (k) are not comparable to data obtained on the several other airplanes used during the trials. Photographs of the airplane are included in enclosure 3. Model F7F-1 airplane No. 80260 was the second production article, designed according to reference (w) and was substantially similar to model XF7F-1 airplane No. 03549 except that it was equipped with Pratt and Whitney model R-2800-22W ("C" Series) engines and Hamilton Standard three-bladed propellers of 13 ft. 2 in. diameter (blade design No. 6501A-0, hub design No. 33E60-41). Airplanes No. 80262 and No. 80263 were the fourth and fifth production articles, respectively, and were similar to airplane No. 80260 except that an additional 60 gallon fuel tank was installed in the forward fuselage section of each airplane. Airplane No. 80266 was the eighth production article, but was altered by the contractor in the following respects:

(a) Elevator throw upward increased 5 degrees.

(b) Elevator control linkage adjusted to give less mechanical advantage.

(c) Revised aileron contour and modified aileron spring tabs.

(d) Power of hydraulic rudder control boost decreased to approximately 70% of its original value.

(e) Lost motion in rudder control system eliminated by addition of springs in the system.

(f) Outer wing panels drooped to zero degrees dihedral angle.

(g) Vertical fin area increased 7 1/2%.

Type AN/ARC-5 MHF, AN/ARC-5 VHF, AN/ARR-2, and AN/APN-1 antennas were installed on airplanes Nos. 80260, 80262, 80263 and 80266. Photographs of the model F7F-1 airplane are included in enclosure 3.

Model XF7F-1 airplane No. 03549 was received from Bethpage, N. Y., on 9 December 1943 for brief evaluation. Such evaluation was made and reported in reference (k). The airplane was transferred to Armament Test, NAS Patuxent River, on 28 December 1943.

Airplane No. 80260 was received from Bethpage, N. Y., on 28 June 1944, for evaluation of flight and handling characteristics. Appropriate tests were conducted and a preliminary report thereon submitted in reference (l). The airplane was transferred to Radio Test, NAS Patuxent River, on 9 August 1944.

Airplane No. 80262 was received from Bethpage, N. Y., on 9 August 1944 for performance tests, which were initiated immediately. The airplane was received with propeller spinners installed, and was tested in that configuration until receipt of reference (k) which authorized the removal of the spinners from all production airplanes. Reference (p) outlined maintenance complications caused by the spinner installation and explained delay in obtaining comparative performance data on this airplane with and without spinners installed, requested by reference (e). Tests were continued with spinners removed until receipt of reference (y) which cancelled the project. A summary of performance data obtained was submitted in reference (t).

Airplane No. 80263 was received from Bethpage, N. Y., on 29 August 1944 for fuel consumption, temperature survey and combat power tests. Temperature survey tests were initiated immediately, but were suspended after a few flights because of unsatisfactory engine operation. The engine trouble was described and the brief temperature survey data obtained were submitted in reference (o). In compliance with reference (z) the airplane was temporarily transferred to NAMC, Philadelphia, on 4 October 1944 for carburetor and surge tests. On 4 January 1945 the airplane was returned to Flight Test for resumption of tests in accordance with reference (aa). Tests were resumed, but before any data could be obtained an engine failure occurred as reported in item 32 of reference (ab). Reference (ac) was received shortly thereafter stating that cooling and fuel consumption data obtained on model R-2800-34W engines would be considered satisfactory for applying to all model F7F-1 and F7F-2 airplanes. Reference (ad) directed that model R-2800-34W engines be installed in the airplane in place of the original model R-2800-22W engines. Temperature survey tests were then conducted with the new engines and results were submitted in reference (u). Fuel consumption tests are presently under way and will be reported separately upon completion. Cooling and fuel consumption data obtained during these tests will be used where applicable in connection with project BIS 2175, as recommended in reference (ae).

Airplane No. 80266 was modified by the contractor in accordance with reference (af) and reference (ag) in an attempt to remedy the deficiencies in flight and handling characteristics noted in reference (l). Reference (ah) requested that the airplane be sent to Flight Test for evaluation of the modifications. The airplane was received from Bethpage, N. Y., on 28 September 1944 and appropriate tests were conducted. On 14 October 1944 the airplane was returned to Bethpage in compliance with reference (ai). Results of the evaluation were reported informally in reference (aj).

Lengthy delays in the progress of the tests on all of the model F7F-1 airplanes were caused by unsatisfactory power plant operation, described in reference (ak), (m), (o), (p), items 1 and 2 of reference (al), and item 15 of reference (ab). Routine test flights were repeatedly delayed or postponed for experimental and check flights directed toward elimination of these power plant difficulties.

Attention is invited to the fact, reported by reference (am), that the contractor has not yet completed final demonstration of the airplane as required by reference (an).

## PURPOSE OF TEST

The Service Acceptance Trials covered by this report were conducted to determine the following:

(a) Performance and handling characteristics of the model XF7F-1 airplane.

(b) General suitability of the model XF7F-1 airplane for service use as a shipboard fighter aircraft.

## METHOD OF TEST

The performance data were obtained and reduced to standard conditions in accordance with established Flight Test methods. Engine power was measured by means of torquemeters installed on each engine except on model XF7F-1 airplane No. 03549, where engine power was estimated from power curves in reference (ao). In determining full throttle performance the brake horsepower per engine delivered was taken as the average power delivered by the two engines.

Model XF7F-1 airplane No. 03549 was loaded by the contractor before delivery to the predicted normal fighter loading of the production airplane, and was tested in that condition. The model F7F-1 airplanes were loaded in accordance with references (v), (w) and (ap), the contractor's actual weight and balance report for the first production airplane. The following table summarizes the loadings of the several airplanes:

| | | | | |
|---|---|---|---|---|
| Loading............... | Normal Fighter | Normal Fighter | Normal Fighter | Normal Fighter |
| Model................. | XF7F-1 | F7F-1 | F7F-1 | F7F-1 |
| Airplane No........... | 03549 | 80260 | 80262 | 80263 |
| Detail Spec........... | SD-294-1A | SD-294-1B | SD-294-1B | SD-294-1B |

| Airplane No. (Cont'd) | 03549 | 80260 | 80262 | 80263 |
|---|---|---|---|---|
| Para. from Detail Spec. | 104a | 104a | 104a | 104a |
| Gross Weight - lbs. | 19965 | *20,893 | *21,441 | *21,558 |
| Useful Load - lbs. | 4780 | 5428.1 | 5788.1 | 5788.1 |
| Useful Load - % Gross Wgt. | 23.9 | 26.0 | 27.0 | 26.9 |
| Weight Empty - lbs. | 15185 | *15465 | *15653 | *15770 |
| Wing Loading - lb/sq. ft. | 43.2 | 45.9 | 47.1 | 47.4 |
| Take-off Power Loading - lb./BHP. | 4.91 | 4.97 | 5.11 | 5.13 |
| Center of Gravity Location - % MAC: | | | | |
| Gear down | 25.4 | 26.9 | 24.5 | **26.1 |
| Gear up | 26.9 | 28.3 | 25.8 | **27.5 |

*Note: The empty weight and gross weight figures given here are without propeller spinners. The spinner installation increases the gross weight 102 lbs. and moves the c.g. forward 0.3% MAC.

**Note: The c.g. of airplane No. 80263 was aft of the normal position, as determined in airplane No. 80262, because of special test equipment which was installed in the after fuselage section. Ballast equal to the weight of this equipment was removed from the useful load ballast in order to maintain proper gross weight, but it was impossible to maintain normal c.g. location.

Detailed Useful Load:

| Airplane No. | (03549) | (80260) | (80262) | (80263) |
|---|---|---|---|---|
| Pilot - lbs. | 200 | 200 | 200 | 200 |
| Fuel: | | | | |
| Main - gals/lbs. | 185/1110 | 210/1260 | 210/1260 | 210/1260 |
| Reserve - gals/lbs. | 156/936 | 156/936 | 156/936 | 156/936 |
| Auxiliary - gals/lbs. | --- | --- | 60/360 | 60/360 |
| Trapped - gals/lbs. | 3.7/22 | 3.7/22 | 3.7/22 | 3.7/22 |
| Oil: | | | | |
| Tanks - gals/lbs. | 34/255 | 24/180 | 24/180 | 24/180 |
| Trapped - gals/lbs. | 24.5/184 | 23.2/174 | 23.2/174 | 23.2/174 |
| A.D.I. Fluid - gals/lbs. | --- | 32/239 | 32/239 | 32/239 |

| | | | | |
|---|---|---|---|---|
| .50 cal. gun instal. (4 guns) - lbs...... | 397.6 | 401.2 | 401.2 | 401.2 |
| .50 cal. ammo. - rds/lbs................ | 1200/360 | 1200/360 | 1200/360 | 1200/360 |
| 20 mm. gun instal. (4 guns) - lbs...... | 581.2 | 584.4 | 584.4 | 584.5 |
| 20 mm. ammo. - rds/lbs................ | 800/520 | 800/520 | 800/520 | 800/520 |
| Illuminated sight - lbs................ | 4.3 | 3.8 | 3.8 | 3.8 |
| Trigger Switch........ | 1.0 | 1.0 | 1.0 | 1.0 |
| Pyrotechnics.......... | 4.9 | 4.9 | 4.9 | 4.9 |
| Navigating equip. - lbs................ | 3.9 | 3.9 | 3.9 | 3.9 |
| Life raft - lbs....... | 14.0 | 16.0 | 16.0 | 16.0 |
| Emergency equip. - lbs................ | 13.0 | 13.0 | 13.0 | 13.0 |
| Oxygen equip. -lbs... | 25.5 | 25.5 | 25.5 | 25.5 |
| Radio & Radar - lbs.. | 143.1 | 478.9 | 478.9 | 478.9 |
| Gun Camera........... | 4.5 | 4.5 | 4.5 | 4.5 |

Airplane No. 80266 was ballasted to approximately the normal fighter loading, giving the following gross weight and c.g.

| | |
|---|---|
| Gross weight - lbs......... | 21,392 |
| c.g. location, % MAC: | |
| Gear up.............. | 26.4 |
| Gear down............ | 25.0 |

RESULTS OF TESTS

1. Performance as Normal Fighter.

A. Model XF7F-1 airplane No. 03549: This data must be segregated from all succeeding data since this airplane was equipped with model R-2800-27 engines. Performance curves are shown in photo PTR 2173, enclosure 1, and are summarized as follows:

(1) Maximum speed (high blower)

| | | |
|---|---|---|
| Power........................ | Normal | Military |
| Airplane Critical Alt. - ft... | 20,100 | 19,600 |
| Vmax at ACA - MPH............ | 397 | 402 |

(2) Service Ceiling - ft. 35,500

(3) Maximum rate of climb
at Sea Level - FPM.......... 3,200

(4) Calibrated airspeed at stall - MPH:
Clean condition, power on.........114.0
Clean condition, power off........119.0
Landing condition, power on....... 86.0
Landing condition, power off......103.0

(5) Take-off performance (full flap)
Calibrated airspeed at take-off -
MPH............................ 86.0
Distance, zero wind - ft.......... 570
Distance, 25 knot wind - ft....... 270

B. Model F7F-1 Airplane No. 80262 (except as noted). Performance curves are shown in enclosure 2 and may be summarized as follows:

(1) Maximum speed (high blower)

| | | |
|---|---|---|
| Power rating.................. | Normal | Military |
| Brake horsepower per engine.... | 1,450 | 1,600 |
| Airplane Critical Altitude - ft.......................... | 24,000 | 23,500 |
| Maximum speed at ACA - MPH..... | 421 | 433 |

(2) Service Ceiling - ft.......... --- 39,700

(3) Maximum rate of climb at sea
level - FPM................. 4,250

*(4) Calibrated airspeed at stall, MPH:
Clean condition, power on........107.0
Clean condition, power off.......118.5
Landing condition, power on...... 85.5
Landing condition, power off.....104.0

*(5) Take-off characteristics:

| | | |
|---|---|---|
| Airplane No........... | 80262 | 80266 |
| Gross weight - lbs.... | 21545 | 21392 |
| Calibrated airspeed at take-off-MPH..... | 91.0** | 81.5** |
| Distance, zero wind - ft.................. | 735 | 555 |
| Distance, 25 knot wind - ft.................. | 365 | 245 |

*Note: Airplane No. 80262 had propeller spinners installed during stalling speed and take-off measurement. During all other performance tests reported above the spinners were removed.

**Note: Up elevator travel on airplane No. 80262 was 27°; on airplane No. 80266 it was 32°.

(6) Maximum speed in low blower using one engine:

| | |
|---|---|
| Power.............................. | Military |
| Brake Horsepower................... | 2,100 |
| Airplane Critical Altitude - ft... | 8,400 |
| Maximum speed at ACA - MPH......... | 309.0 |

(7) Service Ceiling in low blower using one engine (full useful load at a take-off - gross weight of 21,441 lbs.) - ft.............. 18,300

(8) Maximum rate of climb at sea level using one engine at military power - FPM.......................... 1,410

2. Stability and Control Characteristics.

(A) Model XF7F-1 airplane No. 03549.

The airplane was stable about the three axes, controls free and fixed, except that the longitudinal stability became neutral to negative above medium cruise power in clean condition, level flight, and the directional stability at slow speeds in the landing condition was insufficient for operation with widely divergent power output between the two engines. Control forces were very light for all three controls, except that elevator forces became high near full deflection when making carrier-type take-offs. Pronounced aileron buffet was encountered when full aileron displacement was approached. Control effectiveness about all axes appeared to be adequate, although marginal laterally in the landing condition.

(B) Model F7F-1 airplane No. 80260.

Elevator control force versus acceleration was measured in steady accelerated turns at several different loadings to evaluate the maneuvering (free control) longitudinal stability in the clean condition. Data obtained are tabulated below. By extrapolation of these data the c.g. location at which the stick force per "g" drops to the minimum allowable limit of 3.0 lbs/g was found to be 29% MAC, and the maneuvering neutral point, where the stick force per "g" reaches 0, was found to be 37% MAC.

| Gross Wgt. lbs. | c.g. loc. % MAC | Vi- Kts. | Alt.- ft. | BHP/ Eng. | RPM | Stick Force lb./g |
|---|---|---|---|---|---|---|
| 20,013 | 27.1 | 215 | 10,000 | 890 | 1800 | 3.8 |
| 19,833 | 26.6 | 215 | 10,000 | 990 | 2000 | 3.9 |
| 19,992 | 25.4 | 215 | 14,000 | 915 | 2000 | 4.4 |
| 19,752 | 24.7 | 270 | 12,500 | 1450 | 2600 | 4.7 |

Measurements of stick-free and stick-fixed static longitudinal stability were made by establishing trim speed for a certain power, then determining the stick force and stick displacement necessary to attain speeds above and below this speed without changing trim or power. Curves of data obtained in the clean condition are shown in photo PTR Nos. 23684 and 23685, enclosure 2. Similar measurements were made in the landing condition at slow speeds with power off to determine elevator effectiveness. Data obtained in this condition were as follows:

Condition I: Full nose-up trim, c.g. =24.8% MAC, power off, landing condition.

| Vi - Kts. | Stick Force - lbs. | | *Stick displ.-in. |
|---|---|---|---|
| 98 (trim speed) | 0 | (pull) | 9.5 |
| 90 | 4.4 | (pull) | 10.2 |
| 80 | 10.5 | (pull) | 12.3 |
| 73 (stall speed) | 13.3 | (pull) | 14.0 |

Condition II: Full nose-up trim, c.g.= 22.3% MAC, power off, landing condition.

| Vi - Kts. | Stick Force-lbs. | | *Stick displ.-in. |
|---|---|---|---|
| 114 (trim speed) | 0 | (pull) | 9.1 |
| 100 | 8.7 | (pull) | 10.3 |

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Condition II: (Cont'd).

| Vi - Kts. | Stick Force-lbs. | *Stick displ.-in. |
|---|---|---|
| 90 | 12.8 (pull) | 11.5 |
| 85 | 19.8 (pull) | 13.5 |
| 75 (no stall) | 23.3 (pull) | 15.5 (full aft) |

*Note: Full forward position = 3.5 in.; full aft = 15.5 in.

The airplane had very weak directional stability in combination with strong lateral stability. The rudder was highly effective and incorporated a hydraulic boost system, so that rudder control forces were extremely light and large angles of yaw could be attained with exertion of light rudder forces. The strong lateral stability produced strong rolling moments in yawed flight, resulting in a tendency for the airplane to "Dutch Roll" continually as the rudder was deflected and released. The condition was further aggravated by high aileron control forces and the ineffectiveness of the ailerons in preventing the roll due to yaw. In level flight yaw, full aileron was necessary to balance only 40% of full throw of opposite rudder, and sufficient rudder power remained to roll the airplane 360 degrees against the ailerons.

Lateral control effectiveness was unsatisfactory in all conditions. The rate of roll in the landing condition at 90 knots $V_i$, using ailerons only, was found to be 17.5 deg/sec. in going from a 45 deg. left bank to a 45 deg. right bank, and 20.5 deg/sec. in going from a 45 deg. right bank to a 45 deg. left bank. Full aileron deflection was used, requiring a stick force of 23 lbs. It was found that the rolling velocity could be increased to approximately 36 deg/sec. by using large rudder deflections in combination with full aileron deflection. However, the roll resulting from this technique was violent and uncontrollable; on one occasion, with full aileron and full rudder deflection the airplane rolled through 540° before recovery could be effected. In the clean condition, abrupt use of rudder in coordination with ailerons also developed a higher but violent and tactically unusable rolling velocity. The rate of roll was measured in the clean condition at 200 knots $V_i$ with the following results:

| Angle of Roll-deg. | Rate of Roll deg/sec. Left | Right | Stick Force -lb. Left | Right | Method |
|---|---|---|---|---|---|
| 90 | 40 | 47 | 31 | 33 | Full ailerons only |
| 360 | 44 | 50 | | | Full ailerons only |
| 360 | | 107.5 | | | Full ailerons and full rudder |

Single engine operation at low speeds was extremely difficult because of the weak directional stability. It was found that, with only one engine in operation, a minimum speed of 120 knots indicated airspeed was necessary to maintain satisfactory control for level flight (wings level) in the clean condition, and that 130 knots indicated airspeed was necessary in the landing condition with full ailerons and full rudder against the yaw and roll caused by asymmetric power.

C. Airplane No. 80262.
Rate of roll was measured on this airplane equipped with the redesigned ailerons first evaluated on airplane No. 80266. The following data were all obtained at 10,500 feet, using full aileron deflection and keeping the rudder fixed:

| Vi-Kts. | Vt-MPH | Condition | Angle of Roll-deg. | Rate of Roll deg/sec. Left | Right | Pb/2V Left | Right |
|---|---|---|---|---|---|---|---|
| 200 | 267.5 | Clean | 360 | 41 | 50 | .047 | .057 |
| 240 | 314 | " | " | 48 | 57 | .047 | .056 |
| 280 | 361 | " | " | 49 | 60 | .042 | .051 |
| 110 | 129 | Land. Cond. | 60 | 16 | 15 | .038 | .036 |
| 90 | 108.5 | " | 60 | 14 | 14 | .040 | .040 |

Stalling speeds were measured in this airplane with propeller spinners installed. Longitudinal buffeting of the airplane as the stall was approached provided ample stall warning. At the stall, in all conditions, the airplane pitched forward with no abnormal rolling tendencies, and recovery was accomplished without difficulty. The airplane sank rapidly with power off and the lack of sufficient elevator throw made it difficult to obtain stalls in landing condition, power off. Lateral control at or near the stall was unsatisfactory.

D. Airplane No. 80266.
The 5 degree increase in elevator throw improved considerably the controllability of the airplane in landing condition, power off. A comparison of the take-off characteristics of this airplane and airplane No. 80262 is given under performance results. The decreased mechanical advantage of the elevator control system increased the control force to approximately 5 lbs./g at 215 kts. Vi, gross weight = 20,755 lbs., c.g. = 27.9% MAC, altitude = 15,000 ft.

Aileron control forces were reduced with the revised aileron design and rudder control forces were increased by decreasing the power of the hydraulic boost system. Also, the lost motion in the rudder controls was eliminated. These changes greatly improved the handling qualities of the airplane by achieving a more normal balance of the control forces.

The decreased dihedral of the outer wing panels had little or no effect on the strong lateral stability of the airplane. The 7 1/2% increase in vertical fin area strengthened the directional stability only very slightly and did not produce adequate directional stiffness.

3. Temperature Survey (Airplane No. 80263)

Limited tests on this airplane with model R-2800-22W engines installed indicated that cylinder head and base temperatures were well within specified limits. Data obtained were reported in reference (o). Oil in temperatures were consistently excessive, as reported in reference (ah).

Tests conducted on the airplane with model R-2800-34W engines installed were reported in reference (u). It was found that cylinder head and base temperatures were satisfactory under all conditions tested. Oil cooling was marginal at high altitude in military power, climbing flight, and at sea level in military power, level flight. Accessory compartment temperatures were 9°C. over the specified limit (60°C.) at sea level in military power, level flight, were marginal at sea level in maximum cruise power, level fight, and were marginal in military power, climbing flight, exceeding the limit by 4°C at 34,000 feet. Fuel line temperature at the entrance to the accessory compartment was marginal at sea level in military power, level flight.

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The carburetor air temperature rise when using alternate air exceeded the 28°C limit in both military and maximum cruise powers. The following values were obtained:

| Altitude | Blower | Power | CAT rise - using Alt. air °C Port | Stbd. |
|---|---|---|---|---|
| 10,000 | Low | Military | 33 | 34 |
| 10,000 | Low | Max.Cruise | 35 | 39 |
| 22,000 | High | Military | 48 | 48 |
| 22,000 | High | Max.Cruise | 52 | 59 |

It was found that the cylinder head temperature of No. 14 cylinder gave the most representative reading of maximum cylinder head temperature for various power and speed combinations.

4. Miscellaneous Tests

A. Night visibility tests of exhaust flames were conducted with several types of flame dampers installed, and were reported in reference (q), (r) and (s). None of the types of dampers tested satisfactorily reduced the night visibility of the exhaust flames.

B. Reference (g) requested power readings during take-off to establish proper manifold pressure settings for rated take-off power. Following are representative figures (given as port/stbd.), obtained on airplane No. 80262:

| | | | | |
|---|---|---|---|---|
| Ground press.- in Hg......... | 30.20 | 30.20 | 30.08 | 30.18 |
| Outside air temp. - °C.......... | 11 | 1 | 5 | 2 |
| Torque press. - lb/sq in....... | 120/120 | 120/120 | 118/118 | ---/120 |
| Brake horse- power......... | 2135/2135 | 2135/2135 | 2100/2100 | ----/2135 |
| RPM............ | 2800/2800 | 2800/2800 | 2800/2800 | 2800/2800 |
| Manifold press.- in. Hg........ | 53/53 | 52/53 | 53/52 | 52/52 |
| Carburetor deck press.-in.Hg.. | 30.5/30.5 | 30.5/30.5 | 30.5/30.5 | 31/31 |
| Carburetor air temp.-°C. | 18/18 | 5/5 | 15/15 | --- |

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| | | | | |
|---|---|---|---|---|
| Fuel rate lb/hr.. | 1650/1800 | 1600/1800 | --------- | -------- |
| Cyl.head temp.- °C............. | 160/160 | 190/175 | 175/175 | 160/160 |

The torque pressure for rated take-off power is 118 lb/sq. in. The manifold pressure necessary to obtain rated take-off power never exceeded 53 in. Hg.

DISCUSSION

1. Engine ratings used during the trials for the model R-2800-22W engine were obtained from reference (aq) as follows:

| Blower | Altitude-ft. | Brake Horsepower | RPM | Manifold Pressure -in. Hg. |
|---|---|---|---|---|
| | | Normal Power (Auto Lean Mixture) | | |
| Low | 8200 | 1700 | 2600 | 41.5 |
| High | 18300 | 1450 | 2600 | 41.5 |
| | | Military Power (Auto Lean Mixture) | | |
| Low | 4000 | 2100 | 2800 | 52.5 |
| High | 16400 | 1600 | 2800 | 48.5 |
| | | TAKE-OFF POWER (AUTO RICH MIXTURE) | | |
| Low | S.L. | 2100 | 2800 | 55.5 |

It was found during the tests that rated power for the various blower - RPM combinations could be obtained using less than specified manifold pressure. These discrepancies were due to changes in efficiency factors explained in reference (g), caused by the fact that operating cylinder head temperatures of the engines installed in the model F7F-1 airplane were considerably lower than those used during the engine calibration reported in reference (aq).

2. Engine ratings used during the trials for the model R-2800-34W engine were obtained from references (ar) and (as) as follows:

Normal Power (auto lean mixture)

| Blower | Altitude-ft. | Brake Horsepower | RPM | Manifold Press. -in Hg. |
|---|---|---|---|---|
| Low | 8,400 | 1700 | 2600 | 41 |
| High | 18,300 | 1500 | 2600 | 42 |
| | | Military Power (auto rich mixture) | | |
| Low | 3,300 | 2100 | 2800 | 53 |
| High | 16,700 | 1700 | 2800 | 49.5 |
| | | Take-off Power (auto rich mixture) | | |
| Low | S.L. | 2100 | 2800 | 53.5 |

As on the R-2800-22W engines, less than specified manifold pressure was necessary to obtain rated powers from the R-2800-34W engines.

3. References (m), (o), (p), item 15 of reference (ab), reference (ak), and items 1 and 2 of reference (al) dealt with the engine surging which was encountered in all of the model F7F-1 airplanes delivered for use in connection with the trials. It is believed that this surging was first reported by Flight Test in July 1944. The surging was discovered during stability and control tests on model F7F-1 airplane No. 80260, and was described as rhythmic fluctuations of manifold pressure, RPM, and torque pressure occurring in all flight attitudes and at all power settings at any altitude above approximately 18,000 feet. With the fuel booster pump in operation fuel delivery pressure was steady at approximately 17 lb/sq.in and nozzle discharge pressure was steady at approximately 5.5 lb/sq.in. The amplitude of the fluctuations was not consistent from flight to flight and could usually be decreased somewhat by enriching the mixture. Since peak engine performance was not essential for stability and control tests no remedial measures were taken with this airplane. When airplanes No. 80262 and 80263 were received for performance evaluation it became apparent that no data could be obtained at high blower critical altitude or above until the engine surging was eliminated. Accordingly, airplane No. 80263 was sent to the Aeronautical Engine Laboratory, Philadelphia, for a systematic investigation of carburetor and fuel system characteristics. Meanwhile airplane No. 80262 was retained at Flight Test and a series of trial "fixes" recommended by BuAer representatives and other

cognizant personnel was tested. The modification finally adopted, known as the "AEL fix", involved heavier discharge nozzle springs in the carburetor and a revised venting system for the fuel pumps and fuel pressure gages. This change was officially designated as "BuAer Service Change No. 4" for model F7F-1 airplanes and was first incorporated in December 1944. The change appeared to eliminate the original engine surging but gave rise to fuel delivery pressure fluctuation resulting from the sensitiveness of the revised venting system. Through further experimentation this difficulty was eliminated by incorporating suitable flow restrictions in the system, and tests were resumed to fulfill the requirements of the Service Acceptance Trials. During climbing performance tests, after the approved revision of the fuel system, light manifold pressure surging and occasional fuel delivery pressure fluctuation were encountered above 20,000 feet on one engine which was running with an excessively lean mixture. This surging was decreased sufficiently by manual adjustment of the mixture control to continue the tests.

Detailed description of the various "fixes" tried and the results obtained therefrom during the tedious program of experimentation is felt to be more properly a power plant project and therefore beyond the scope of this report. The preceding brief outline of the program to eliminate engine surging is included for general information concerning the first trials of the model F7F airplane.

## CONCLUSIONS

1. The lack of directional stiffness in this airplane was unacceptable. This deficiency combined with the strong lateral stability greatly impaired the efficiency of the airplane as a gun platform. In addition, the airplane was uncontrollable in the carrier approach condition below 130 knots IAS with only one engine operating.

2. The aileron effectiveness was unsatisfactory, as shown by low values of Pb/2V tabulated in Results.

3. The changes in the controls of airplane No. 80266 accomplished a more nearly acceptable harmony of control forces which had been lacking in airplane No. 80260. Also, the increase in upward elevator travel increased the effectiveness of this control to an acceptable value. This improvement was reflected in considerably reduced take-off distance and in adequate longitudinal control of the airplane

in the landing condition, power off.

4. The lack of directional stiffness was considered the outstanding defect in this airplane. Subject to correction of this condition, increasing the aileron effectiveness, and correction of the several defects covered under paragraph (a), Recommendations, the model XF7F-1 airplane was found to be acceptable for service use as a shipboard fighter aircraft.

RECOMMENDATIONS

As a result of the trials, changes in the model XF7F-1 airplane have been recommended in references (ab), (al), (at), and (au). Recommended revisions to the preliminary handbook of operating instructions are contained in reference (av). Responsibility for incorporation of these changes is indicated thus:

C - Contractor responsibility

G - Government responsibility

Following is a summary of the recommended changes:

A. Necessary changes considered essential to obtain a satisfactory combat airplane. These changes should be incorporated on undelivered airplanes prior to delivery and on delivered airplanes as soon as practicable.

1. Improve optical quality of windshield -C

2. Relocate arresting hook operating control to starboard side of cockpit. -C

3. Rearrange starter and primer switches to provide (a) simultaneous priming and booster energizing for each engine, and (b) a satisfactory location. -C

4. Reduce operating forces on fuel transfer valves, either by improving mechanical advantage or otherwise, to an acceptable level. -C

5. Relocate wing fold lock operating handle to an acceptable position. -C

6. Reduce cockpit hood operating forces while airborne. -C

7. Provide positive indication that nose wheel is locked down for landing. -C

8. Provide throttle and propeller control linkages so that engine manifold pressures and RPM are equal between the engines when the controls are equally displaced. -C

9. Provide automatic cowl flaps and oil cooler flap control; or, in the event that automatic control proves impracticable, provide (a) faster flap actuation, and (b) separate manual control for each engine. -C

10. Provide emergency means of relieving all hydraulic pressure and eliminating hydraulic locks in the rudder boost system. -C

11. Provide a greater degree of aerodynamic balance in the rudder. -C

12. Eliminate unstable engine operation in auto lean at all altitudes and cruising powers, and in auto rich at altitudes above 18,000 feet at powers in excess of maximum cruising power. -C

13. Increase aileron effectiveness, reduce aileron control forces, and eliminate oscillation, or "bounce", which occurs at full aileron deflection. -C

14. Increase elevator control force to 5 or 6 pounds per g at 20,000 feet; provide sufficient elevator control to make power off landings on main wheels at 22% MAC center-of-gravity position. -C

15. Provide satisfactory exhaust flame damping in accordance with specification AN-D-10. -C

16. Provide satisfactory exhaust stacks. -C

17. Provide satisfactory engine oil lines. -G

18. Relocate radio receiver tuning and volume controls so that pilot may comfortably observe and manipulate them; protect push button selectors from inadvertent operation. -C

19. Rearrange aileron trim tab control so that it may be manipulated without interference and so that the tab position indicator may be seen by the pilot from flying posture. -C

20. Eliminate lost motion in rudder control system; increase rudder control forces with hydraulic boost in operation, and decrease rudder control forces with hydraulic boost not in operation. -C

21. Provide positive lock to hold boarding ladder in retracted position under all flight operating conditions. -C

22. Provide pitot static head and bracket which will withstand all stresses caused by vibration and high speed. -C

23. Place fuel quantity gage in a prominent position unobscured by wing lock controls or other controls. -C

24. Provide a cockpit enclosure which is watertight, free from draft, and which can be opened easily at 300 MPH indicated airspeed. -C

25. Provide a vacuum pump for each engine with appropriate selection and regulation of suction pressure. -C

26. Provide a hydraulic pump for each engine. -G

27. Provide supercharger control handle which cannot be confused with propeller governor controls and which can be positively locked in position. -C

28. Provide standard voltammeters in place of voltmeters installed. -G

29. Relocate ignition switch so that pilot may see all positions thereon. -C

30 Improve sealing strips on main landing gear doors. -C

31. Increase capacity of hydraulic hand pump to 1.5 cubic inches per stroke; install telescopic pump handle to increase operator's mechanical advantage. -C

32. Provide sight hydraulic fluid quantity gage. -C

33. Provide for more rigorous inspection of windshields and cockpit enclosures before delivery of airplanes. -C

34. Modify engine control quadrant to provide only two positions "Rich" and "Lean", for mixture controls. -C

35. Provide for more rigorous inspection of Airex landing flap selector valves (Airex part No. D449) at source and upon installation to assure proper funtioning and the elimination of all dirt and foreign matter in the valve. -C

36. Provide for more rigorous inspection of hydraulic hand pump selector valves (GAEC part No. 25249) at source and upon installation to assure proper functioning and the elimination of all dirt and foreign matter in the valve. -C

37. Provide satisfactory method of securing all inspection plates, hand-hole covers and access doors. -C

38. Investigate effect on operating efficiency of unusually low cylinder head temperatures encountered at low cruising powers above 10,000 feet. -C

39. Provide reliable manifold check and thermal relief valve assembly (GAEC part No. K-39395). -C

40. Provide illumination for fuel quantity gage, voltmeters, radio controls; provide luminously painted synchroscopes on tachometers; provide glare shield to block cockpit light reflections on windshield during night operation. -C

41. Provide satisfactory dual manifold pressure gage. -G

42. Eliminate excessive power plant vibration during operation at powers above normal rated power. -G

43. Provide satisfactory generators. -G

44. Improve method of fairing the track upon which the cockpit hatch slides. -C

45. Provide for freer action of landing gear oleo struts so that they will compress properly on landing. -C

46. Improve method of remotely controlling oxygen bottle valve and modify the system to assure ease of inspection and maintenance. -C

47. Provide satisfactory hydraulic actuating cylinders for main landing gear. -C

48. Replace plastic carburetor air intake ducts with ducts made of standard dural sheet. -C

49. Provide for more careful installation and inspection of cylinder head temperature measuring equipment. -C

50. Provide satisfactory fairing at junction between landing flaps and fuselage. -C

51. Provide satisfactory nose wheel door retracting strut. -C

52. Provide a nose section which will withstand stresses imposed by all speeds and accelerations which may be encountered. -C

53. Determine cause for failure of model R-2800-22W engine No. P-50169, and eliminate this difficulty. -G

54. Redesign alternate air system so that carburetor air temperature rise resulting from use of alternate air will be within allowable 28°C limit. -C

55. Provide satisfactory windshield material. -C

56. Relocate pitot static head to eliminate excessive and variable error in measuring static pressure for altitude and airspeed indicators. -C

57. Improve propeller feathering mechanism. -G

58. Provide propeller feathering system which will feather propeller within ten seconds after pressing the feathering button and which will maintain propeller in the fully feathered positiion up to maximum permissible IAS. -G

59. Provide more reliable quick disconnect blocks between engine and nacelle section for fuel, oil, water, and vent lines. -C

60. Restrict the use of Pesco Type AN 4101 main fuel pumps in the fuel system of model F7F-1 airplanes which incorporate -G

60. (Cont'd) BuAer Service Change No. 4. -C

61. Provide satisfactory screws for securing top wing skin along walkway. -C

62. Provide satisfactory cowling aft of exhaust stacks. -C

63. Provide more clearance between landing gear doors and adjacent fairing. -C

64. Provide satisfactory propeller governors. -C

B. Desirable changes which will improve the airplane's efficiency as a combat airplane. These changes should be incorporated when practicable and should be considered for any redesign or future construction.

1. Relocate fuel tank and pressurizer dome vent to a position which eliminates spillage over the fuselage area. -C

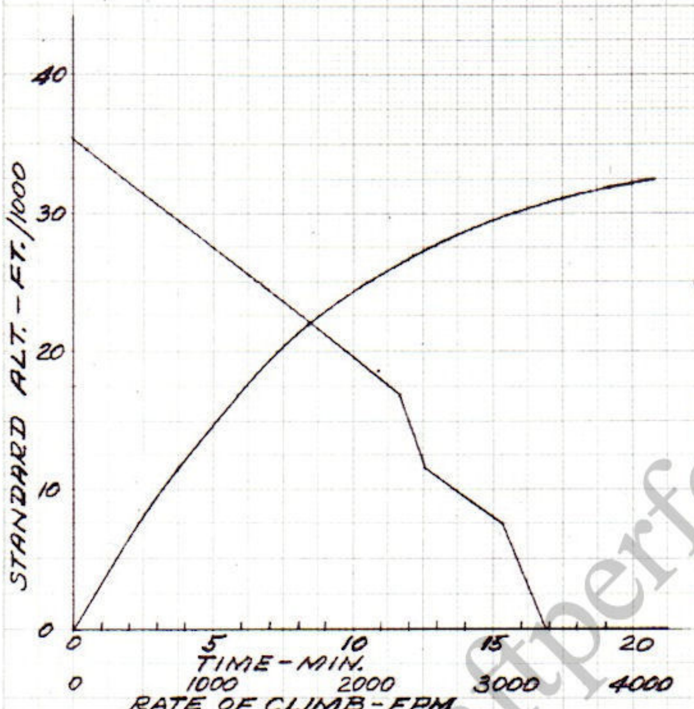
2. Relocate emergency brake control handle to a position more easily accessible to Pilot's right hand, and redesign the control to permit more positive operation of the brakes. -C

3. Provide a low power taxying light, to be attached to the nose wheel assembly. -C

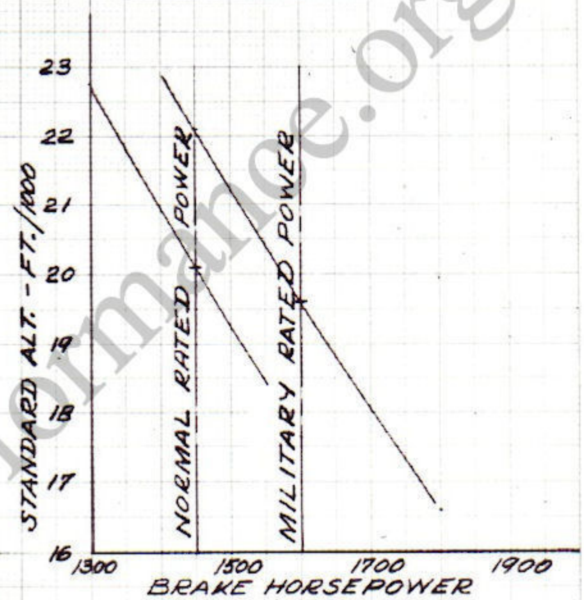
Encls. (HW)
1. One (1) Performance Curve, Photo PTR 2173.
2. Six (6) Performance Curves, Photo PTR 23680, 23681, 23682, 23683, 23684, 23685.
3. Sixty-nine (69) Photographs, 2018, 2019, 2021, 2029, 2030, 22530, 22531, 22532, 22533, 22535, 22536, 22537, 24230, 24231, 12484, 12485, 12486, 12487, 12488, 12684, 12728, 12729, 12730, 12731, 12732, 12733, 12734, 12735, 12736, 12737, 12837, 12838, 12839, 12840, 12845, 12846, 12934, 13028, 13029, 13030, 13031, 13032, 13033, 13034, 13035, 13036, 13037, 13038, 13039, 13044, 13661, 13662, 13663, 13664, 13665, 13666, 14398, 15186, 15187, 20952, 20753, 20749, 20748, 18696, 18694, 18700, 18699, 18693, 12847.

MODEL XF7F-1 AIRPLANE No. 03549
PERFORMANCE CHARACTERISTICS PHOTO PTR 2173
NORMAL FIGHTER GR. WT. = 19,965 LBS.

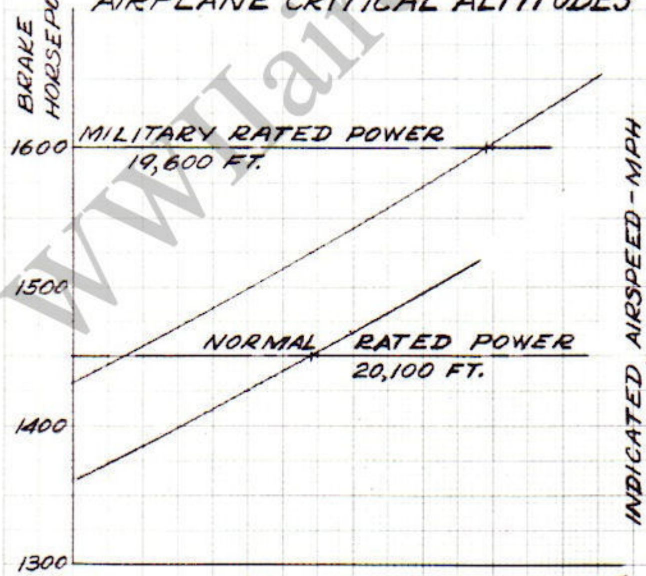
CLIMB



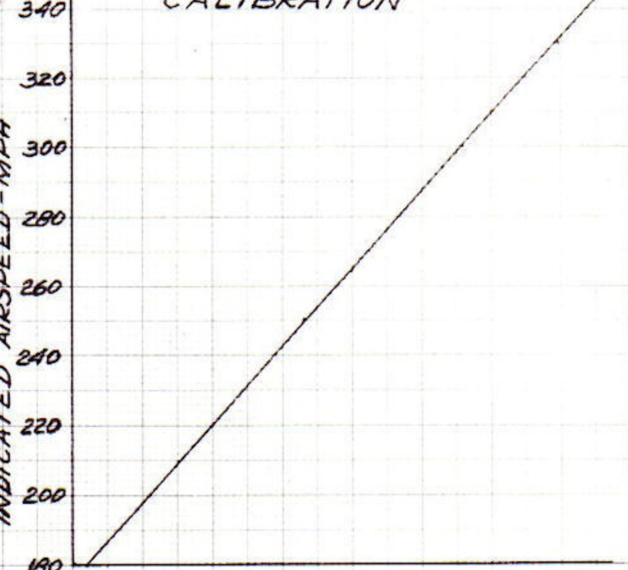

AIRPLANE CRITICAL ALTITUDES
HIGH BLOWER

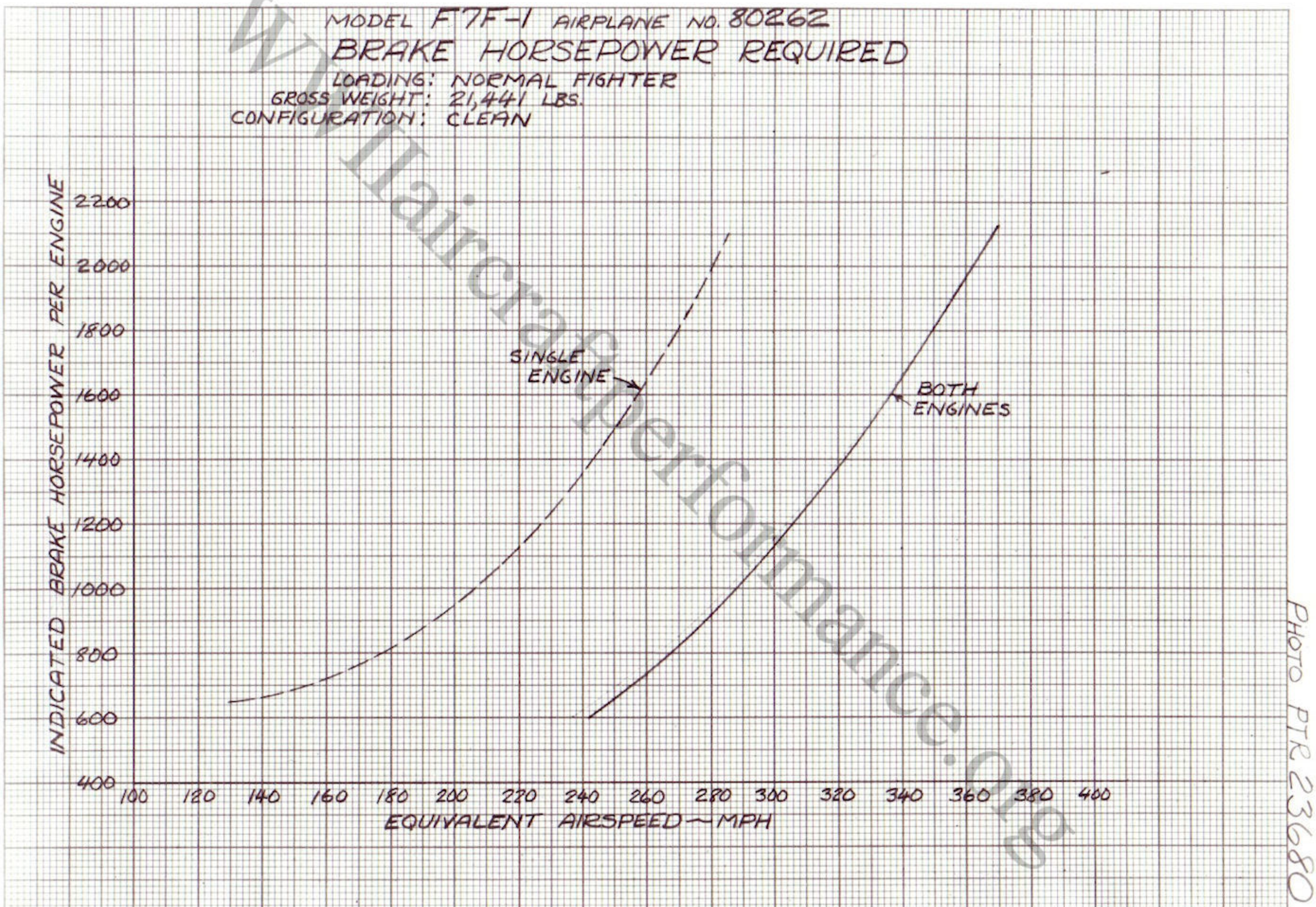



MAXIMUM SPEEDS AT
AIRPLANE CRITICAL ALTITUDES




AIRSPEED INDICATOR
CALIBRATION





MODEL F7F-1 AIRPLANE NO. 80262
BRAKE HORSEPOWER REQUIRED
LOADING: NORMAL FIGHTER
GROSS WEIGHT: 21,441 LBS.
CONFIGURATION: CLEAN
INDICATED BRAKE HORSEPOWER PER ENGINE
400
600
800
1000
1200
1400
1600
1800
2000
2200
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
EQUIVALENT AIRSPEED ~ MPH
SINGLE ENGINE
BOTH ENGINES
PHOTO PTR 23680
4-24-45 F.K.

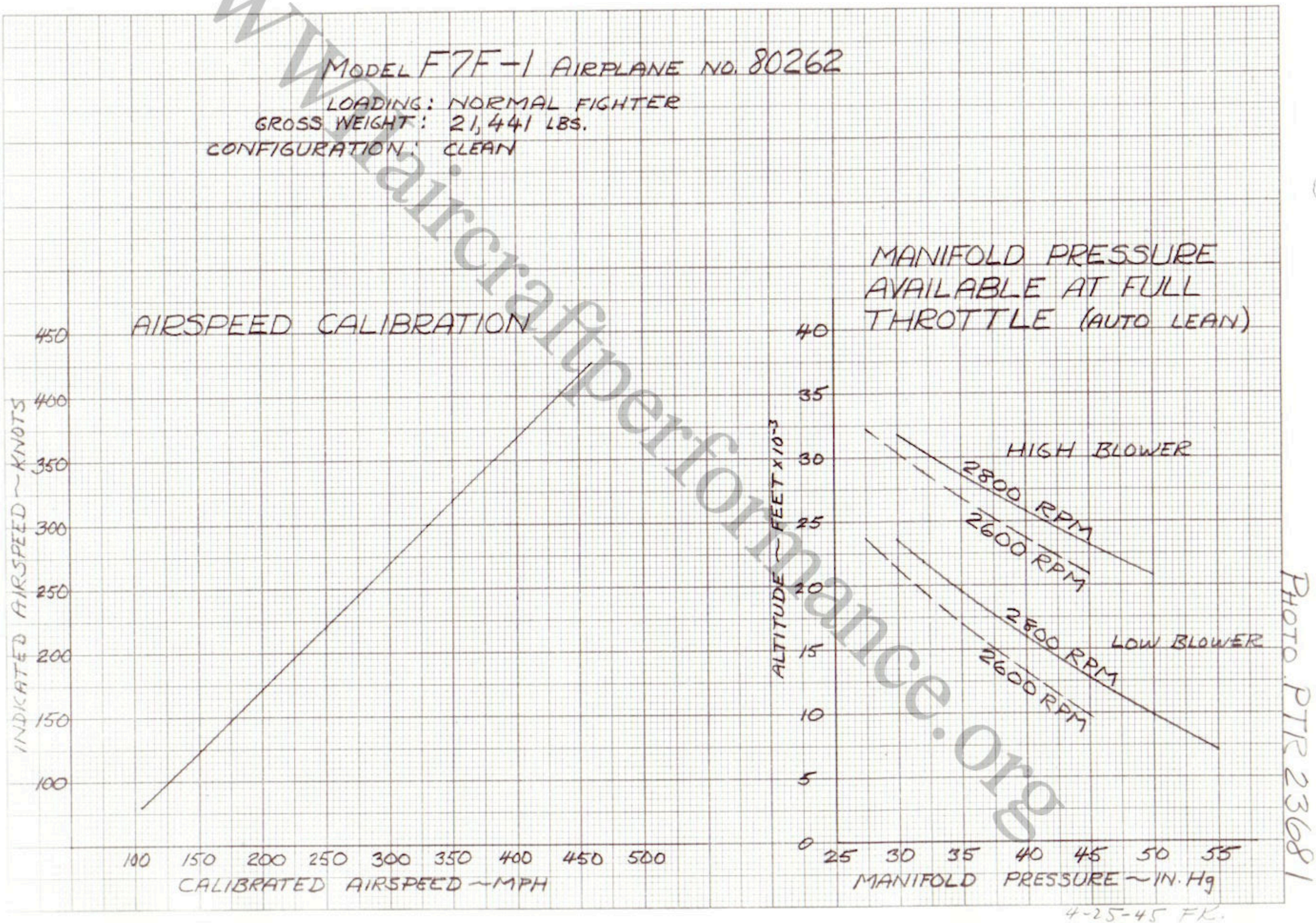
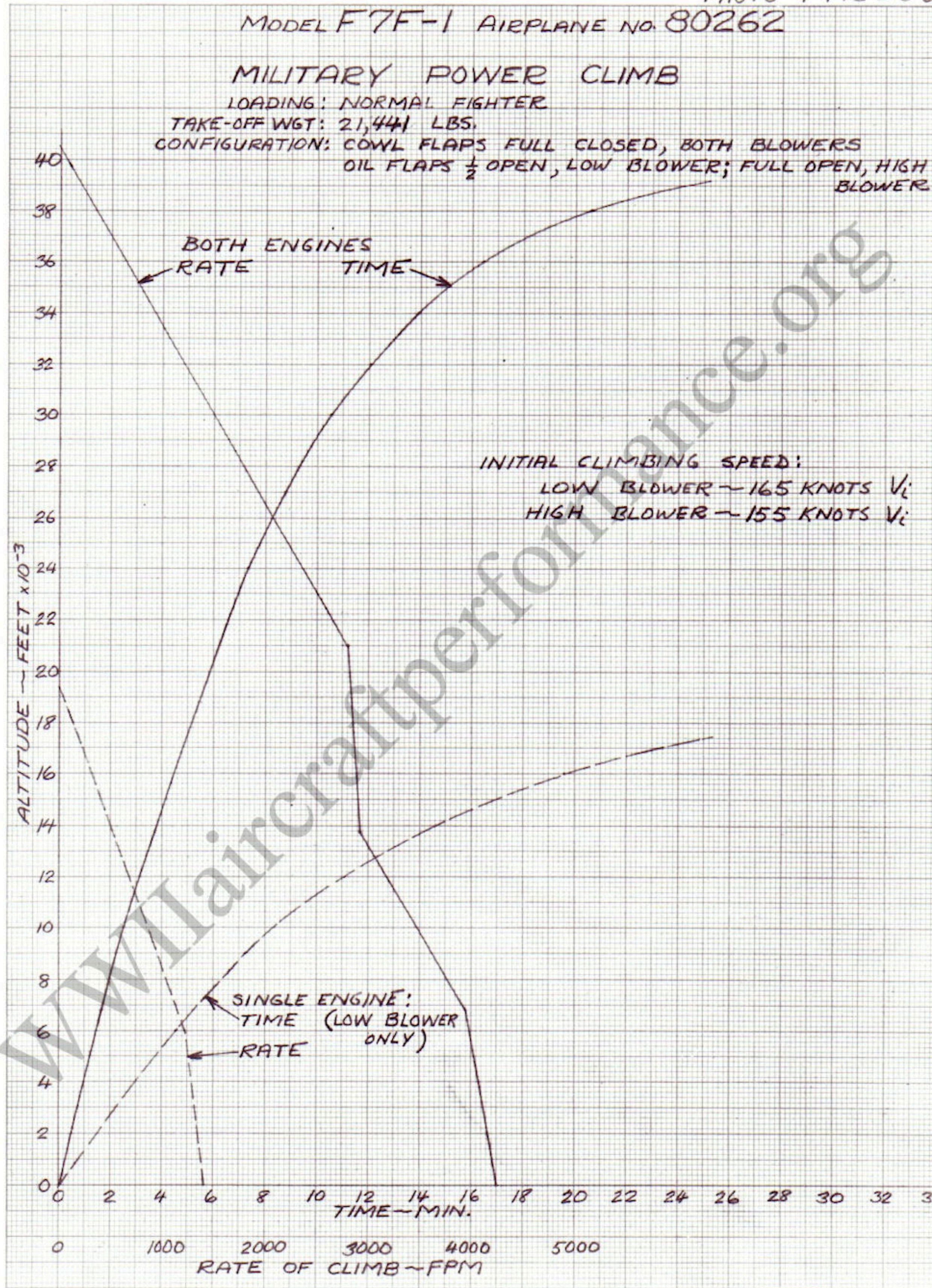

MODEL F7F-1 AIRPLANE NO. 80262
LOADING: NORMAL FIGHTER
GROSS WEIGHT: 21,441 LBS.
CONFIGURATION: CLEAN
AIRSPEED CALIBRATION
INDICATED AIRSPEED ~ KNOTS
100
150
200
250
300
350
400
450
CALIBRATED AIRSPEED ~ MPH
100 150 200 250 300 350 400 450 500
MANIFOLD PRESSURE AVAILABLE AT FULL THROTTLE (AUTO LEAN)
ALTITUDE ~ FEET x 10^-3
0 5 10 15 20 25 30 35 40
HIGH BLOWER
2800 RPM
2600 RPM
LOW BLOWER
2800 RPM
2600 RPM
MANIFOLD PRESSURE ~ IN. Hg
25 30 35 40 45 50 55
PHOTO PTR 23681
4-25-45 FK.

PHOTO PTR 23682




4-23-45 F.K.

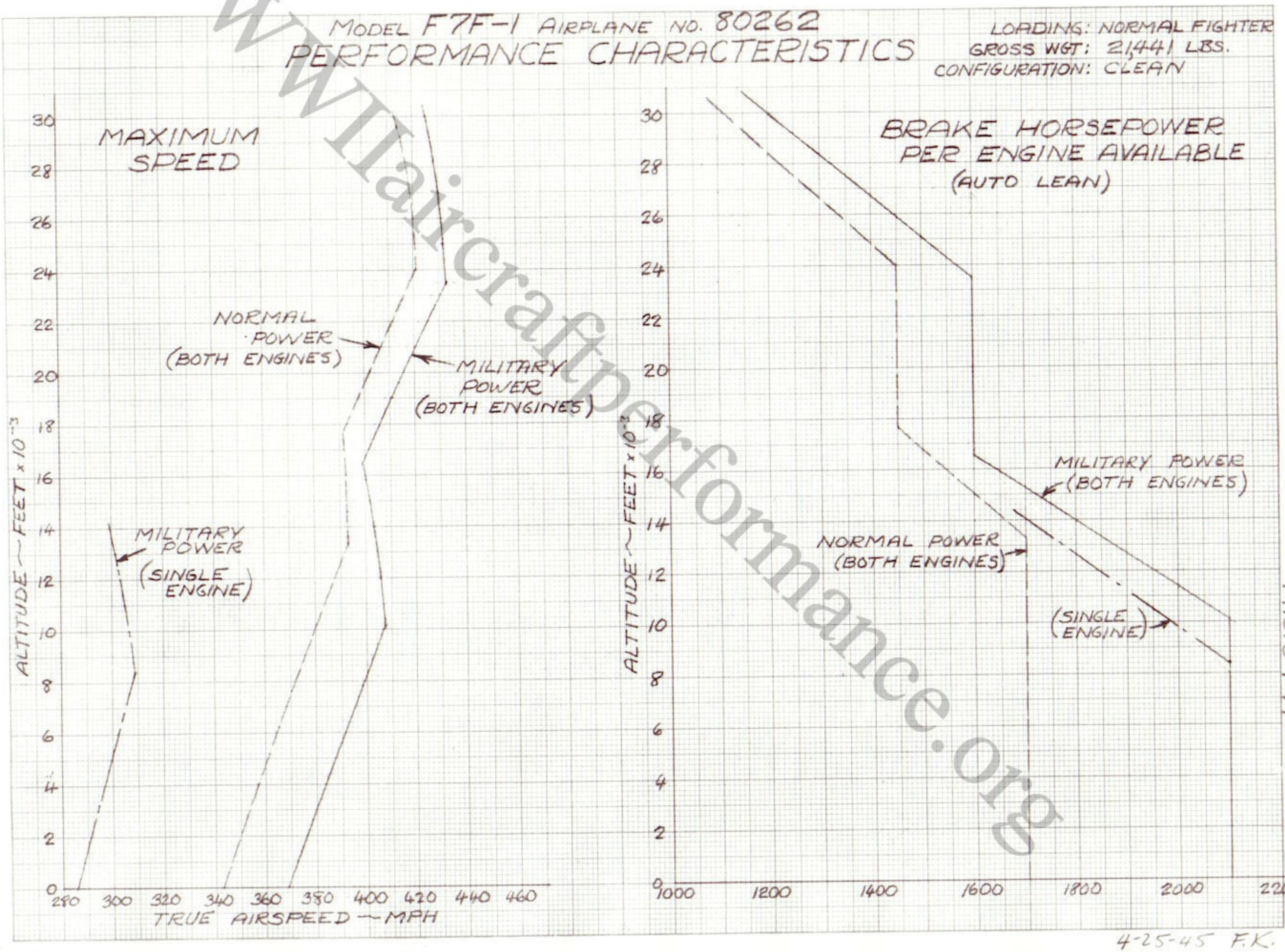

MODEL F7F-1 AIRPLANE NO. 80262
PERFORMANCE CHARACTERISTICS
LOADING: NORMAL FIGHTER
GROSS WGT: 21,441 LBS.
CONFIGURATION: CLEAN
MAXIMUM SPEED
NORMAL POWER (BOTH ENGINES)
MILITARY POWER (BOTH ENGINES)
MILITARY POWER (SINGLE ENGINE)
ALTITUDE ~ FEET x 10^-3
TRUE AIRSPEED ~ MPH
280 300 320 340 360 380 400 420 440 460
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
BRAKE HORSEPOWER PER ENGINE AVAILABLE
(AUTO LEAN)
MILITARY POWER (BOTH ENGINES)
NORMAL POWER (BOTH ENGINES)
(SINGLE ENGINE)
1000 1200 1400 1600 1800 2000 2200
PHOTO PTR 23683
4-25-45 F.K.

PHOTO PTR23684

MODEL F7F-1 AIRPLANE NO. 80260

# STATIC LONGITUDINAL STICK FIXED STABILITY

CONFIGURATION: CLEAN

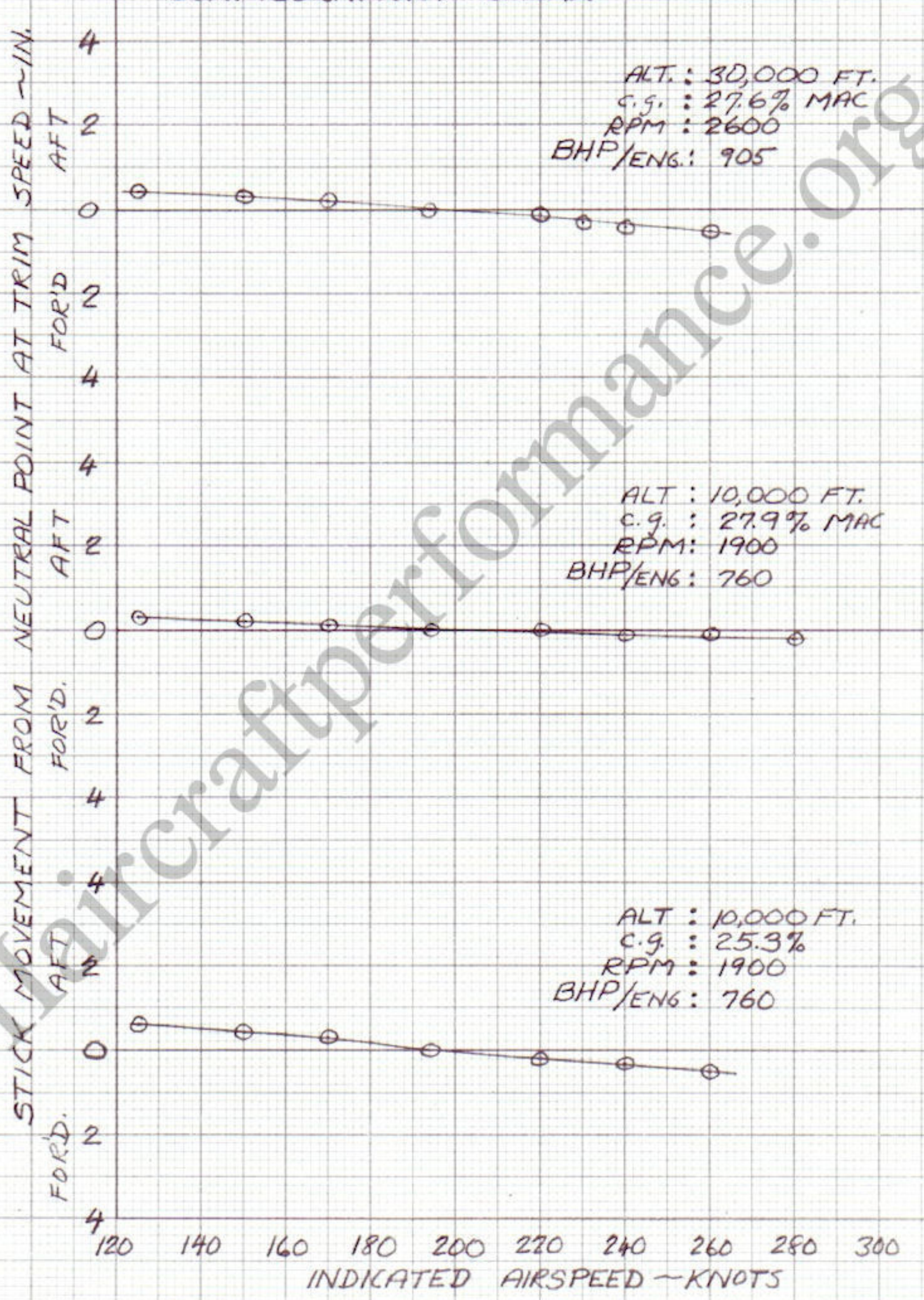
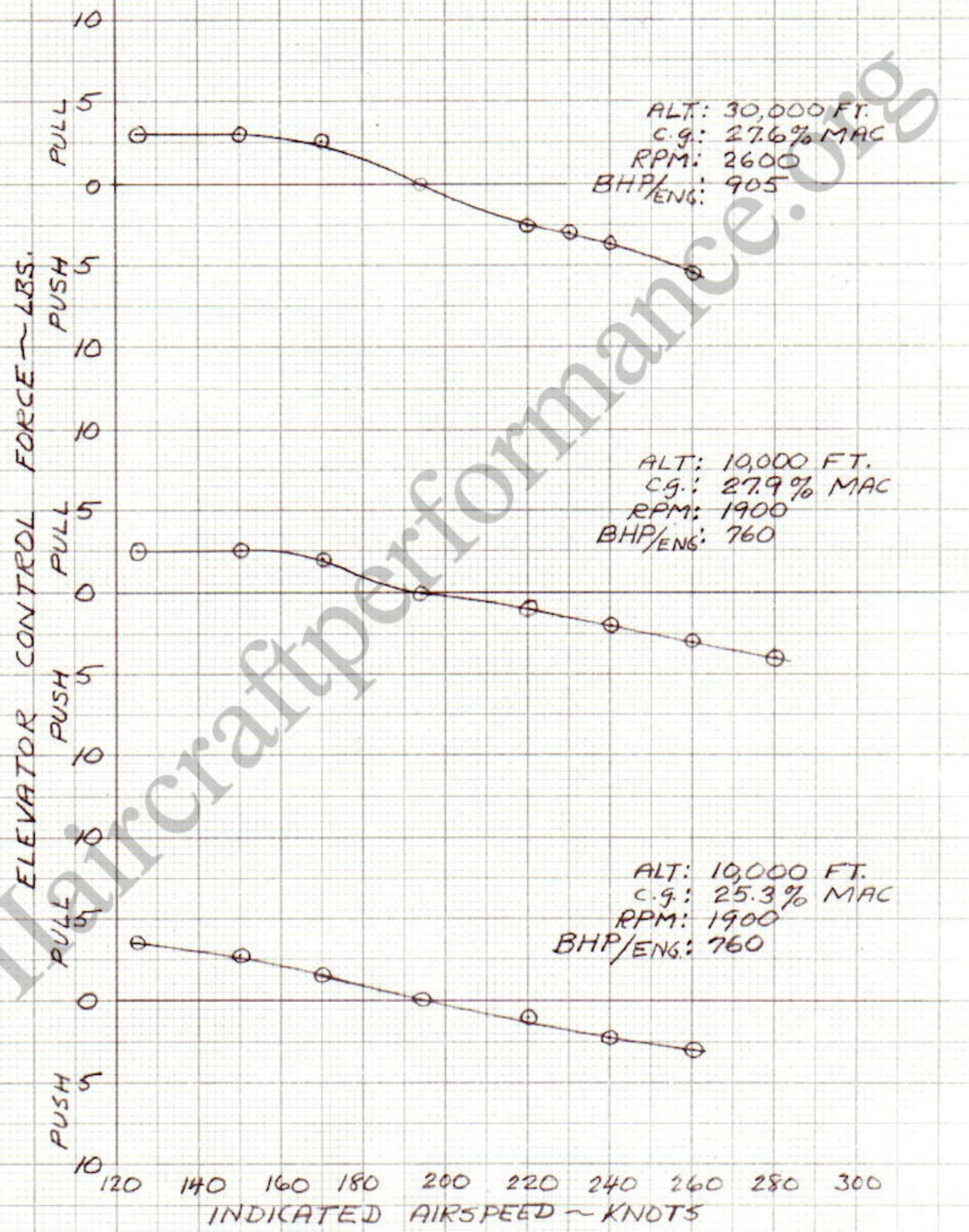


PHOTO PTR 23685

MODEL F7F-1 AIRPLANE NO. 80260

# STATIC LONGITUDINAL STICK FREE STABILITY

CONFIGURATION : CLEAN






4-25-45 F.K.


XF7F-1 No. 03549
E-Level Flight - Clean - Port

Photo PTR 2018
12-23-43

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TO BE USED FOR PUBLICATION


BIS 2143 - Model F7F-1 No. 80262
Left side view - spinners off

Photo PTR 13663
9-28-44

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