

FLIGHT TEST
U. S. Naval Air Station
Patuxent River, Md.

Final Flight Report

of

Production Inspection Trials
(TED No. BIS 2127)

on

Model FM-2 Airplane
(Contract NOa(s)-227)

held

18 November 1943 to 4 May 1944

by

Flight Test

for

Board of Inspection and Survey

at

U. S. Naval Air Station
Patuxent River, Md.

Project Pilot:

M. J. ROZAMUS
Lt. Comdr., USNR

Project Engineer:

F. E. ELLIS, Jr.
Lt. Comdr., USNR

Approved:

C. T. BOOTH
Comdr., USN

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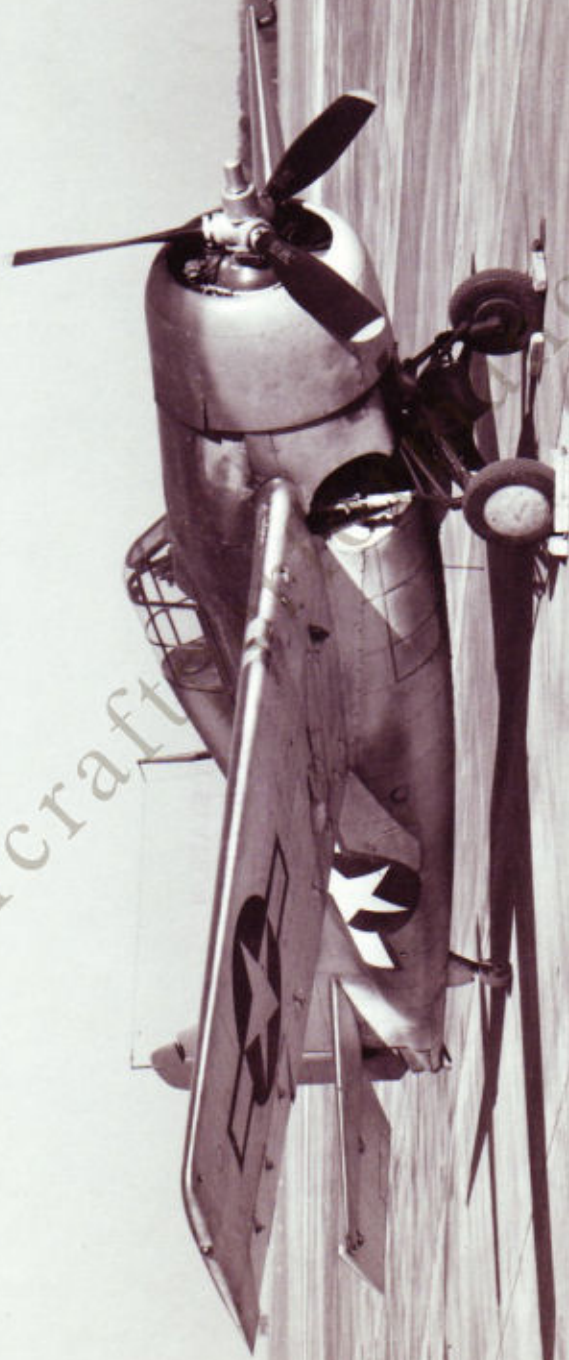
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References

- (a) BuAer conf. ltr. Aer-E-211-RJ, C-99036, C20797 of 9 Sept. 1943.
- (b) Contract NOa(s)-227, dated 31 Dec. 1943.
- (c) Flight Test conf. memo for VF Design Desk, NA83 VFM-2 (FT) (138) of 7 Dec. 1943.
- (d) Flight Test conf. memo for VF Design Desk, NA83 VFM-2 (FT) (80) of 27 Jan. 1944.
- (e) SD-204-2, Detail Specification for Model FM-2 Airplane, dated 18 May 1943.
- (f) NAS, Patuxent River conf. ltr. NA83 VFM-2 BIS 2127 (FT) (44099) of 19 May 1944.
- (g) Report No. GR-124, Actual Weight and Balance of Model FM-2 Airplane No. 15952, Eastern Aircraft Division, General Motors Corporation, Linden, N. J., dated 14 Oct. 1943.
- (h) Power Curves for model XR-1820-56 engine, A. E. L. Project No. 4322.
- (i) BuAer spdltr. Aer-E-41-RWS 24230 of 16 Feb 1944.
- (j) NAS, Patuxent River conf. spdltr. NA83 VFM-2 of 17 Mar. 1944.
- (k) NAS, Patuxent River conf. ltr. NA83 BIS 2127 VFM-2 (FT) (352) of 14 Apr 1944.
- (l) Recommended Changes in the model FM-2 airplane, Items 1 to 14, dated 17 Dec. 1943 to 7 Apr. 1944.
- (m) BuAer conf. ltr. Aer-E-211-JMC/LB C24122, dated 16 Oct. 1943.
- (n) NAS, Patuxent River conf. ltr. NA83 VFM-2 BIS 2127 (FT) (44097) of 9 May 1944.

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Model FM-2 - #15958
3/4 Right Front View

Photo FTR 2366
1-10-44

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Object of Trials:

1. The objects of the trials conducted by Flight Test on the model FM-2 airplane in accordance with reference (a) were to determine the following:

- (a) Whether or not the performance guarantees were met.
- (b) Performance and flight characteristics.
- (c) General suitability for service use as a fighter airplane.

Conclusions:

1. All performance guarantees were exceeded except those of minimum speed without power at sea level and take-off distance in a 25 knot wind.

2. The model FM-2 airplane was found to be satisfactory for service use as a fighter airplane, either carrier or land-based, except that a number of defects were found which are covered under Recommendations.

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Summary of Results

A. Performance (as a "normal" fighter except as noted)

1. Maximum speed (high blower):

<u>Power</u>	<u>Normal</u>	<u>Military</u>
Brake horsepower.....	900.	1000.
Airplane critical altitude-ft.	19,500	16,600
Maximum speed at A. C. A.-MPH.	327.	328.

2. Service Ceiling-ft..... 35,000 35,100
3. Maximum rate of climb at sea level-FPM..... 3150. 3600.
4. Minimum speed at sea level:

	<u>"Normal" Fighter</u>	<u>"Overload" Fighter</u>
Clean condition-power on-MPH..	81.5	86.0
Clean condition-power off-MPH.	85.0	91.0
Landing condition-power on-MPH	67.0	72.5
Landing condition-power off-MPH	74.5	78.0

5. Take-off data: (Full Flap)

"Normal" Fighter

Brake horsepower.....	1300	1350
RPM.....	2600	2700
Take-off speed-MPH.....	74.0	74.0
Take-off distance-no wind-ft..	490.	460.
Take-off distance-25 knot wind-ft.....	195.	185.

"Overload" Fighter

Brake horsepower.....	1300	1350
RPM.....	2600	2700
Take-off speed-MPH.....	78.5	78.5
Take-off distance-no wind-ft..	675.	650.
Take-off distance-25 knot wind-ft.....	290.	280.

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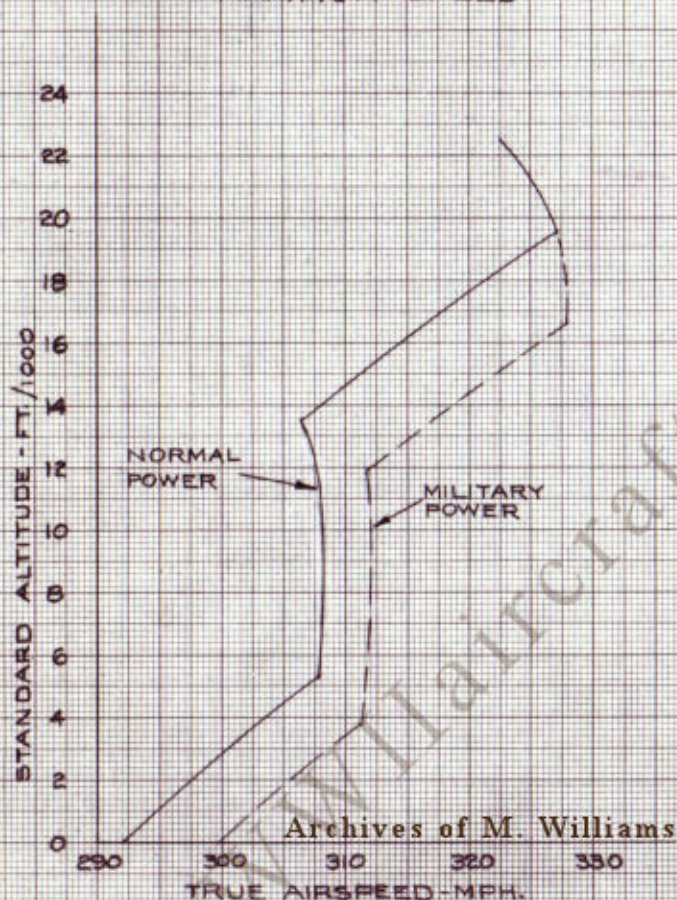
B. Weight and Balance Summary:

<u>Loading</u>	<u>"Normal"</u> <u>Fighter</u>	<u>"Overload"</u> <u>Fighter</u>
Par. from Detail Spec.....	104a	104b
Gross wt-lbs.....	7282	8084
Useful load-lbs.....	1958.	2760.
Useful load-% gross wt.....	26.9	34.1
Weight empty-lbs.....	5324.	5324.
Wing loading-lbs. per sq. ft...	28.0	31.1
Take-off power loading-lbs. per BHP.....	5.4	6.0
Center of gravity location-% MAC:		
Wheels up.....	29.8	29.2
Wheels down.....	29.6	29.0
Detailed Useful Load:		
Pilot-lbs.....	200.	200.
Fuel:		
Main-gal.....	117.	117.
Droppable fuel tanks-gal.		116.
Oil-gal.....	9.	11.
Trapped fuel and oil-lbs...	44.	44.
Fixed wing guns installation- lbs.....	278.3 (4-50 cal.)	278.3 (4-50 cal.)
.50 cal. ammunition-rds....	1600	1600
Pyrotechnics-lbs.....	4.9	4.9
Gun camera-lbs.....	3.8	3.8
Radio-lbs.....	121.	121.
Navigating equip-lbs.....	4.5	4.5
Life raft-lbs.....	15.0	15.0
Emergency equip.-lbs.....	9.5	9.5
Oxygen-lbs.....	27.5	27.5
Droppable fuel tanks (2-58 gal)-lbs.....		91.0

MODEL FM-2 AIRPLANE No. 15953
PERFORMANCE CHARACTERISTICS
NORMAL FIGHTER GROSS WEIGHT • 7282 LBS.

PHOTO. PTR. 2772
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MAXIMUM SPEED



BRAKE HORSEPOWER AVAILABLE
MODEL R-1820-56 ENGINE

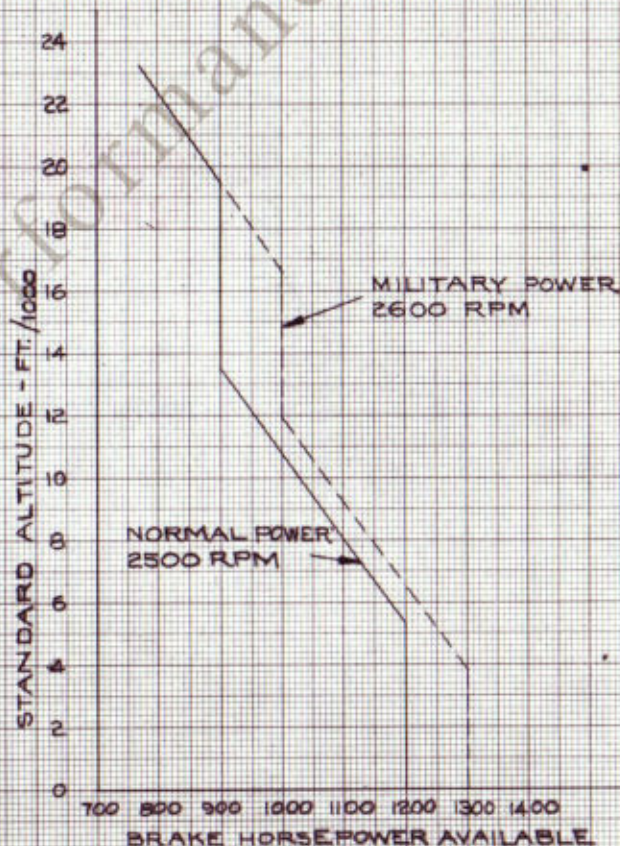


FIG. 1

MODEL FM-2 AIRPLANE No. 15953
 PERFORMANCE CHARACTERISTICS
 NORMAL FIGHTER GROSS WEIGHT • 7282 LBS

PHOTO RTR NO. 2773
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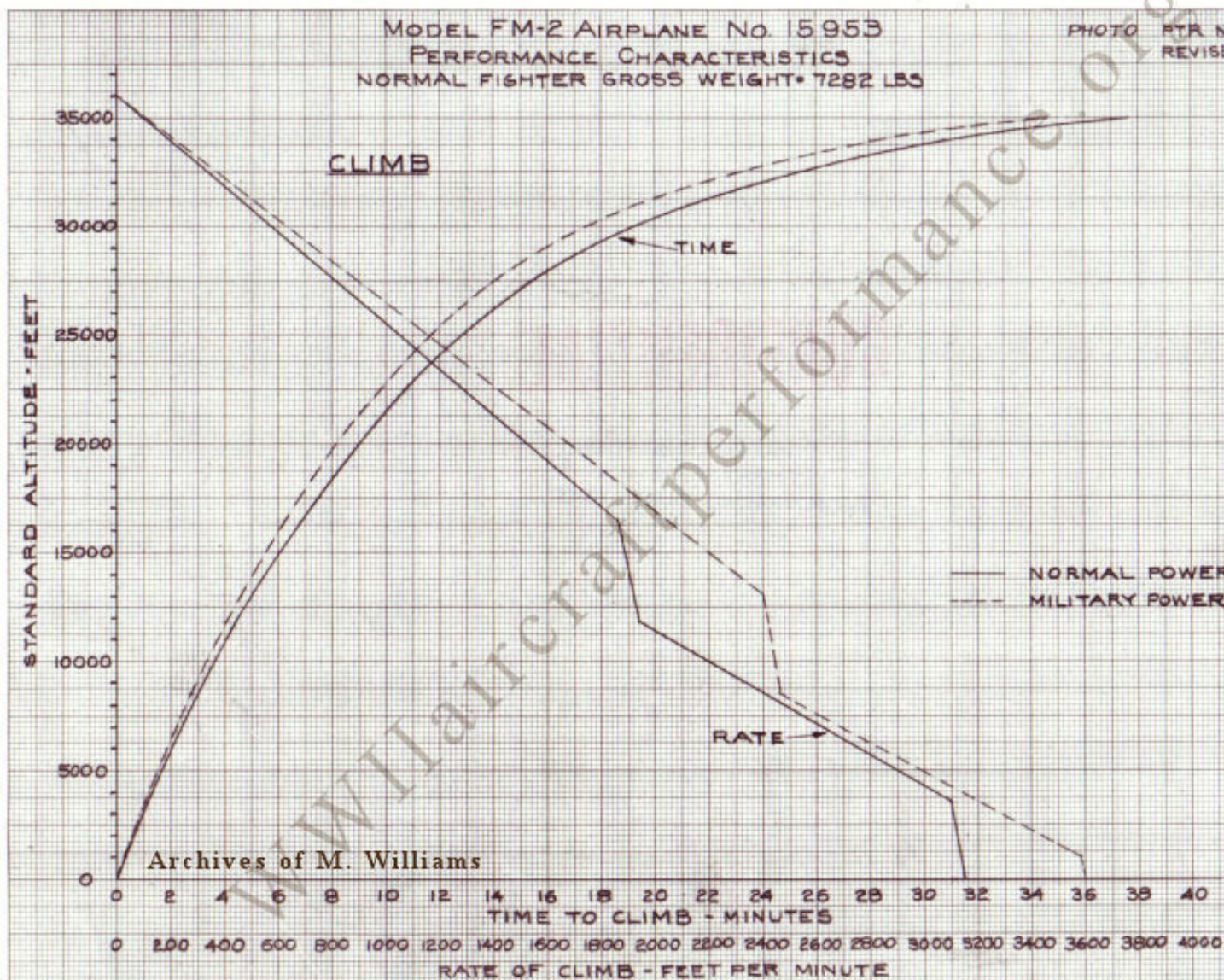
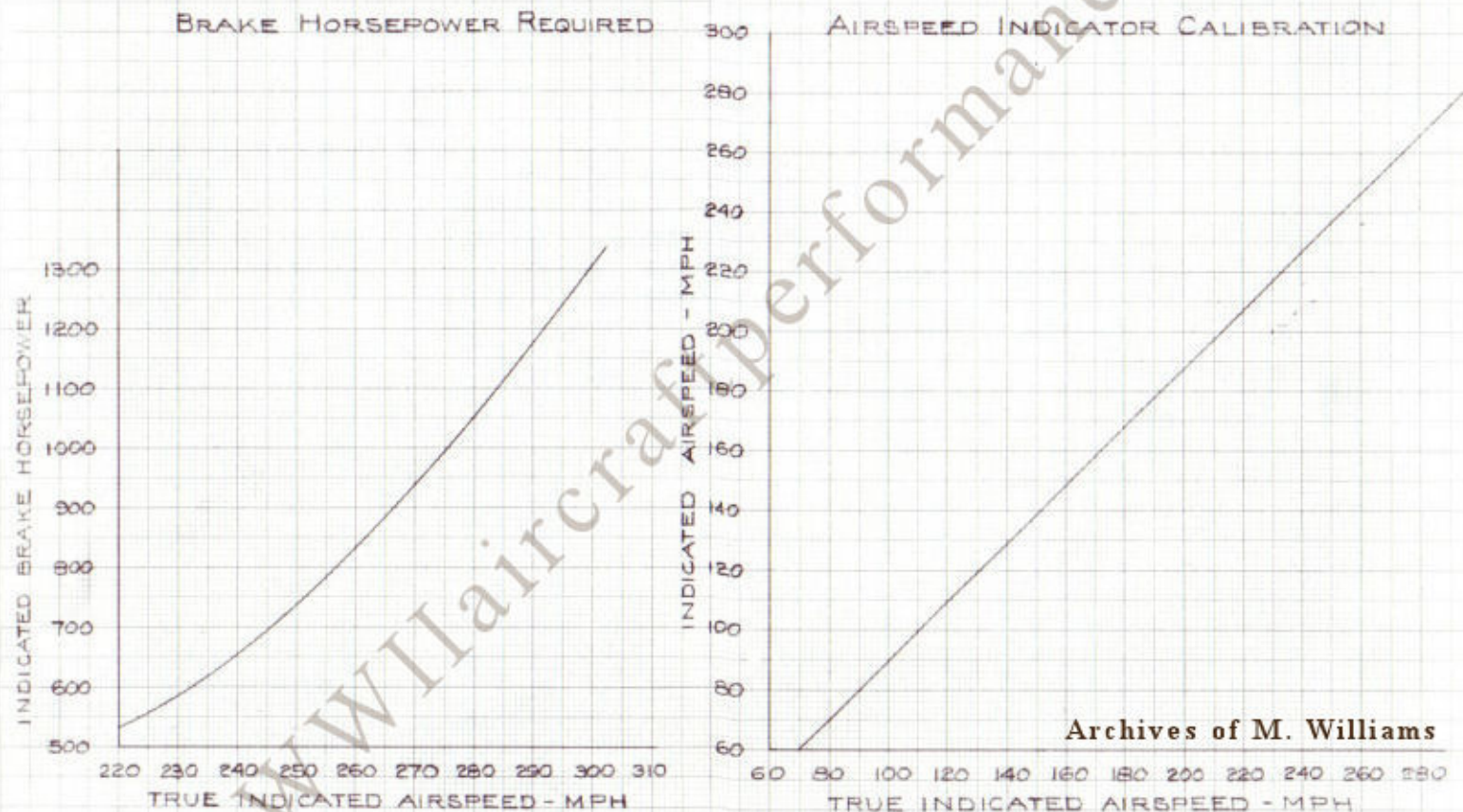


FIG. 2

MODEL FM-2 AIRPLANE NO. 15953
 PERFORMANCE CHARACTERISTICS
 NORMAL FIGHTER GROSS WEIGHT 7282 LBS.

PHOTO PTR 2774
 REVISED 7-10-44

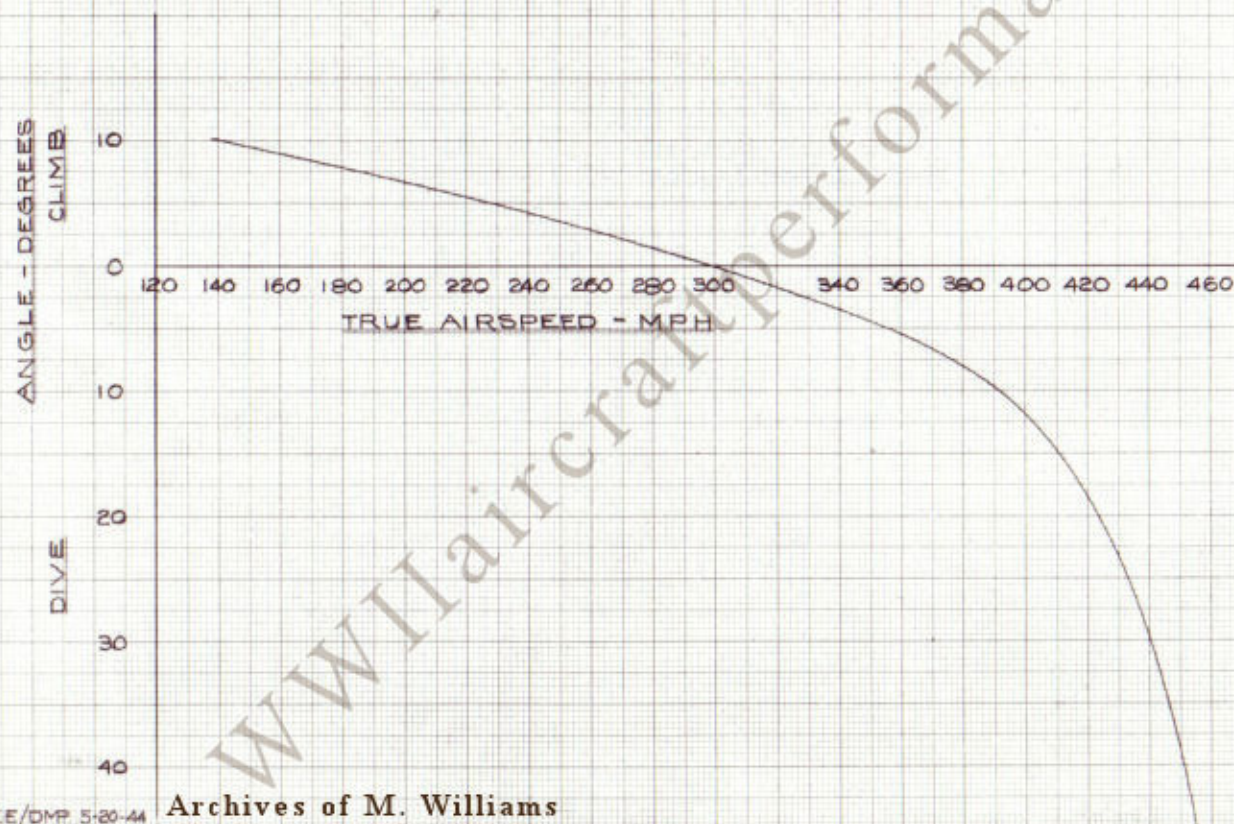


Archives of M. Williams

FIG. 3

MODEL FM-2 AIRPLANE No. 15953
PERFORMANCE CHARACTERISTICS
DIVE & CLIMB ANGLES AT 10000 FT. ALTITUDE
NORMAL FIGHTER GROSS WEIGHT 7282 LBS.
NOTE - ALL CLIMBS & DIVES AT 2600RPM
M.P. 35 IN. HG - APPROX. 935 BHP

PHOTO PTR. 7289



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General Comment

History

1. The second production model FM-2 airplane, procured under reference (b), No. 15953, was delivered at the Naval Air Station, Patuxent River, Md., by air from Trenton, New Jersey on 15 November 1943. Trials were commenced on 18 November 1943 and completed on 4 May 1944. Preliminary performance data obtained during the trials were submitted in references (c) and (d).

Description

1. The model FM-2 airplane is manufactured by the Eastern Aircraft Division, General Motors Corporation, Linden, New Jersey, and is similar to the model XF4F-8 airplane designed and constructed by the Grumman Aircraft Engineering Corporation, Bethpage, New York. The airplane is a single-engine, single-place, landplane fighter for use aboard aircraft carriers and was designed and constructed in general accordance with reference (e). The model FM-2 airplane is also very similar to the model FM-1 airplane manufactured by the Eastern Aircraft Division under the same contract, the most important difference being the change from the model R-1830-86 to the model R-1820-56 engine. A Curtiss Electric, constant-speed, 3-blade propeller of 10'-0" diameter, blade design No. 109354-12, was installed. Airplane No. 15953, which was used for the performance tests, was a typical early production model FM-2 airplane. The finish condition was average and all external items specified in reference (e), such as radio antennae, were installed. Gun blast openings were faired over with tape.

Flight Characteristics

1. Longitudinal stability characteristics were discussed and center of gravity limits recommended at gross weights between 6480 pounds to 8079 pounds in reference (f) which may be summarized as follows:

- (a) The most forward center of gravity location for satisfactory landing characteristics was found to be 26% MAC (wheels extended). With the C. G. forward of this point, there is not sufficient elevator control to make a normal landing without power.

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- (b) The most rearward C. G. location beyond which flight is not safe was determined to be 32% MAC (wheels retracted). With the C. G. located aft of this position the airplane is longitudinally unstable in all flight conditions except the power off glide, where a slight amount of stability remains.
- (c) The most rearward center of gravity location for reasonably safe operation, assuming the pilot is familiar with the airplane and the effects of instability was found to be 31% MAC (wheels retracted). With the C. G. at this location the airplane is longitudinally unstable in the high power climb in the clean condition, barely stable in the high power climb in the landing conditions, and possesses varying degrees of positive longitudinal stability in all other flight conditions.
- (d) The most rearward center of gravity position for positive longitudinal stability in all flight conditions was determined to be 28.5% MAC. With this C. G. location stability in the clean condition high power climb is slightly positive.

2. Directional stability was found to be positive in all flight conditions as a "normal" fighter. Installation of the droppable wing tanks was found to increase directional stability slightly in the clean condition and to decrease stability to a slight extent in the landing condition. No rudder reversal was found although there was a slight decrease in rudder force at full yaw at low speeds, accompanied by rudder shake and buffeting. Rudder forces increased with speed to the extent that it was not possible to apply full rudder in maximum speed flight. Rudder effectiveness was sufficient to control the strong tendency of this airplane to swing to the left on take-off.

3. Lateral stability was found to be positive in all flight conditions as a "normal" fighter, being slightly greater in the clean than in the landing condition. Installation of the droppable wing tanks was found to have no detrimental effect on lateral stability. Aileron control forces and effectiveness were found to be normal and similar to those found on previous model F4F airplanes. Rolling velocity tests to evaluate aileron effectiveness were conducted and are discussed under Miscellaneous Tests.

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4. Stalling characteristics were similar to those exhibited by the models FM-1 and XF4F-8 airplanes. Both with and without droppable wing tanks stalls were gentle but with little or no warning, the airplane falling off to the right in all conditions except the power on stall in the landing condition where the airplane tended to fall off to the left. Recovery in all conditions was normal without excessive loss of altitude. Approximately 200 feet of altitude were lost when stalls were entered slowly from unaccelerated flight.

5. All maneuvers expected of a fighter type airplane were satisfactorily performed except spins. No unusual tendencies to enter unintentional spins were observed however.

Guarantees

1. The guaranteed weight empty of the model FM-2 airplane as defined in paragraphs 105a of reference (e) was given in the contract as 5268 pounds. The actual weight empty of model FM-2 airplane No. 15952 was given in reference (g) as 5312 pounds. At Patuxent River, the actual weight empty of airplane No. 15953 was found to be 5324 pounds.

2. The actual performance of model FM-2 airplane No. 15953 as a normal fighter is compared with the guarantees as follows:

	<u>Actual</u>	<u>Guaranteed</u>
Maximum speed at engine military rated power and at airplane critical altitude (16,600 ft.)-MPH.....	328.0	313.0
Maximum speed at engine normal rated power and at airplane critical altitude (19,500 ft.)-MPH.....	327.0	302.0
Minimum speed without power at sea level-MPH.....	74.5	72.5
Service ceiling, starting with normal useful load and with normal power-ft.....	35,000.	32,200.
Take-off distance in a 25 knot wind-ft.....	185.	157.
Initial rate of climb at sea level using take-off power-FPM	3730.	3340.

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3. The performance guarantees were made with the understanding that the model R-1820-56 engines furnished by the Government, operated with domestic aviation gasoline Grade 100/130 in accordance with Specification An-F-28, would deliver the following powers:

Normal Rating

1200 BHP at 2500 RPM from S. L. to 5500 ft. alt.
900 BHP at 2500 RPM at 18,500 ft. alt.

Military Rating

1300 BHP at 2600 RPM from S. L. to 4000 ft. alt.
1000 BHP at 2600 RPM at 17,500 ft. alt.

Take-off Rating

1350 BHP at 2700 RPM.

4. Reference (h) gives the normal and military power critical altitudes of the engine as determined by dynamometer tests as 17,000 and 14,300 ft., which values are 1,500 and 3,200 ft. lower than the respective guaranteed engine critical altitudes.

Miscellaneous Tests

1. Tests were made to determine angles of climb and dive at 10,000 ft. altitude using 2600 RPM. The results are plotted in Figure 4 of Performance Characteristics. For all runs the manifold pressure was held at 35 inches Hg. which was the maximum obtainable at the lowest climbing speed used at 10,000 ft. in low blower, giving approximately 935 brake horse power.

2. Take-off tests at 2600 RPM in addition to these at the normal rating of 2700 RPM were conducted in accordance with reference (i) and reported on in reference (j). The results are included under Performance.

3. Rates of roll were measured under various conditions. The data obtained are summarized below:

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360° Roll

Condition	IAS -MPH	Rate of Roll - Degrees per sec.		Stick Force-full Deflection - lbs.	
		Left	Right	Left	Right
Clean	150	62.	65.	19	22
Clean	180	61.	67.	23	25
Clean	200	63.	69.	26	26
Clean	230	62.	69.	29	34
Clean	260	58.	69.	--	--

90° Roll

Condition	IAS -MPH	Rate of Roll - Degrees per sec.	
		Left	Right
Landing	100	55.	47.
Clean	100	56.	60.
Clean	125	65.	72.
Clean	150	78.	90.
Clean	175	86.	100.
Clean	200	90.	120.

Times for the 360° rolls were measured from the instant the ailerons were deflected in level flight to the time when the airplane had rolled completely over and was again in level flight. The rates given thus are average for a complete roll and include the effect of starting and stopping the roll. The 90° rolls were started from a 60° bank opposite to the direction of roll. The time was measured from the instant the gyro horizon passed thru 30° on one side to the time it passed thru 60° on the opposite. The rates thus measured represent approximately the maximum steady rate of roll at full aileron deflection.

4. Engine temperature surveys were conducted on model FM-2 airplane No. 15953 and results forwarded to the Bureau of Aeronautics by reference (k). Engine cooling characteristics were found to be in general satisfactory. It was found necessary to bypass the oil cooler valve in order to keep the oil-in temperatures below the limit in the high power climb. Cowl flaps were full open for climbs and full closed for level flight, both maximum speed and maximum cruising lean runs.

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5. Tests were made using heated fuel to determine whether or not fuel vaporization and vapor lock would occur during a climb to high altitude. At the start of a typical climb the fuel pressure was 15 to 19 lbs. per sq. inch and fluctuated between these values until the auxiliary fuel pump was turned on at 14,000 ft. altitude after which the pressure stayed at 18 psi for the remainder of the climb to 34,100 ft. altitude. There was no apparent difference in engine power or rate of climb over that obtained on previous unheated fuel climbs. Temperatures obtained on this flight were as follows:

	Take-off	19 Min.	27 Min.
Fuel tank outlet-°F.....	100.4	89.6	86.0
Fuel line-half way between tank and carburetor-°F....	100.4	86.0	84.2
Carburetor entrance-°F.....	98.6	80.6	78.8
Outside air temp.-°C.....	0.	-45.	-47.

6. A check of the carburetor air temperature rise using alternate air supply showed a rise of 24°C over outside air temperature at 6,000 ft. alt. Using direct carburetor air supply the rise was 11°C.

7. Oil scavenger pump back pressures were measured under various conditions with the following results which represent average values obtained from several tests.

Condition	Back Pressure lbs/sq.in.	Engine RPM	Oil Pressure lbs/sq.in.	Oil Temperature °C
Starting	4	----	80	27
Warm-up	4	1200	70	60
Level Flight	12 to 14	2000 to 2600	70	75

8. The oil pressure in a push-over dive from level flight was found to drop momentarily to approximately 15 lbs. per sq. in. from its normal value of 70.

9. Excessive carbon monoxide concentrations were found in the model FM-2 airplane. Tests made on airplane No. 15953 gave the following results which were included in item 9 of reference (1).

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	Carbon Monoxide Concentration - %
Engine idling at 1000 RPM, headed into wind, hood open.....	.052
Same as above, hood closed.....	.052
Taxying at 900 RPM, cross wind, hood open.....	.069
Take-off, hood open.....	.021
Rated power climb at 6000 ft., hood closed.....	.021
Rated power level flight at 6000 ft., hood closed.....	.009
50% power, level flight at 6000 ft., hood closed.....	.008
Rated power climb, 10,000 ft., hood closed.....	.021
Rated power climb, 15,000 ft., hood closed.....	.022
Glide, low power, hood closed....	.012
Glide, low power, hood open.....	.008
Carrier approach, hood open.....	.006

The carbon monoxide concentration was also rechecked on a later production airplane, No. 16373, and was again found to be excessive in most conditions. A summary of the data obtained in these tests which was forwarded to the Bureau of Aeronautics in item 14 of reference (1) is as follows:

	Carbon Monoxide Concentration - %
Engine idling at 1000 RPM, headed into wind, hood open.....	.025
Same as above, hood closed.....	.030
Taxying at 900 RPM, cross wind, hood open.....	.042
Rated power climb at 6000 ft., hood closed.....	.020
Rated power level at 6000 ft., hood closed.....	.020
Rated power climb at 10,000 ft., hood closed.....	.030
Rated power climb at 15,000 ft., hood closed.....	.032
Carrier approach, hood open.....	.006
Glide, low power, hood open.....	.004

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From a comparison of the data on the two airplanes, it may be observed that concentrations in the later production airplane are considerably less in the ground conditions but as great or greater in the various flight conditions.

10. A night flight was made to check cockpit lighting and vision from the cockpit. When operating with auto rich mixture the exhaust flames were visible on both sides of the engine. Shifting to auto lean caused the flames to disappear. Cockpit lighting was not satisfactory, there being no light on the airspeed indicator, manifold pressure gauge, or oil temperature gauge. Optical qualities of the windshield and canopy were satisfactory when these items were thoroughly cleaned before flight. Formation lights were found to be very bright, even when dimmed, and were somewhat blinding to the pilot.

11. The cockpit check-off list for take-off and landing was checked for adequacy and an improved revised list was submitted in item 5 of reference (1).

12. In accordance with reference (m) carrier accelerated service operations were conducted aboard the USS Charger by Composite Squadron Six. A report of these operations was forwarded by reference (n) from which the following conclusion is quoted, "It is considered that the initial carrier operating characteristics of the model FM-2 airplane are highly satisfactory, and that no serious defects are apparent judging from the preliminary operations conducted aboard the USS Charger."

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Recommendations

1. As a result of the trials, changes in the model FM-2 airplane have been recommended in reference (1). These and several additional 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 airplane. These changes should be incorporated on undelivered airplanes prior to delivery and on delivered airplanes as soon as practicable.

1. Properly align tail wheel assembly to center line of airplane to prevent shearing lock pin plunger. -C
2. Make careful inspection of all airplanes to insure that a properly vented plug, Part No. TFA-155-1, is installed on the Thompson fuel pump. -C
3. Reroute the alternate air control flexible cable to prevent binding. -C
4. Replace the "ball" type alternate air control handle by a "T" type. -C
5. Revise the take-off and landing check-off lists as outlined in item 5 of reference (1). -C
6. Revise landing gear control so that handle is in a down position, i.e., 6 o'clock position, when the wheels are fully down. -C
7. Provide a reliable fuel quantity gauge. -C
8. Provide a reserve standpipe in the main tank. -C
9. Take steps to reduce the high carbon monoxide concentrations to acceptable limits and require pilots to use oxygen whenever possible in airplanes having the present high concentration. -C

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10. Increase the clearance between the exhaust stacks of Nos. 4, 5, 6, and 7 cylinders and the engine cowling to prevent rubbing. -C
11. Provide exhaust stacks, exhaust stack clamps, and exhaust stack clamp springs that are more serviceable. -C
12. Provide more reliable generator cut-out. -C
13. Eliminate binding of the supercharger flexible control cable against the flexible cable tubing, Part No. 7150207-2. -C
14. Improve cockpit lighting. -C

(b) Changes required by specifications:

1. Reduce excessive carburetor air temperature rise over outside air temperature to conform with NAVAER Spec. E-59C. (in direct air intake)-C