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PROOF DEPARTMENT
ARMY AIR FORCES PROVING GROUND COMMAND
EGLIN FIELD, FLORIDA

FILE

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FINAL REPORT

ON

TEST TO DETERMINE THE EFFECT OF AN ADDITIONAL 85 GALLONS OF INTERNAL FUEL ON PERFORMANCE AND HANDLING OF THE P-51B AIRPLANE

Serial No.: 4-43-23-1 (M-1)44 No. of Pages: 7 Date: 22 December 1943.

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Approved:

GRANDISON GARDNER,
Brigadier General, U.S. Army,
Commanding.

1. OBJECT:

To determine the effect of eighty-five (85) gallons of additional internal fuel on the performance and handling qualities of the P-51B type airplane.

2. INTRODUCTION:

This test was requested in a letter from the Commanding General, Army Air Forces, dated 8 April 1943, to Commanding General, Army Air Forces Proving Ground Command, Eglin Field, Florida, subject: "Duties and Responsibilities of the Army Air Forces Proving Ground Command." The test began 28 November 1943, and ended 10 December 1943.

a. Description.--The articles tested were two (2) standard P-51B-1-NA airplanes, each having an eighty-five (85) gallon self-sealing fuel tank installed inside the fuselage behind the pilot, in addition to the standard internal wing fuel tanks. This installation resulted in a total internal fuel supply of two hundred sixty-nine (269) U.S. gallons. The fuselage tanks were the same as those to be used in production, except for a lack of internal baffling, which allowed some movement of the fuel when the tank was partially full. Oil tank capacity, as originally provided, was sufficient for the flight endurance afforded by maximum fuel load.

3. CONCLUSIONS.--It is concluded that:

a. The eighty-five (85) gallon fuselage fuel tanks is desirable as a production item because of the additional range it affords.

b. With the internal fuselage tank filled with eighty-five (85) gallons of fuel, the airplane is so unstable longitudinally that violent pullouts or tight turns must be executed with caution, as stick loads rapidly reverse; with the fuselage tank half empty these maneuvers may be executed in practically the normal manner.

c. When the airplane is to be used with full internal and external fuel for long range combat missions, it is best to use the fuselage tank for warm-up, take-off, and partial climb, before drawing from the drop tanks.

d. Additional time in the airplane is required to become accustomed to the handling qualities of the airplane with full fuel load before violent maneuvers are attempted.

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e. Lack of internal baffle bulkheads in the leak-proof fuselage tank resulted in shifting of airplane balance.

f. The present location of the fuselage tank quantity gauge is unsatisfactory, as it requires the pilot to crane his neck and look full to the rear to read it.

g. The extra load of fuel in the fuselage tank has no measurable effect on the maximum speed of the airplane.

h. The weight of the extra fuel affects military power climbing time to thirty thousand (30,000) feet by approximately one (1) minute. (See climb curve, Inclosure 2.)

i. Turning circle of the P-51B with the fuselage tank half full is about even with the P-38J and is smaller than the P-47D-15. (This is a slight increase over the standard airplane without the tank.)

j. Full external droppable tanks have no appreciable effect on the stability of the airplane with a full internal fuel load.

k. Take-off and landing characteristics are satisfactory with all loading conditions in which the airplane will be flown.

4. RECOMMENDATIONS.--It is recommended that:

a. Internal, self-sealing fuel tanks of eighty-five (85) gallon capacity be installed in production P-51B type aircraft.

b. Missions be so planned that the greatest possibility is offered to enter combat with the fuselage tank not more than half full.

c. Fuel be used for long range combat missions in the following order:

(1)	Fuselage tank	Approximately 20 gals. for warm-up, take-off, and climb, leaving 65 gals. in fuselage tank.
(2)	Droppable tanks	Expended in cruise toward destination.

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(3)	Fuselage tank	Continue cruise. (Approximately 30 more gallons.) At this point the fuselage tank contained about 35 gallons, and the airplane is ready to participate in combat.
(4)	Main wing tanks	Combat and return to base.
(5)	Remainder of fuselage tank	Reserve (35 gals.)

Note: Missions must be so planned that the fuselage tank will not contain more than forty (40) gallons at the point where the pilot has a reasonable expectation of engaging in combat.

d. Pilots should be given extra time to become accustomed to the handling qualities of airplanes with full fuselage tanks before engaging in tight turns or similar maneuvers. Experience at this field, indicates that one (1) to two (2) hours of flying should accomplish the desired result.

e. An internal baffle system be installed in fuselage tanks to definitely prevent fuel movement both longitudinally and laterally.

f. The present fuel gauge for the fuselage tank should be extended forward so that the pilot can read it by glancing over his shoulder, or a remote indicating gauge be placed on the instrument panel.

5. RECORD OF TEST:

This test was run in accordance with the test program, this headquarters, dated 8 December 1943. (See Inclosure 1.)

6. DISCUSSION:

a. Increased Range.--The addition of eighty-five (85) gallons to the internal fuel supply of the P-51B increases the original internal tankage by about forty-five per cent (45%). The corresponding increase in combat radius of action resulting from this supplemented fuel supply allows the P-51B to engage

in combat at greater distances from its base than any other contemporary fighter. The long range bomber-convoy possibilities afforded by this airplane make the installation of the additional inboard tank of primary importance.

b. Center of Gravity.--Both of the aircraft tested were weighed with full military load and the internal fuselage tanks full. Gross weights were nine thousand six hundred ten (9,610) pounds and nine thousand six hundred forty (9,640) pounds as flown. Center of gravity positions were determined as 103.8" and 104.7" aft of the main datum line respectively (corresponding approximately to 31% and 32.1% M.A.C.). Safe C.G. limits are specified as 96" to 102" from datum line. It was the consensus of pilot opinion that combat could be safely engaged in with about half of the fuel expended from the fuselage tank. Computations show the center of gravity at this condition to be approximately at the rearmost specified limit.

c. Fuselage Tank Full.--To check the effect of the loaded fuselage tank on general handling qualities and performance, several experienced pilots made flights on each of the subject aircraft. Take-offs and climbs were made on the main wing tanks, so that combat maneuvers could be tested at altitude as the degree of stability changed progressively while fuel was expended from the fuselage tank. Tight turns in both directions, pull outs, acrobatics, and longitudinal oscillation tests were made with progressive amounts of fuel used from the fuselage tank. Severe stick force reversal was met with in both tight turns and pull outs, when they were entered with the fuselage tank full. Considerable forward pressure on the stick was necessary at an estimated three (3) to five (5) "G" to keep the turn or pull-out from rapidly tightening up to a dangerous degree. This tendency was definitely more severe in left turns than in right. In this condition it was practically impossible to trim the aircraft for hands-off level flight. Oscillation trials were carried out by trimming the aircraft as closely as possible for level flight and then displacing the nose up or down and releasing the controls. Level flight trim speed was about two hundred fifty (250) I.A.S. When displaced twenty (20) m.p.h. below this speed, the airplane continued on to a stall; and when displaced twenty (20) m.p.h. above trim speed, the resulting dive showed no tendency to recover without pilot action.

d. Fuselage Tank Half Full.--With about half of the fuel used from the fuselage tank, stability was much improved.

Only slight tendency to tighten up was noticeable in turns, and that was only in a left turn. Acrobatics were engaged in with almost normal reaction, and trimming for hands-off flight was much easier. From the half full point on, the stability is constantly improving with use of fuel, finally returning completely to normal.

e. Additional Attention Required.--From the stability standpoint it is obvious that great caution must be observed when maneuvering the airplane with a full load in the fuselage tank. Continuous low level flying should be avoided with fuselage tank full. Instrument flying, except as an emergency measure for short periods of time, should not be attempted with the fuselage tank fully loaded. A small additional amount of flying time should suffice to acquaint the average pilot with the loaded tank characteristics of the aircraft.

f. Order of Draining Tanks.--It is felt that use of fuel in the order outlined will result in maximum effective use of the inboard fuselage tank. Expending about twenty (20) gallons from this rear tank during warm-up, take-off, and climb on course will improve the stability immediately without materially affecting the range. Again, burning fuel from the fuselage tank after external tanks are dropped further improves the stability, and leaving approximately thirty (30) to thirty-five (35) gallons reserve in the rear tank eliminates the necessity for the pilot to estimate his reserve by his wing tank gauges. With ammunition gone, the aircrafts flying and landing characteristics are improved if reserve is carried in fuselage tank.

g. During landing, and during some maneuvers, some directional oscillation or "fish-tailing" was noticed. This is believed to have been caused by sloshing of fuel in the unbaffled fuselage tank. The same effect was also occasionally noticeable as a pitching motion during landing approach. It is understood that the production item will be fitted with internal baffles, which will prevent fuel sloshing.

h. Speed runs were made by three (3) different pilots at two (2) altitudes (15,000 and 25,000 feet). Each time runs were made in the full, half-full, and empty conditions during the same flight as gas was used from the fuselage tank. No difference whatsoever was found in indicated air speed for the three (3) runs in each flight. Both airplanes were checked in this manner.

i. Military power climbs (3,000 R.P.M. at 61" Hg)

were made with both airplanes, fuselage tank full and empty. Trim in the climb was difficult with the full tank and the airplane had to be carefully flown. The time difference to thirty thousand (30,000) feet altitude caused by the extra fuel load was slightly under one (1) minute for both airplanes. Time-altitude data are plotted as Inclosure 2.

j. The subject airplanes were flown in turning circle comparison with a P-38J and a P-47D-15. Turns were made with the fuselage tank empty and half-full. The difference in turning radius, while noticeable, was not great. With the tank empty the P-51B had a very slight edge on the P-38J, and with a half fuel load the two (2) airplanes were approximately equal. In both cases the P-51B turned easily inside the P-47D-15. Because of the tendency to tighten up to high accelerations, it was not possible to accurately compare turning circles with the additional tank fully loaded.

k. As an additional check, the airplanes were flown with full internal and external fuel. The external droppable tanks had no appreciable effect on stability with the fuselage tank full or nearly empty.

l. Landings were made in two (2) loading conditions to simulate aircraft returning from combat missions. Landing characteristics were very satisfactory in both of the following instances:

(1) Fuselage tank empty, no ammunition, reserve amount (30 gals.) in wing tanks.

(2) Reserve amount (30 gals.) in fuselage tank, combat ammunition load, wing tanks empty.

7. INCLOSURES:

Incl 1 - Test Program.
Incl 2 - Time-Altitude Data.

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PROOF DEPARTMENT
ARMY AIR FORCES PROVING GROUND COMMAND
EGLIN FIELD, FLORIDA

8 December 1943.

SUBJECT: Program for Test to Determine the Effect of an Additional 85 Gallons of Internal Fuel on the Performance and Handling of the P-51B Airplane. (S.T. No. 4-43-23-1)

TO: Commanding Officer, 1st Proving Ground Group, AAFPGC, Eglin Field, Florida.

1. GENERAL:

a. Two (2) P-51B-1NA airplanes, equipped with additional internal fuselage tanks of eighty-five (85) gallon capacity, have been furnished this station for test of performance and flying characteristics.

b. This is a 1A PRIORITY service test.

c. This test was requested in letter, Commanding General, Army Air Forces, dated 8 April 1943, to Commanding General, Army Air Forces Proving Ground Command, Eglin Field, Florida, subject: "Duties and Responsibilities of the Army Air Forces Proving Ground Command."

d. Captain D. F. Casey is designated as the Operational Suitability Project Officer for this test.

e. Major I. W. Toubman is designated as the 1st Proving Ground Group, AAFPGC, Test Officer for this test.

f. At the conclusion of this test, the Commanding Officer of the 1st Proving Ground Group will be informed by the Chief of the Proof Department as to the disposition of the test articles.

2. OBJECT:

To determine the effect of eighty-five (85) gallons of additional internal fuel on the performance and handling qualities of the P-51B type airplane.

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3. METHOD OF CONDUCTING TEST:

a. Phase I.

(1) Aircraft will be weighed with the additional fuselage tank full, and center of gravity positions computed for both full and empty conditions.

b. Phase II.

(1) Trial climbs at military power will be made to operational ceiling to determine the effect of the additional fuel load on rate of climb.

(2) Flights will be made to determine the effect of the additional fuel load on high speed at thirty thousand (30,000) feet altitude.

(3) Test flights will be made by as many experienced pilots as practicable, with the additional fuel load varied from full to empty, to note the flying characteristics and handling qualities of the airplane under the different load conditions. Special attention will be paid to changes in longitudinal stability as fuel is used from the additional internal tank. Tight turns and combat acrobatics will be performed.

(4) Turning circle comparisons will be made with other fighter aircraft to check changes in turning circle radius caused by the extra internal fuel load.

(5) Landing characteristics will be investigated with the extra tank empty, ammunition expended, and a normal reserve in main tanks, to check the most nose heavy landing condition. Comparative landings will also be made with main tanks empty and a normal reserve in the additional tank.

(6) Flights will be made with full internal fuel load and two (2) full droppable auxiliary tanks to investigate stability and trimming characteristics.

4. RECORDS:

Complete data cards with pilots' comments will be turned in to the Test Officer for all flights involving comparison and tests of flying characteristics.

5. REPORTS:

a. A daily progress report will be maintained by the Project Officer in the office of the Operational Suitability Section and will be accessible at all times to the Chiefs of the Testing Branch and Proof Department.

b. A final report will be prepared by the Project Officer, after a conference with all participating personnel, and submitted to the Chief of the Proof Department, through the Chiefs of the Testing Branch and Operational Suitability Section, immediately upon completion of the test.

By command of Brigadier General GARDNER:

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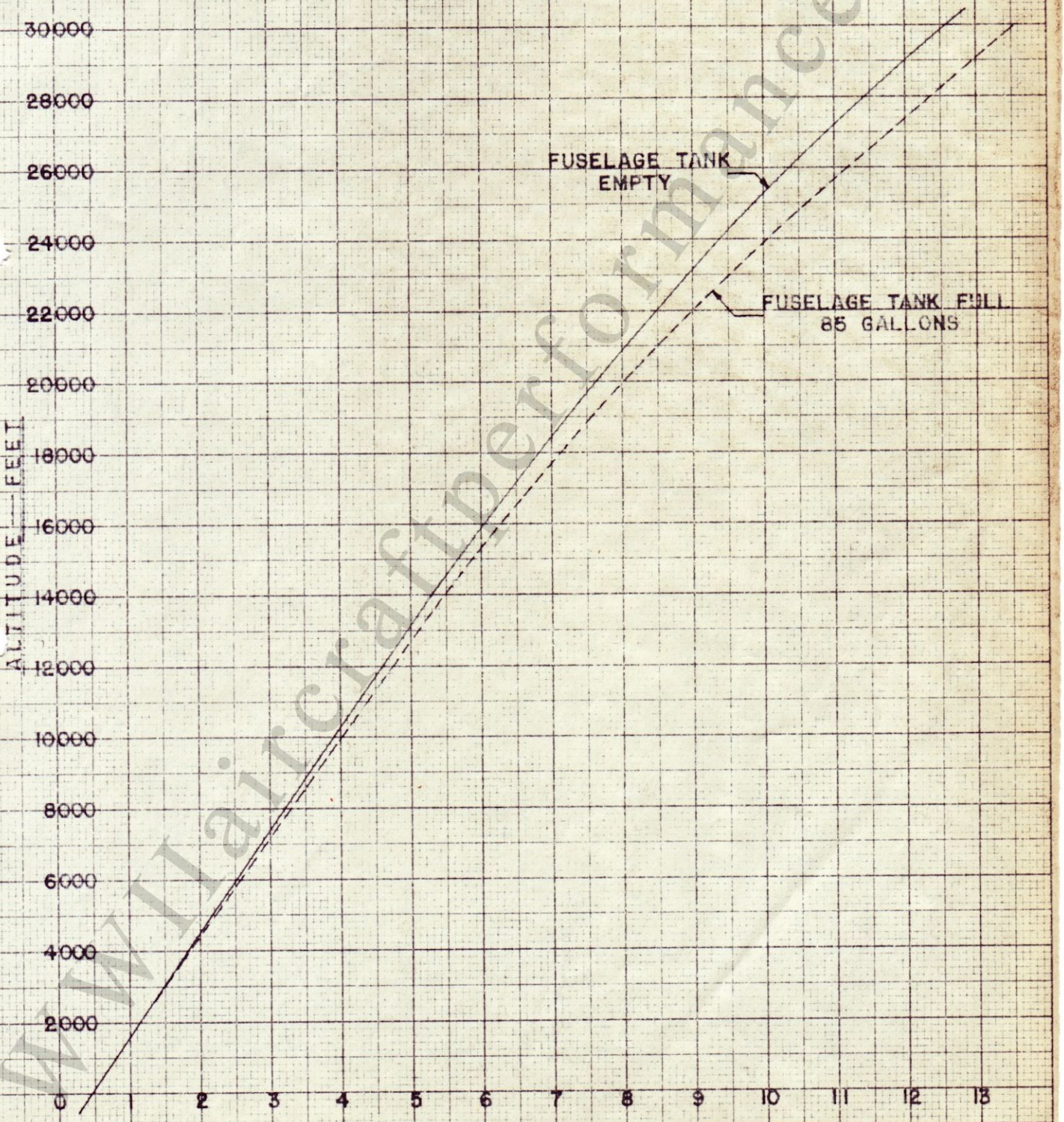
CLIMB COMPARISON --3,000 R.P.M.— 61" HG
P-51-1 AIRPLANE --WITH & WITHOUT
85 GALLONS OF ADDITIONAL INTERNAL FUEL



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