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PERFORMANCE FLIGHT TESTS OF THE NORTHROP BLACK WIDOW P-61A AIRPLANE, AAF NO. 42-5488.

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I. Introduction

Flight tests were conducted at the manufacturer's plant at Hawthorne, California, on the P-61A Airplane, AAF No. 42-5488 to obtain performance data requested by the project engineer, Mr. M. A. Robin of the Fighter Branch, Production Engineering Section, Production Division, and Major W. G. Logan of the Fighter Branch, Aircraft Projects Section of the Engineering Division. The airplane was flown by Capt. J. D. Onerem of the Fighter Flight Test Branch, Flight Section.

The airplane is a twin-engine night fighter of all-metal construction manufactured by Northrop Aircraft, Inc. of Hawthorne, California. Popularly known as the "Black Widow", it carries a normal crew of three (a pilot, gunner, and radio operator-gunner) for operation at night or during periods of poor visibility. It is a midwing monoplane with two tail booms and a fully retractable tricycle landing gear. The wing is a stressed skin, two-spar cantilever structure with nearly full-span landing flaps. Small wing tip ailerons of the conventional type are for pilot "feel" only with the major aileron action performed by spoiler type ailerons rising out of the upper panel of the wing.

The power plant consists of two (2) Pratt and Whitney R-2800-65 W eighteen cylinder twin-row, two-stage, two-speed supercharged aircooled engines designed to operate on 130 grade fuel with Stromberg injection type carburetors fitted with water injection control. The engines drive two (2) Curtiss Electric, full feathering four-bladed propellers, blade design no. 714-702-12, with a normal blade angle range of 28° to 58° measured at the 42 inch radius station. The propellers are 12 feet 2 inches in diameter and are equipped with spinners and cuffs for better distribution of cooling air to the engine cylinders at cruising speeds and during ground operation.

II. Summary

The rudders, ailerons, and elevators were very effective in all normal positions of flight from limiting diving speed down to the stall. Forward vision during taxiing and take-off was very good, except for some distortion caused by the curved windows, but poor during climb because of the nose-high attitude of the airplane. The airplane was considered very maneuverable for its weight. It was statically and dynamically stable both longitudinally and directionally with neutral lateral stability. With power off and the airplane "clean" the stalling speed was 105 MPH indicated airspeed with the turret off at a gross weight of 26,200 pounds. The supercharger regulator control operated satisfactorily when using water injection and no objectionable time lag was noted between the time the water in-

jection was turned on, until the engine manifold pressure stabilized on 60" Hg.

The principal airplane performance corrected to a standard weight at altitude (take-off gross weight less the weight of fuel used in ground operations, take-off and climb to the altitude) is given below.. The take-off gross weight with the turret installed was 29,240 pounds while the gross weight without the turret was 27,600 pounds.

	Turret Off	Turret On
Maximum Speed at War Emergency Power at 17,600 feet	372 MPH	369 MPH
Maximum Speed at Military Power at 21,600 feet	363 MPH	360 MPH
Maximum Rate of Climb at Sea Level at War Emergency Power	2,925 ft./min.	2,640 ft./min.
Maximum Rate of Climb at Sea Level at Military Power	2,420 ft./min.	2120 ft./min.
Time to climb to 20,000 feet at War Emergency Power	8.5 mins.	9.6 mins.
Time to climb to 20,000 feet at Military Power	10.0 mins.	11.7 mins.
Service Ceiling at Military Power	33,700 feet	32,100 feet
Range at 10,000 feet at 200 MPH (based on 630 U.S. gallons of internal fuel with allowance of 45 gallons for take-off, climb and incidental operation)		1,210 miles

III. Condition of the Aircraft Relative to Tests

A. Airplane performance was obtained with and without the .50 caliber gun top turret installed, using 130 grade fuel.

The airplane was equipped with torquemeters and a Bowser fuel-flow meter, complete with totalizer, which was connected to the right engine fuel system. Other test equipment consisted of a sensitive airspeed indicator, dual manifold pressure gages, test tachometers and a test altimeter, all of which were accurately calibrated in the laboratory before installation. Carburetor air temperatures and outside air temperatures were measured by calibrated, type C-10, resistance thermometers. A calibrated manifold pressure gage was also installed to indicate the carburetor deck pressure on the right engine for the purpose of checking the operation of the supercharger regulator unit while auxiliary blower was being used.

No special test instrumentation was made to measure the oil-in temperature, engine oil pressure and cylinder head temperatures, but the ship's instruments were removed, calibrated in the laboratory, and reinstalled prior to flight testing, so that the true readings of these instruments would be known at all times.

Speed vs. Altitude at war emergency power using water injection (20% alcohol and 80% water mixture,) military power and normal rated power; war emergency, military power, and seventy-five per cent power climbs; cruising power calibrations and range surveys at 5,000 and 10,000 feet were obtained without the turret installed at a take-off gross weight of 27,600 pounds, c.g. at 25.5 percent mac, wheels up. Complete stall information was also obtained.

Speed vs. Altitude and the climbs were repeated with the turret installed and cruising power calibrations were also run at 5,000, 10,000, 15,000 and 25,000 feet. The gross weight at take-off was 29,245 pounds with a c.g. of 27.5 per cent mac, wheels up and 25.6 per cent mac, wheels down.

All level flight speed vs. altitude data was corrected to a standard weight at altitude, which was take-off gross weight less the weight of the fuel used to take-off and climb to the altitude plus a small allowance for necessary engine warm-up and ground operation. All other data was corrected to an N.A.C.A standard day.

B. For the initial flight tests armament consisted of four (4) 20 M.M. high velocity cannon in fixed position pointed forward and mounted in the bottom of the crew nacelle. For this condition the airplane was ballasted for the equivalent loading of 800 rounds of 20 m.m. ammunition and carried 630 U.S. gallons of internal fuel and a crew of two.

For the second phase of the tests the remote controlled power turret, complete with deflector vanes to eliminate buffeting, and housing four .50 caliber guns, was installed, and the airplane was ballasted to a loading equivalent to 600 rounds of 20 m.m. ammunition and 2000 rounds of .50 caliber ammunition, and a crew of three. All guns were wrapped with masking tape.

The pilot is protected from machine gun fire by bullet resistant glass in the front windshield panel and the gunner by bullet resistant glass in his forward windshield panel and by adjustable sections of armor plate on either side of the fuselage.

C. The airplane was flown with standard army camouflage paint on all metal surfaces. The radar poles and all radio masts and antennae were in place.

D. The alcohol-water mixture for the water injection supply was carried in specially constructed tanks built into the standard engine cowl. No external changes were made in the cowling that would effect drag characteristics. A mixture of 20% alcohol and 80% water was used to prevent freezing at altitude.

E. This airplane was not equipped with de-icer boots.

F. The airplane was flown with the landing gear retracted, wing flaps neutral and carburetor cold unless otherwise stated. Upper cowl flaps were closed for all conditions of flight. All level flight performance was obtained with the oil cooler shutters one quarter open so that the oil-in temperature would stay within limits on the test days which averaged 14° C above standard. No measurable loss in speed was noted at normal rated power and above, but at very low cruising powers this configuration resulted in a loss of approximately one (1) mile per hour in true speed. On a standard day it would be possible to run with oil cooler shutters closed in level flight. Lower cowl flaps were closed for level flight and one-quarter open for climbs; intercooler shutters and mixture setting as noted.

IV. Flight Characteristics

A. Taxiing and Ground Handling

The subject airplane had very good taxiing and ground handling characteristics. Directional control could be very easily maintained by application of engine power and it was seldom necessary to use the brakes for this purpose. Braking action was very smooth and easily applied as desired. The nose wheel was smooth in all operation, both on concrete and rough sod, and strong cross-winds had very little effect on the airplane.

B. Take-Off

The acceleration was very rapid when full take-off power was used. The length of ground roll was short and intitial rate of climb very good. Very little torque was experienced but a burble tendency was quite apparent under the fuselage immediately after the gear was retracted and while the flaps were still extended. This condition subsided as soon as the flaps were retracted and the climb maintained. After the landing gear was retracted, slight elevator trim was required to bring the nose up. The landing flaps retracted evenly without causing any undesirable effects; aileron loads during take-off were very light for an airplane of this weight due to the spoiler type aileron system employed.

It is recommended that one-quarter wing flaps (15°) be used for take-off and the nose wheel should be held on the runway until take-off speed is attained. Upper cowl flaps should be closed to prevent undesirable buffeting.

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C. Stability

The stability of this airplane was good. Trimmed for level flight, the airplane was statically and dynamically stable both longitudionally and directionally. Lateral stability was neutral. These characteristics were found to be the same for both normal rated and cruising powers.

In a power-off glide in the landing configuration (full wing flaps and landing gear extended) the airplane was statically and dynamically stable in all planes.

A slight hunting tendency was noted in rough air.

D. Trim and Balance

Changes in elevator and rudder trim were required for slight changes in flight attitude. The use of aileron trim had very slight effect and was not considered ample. The airplane became extremely nose heavy when the wing flaps and landing gear were extended but this condition could be readily corrected by use of elevator trim. Slight elevator trim was necessary for steep climbs and dives.

Sufficient rudder trim was available for all conditions of flight.

E. Controllability

The rudder, aileron, and elevator were very effective in all positions of flight from limiting speed down to the stall.

The elevator control forces were heavy at all speeds and extremely heavy at high speeds. The aileron control forces were light at all speeds, although there was considerable friction in the actuating linkage. Full aileron deflection was made up to 260 MPH indicated airspeed without any sign of reversals and the forces remained light due to the spoiler type ailerons extending from the top surface of the wing with the small outboard ailerons for "feel and centering" only.

More than average displacement of the control wheel was necessary for lateral control at slow speeds and there was considerable lag in the response of the airplane.

F. Maneuverability

The airplane appeared to be very maneuverable for one of its weight class. The rate of roll was rapid; maneuvering flaps are to be installed on later models to increase the rate of turn. Longitudinal control was heavy requiring considerable effort for acrobatics. A tendency to climb or dive accompanied a turn unless a definite effort was made to suppress it.

G. Stalling Characteristics.

All stalls were obtained with the turret removed at a gross weight of approximately 26,000 pounds. All stalls were straight through and clean with sufficient warning in the form of tail buffeting occuring approximately three miles per hour before the break. All controls were effective up to the stalling point.

In the clean configuration and the power off the airplane stalled at about 105 MPH indicated airspeed. With the landing gear extended and the wing flaps full down the indicated stalling speed was 85 MPH.

Using approximately 975 brake horsepower per engine the airplane stalled clean at 97 MPH with wide open cowl flaps and at 91 MPH with cowl flaps one-quarter open and the landing gear extended. Changing either the cowl flap or intercooler shutter position from closed to wide open had no noticeable effect on the stalling speeds.

H. Spinning Characteristics

No spins were attempted on this airplane because intentional spins were prohibited.

I. Diving Characteristics

During the dives the elevator forces were very heavy although light control was allowed by the use of the sensitive elevator trim. Aileron action was light and positive but the rudder control was moderately heavy although effective.

J. Operation on Reduced Number of Engines

No tests were run to determine the single engine ceiling of this airplane but a single engine landing was made which indicated that the airplane had good single engine landing control. However, level flight cannot be maintained on one engine with the landing gear and wing flaps extended.

K. High Altitude Trails.

The airplane handled satisfactory at altitude although it began to feel sluggish at 30,000 feet. Trouble was experienced with low oil pressure on the right engine above 20,000 feet at military power. The pressure dropped below the minimum allowable operating limit although the oil-in temperature was still normal. An engine change was required on the left engine midway through the tests due to a damaged impeller in the main stage supercharger section. Neither one of the left engines showed the above mentioned loss of oil pressure that was evidence on the right engine. The cause

of this low oil pressure was never actually determined although several corrective measures were suggested and tried by the Pratt & Whitney field representatives, all to no avail.

The engines would not run at high altitude with the fuel booster pumps off when changing fuel selector valves as the pilot's handbook of operating instructions recommends.

Considerable cold air leakage was experienced around the windows, escape hatch, and along the exit door.

L. Approaches and Landings

The airplane was found to possess desirable landing characteristics. The nose heaviness that accompanied the extension of the landing gear and wing flaps was easily corrected by the use of elevator trim. An apparent lack of aileron control was experienced at first but was found to be not objectionable as the pilot became accustomed to the airplane.

Approximately 120 MPH indicated airspeed is recommended for safe gliding speed on approach when using full wing flaps.

M. Night Flying

No night flights were made.

N. Noise and Vibration Level Tests At Crew Stations.

Engine vibration and noise level was considered normal at all crew stations.

O. Pilot's Report on Vision and Cockpit Layout.

Forward vision during taxiing was very good except for some distortion caused by the curved plexiglass enclosure. Vision to the rear was obstructed by the wing and engine nacelles. Forward vision during take-off was good but became exceedingly poor as the nose was lifted, due to the long nose of the crew nacelle. The canopy had too much distortion in the plexiglass and the position of the metal structure was such as to seriously impair vision in several directions from the gunner's seat.

Trim tab controls for the rudder, aileron, and elevator were operated all in the same plane which required some thought each time to decide which way the control should be moved to effect the desired results. Also, sufficient room between the seat and the side of the fuselage was lacking for access to the trim tab controls. These two

factors resulted in wasted time before required trim could be made. It would be more desirable to have the controls mounted so that each would operate in the respective plane of action of the surface which it controlled.

The instrument layout was in general satisfactory. The generator ammeters and breaker switches were inconveniently placed behind the pilot on the right rail of the fuselage.

The controls for the oil cooler shutters were considered inaccesible. Furthermore, it would be desirable to have the oil cooler shutters and also the intercooler shutters and engine cowl flaps operated automatically.

The warning horn release button was located on the left rail of the fuselage somewhat behind the pilot and was difficult to reach and operate. A more convenient location ahead of the pilot would be desirable.

The ignition switches could be more advantageously placed by rotating the panel toward the pilot. The location of the electric propeller feathering switches was considered unsatisfactory.

The canopy design was very inadequate during a heavy rainstorm. Considerable water leaked into the cockpit from the metal-glass seals in the overhead enclosure. This unsatisfactory condition was experienced both on the ground and in flight.

The emergency exit provided for the pilot was poor, as one control handle operated without violence, should release the canopy. The entrance door was not provided with an emergency release on this airplane, although subsequent models are to be so equipped.

The fresh air inlet on the side of the fuselage was unsatisfactory. A large inlet placed near the pilot's feet would be more desirable for operation during extremely warm weather.

The pilot's seat had insufficient longitudinal adjustment. Sufficient vertical adjustment was provided but a tall pilot wearing a large seatpack type of parachute would experience an uncomfortable lack of overhead clearance in rough air, without some means of horizontal adjustment. The control column was well located, however, and the travel was very suitable.

In general, sufficient room was available for the wearing of winter clothing.

P. Crew Report on Layout of Individual Stations

No detailed comments can be made regarding the layout of the crew stations because of the nature of the test instrumentation.

The gunner's sight was removed to allow suitable placing of the observer's instrument test panel without undue interference. At no time was it possible to ride in the radio operator's position in flight because passage was impossible through the crew nacelle from front to rear and the positions therefore are not interchangable.

Emergency exit from the radio-gunner's position would be very simple with little likelihood of collision with the empennage.

Q. General Functioning.

1. Power Plants and Associated Equipment.

In general the operation of the power plant was satisfactory. However, mention should be made of several minor occurences that were encountered.

The use of water injection caused numerous exhaust stacks to fail along the weld and in several instances burn off. During approximately 60 hours of test flying including several hours of war emergency power operation, some seventy-five siamese stacks had to be replaced on the two engines. The failure always occured along the welded joint between the individual stacks.

Throughout the flight test program considerable trouble was also encountered with oil leaks at the rocker box cover gaskets. This resulted in the nacelles and empennage being sprayed with oil on several flights. This also was a fire hazard because on one flight the carburetor air filter on the right engine burned out at an altitude of 30,000 feet and was apparently a direct cause of the leaking engine oil becoming ignited after it had completely saturated the filter.

The carburetor preheat-door control rods were a source of annoyance since they broke off on occasions causing excessive carburetor air temperature by allowing the pre-heat door to open slightly. This also resulted in a lowering of manifold pressure and loss of available horsepower. The carburetor air filters should be redesigned so that some ram air could be obtained since it would be impossible to obtain take-off manifold pressure with the filter in operation.

On one occasions, while running a high speed point using water injection, the throttle linkage jammed in the fairlead in the fire wall while the throttle was in the wide open position. This was due to improper adjustment of the throttle linkage allowing the shoulder on the end of the throttle rod to wedge in the fairlead. It very nearly required feathering of the effected engine but eventually the throttle rod

was unstuck by application of such force on the throttle handle on the quadrant as to cause it to bend out of its proper place.

In view of the fact that the same difficulty was experienced at an earlier date at Wright Field corrective measures are strongly recommended.

2. Hydraulic, Electrical, and Pneumatic Systems.

In general, the hydraulic, electrical, and pneumatic systems on this airplane gave dependable service and required little more than normal maintenance.

3. Miscellaneous

The nose wheel gear retracted with excessive violence as it assumed the "locked-up" position.

A spring loaded elevator, with the trim tabs rigged in "deboost", was installed after several flights had been made and considerably improved the previous extreme heaviness of the control.

The windows and instrument panel "fogged-up" on descent to warmer air after a high altitude flight indicating the need for a defroster. The cockpit heater was considered unsatisfactory in that its dependability of operation was inconsistent.

On several occasions it was noted that gasoline fumes filled both the front and rear cockpits during taxiing, take-off, and climbs with full fuel tanks.

During the running of the flight tests new ailerons, elevators, and rudders were put on due to fabric failure of the original control surfaces. Considerable trouble had been experienced on other P-61A airplanes with the same type of fabric, the cause of which was improper application of dope to the fabric by the subcontracting firm that furnished these parts. The method of application has now been corrected and no further trouble of this nature is anticipated.

V. Shipboard Tests

Not applicable to this airplane.

VI. Performance Data

All performance was run at the limiting manifold pressures specified in the Pilot's check chart of the Pratt and Whitney Operator's Handbook (Second Edition) for R-2800-3 series engines.

A. Airspeed Calibration

The airspeed position correction and location of the airspeed head are shown in fig. 1.

B. Altimeter Correction

The altimeter correction is shown in Fig. 2.

C. High Speed in Level Flight

High speed in level flight with and without top turrets installed are given in the following tables. The testswere flown with mixture auto-rich, cowl and intercooler flaps closed, oil cowl shutters 1/4 open and (1 1/8" exit).

1. Data for normal rated power, 2550 RPM is as follows. Curves are given in Fig. 3 and 4.

Altitude feet	Torque BHP/eng.	Man. Press"Hg.	Throttle	Blower	TURRET OFF TRUE SPEED	TURRET OFF EST. GROSS WT. POUNDS	TURRET ON TRUE SPEED	TURRET ON EST. GROSS WT. POUNDS
0	1500	44.5	Part	Neutral	287.5	27530	280.5	29170
5000	1555	44.5	Part	Neutral	305.5	27450	300.0	29080
8200	1590	44.5	W.O.	Neutral	317.0	27390	313.0	29030
** 8600	1570	43.9	W.O.	Neutral	317.0	27380	313.0	29020
8600	1570	49.5	Part	Low	317.0	27380	313.0	29020
10000	1585	49.5	Part	Low	322.0	27360	319.0	28980
15000	1630	49.5	Part	Low	343.0	27220	340.0	28830
*** 17500	1650	49.5	W.O.	Low	353.0	27140	350.0	28730
**** 19200	1540	46.2	W.O.	Low	351.0	27060	348.0	28630
19200	1540	49.5	Part	High	351.0	27060	348.0	28630
20000	1542	49.5	Part	High	354.0	27030	351.0	28590
***** 22500	1557	49.5	W.O.	High	365.0	26900	363.0	28410
25000	1400	44.8	W.O.	High	360.5	26730	357.0	28170
28000	1225	39.4	W.O.	High	350.0	26520	346.0	27810

* Critical Altitude in Neutral Blower for 44.5 " Hg. manifold pressure.
** Optimum Altitude for Shift to Low Blower.
*** Critical Altitude in Low Blower for 49.5" Hg. Manifold pressure.
**** Optimum Altitude for Shift to High Blower.
***** Critical Altitude in High Blower for 49.5" Hg. Manifold Pressure.

†Note: Closing the oil cooler shutters from the one-quarter open position gave no measurable increase in speed.

2. Data for military power at 2700 RPM is as follows. Curves are given in Fig. 3 and 4.

Altitude feet	Torque BHP/ eng.	Man. Press "Hg.	Throttle	Blower	TURRET OFF TRUE SPEED	TURRET OFF GROSS WT. POUNDS	TURRET ON TRUE SPEED	TURRET ON GROSS WT. POUNDS
0	1853	53.0	Part	Neutral	312.0	27530	307.5	29170
*4600	1870	53.0	W.O.	Neutral	324.0	27450	321.5	29090
5000	1848	52.4	W.O.	Neutral	324.0	27440	321.5	29080
**7100	1738	49.2	W.O.	Neutral	323.0	27410	321.0	29040
7100	1738	54.0	Part	Low	323.0	27410	321.0	29040
10000	1742	54.0	Part	Low	333.0	27360	330.5	28980
15000	1750	54.0	Part	Low	350.5	27220	348.0	28830
***16600	1754	54.0	W.O.	Low	355.5	27170	353.5	28870
****19200	1590	49.2	W.O.	Low	352.5	27060	350.5	28630
19200	1590	53.0	Part	High	352.5	27060	350.5	28630
20000	1590	53.0	Part	High	356.0	27030	353.5	28590
*****21600	1600	53.0	W.O.	High	363.0	26950	360.0	28470
25000	1400	46.1	W.O.	High	359.5	26740	356.0	28170
30000	1110	36.8	W.O.	High	340.0	26340	334.0	27500
32000	1000	33.5	W.O.	High	319.0	26100	---	---

* Critical altitude in Neutral Blower for 53"Hg. manifold pressure.
** Optimum altitude for shift to Low Blower
*** Critical altitude in Low Blower for 54"Hg. manifold pressure.
**** Optimum altitude for Shift to High Blower.
***** Critical altitude in High Blower for 53"Hg. Manifold pressure.

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3. Data for war emergency power at 2700 RPM using water injection is as follows. Curves are given in Fig. 3 and 4.

Altitude feet	Torque BHP/ eng.	Man. Press"Hg.	Throttle	Blower	TURRET OFF TRUE SPEED	TURRET OFF GROSS WT POUNDS	TURRET ON TRUE SPEED	TURRET ON GROSS WT. POUNDS
0	2240	60.0	Part	Neutral	333.0	27530	330.0	29170
*1400	2247	60.0	W.O.	Neutral	337.0	27500	334.0	29150
**4700	2010	53.3	W.O.	Neutral	334.0	27450	331.0	29090
4700	2010	60.0	Part	Low	334.0	27450	331.0	29090
5000	2012	60.0	Part	Low	335.0	27450	332.5	29080
10000	2047	60.0	Part	Low	355.0	27360	352.5	28980
***13000	2070	60.0	W.O.	Low	366.5	27280	364.0	28900
15000	1925	56.1	W.O.	Low	364.5	27220	361.5	28830
****15300	1910	55.5	W.O.	Low	364.0	27210	361.0	28820
15300	1910	60.0	Part	High	364.0	27210	361.0	28820
*****17600	1920	60.0	W.O.	High	372.0	27130	369.0	28720
20000	1735	54.6	W.O.	High	369.0	27030	366.0	28590
25000	1375	43.6	W.O.	High	356.5	26740	353.0	28170
28000	1165	37.5	W.O.	High	341.0	26520	- - -	- - -

* Critical altitude in Neutral Blower for 60.0"Hg. manifold pressure.

** Optimum altitude for Shift to Low Blower.

*** Critical altitude in Low Blower for 60.0"Hg. manifold pressure.

**** Optimum Altitude for shift to High Blower.

***** Critical altitude in High Blower for 60.0"Hg. manifold pressure.

D. Climb Performance

Climb performance with and without the .50 caliber top turret installed is given in the following table. Take-off gross weight without turret was 27,600 pounds and 29,245 pounds with turret and guns installed.

Tests were flown with mixture setting "auto-rich", upper cowl flaps closed, lower cowl flaps one-quarter open (3 1/4" exit gap); oil cooler shutters open wide, intercooler shutters closed in neutral blower and one-half open (2 1/2" exit gap) in auxiliary blowers at military and war emergency power and one-quarter open (1 1/4" exit gap) at seventy-five per cent power.

1. Data for military power climb at 2700 RPM is as follows. Curves are given in Fig. 5, 6, and 7.

Altitude feet	Torque BHP/ engine	Man. Press. "Hg.	Blower	Throttle	True Speed MPH	TURRET OFF Std. True R/C ft/ min.	TURRET OFF Time to Climb min.	TURRET OFF Gross Wt. Pounds	TURRET ON Std. True R/C ft/min.	TURRET ON Time to Climb min.	TURRET ON Gross Wt. Pounds
0	1880	53.0	Neutral	Part	163.0	2420	0	27530	2120	0	29200
*2600	1920	53.0	Neutral	W.O.	169.5	2420	1.1	27480	2120	1.25	29130
5000	1745	48.6	Neutral	W.O.	170.5	2150	2.15	27450	1850	2.45	29080
**6100	1675	46.7	Neutral	W.O.	172.0	2030	2.7	27430	1735	3.1	29060
6100	1675	54.9	Low	Part	172.0	2030	2.7	27430	1735	4.1	29060
10000	1685	54.0	Low	Part	181.0	2010	4.6	27350	1710	5.3	28980
***14100	1700	54.0	Low	W.O.	193.0	2000	6.65	27250	1695	7.7	28360
15000	1650	52.2	Low	W.O.	194.0	1910	7.1	27220	1600	8.3	28840
****16800	1555	48.8	Low	W.O.	199.0	1720	8.1	27160	1425	9.5	28770
16800	1555	53.9	High	Part	199.0	1720	8.1	27160	1480	9.5	28770
*****18600	1555	53.0	High	W.O.	203.0	1705	9.15	27090	1475	10.7	28690
20000	1480	50.1	High	W.O.	205.0	1545	10.0	27020	1330	11.7	28630
25000	1225	41.2	High	W.O.	212.5	1005	14.0	26740	820	16.4	28330
S/C 32100	870	31.0	High	W.O.	223.5	480	21.0	26340	310	23.8	27890
A/C 33100	820	29.7	High	W.O.	230.5	--	--	25790	100	36.6	27620
S/C 33700	795	28.9	High	W.O.	232.0	100	35.9	25610	0	--	---
A/C 34700	745	27.7	High	W.O.	234.0	0	--	---	--	--	---

* Critical altitude in neutral blower for 53"Hg manifold pressure.
** Optimum altitude for shift to low blower.
*** Critical altitude in low blower for 54" Hg. manifold pressure.
**** Optimum altitude for shift to high blower.
***** Critical altitude in high blower for 53"Hg. manifold pressure.

2. Data for war emergency power climbs using water injection at 2700 RPM is as follows. Curves are given in Fig. 5, 6, and 7.

Altitude feet	Torque BHP/ engine	Man. Press. "Hg.	Blower	Throttle	TURRET OFF True Speed MPH	TURRET OFF Std. R/C, True ft/ min.	TURRET OFF Time to Climb Minutes	TURRET OFF Gross Weight Pounds	TURRET ON Std. R/C, True ft/min.	TURRET ON Time to Climb Minutes	TURRET ON Gross Wt. Weight Pounds.
0	2165	57.5	Neutral	W.O.	163	2925	0	27530	2610	0	29190
*2400	1980	52.6	Neutral	W.O.	163.5	2620	0.9	27490	2305	1.0	29130
2400	1980	60.0	Low	Part	163.5	2620	0.9	27490	2305	1.0	29130
5000	1980	60.0	Low	Part	168.0	2610	1.9	27450	2300	2.1	20980
**9800	1980	60.0	Low	W.O.	180.5	2585	3.7	27360	2280	4.2	28990
10000	1962	59.6	Low	W.O.	181.0	2560	3.8	27350	2255	4.3	28980
***11400	1910	57.8	Low	W.O.	182.0	2390	4.4	27330	2125	4.85	28960
11400	1910	60.0	High	Part	182.0	2390	4.4	27330	2125	4.85	28960
****14000	1920	60.0	High	W.O.	188.0	2365	5.45	27250	2120	6.2	28870
15000	1854	57.8	High	W.O.	190.0	2245	5.9	27220	1995	6.65	28840
20000	1530	48.2	High	W.O.	199.5	1625	8.5	27330	1410	9.6	28630
25000	1238	39.8	High	W.O.	210.0	1025	12.35	26740	845	13.95	28340
28000	1076	35.2	High	W.O.	216.5	685	16.0	26520	520	18.4	28090

* Optimum altitude for shift to low blower.
** Critical altitude in low blower for 60.0"Hg. manifold pressure.
*** Optimum altitude for shift to high blower.
**** Critical altitude in high blower for 60.0" Hg. manifold pressure.

3. Data for seventy-five percent power climb at 2330 RPM is as follows. Curves are given in Fig. 5,6, and 7.

Altitude feet	Torque BHP/ engine	Man. Press. "Hg.	Blower	Throttle	True Speed MPH	TURRET OFF			TURRET ON		
						Std. True R/C, ft/min.	Time to Climb Minutes	Gross Weight Pounds	Std. True R/C, ft/ min.	Time to Climb Minutes	Gross Weight Pounds
0	1090	34.2	Neutral	Part	152.5	1040	0	27550	910	0	29200
5000	1141	34.2	Neutral	Part	164.0	1075	4.75	27450	945	5.4	29090
10000	1194	34.2	Neutral	Part	177.0	1108	9.3	27360	978	10.6	28980
*11400	1210	34.2	Neutral	W.O.	182.0	1117	10.6	27320	988	12.1	28950
11400	1255	38.2	Low	Part	182.0	1120	10.6	27320	1011	12.1	28950
15000	1265	38.2	Low	Part	190.5	1100	13.8	27220	987	15.6	28830
**19500	1280	38.2	Low	Part	205.5	1072	18.0	27050	960	20.3	28650
20000	1256	38.2	Low	W.O.	205.5	1028	18.45	27020	916	20.8	28630
***20900	1216	36.3	Low	W.O.	205.5	946	19.4	26980	837	21.8	28580
20900	1216	37.5	High	Part	205.5	946	19.4	26980	837	21.8	28580
****24500	1232	37.5	High	W.O.	218.0	910	23.2	26780	800	26.2	28360
25000	1203	36.8	High	W.O.	217.0	868	23.8	26740	746	26.9	28330
27000	1105	34.2	High	W.O.	218.5	665	26.4	26600	540	30.0	28170

* Critical Altitude in neutral blower for 34.2" Hg. manifold pressure and Optimum altitude for shift to low blower.
** Critical altitude in low blower for 38.2" Hg. manifold pressure.
*** Optimum altitude for shift to high blower.
**** Critical altitude in high blower for 37.5" Hg. manifold pressure.

E. Cruising Power Calibrations and Range Surveys.

1. Turret Off: Gross weight at take-off was 27,600 pounds, including 630 U.S. gallons of internal fuel.

a. Power required curves for 5000 feet and 10000 feet in neutral blower, corrected to 26,000 pounds gross weight, are shown on Figure 8.

b. Curves of Air Miles per Gallon vs. Airspeed at 5,000 and 10,000 feet, with all data corrected to an N.A.C.A. Standard Day at a gross weight of 26,000 pounds and based on the average fuel consumption curves on Fig. 11 and 12, are shown on Figures 15 and 16, respectively.

2. Turret Installed: Gross weight at take-off was 29,240 pounds including 630 U.S. gallons of internal fuel.

a. Power required curves for 5000 feet in neutral blower and 15,000 feet in low auxiliary blower are shown on Figure 9 at a corrected gross weight of 28,000 pounds.

b. Power required curves for 10,000 feet and 25,000 feet in high auxiliary blower corrected to a gross weight of 28,000 pounds are shown in Figure 10.

c. Curves of Air Miles per Gallon vs. Airspeed at 5000, 10,000, 15,000, and 25,000 feet, with all data corrected to an N.A.C.A. Standard Day at a gross weight of 28,000 pounds and based on the average fuel consumption curves on Figs. 11 through 14, are shown on Figures 17, 18, 19, and 20, respectively.

3. Full flow data showing specific fuel consumption in pounds per brake horsepower per hour vs. torquemeter brake horsepower at variable engine speeds are given in Figures 11 thru 14, for altitudes of 5000, 10,000, 15,000, and 25,000 feet.

4. Endurance and range guarantees made by the manufacturer, on a basis of 528 U.S. gallons of fuel at 200 MPH at 15,000 feet, were 5.7 hours and 1140 miles, respectively.

Range and endurance figures given below were obtained on this airplane for purposes of comparison to the manufacturer's guarantee. As far as was known, the carburetors on this airplane functioned in a representative manner and the engine had sufficient running time to be considered an average service engine. The figures are based on an available internal fuel capacity of 630 U.S. gallons of fuel, less the average amount consumed in ground operation, take-off, and climb to the altitude.

a. At 10,000 feet at an average gross weight of 28,000 pounds (turret on) the approximate range for 200 MPH was 1210 miles on 585 U.S. gallons of fuel at 1580 RPM and wide open throttle in neutral blower, mixture automatic lean. The indicated airspeed would be 165 MPH.

b. At 15,000 feet at an average gross weight of 28,000 pounds (turret on) the approximate range was 1190 miles on 560 U.S. gallons of fuel at 1350 RPM at maximum allowable BMEP for low auxiliary blower part throttle operation, mixture automatic lean. Corresponding endurance at this range is approximately 5.3 hours at an indicated airspeed of 170 MPH (223 MPH true speed).

At 15,000 feet at an average gross weight of 28,000 pounds, turret on, the approximate range at 200 MPH using 528 gallons of fuel was 1080 miles at 1580 rpm, wide open throttle, neutral blower, automatic lean mixture.

c. At 25,000 feet at an average gross weight of 28,000 pounds (turret on) the range is approximately 1025 miles on 475 U.S. gallons of fuel remaining after climb to altitude. The true speed would be 200 mph at 1850 RPM in automatic lean in low auxiliary blower.

F. Stalling Speeds

Stalling speeds with the turret off are tabulated below. Power-off stalls were made at an average indicated rate of descent of 1800 feet per minute and the power on stalls were started at an average rate of ascent of 500 feet per minute at 2200 RPM and 1500 feet per minute at 2550 RPM.

Stall No.	Density Altitude feet	Wing Flaps	Landing Gear	Cowl Flaps	Inter-cooler flaps	ave. RPM	Man. Press. "Hg.	Test BHP/ engine	Indicated Airspeed (Corr. for Instrument error)	Gross Weight, Pounds
1	13000	Up	Up	W.O.	Closed	1500	Idling	- -	105	26220
2	11200	Up	Up	Closed	Closed	1520	"	- -	105	26210
3	11700	Up	Down	Closed	Closed	1520	"	- -	102	26100
4	14300	1/4	Down	Closed	Closed	1520	"	- -	95	25930
5	12000	1/2	Down	Closed	Closed	1420	"	- -	87	25930
6	11700	3/4	Down	Closed	Closed	1250	"	- -	86	25930
7	10400	Full	Down	Closed	Closed	1280	"	- -	85	25930
8	9400	Up	Down	Closed	W.O.	1550	"	- -	101	25660
9	8800	Up	Down	Closed	Closed	1520	"	- -	101	25650
10	13400	Up	Up	W.O.	Closed	2180	31	975	97	26220
11	13000	Up	Down	1/4	Closed	2180	31	975	91	26120
12	13500	Up	Down	1/4	W.O.	2180	31	975	91	26110
13	16800	Up	Up	1/4	1/2	2550	45	1465	91	26640
14	17800	Up	Down	1/4	1/2	2550	43	1410	84	26590

G. Performance on a Reduced Number of Engines

No request was made for the determination of single engine ceiling on this airplane.

H. Take-Off and Landing Tests

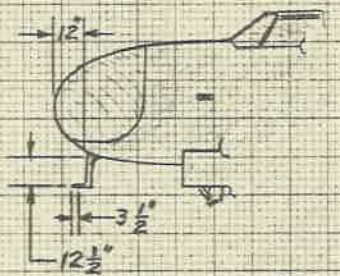
No request was made for either take-off or landing tests on this airplane.

VII. Curves

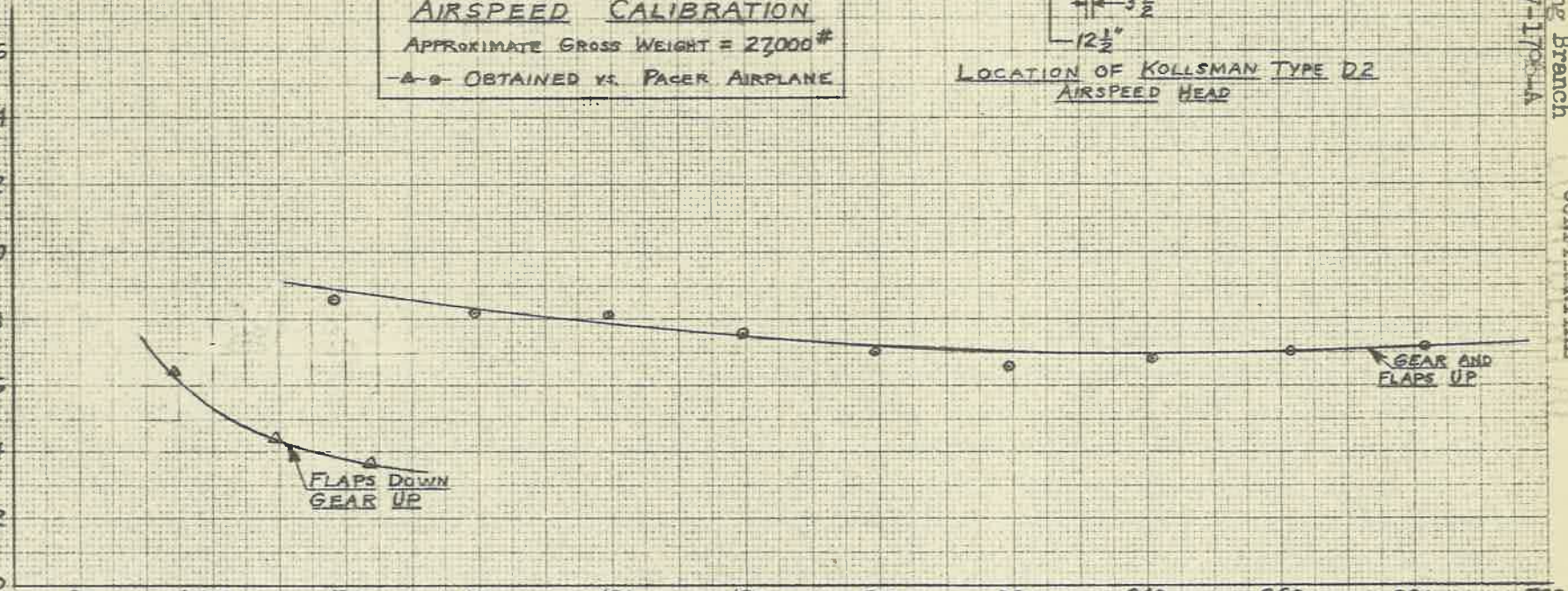
All data reduced to N.A.C.A. Standard Atmosphere Day.

FIGURE 1.

P-61A, AAF No. 42-5488
AIRSPEED CALIBRATION
APPROXIMATE GROSS WEIGHT = 27,000#
-A-B- OBTAINED VS. PACER AIRPLANE



LOCATION OF KOLLSMAN TYPE D2 AIRSPEED HEAD



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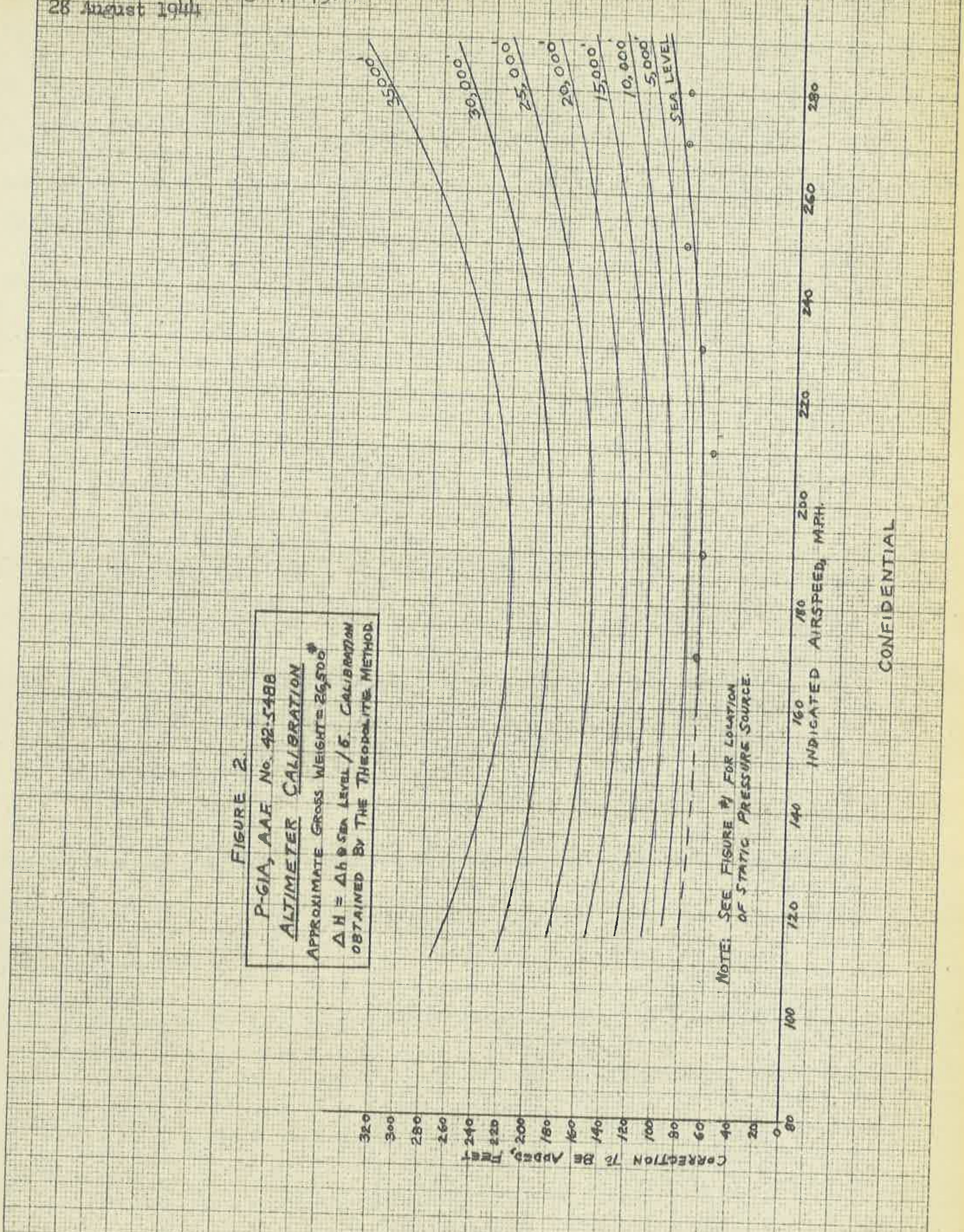

FLIGHT TEST ENGG. BR. WF 8/25/44 W.A.B.

Y-5825 ?

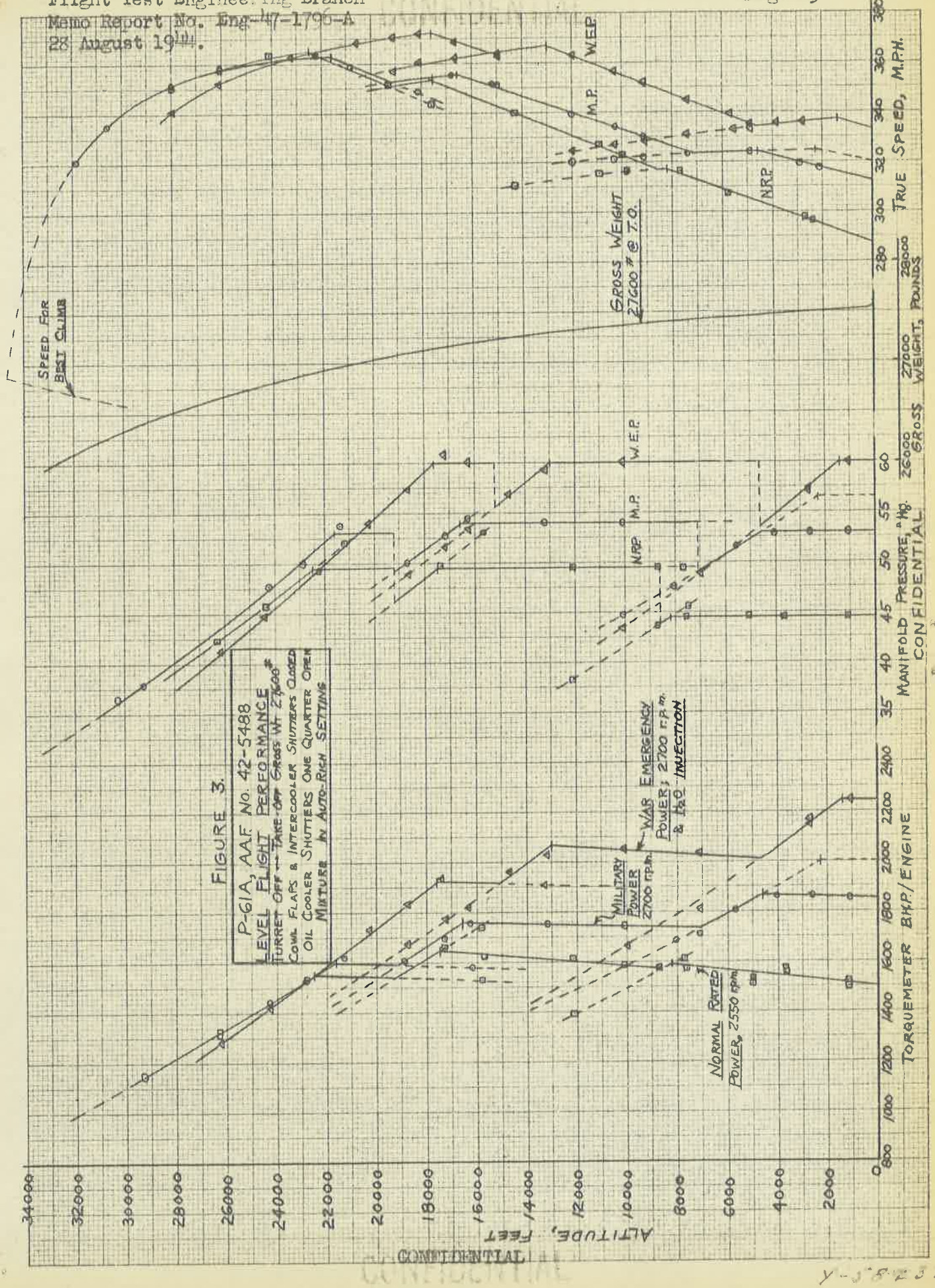

FIGURE 3.

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Y-5[illegible]37

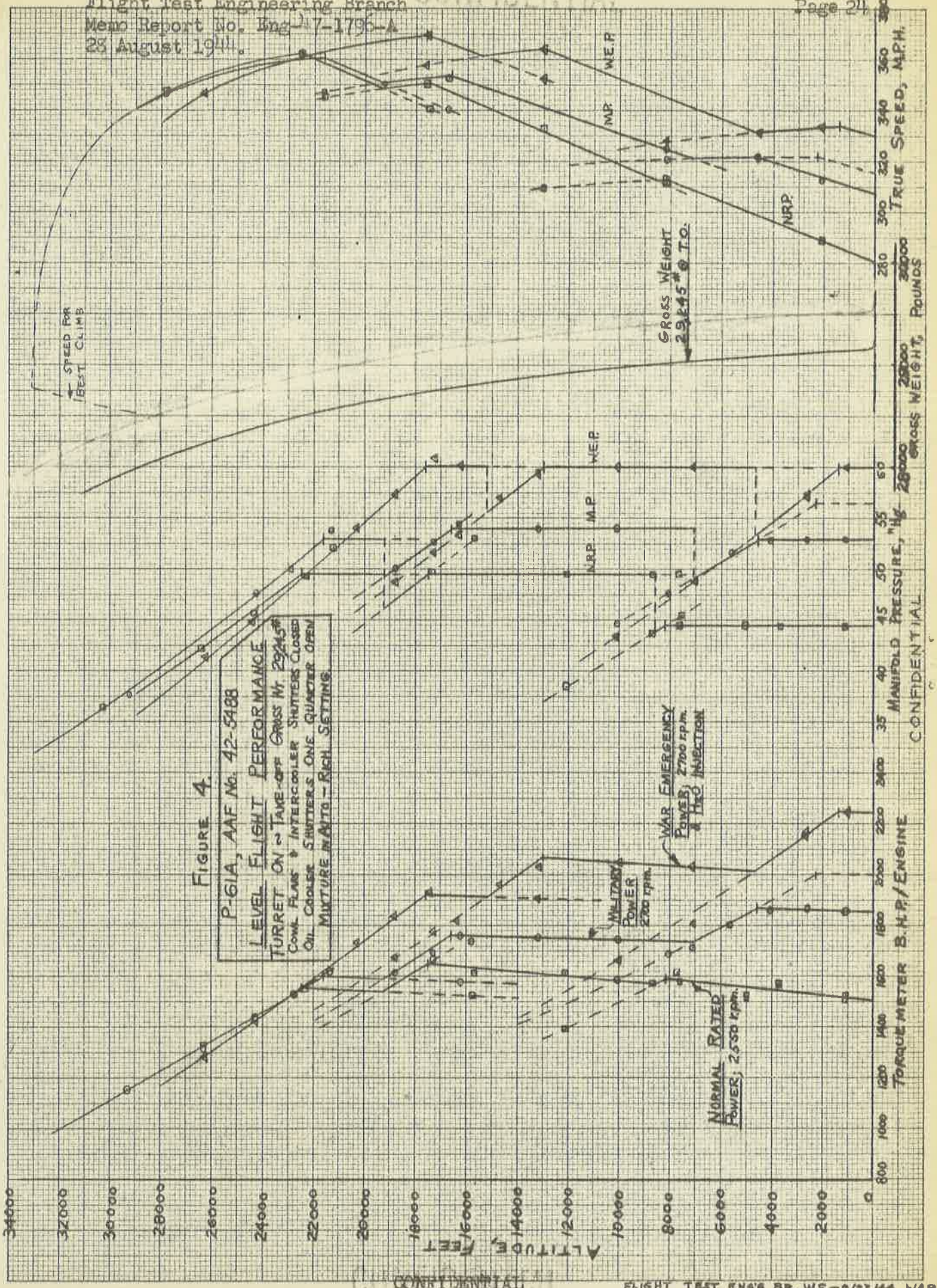


FIGURE 4.

FLIGHT TEST ENG'G BR., W.F.—8/23/44 WAB.

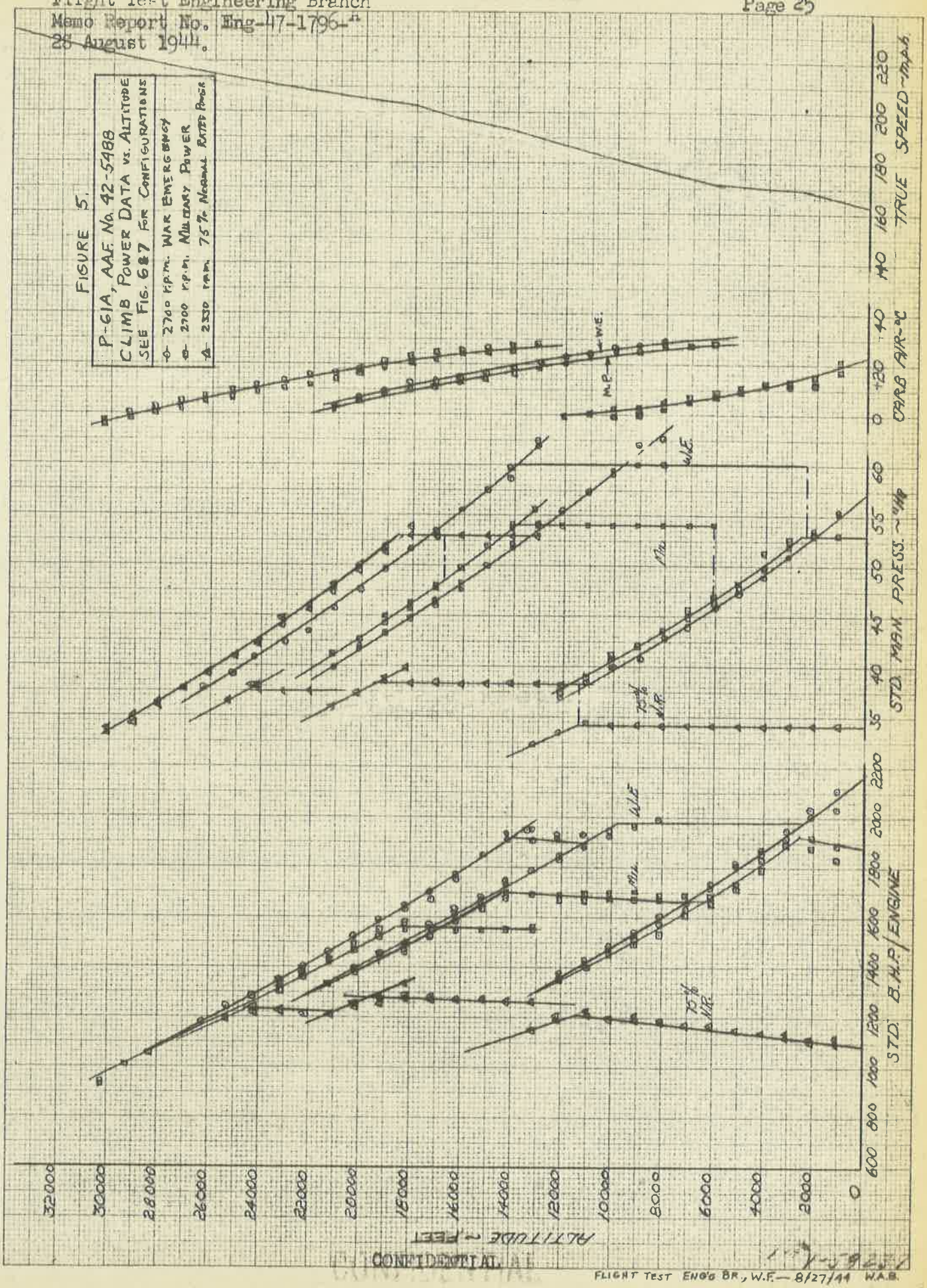
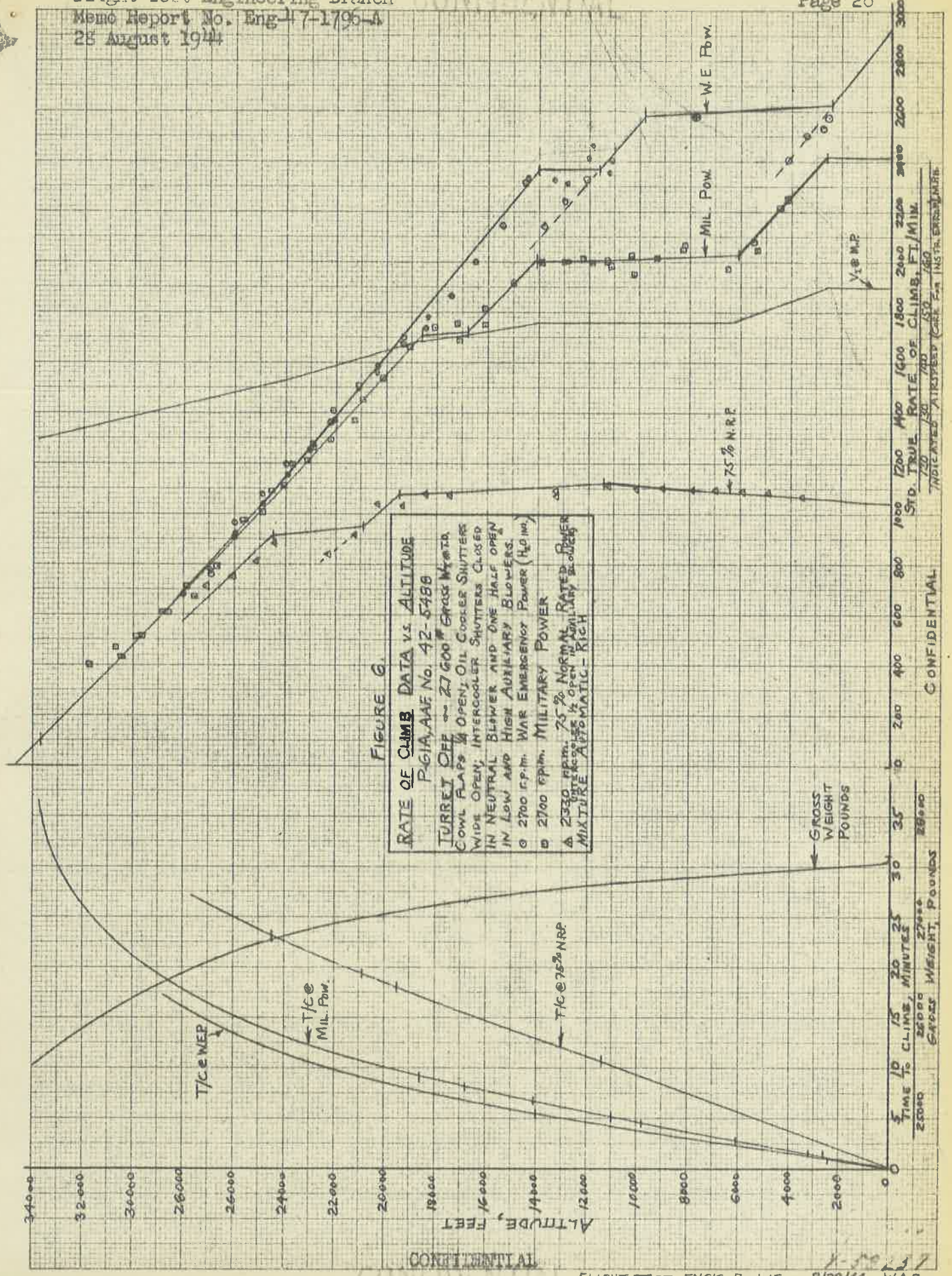


FIGURE 5.
P-61A, AAF. No. 42-5488
CLIMB POWER DATA vs. ALTITUDE
SEE FIG. 687 FOR CONFIGURATIONS
2700 R.P.M. WAR EMERGENCY
2700 R.P.M. MILITARY POWER
2550 R.P.M. 75% NORMAL RATED POWER
TRUE SPEED ~ M.P.H.
CARB AIR ~ °C
STD. MAN. PRESS. ~ "Hg
STD. B.H.P./ENGINE
ALTITUDE ~ FEET
W.E.
M.P.
75% M.P.
CONFIDENTIAL
FLIGHT TEST ENG'G BR., W.F. — 8/27/44 W.A.B.

CONFIDENTIAL



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FLIGHT TEST ENG'G. BR., W.F.— 8/29/44 W.A.B.

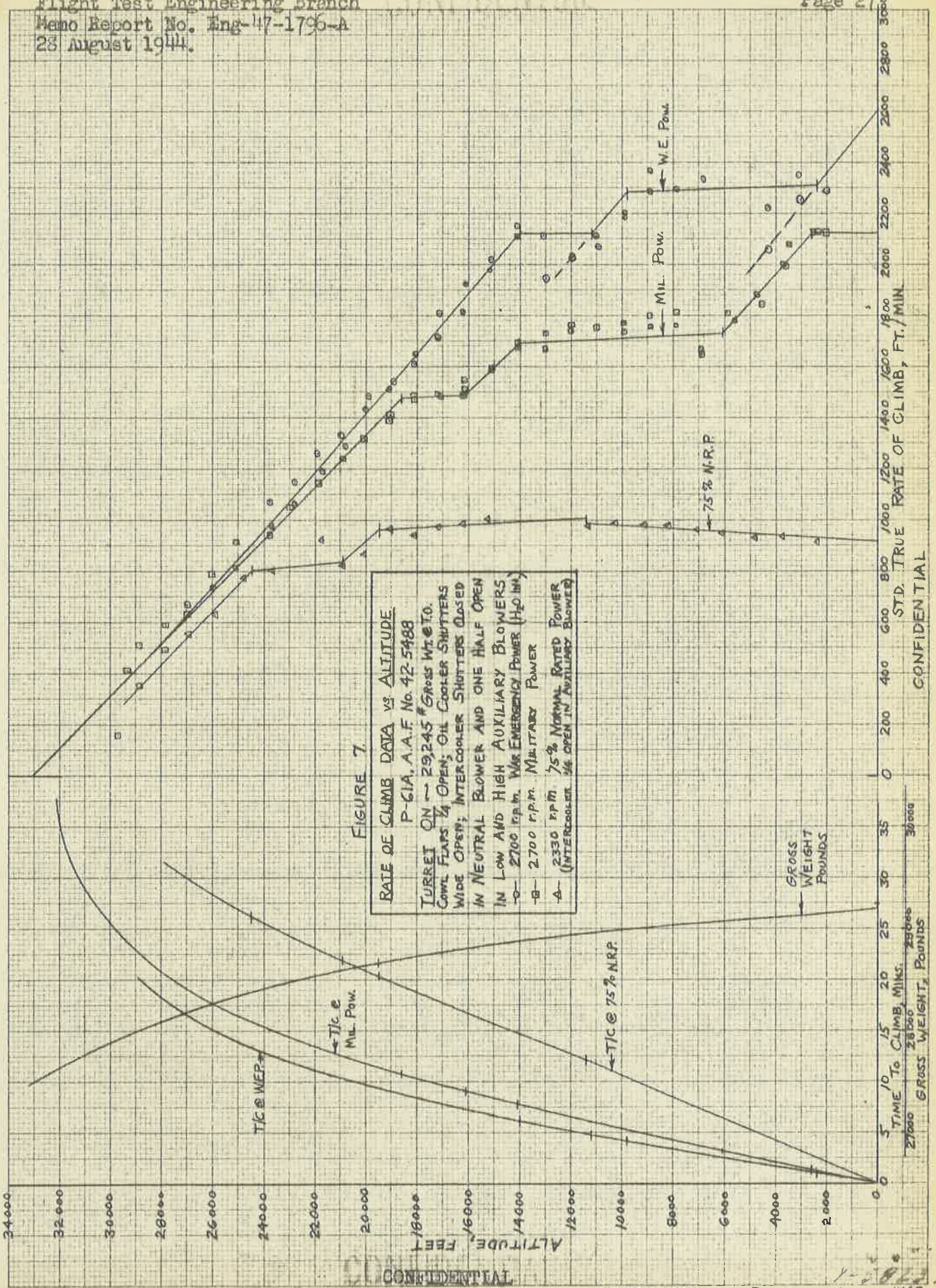
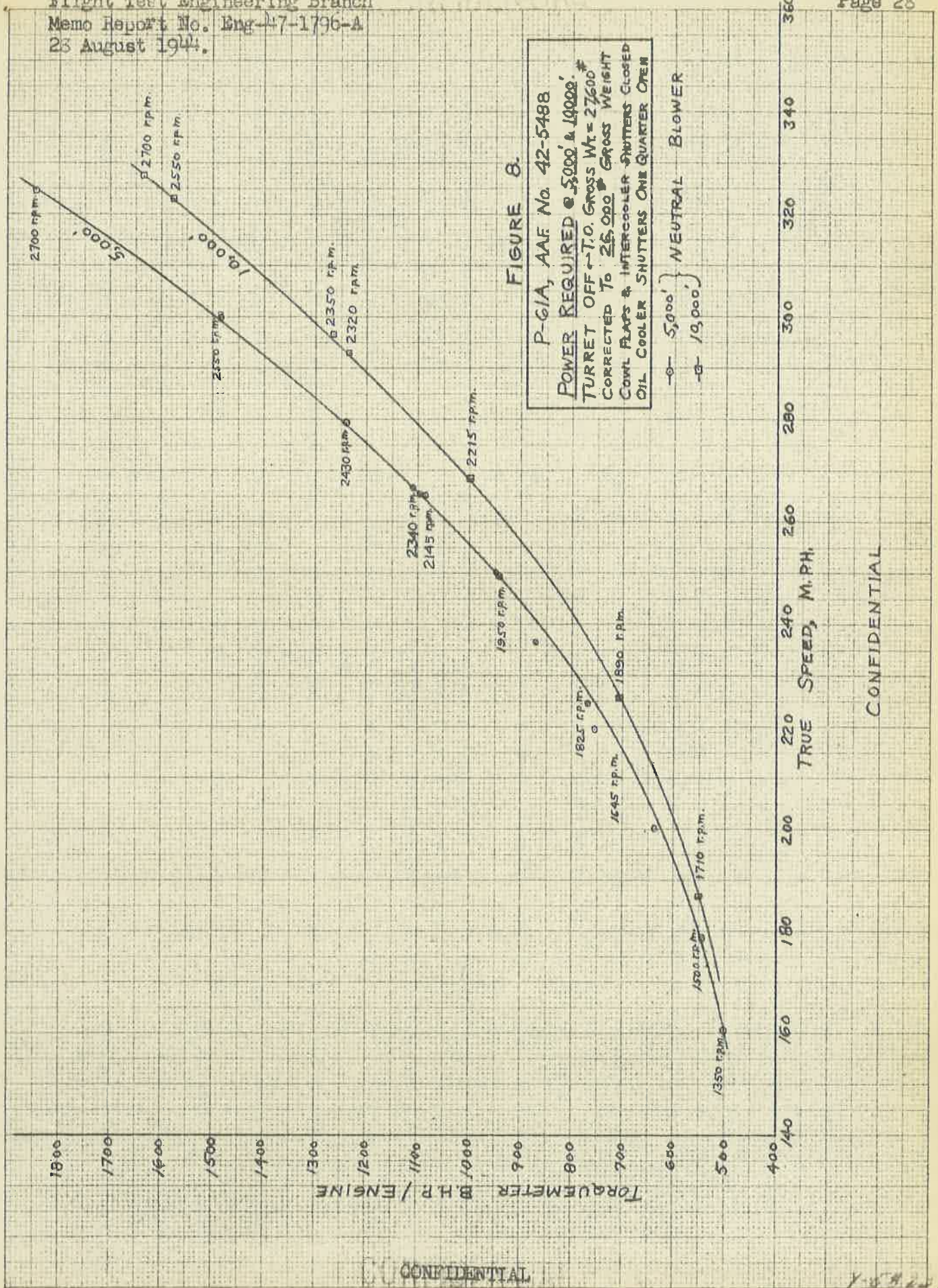
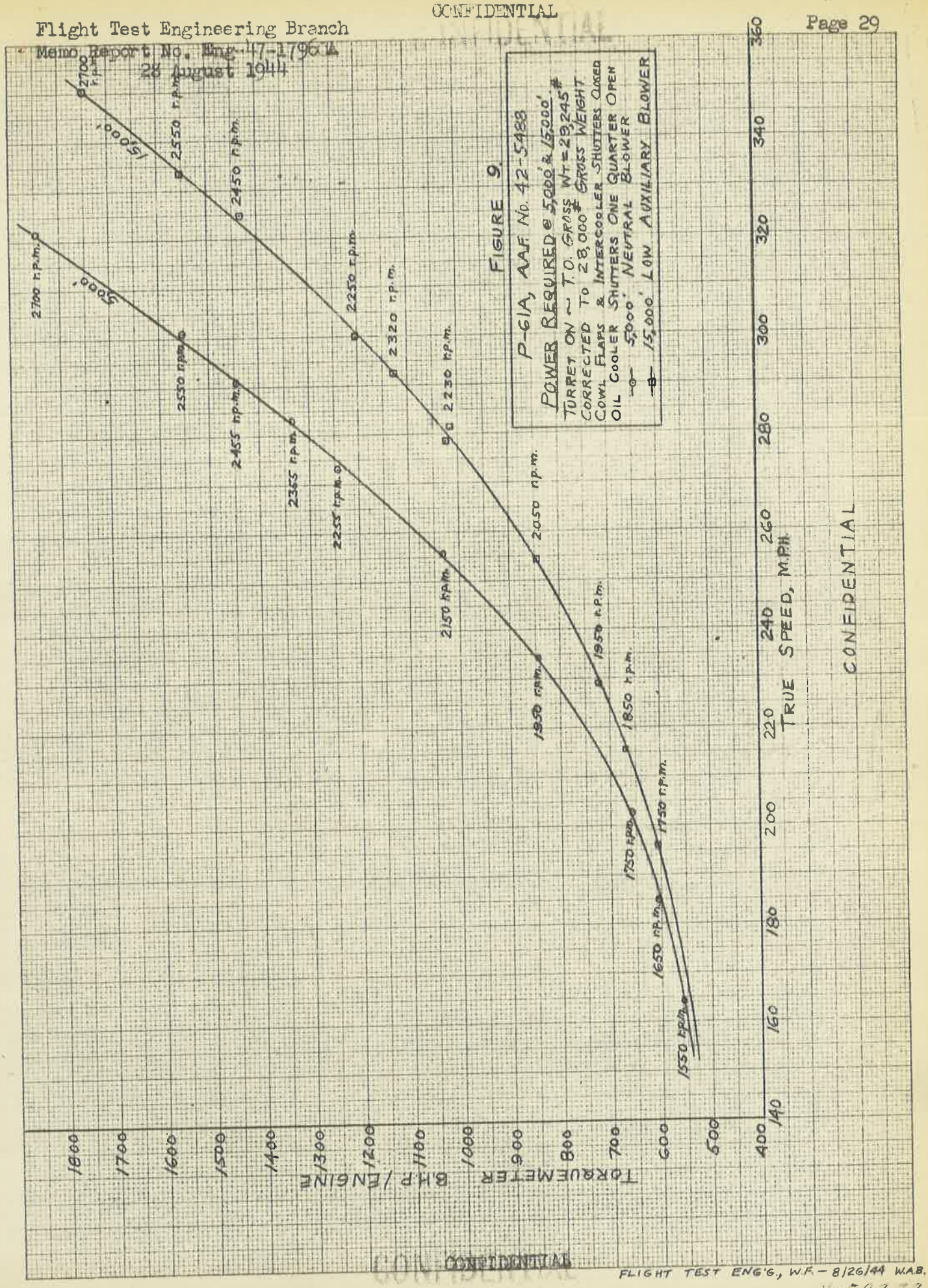


FIGURE 7.

FLIGHT TEST ENG'G. BR., W.F. — 8/27/44 WAB



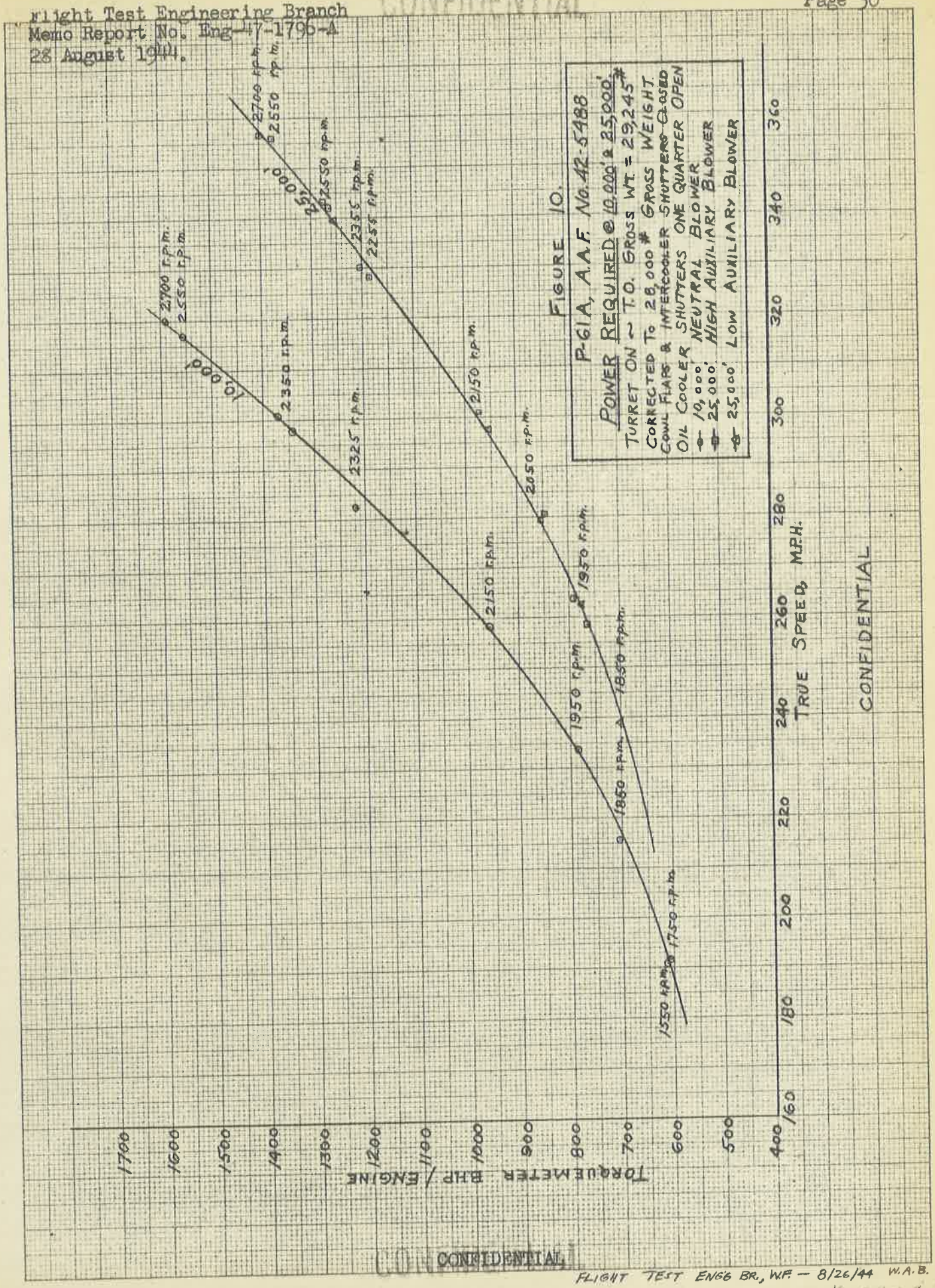
FLIGHT TEST ENG'G BR., W.F. — 8/26/44 W.A.B.



FLIGHT TEST ENG'G., W.F. – 8/26/44 W.A.B.

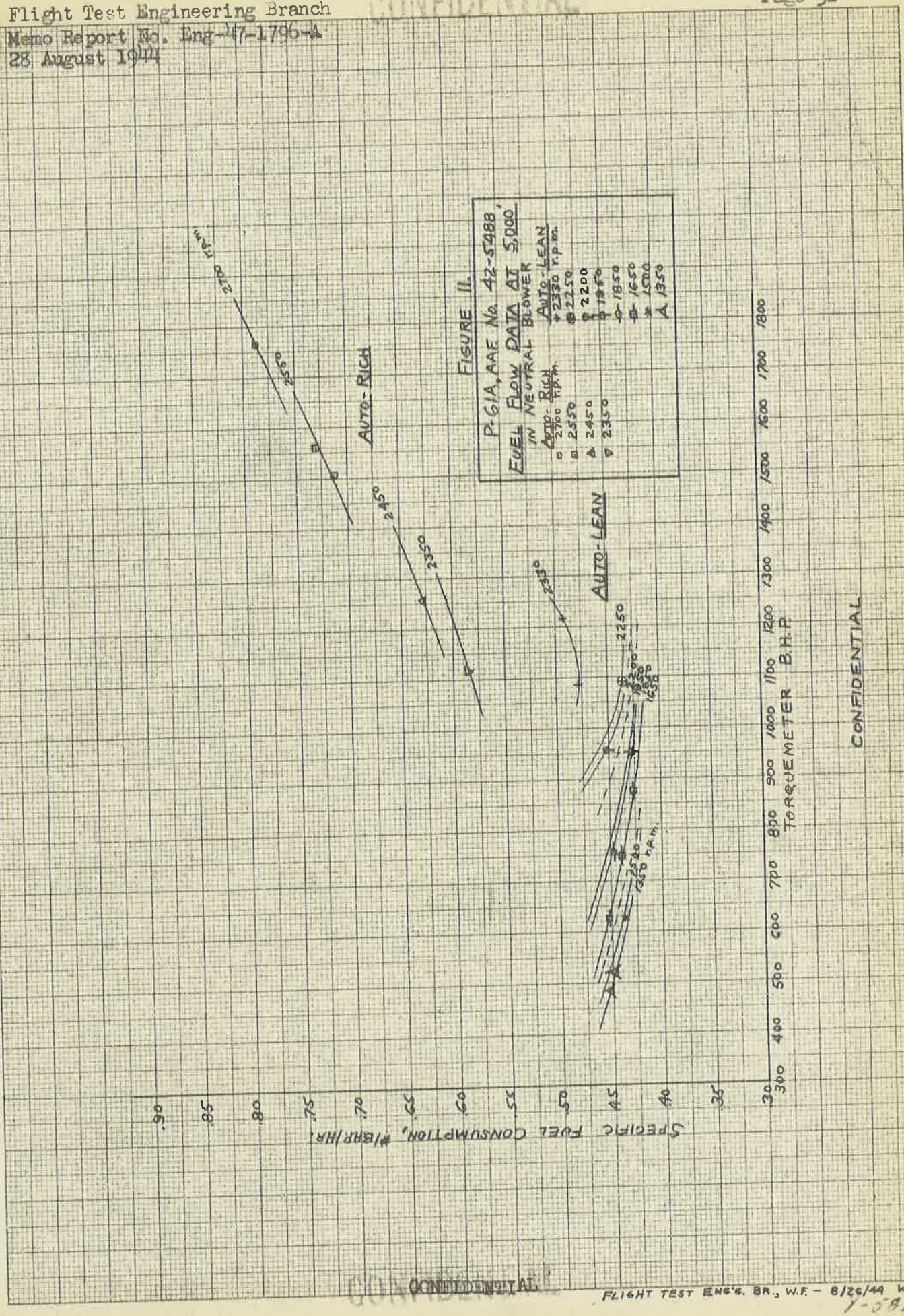
Y-58237

Flight Test Engineering Branch
Memo Report No. Eng-47-1796-A
28 August 1944.



Y-58221

Flight Test Engineering Branch
Memo Report No. Eng-47-1796-A
28 August 1944



FLIGHT TEST ENG'G. BR., W.F. – 8/26/44 W.A.B.

I-58237

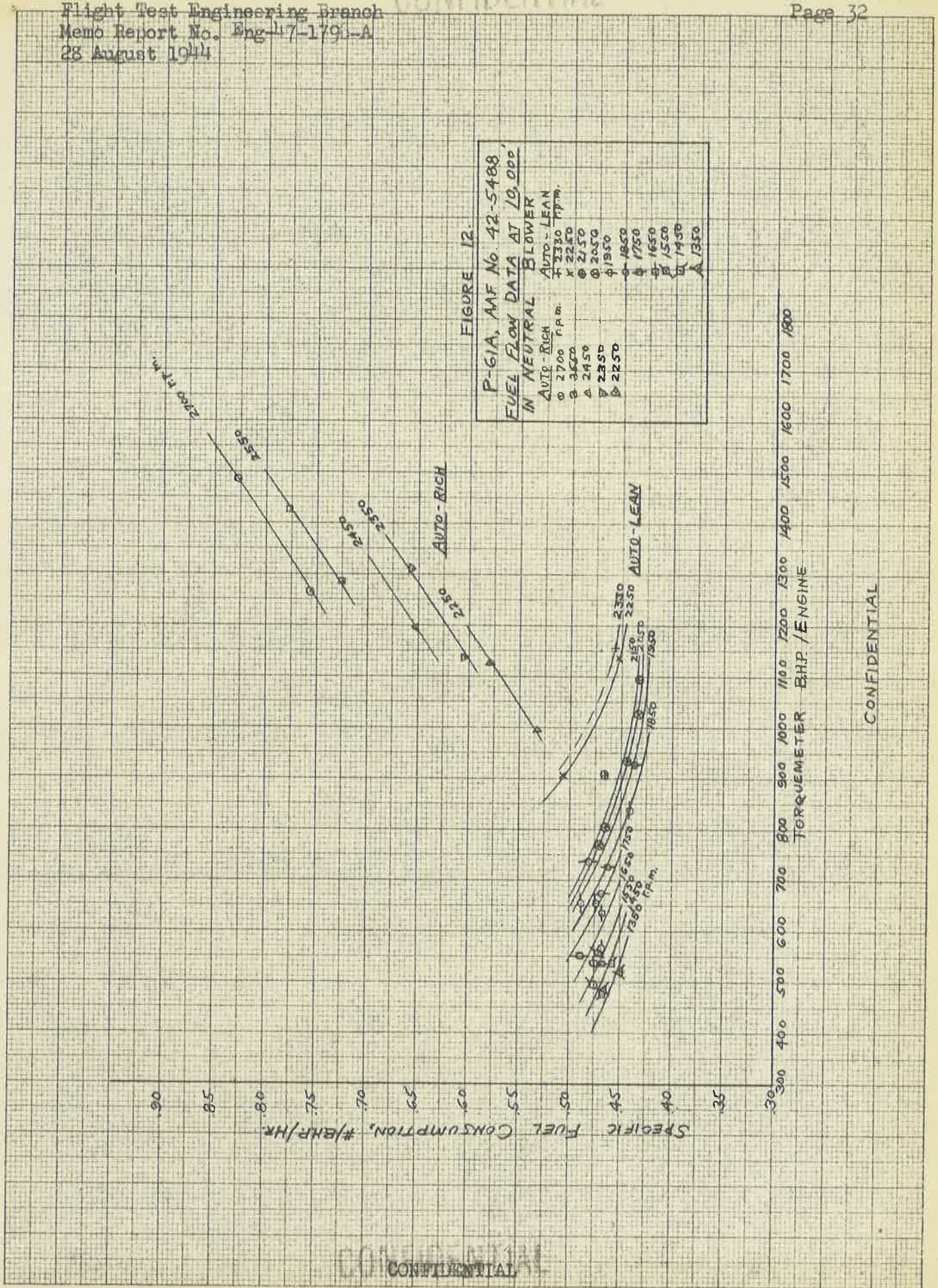
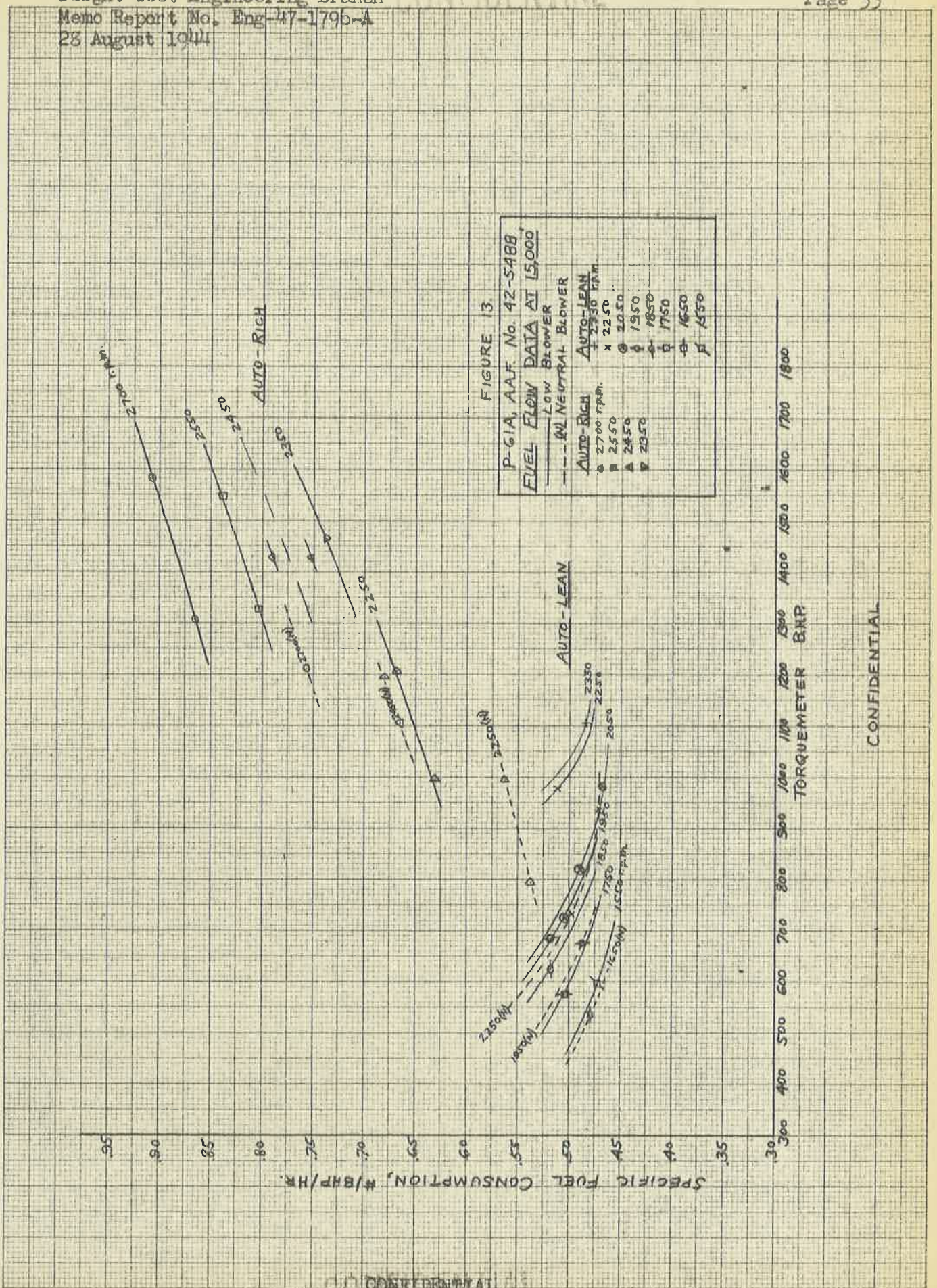


FIGURE 12.

AUTO-RICH	AUTO-LEAN
⊙ 2700 r.p.m.	2330 r.p.m.
⊡ 2550	× 2250
⊙ 2450	⊙ 2150
△ 2350	⊙ 1950
▽ 2250	◇ 1850
	◇ 1750
	⊟ 1650
	⊞ 1550
	⊔ 1450
	△ 1350



FLIGHT TEST ENG'G. BR., W.F. — 8/26/44 — N.A.S.

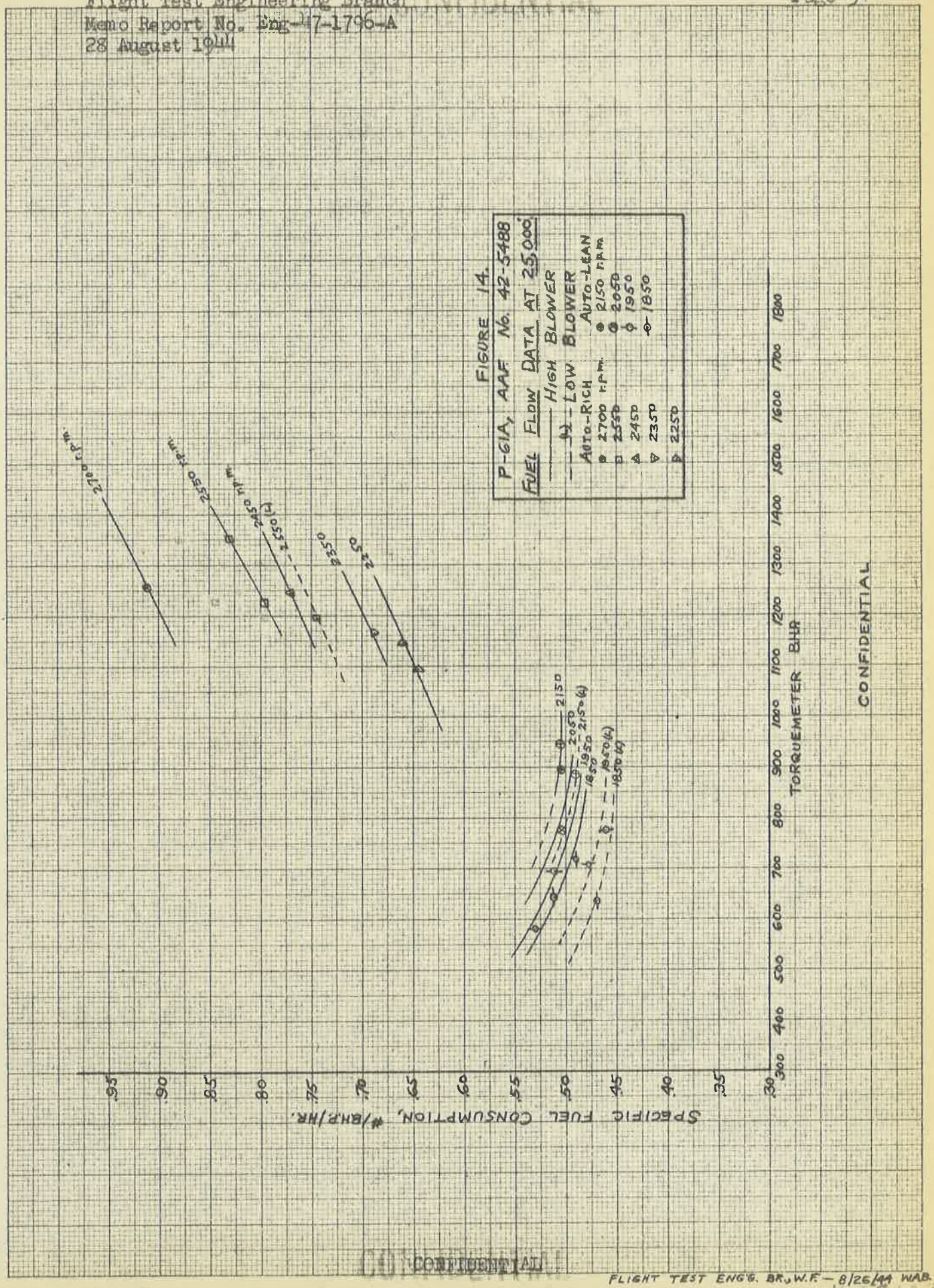

P-61A, AAF No. 42-5488
FUEL FLOW DATA AT 25,000'
H - HIGH BLOWER
L - LOW BLOWER
AUTO-RICH
AUTO-LEAN
2700 r.p.m.
2550 r.p.m.
2450 r.p.m.
2350 r.p.m.
2250 r.p.m.
2150
2050
1950
1850
SPECIFIC FUEL CONSUMPTION, #/BHP/HR.
TORQUEMETER BHP
CONFIDENTIAL

FIGURE 14.

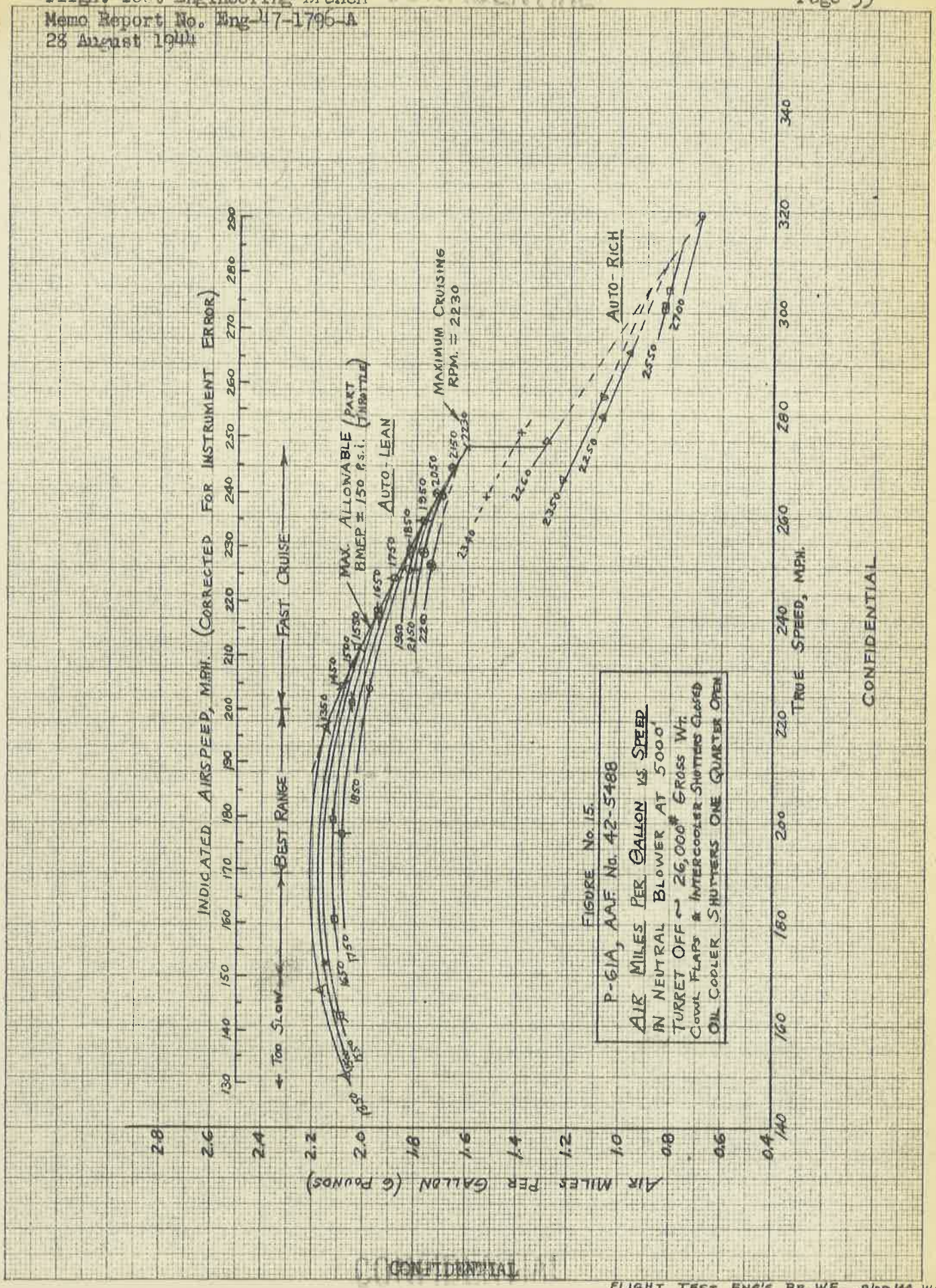
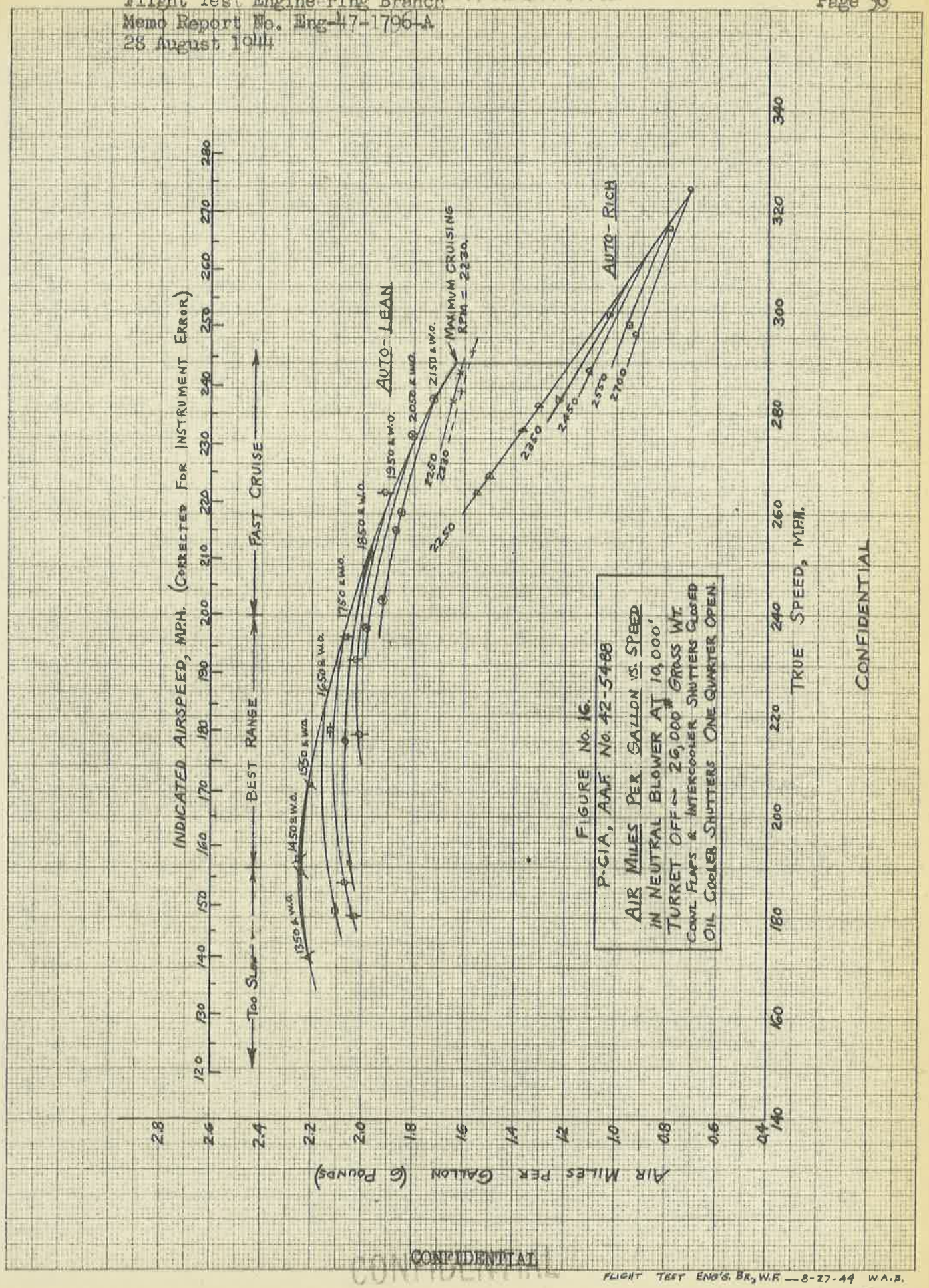


Figure No. 15.



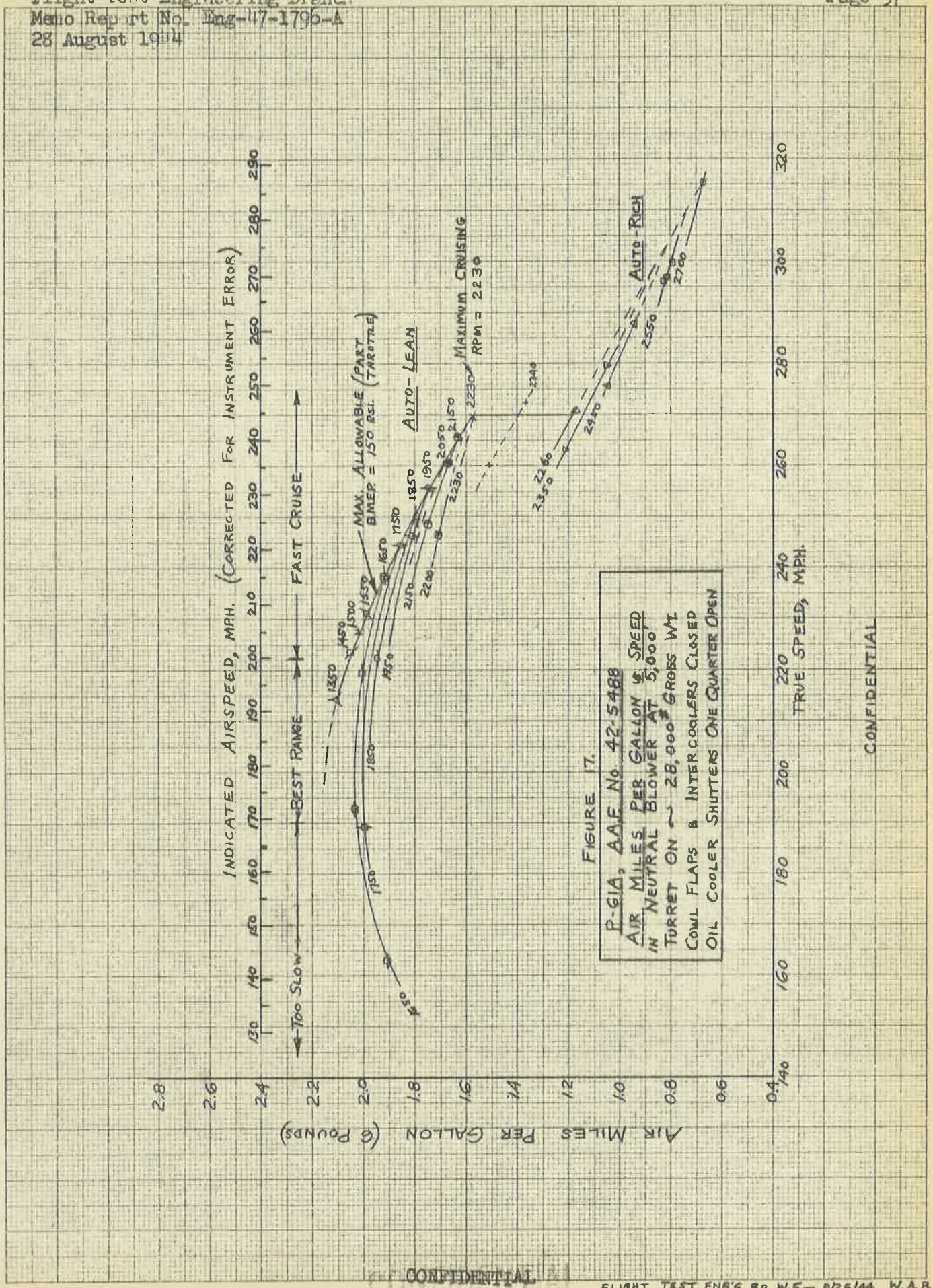

INDICATED AIRSPEED, MPH. (CORRECTED FOR INSTRUMENT ERROR)
TRUE SPEED, MPH.
AIR MILES PER GALLON (6 POUNDS)
TOO SLOW
BEST RANGE
FAST CRUISE
MAX. ALLOWABLE (PART THROTTLE) BMEP = 150 PSI.
AUTO-LEAN
MAXIMUM CRUISING RPM = 2230
AUTO-RICH
P-61A, AAF No. 42-5488
AIR MILES PER GALLON @ SPEED IN NEUTRAL BLOWER AT 5,000'
TURRET ON — 28,900# GROSS WT.
COWL FLAPS & INTERCOOLERS CLOSED
OIL COOLER SHUTTERS ONE QUARTER OPEN
CONFIDENTIAL

FIGURE 17.

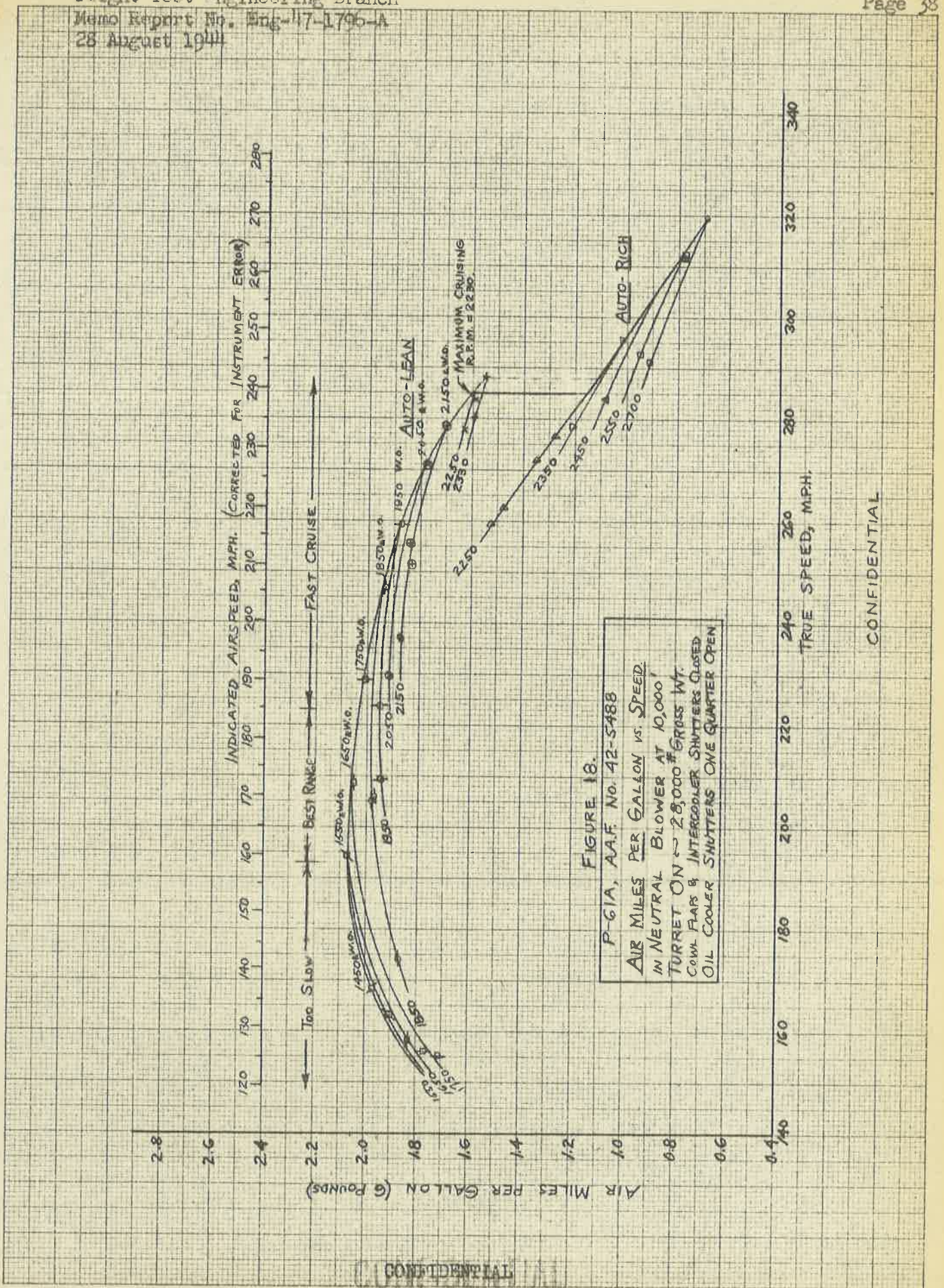


FIGURE 18.
P-61A, A.A.F. No. 42-5488
AIR MILES PER GALLON VS. SPEED
IN NEUTRAL BLOWER AT 10,000'
TURRET ON - 28,000 # GROSS WT.
COWL FLAPS & INTERCOOLER SHUTTERS CLOSED
OIL COOLER SHUTTERS ONE QUARTER OPEN

FLIGHT TEST ENG'G. BR., W.F. — 8/26/44 : W.A.B.

Y-59231

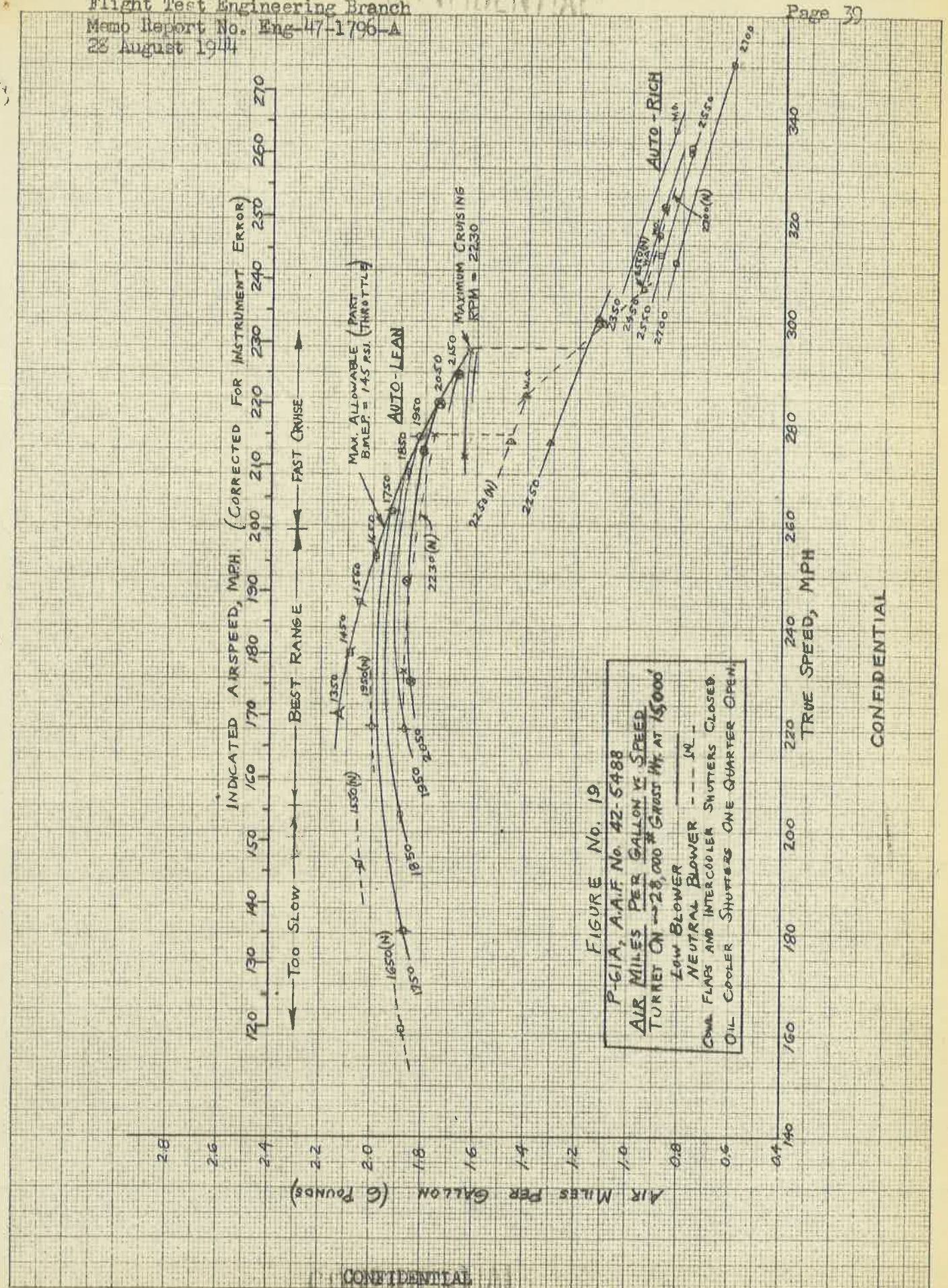


FIGURE No. 19
P-61A, A.A.F. No. 42-5488

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FLIGHT TEST ENG'G. BR., W.F. — 8-27-44 W.A.B.

Y-58237

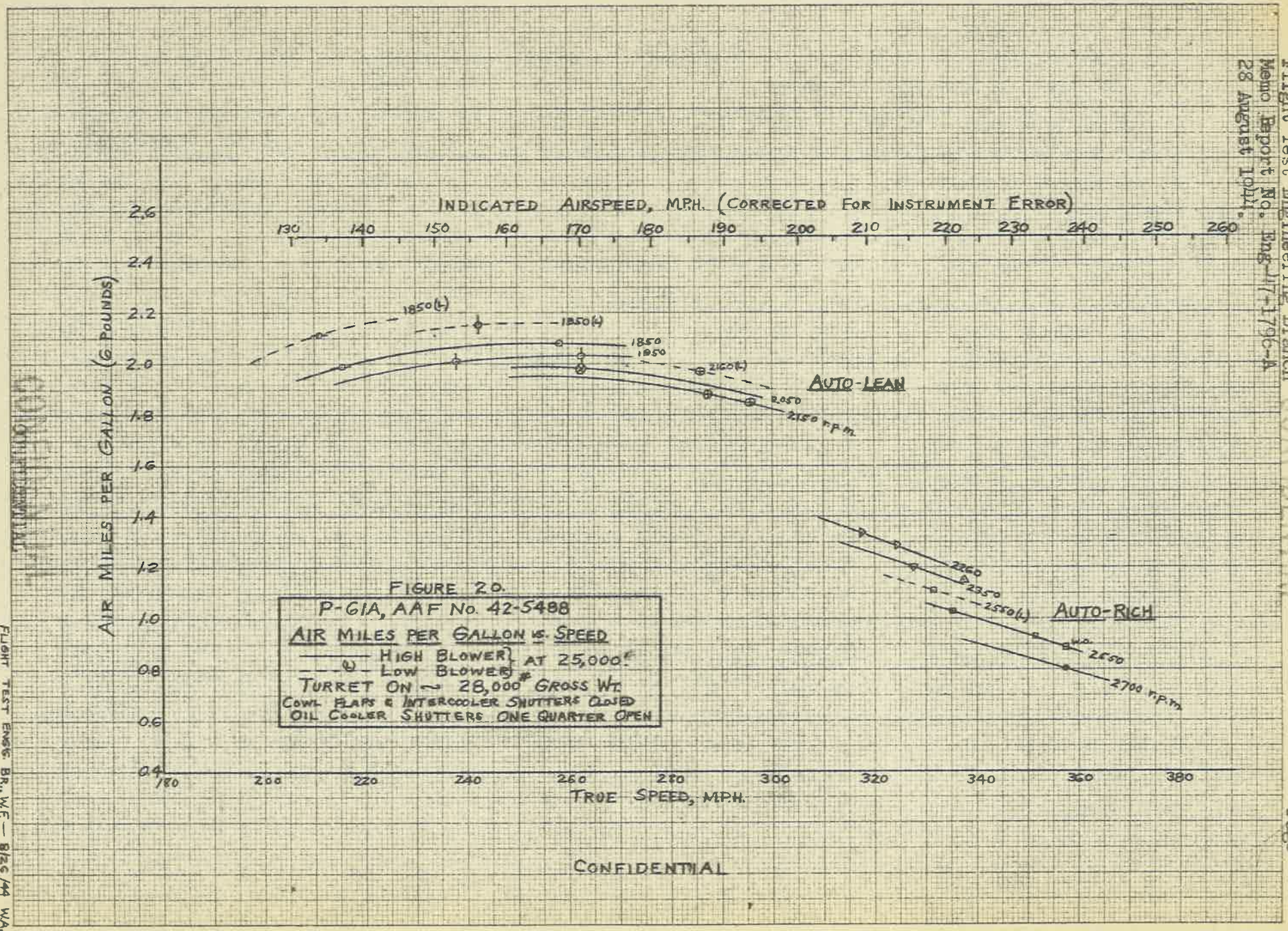


FIGURE 20.

P-61A, AAF No. 42-5488

AIR MILES PER GALLON vs. SPEED

——— HIGH BLOWER } AT 25,000'
– – – LOW BLOWER }

TURRET ON — 28,000# GROSS WT.

COWL FLAPS & INTERCOOLER SHUTTERS CLOSED
OIL COOLER SHUTTERS ONE QUARTER OPEN

CONFIDENTIAL

FLIGHT TEST ENGR. BR., W.F. — 8/26/44 WAB.

FIGURE 21.

P-61A, AAF No. 42-5488
SAWTOOTH CLIMB IN NEUTRAL BLOWER
CORRECTED TO 27,450# GROSS WEIGHT AT G550
INTERCOOLER SHUTTERS CLOSED; COWL FLAPS 1/4 OPEN; OIL COOLER SHUTTERS WIDE OPEN
2700 R.P.M.; W.O. THROTTLE, MIXTURE AUTO-RICH
TURRET OFF

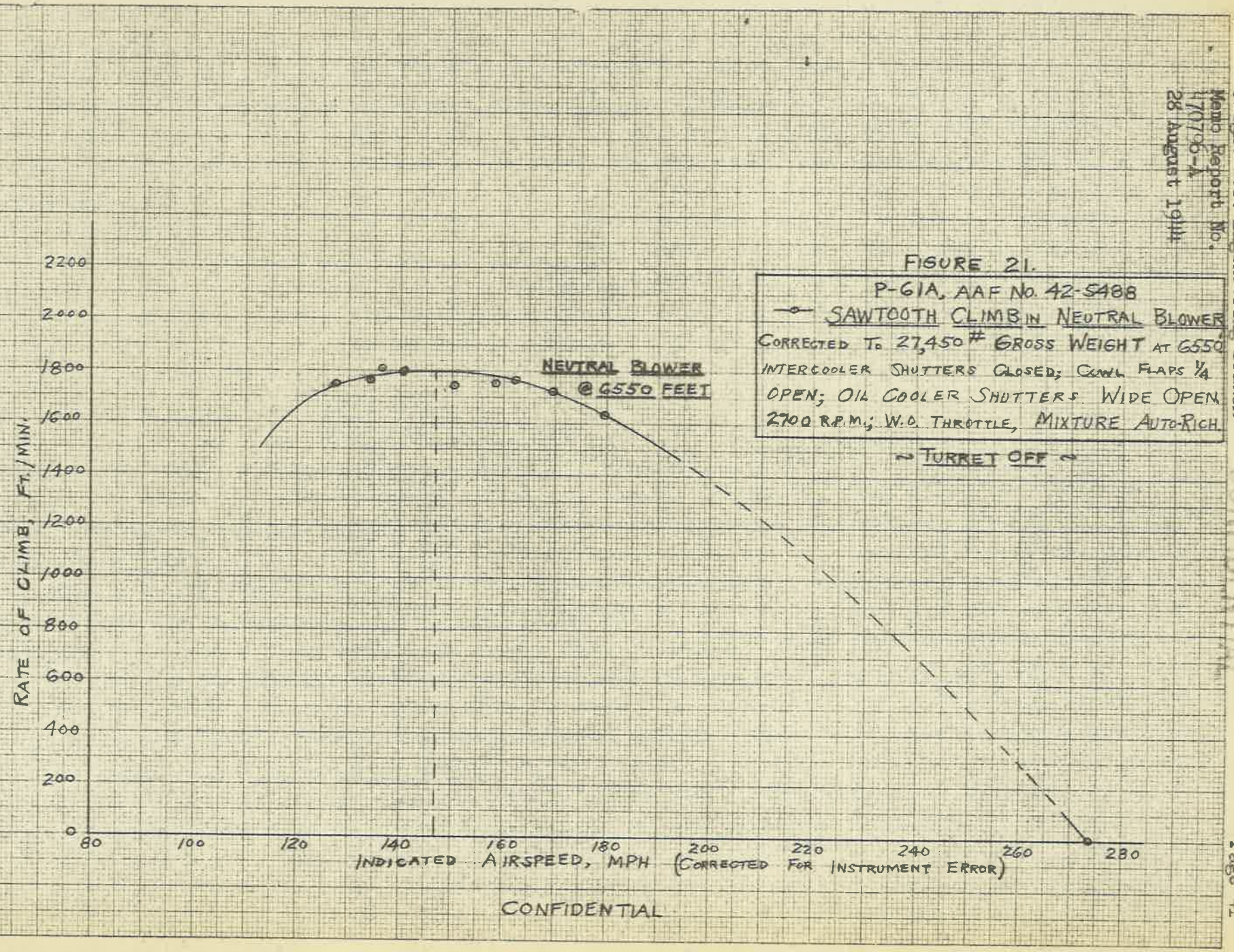


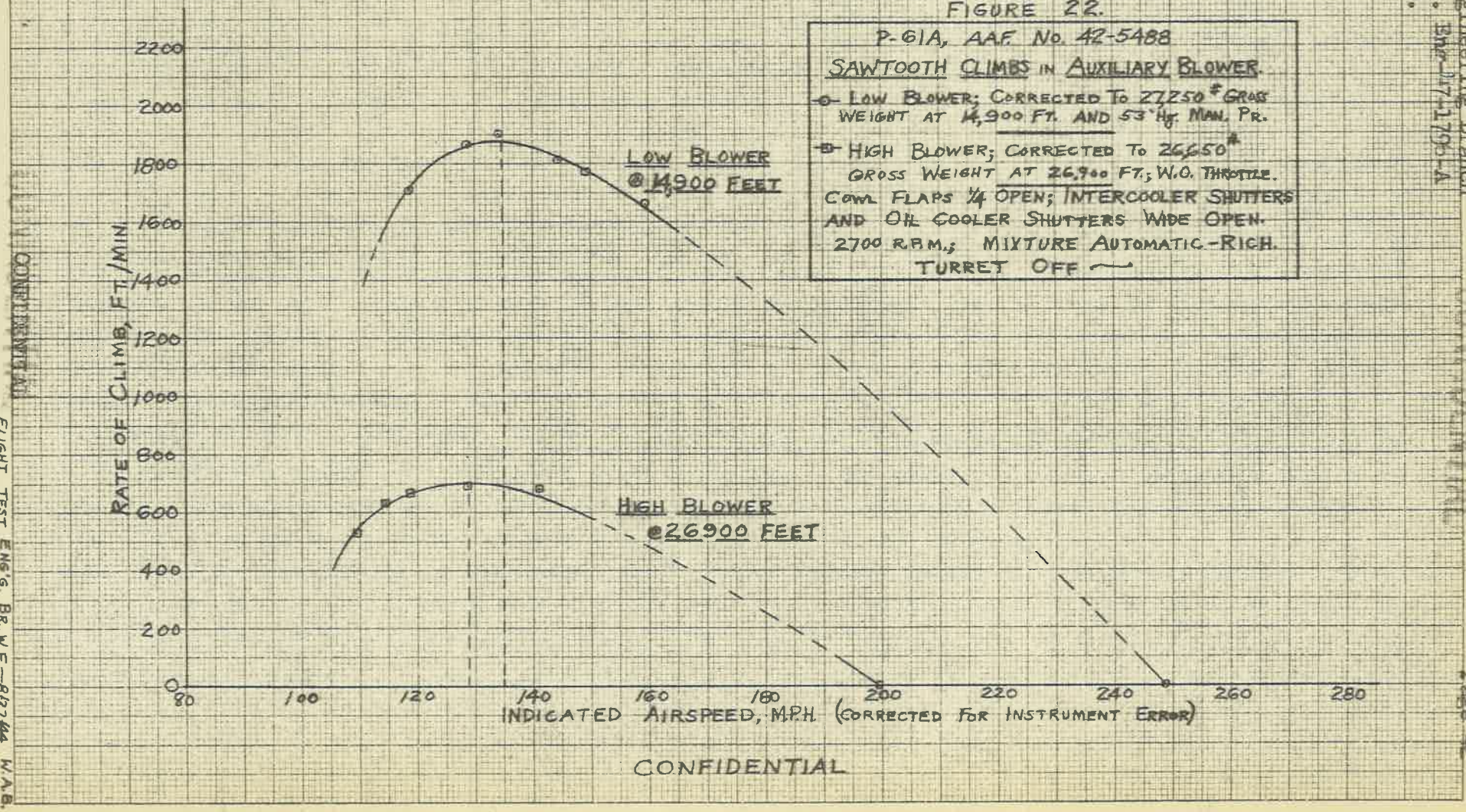
FIGURE 22.

P-61A, A.A.F. No. 42-5488

SAWTOOTH CLIMBS IN AUXILIARY BLOWER.

-o- LOW BLOWER; CORRECTED TO 27,250# GROSS WEIGHT AT 14,900 FT. AND 53" Hg. MAN. PR.

-□- HIGH BLOWER; CORRECTED TO 26,650# GROSS WEIGHT AT 26,900 FT.; W.O. THROTTLE. COM. FLAPS ¼ OPEN; INTERCOOLER SHUTTERS AND OIL COOLER SHUTTERS WIDE OPEN. 2700 R.P.M.; MIXTURE AUTOMATIC-RICH. TURRET OFF



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FLIGHT TEST ENG'G, BR, W.F.—8/27/44 W.A.B.

VIII. Conclusions

1. The removal of the turret from the P-61A and the resulting decrease in weight had only a slight effect on the high speed performance of this airplane. At sea level, a gain of 7 MPH was attained at normal rated power; at military power the gain was 4.5 MPH , and at war emergency power the differential was further decreased to 3 MPH. Throughout the normal operating range of altitudes the average gain in speed effected by the removal of the turret was but 3MPH (less than one per cent) at war emergency power.

2. The removal of the turret increased the rate of climb by approximately 300 feet per minute (14 per cent) at sealevel at military power. This differential decreased to 210 feet per minute at 15,000 feet.

3. No practical advantage is derived from the use of water injection above 22,500 feet and above this altitude the military power rating of 2700 RPM could be reduced to the normal rated power engine speed of 2550 RPM with no sacrifice in airplane performance.

4. The removal of the .50 caliber turret would cause a considerable loss in the effective fire power of the airplane and it seems doubtful if this disadvantage would be off-set by the resulting slight improvement in performance.

5. Range data secured on this airplane shows that the pilot's flight operations instruction chart in Technical Order No. 01-15FB-1, revised 20 JULY, 1944, is from 12 to 34 percent conservative when operating in automatic lean and approximately correct in the automatic rich setting in neutral and low auxiliary blower and as much as 17 per cent conservative in high auxiliary blower. However, the subject airplane was operating on slightly lower than average specific fuel consumption, and with this in mind it is concluded that, in general, the T.O.'s were approximately 10 per cent on the conservative side in automatic lean and four per cent in automatic rich mixture settings.

6. A cruising control chart for P-61A and P-61B airplanes prepared by the manufacturer, and dated 3 August 1944, was examined and found to compare very favorably with the results of these tests with the following exception. Operation in low auxiliary blower was found to be nearly 10 per cent higher on the subject airplane than is shown on the above mentioned cruising control chart.

7. Operation of the new type Bendix supercharger regulator for use with water injection was satisfactory and no objectionable time lag was experienced in the stabilization of manifold pressure in a climb.

IX. Recommendations

1. It is recommended that the effectiveness of the aileron trim be increased.

2. It is recommended that the trim tab controls be redesigned so that each will operate in the respective plane of action of the surface which it controls.

3. It is recommended that the pilot's seat be provided with a means of longitudinal adjustment.

4. It is recommended that the nose wheel well entrance door be conspicuously placarded for emergency release.

5. It is recommended that a suitable decal be placed in a conpicious position to impress on the pilot at all times, the advisability of shifting through a complete blower cycle at least once every two hours of operation to prevent disastrous sludging of the blower clutches.

6. It is recommended that the nose wheel retracting mechanism be redesigned so that the force of the "lock-up" impact will be cushioned.

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X General Dimensions and Photographs

A. General Dimensions

Span - 66 feet 0 inches
Length - 48 feet 11 inches
Height - 14 feet 8 inches
Wing Area - 651.4 square feet
Aileron Area - 11 square feet
Wing Flap Area - 112 square feet
Landing Gear Tread - 17 feet 7 inches
Length of Crew Nacelle - 33 feet 10 inches

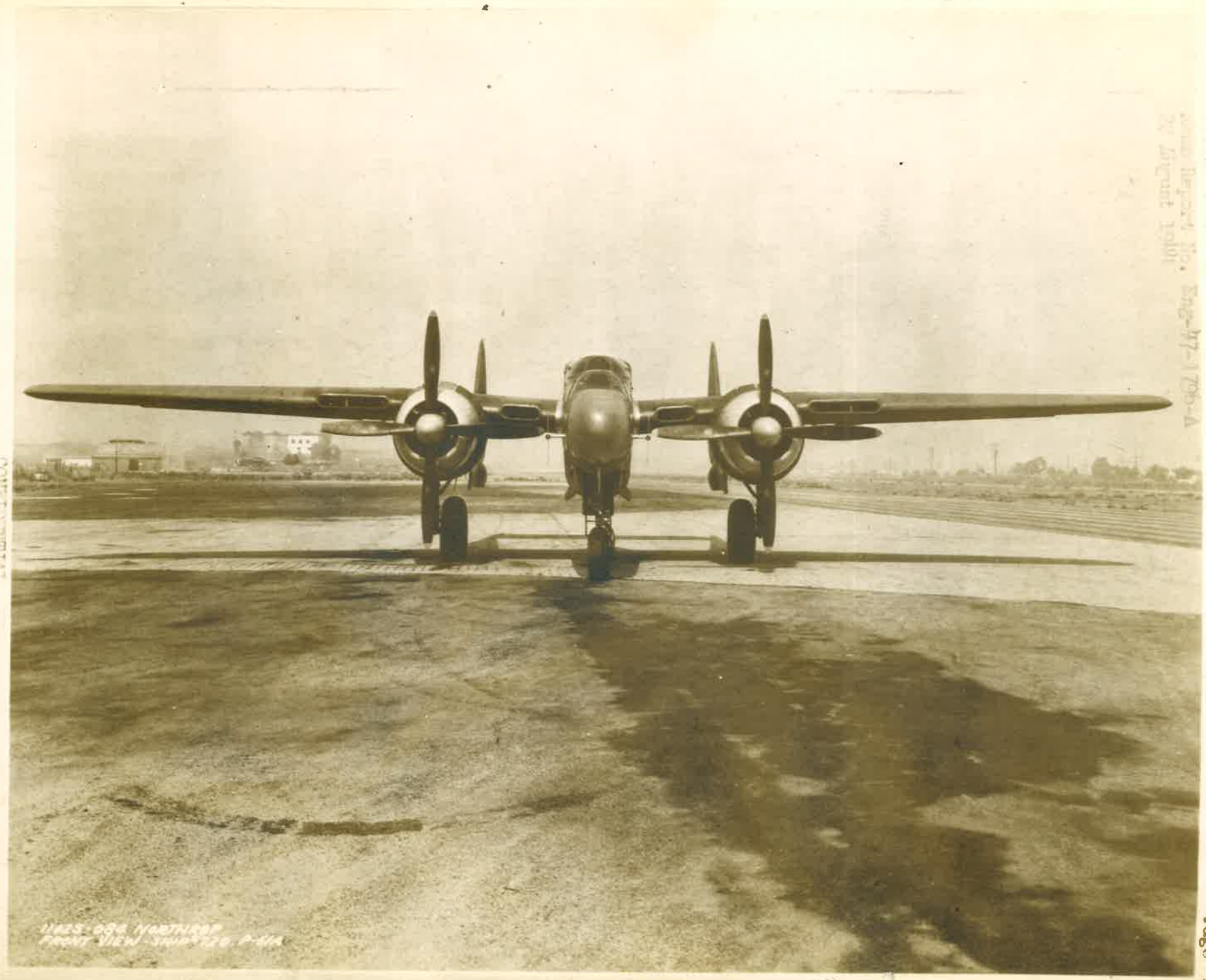
B. Photographs

1. P-61A airplane, AAF No. 42-5488 (Turret off)

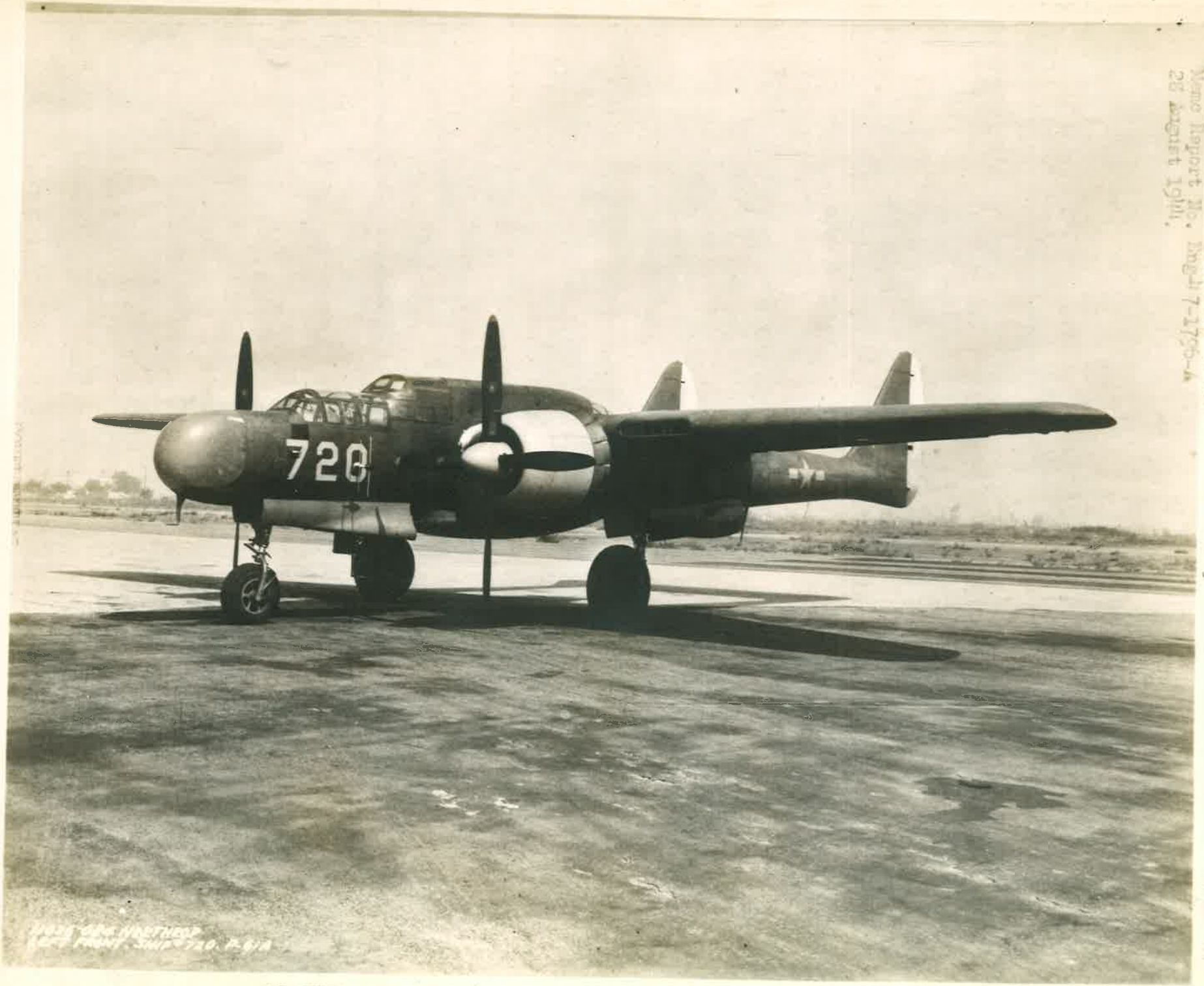
   a. Front view, #11025
   b. Three quarter left front view, #11026
   c. Three quarter left rear view (flaps down), #11030

2. P-61A airplane, AAF No. 42-5488 (Turret on)

   a. Front view, #11040
   b. Three quarter right front view, #11047
   c. Three quarter left front view, #11041
   d. Left side view, #11042
   e. Three quarter left rear view, #11043
   f. Rear view, #11044
   g. Close-up, three quarter left front view of turret installation, #11039 -

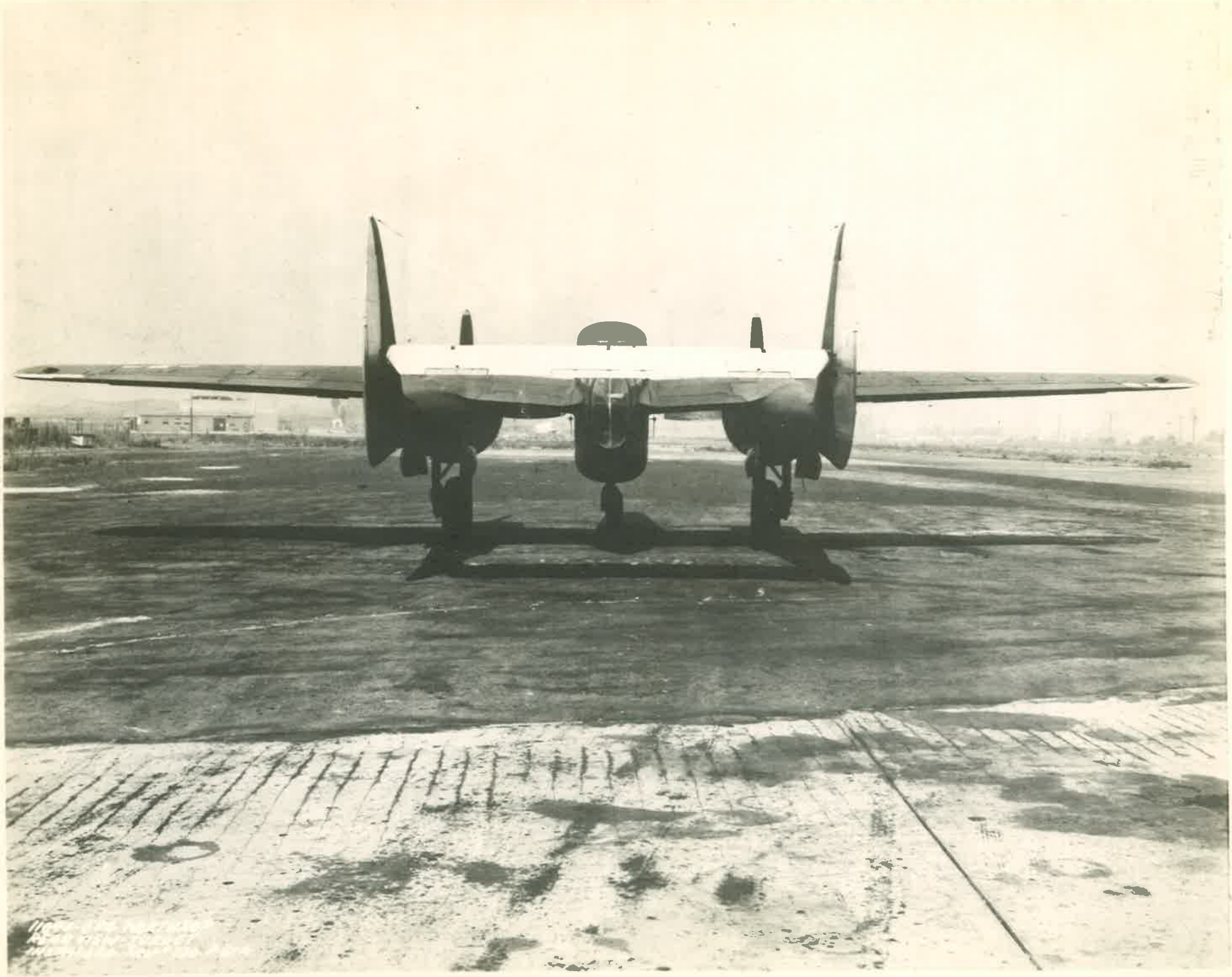


FRONT VIEW (TURRET OFF) P-61A AIRPLANE, AAF NO. 42-

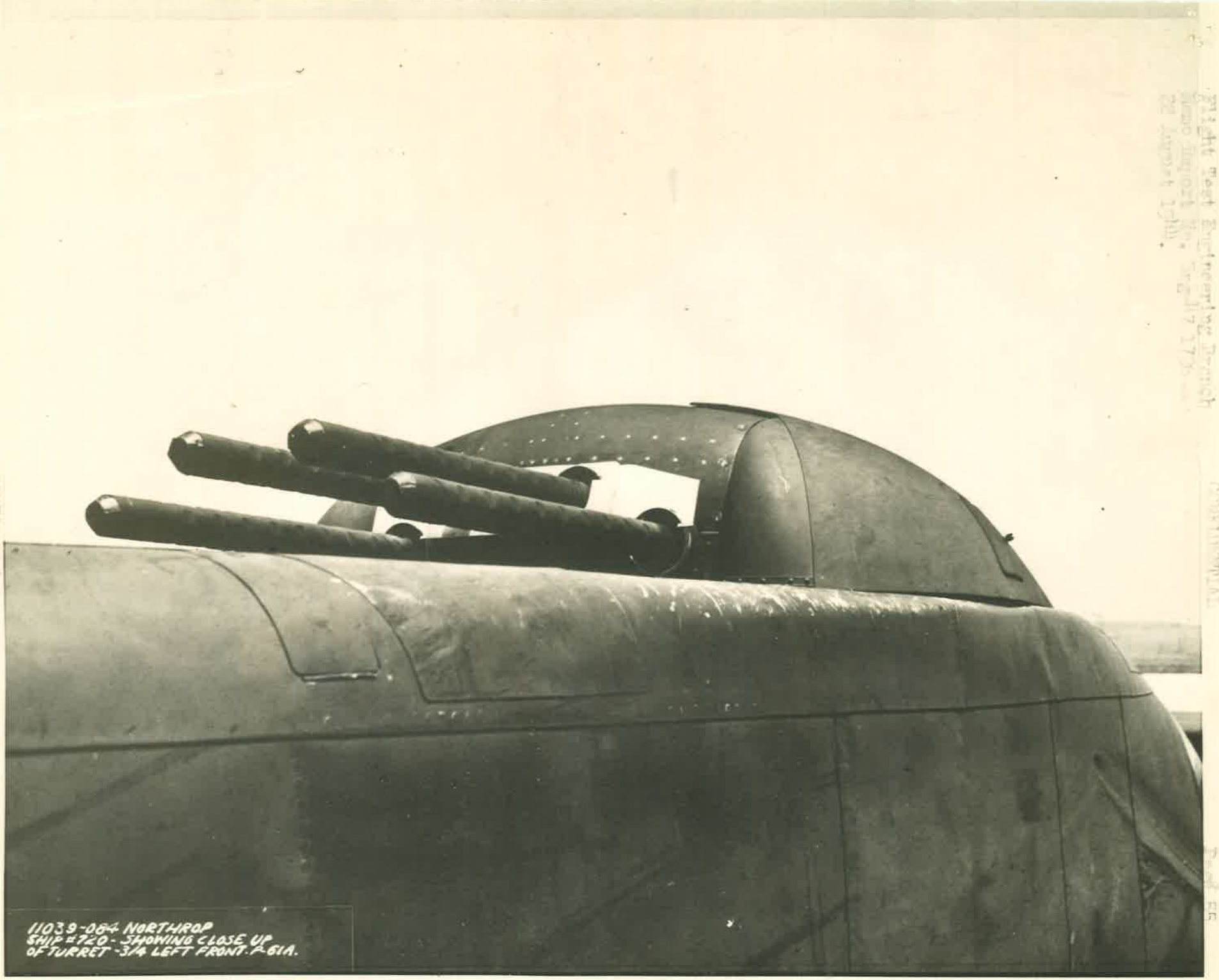


J.4 LEFT FRONT VIEW (TURRET OFF) P-61A AIRPLANE, AAF NO. 42-5488

3/4 LEFT REAR VIEW (FLAPS DOWN) (TURRET OFF) P-61A AIRPLANE, AAF NO. 42-5488



REAR VIEW (TURRET ON) P-61A AIRPIANE, AAF NO. 42-5488



CLOSE UP - 3/4 LEFT FRONT VIEW OF TURRET INSTALLATION - P-61A AIRPLANE, AAF NO. 42-5[illegible]

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