412TW-PA-23103

FLIGHT TEST OF AN F-86F WITH SOLID FUEL ROCKET FOR IN-FLIGHT THRUST AUGMENTATION

ROBERT C. JACKSON
FLIGHT TEST ENGINEER

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE,
CALIFORNIA

DECEMBER 1952

A
F
F
T
C

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE MATERIEL COMMAND
UNITED STATES AIR FORCE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
16-06-2023	Final Report	July to September 1952

4. TITLE AND SUBTITLE

Flight Test of an F-86F with Solid Fuel Rocket for In-Flight Thrust Augmentation

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Jackson, Robert C., Flight Test Engineer
Stephens, Robert L., Major, USAF, Test Pilot

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AND ADDRESS(ES)

AFTC/HO
307 E Popson Ave
Edwards AFB CA 93524

8. PERFORMING ORGANIZATION REPORT NUMBER

412TW-PA-23103

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

412th Test Wing
195 E Popson Ave
Edwards AFB CA 93524

10. SPONSOR/MONITOR'S ACRONYM(S)

N/A

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release Distribution Statement A: distribution is unlimited.

13. SUPPLEMENTARY NOTES

Source Code 012100 (This number comes from STINFO via EAFB Technical Library)
CA: 412th Test Wing, Edwards AFB, CA

14. ABSTRACT

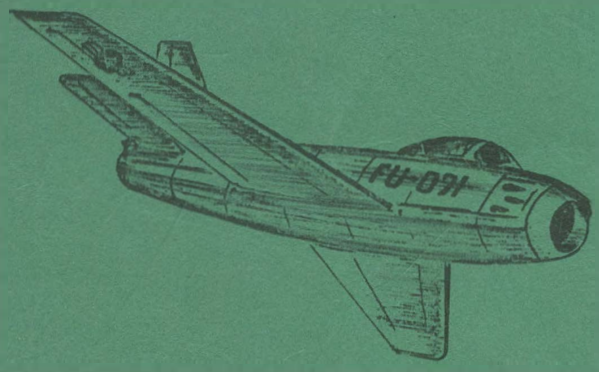
15. SUBJECT TERMS

F-86F, Flight Test

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
					412 TENG/EN (Tech Pubs)
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified	None	58	661-277-8615

AIR FORCE FLIGHT TEST CENTER

RESEARCH & DEVELOPMENT COMMAND



AF TECHNICAL REPORT NO. AFFTC 52-36

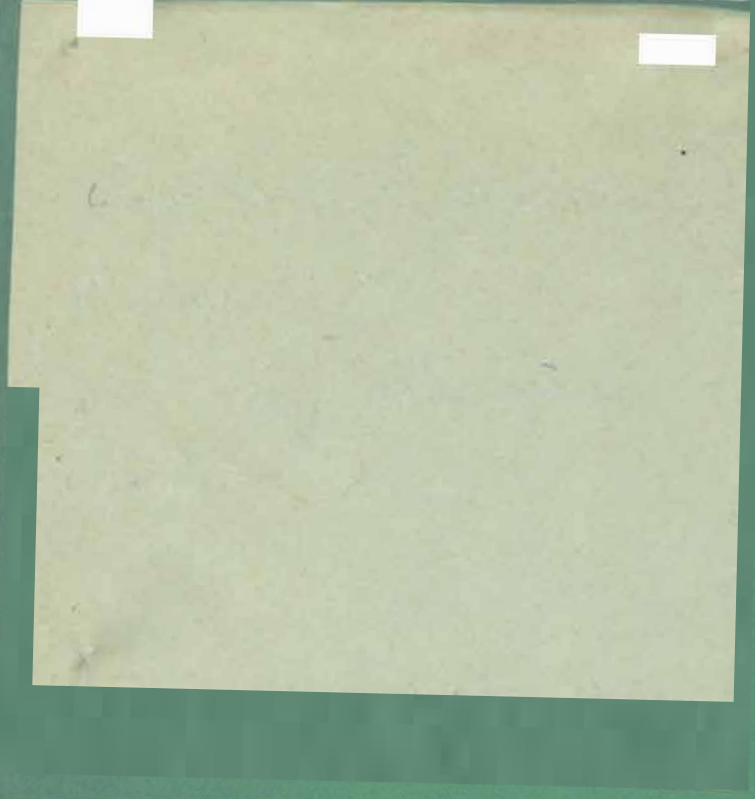
FLIGHT TEST OF AN F-86F WITH SOLID FUEL ROCKET FOR IN-FLIGHT THRUST AUGUMENTATION

DEC. 1952

ROBERT C. JACKSON
FLIGHT TEST ENGINEER

ROBERT L. STEPHENS, MAJOR, USAF
TEST PILOT

EDWARDS AIR FORCE BASE
EDWARDS, CALIFORNIA



AF Technical Report No. AFFTC 52-36

FLIGHT TESTS OF AN F-86F With Solid Fuel Rockets For In-Flight Thrust Augumentation

ROBERT C. JACKSON
Flight Test Engineer

ROBERT L. STEPHENS, Major, USAF
Test Pilot

UNITED STATES AIR FORCE
AIR RESEARCH AND DEVELOPMENT COMMAND
AIR FORCE FLIGHT TEST CENTER
EDWARDS, CALIFORNIA

AF Technical Report No. AFFTC 52-36

PUBLICATION REVIEW

This Report has been reviewed and is approved

Fred J. Ascani

FRED J. ASCANI, Colonel, USAF
Director, Flight Test and Development
Air Force Flight Test Center

J. S. Holtoner

J. S. HOLTONER
Brigadier General, USAF
Commanding

TABLE OF CONTENTS

ABSTRACT

The F-86F is the same as the F-86E except for the installation of a J-47-GE-27 engine rated at 5900 lbs static thrust and UHF radio equipment. Provisions have also been made for the use of 200 gal. auxilliary fuel tanks. A modification kit is available for incorporating a three unit ATO installation on the underside of the aft fuselage section. This installation was intended for in-flight thrust augmentation for emergency combat use. The F-86F shows improved climb and high speed performance over the F-86E. Flying qualities remain unchanged from those of the F-86E. The 200 gal. fuel tank installation is very satisfactory with no speed restriction imposed. The thrust augmentation installation resulted in only a slight increase in high speed drag but did appreciably increase the drag at cruising airspeeds. The additional thrust in flight could be utilized to gain 2000 ft. in altitude or to increase the level speed to approximately 0.95 M at 35,000 feet. This extra performance is available only once and only for a short period of time. Except for some special tactical situation, it is doubted if the gains outweigh the disadvantages of increased weight, drag, and a more aft cg loading.

A. PURPOSE

1. This report presents the results of flight tests conducted at the Air Force Flight Test Center to evaluate the performance of the basic F-86F aircraft and the same aircraft with flight thrust augmentation developed by the firing of three 14-AS-1000 solid fuel ATO units.

B. FACTUAL DATA

2. Introduction:

The test airplane arrived at AFFTC Edwards, California, 9 July 1952. Two flights were accomplished in the delivery configuration. The ATO unit pod was then installed on the underside of the fuselage below the speed brakes, and the remaining 17 flights were accomplished with this pod installed. A total of 23:40 hours of flight testing was required to ascertain the safety and efficiency of this ATO unit installation and obtain comparative performance data with various service loading configurations.

3. Description of the Test Airplane:

a. The F-86F was designed as a high speed, high altitude, single place, multi-purpose fighter airplane. It is powered by one J-47-GE-27 axial flow turbo-jet engine rated at 5900 lbs static thrust. An AN/ARC-33 UHF radio is installed in this aircraft. In all other respects the basic airplane is identical to the F-86E type aircraft.

b. Early in the flight test program the test airplane was modified with an installation of a three unit ATO installation for in-flight thrust augmentation. This installation consisted of a small insulated compartment submerged in the underside of the aft fuselage section directly below the speed brakes with provisions to secure and fire the three ATO units. Ceramic lined nozzle adaptors and steel blast tubes were provided to duct the ATO blast clear of the airplane. A detachable fairing was then fitted over the portions of the ATO units which protruded from the fuselage to provide satisfactory aerodynamic characteristics. These units were operated by the two switches mounted in the cockpit. One three-position toggle switch was provided to enable the pilot to select simultaneous or sequenced firing of the augmentation units or to disarm the entire system. A two-position toggle switch was installed to accomplish the actual firing of the ATO units. Sequence firing intervals were controlled by electric timers providing a 2-second overlap between the individual ATO units.

4. Test Configuration:

a. The airplane was weighed on electric weighing cells at Edwards AFB and the basic weight was found to be 11,750 lbs including test equipment, engine oil, and ballast. Flight tests were accomplished at the following loading conditions at engine start:

Basic Wt	Pilot	Fuel	External Tanks	ATO Casings	ATO Fuel	Total
11750	230	2830	-	-	-	14810
11750	230	2830	-	360	-	15170
11750	230	2830	-	360	240	15410
11750	230	2830	*200	360	-	15370
11750	230	4390	200	360	-	17930
11750	230	2830	**320	360	-	15490
11750	230	5430	320	360	240	18330

* - 120 gallon wing tanks
** - 200 gallon wing tanks

5. Cockpit Layout:

The cockpit layout was satisfactory both in arrangement and types of equipment installed except for the following items:

a. The electrical circuit-breaker panels are positioned so that they are not readable from the pilot's seat. These panels could possibly be tilted slightly to aid the pilot in identifying the circuit breakers.

b. The landing gear warning light incorporated in the landing gear actuating handle is unreliable. A need for better shock mounting of this light is indicated to preclude breaking the light bulb when raising or lowering the alighting gear.

6. Taxiing & Ground Handling:

The ground handling and taxi characteristics were considered normal and satisfactory in all respects.

7. Take-off and Initial Climb:

a. Two performance take-offs with full 200 gallon external wing tanks installed were measured by ground recording photographic theodolite. These data have been corrected to standard day, sea level, no wind conditions. The average values of these take-offs are presented below and the original data are included in Appendix III.

Ground Roll ft	Air Distance to 50' Obstacle ft	Weight	IAS @ TO Knots	IAS @ 50 ft Knots	V_T @ TO Knots	V_T @ 50 ft Knots
3770	1240	17940	143	149	148	155

NOTE: The difference between indicated and true airspeeds can, in this case, be attributed to position error at these speeds.

b. The airplane accelerated well and handling characteristics were satisfactory without the ATO units installed. With the ATO units installed, the handling characteristics deteriorated slightly because of the rearward center-of-gravity position incurred by this loading configuration. After take-off the airplane rapidly accelerated to best climbing airspeed with no unusual tendencies to sink during flap retraction.

8. Climb Performance:

a. Climb data were obtained in each configuration tested. These data were obtained with 7950 rpm (100%) and exhaust gas temperatures commensurate with 700°C with static, sea-level, no-wind conditions on a NACA standard day. The climbing speeds for best rate-of-climb of the F-86E were used during these climbs. All climb data have been reduced to standard atmospheric conditions and are presented in Figure 1, Appendix I. A summary of these data is presented in the following tables:

Clean Configuration

Alt-Ft	R/C-Ft/Min	T/C-Mins.	NAMT	Fuel Used - Lbs	Gross Wt-Lbs
0	8500	0	0	0	14580
5000	7680	.6	4	60	14500
10000	6870	1.3	9	140	14420
15000	6030	2.1	14	200	14360
20000	5250	3.0	22	265	14300
25000	4420	4.2	30	330	14230
30000	3600	5.2	40	390	14170
35000	2750	6.8	52	455	14100
40000	1800	9.0	70	525	14000
45000	850	13.0	98	645	13890
49000	100	21.5	-	815	-

A.T.O. Pod Installed

0	7800	0	0	0	15260
5000	7050	.8	4	80	15180
10000	6900	1.6	10	160	15100
15000	5200	2.5	16	240	15020
20000	4725	3.5	24	310	14950

Clean Configuration

A.T.O. Pod Installed

Alt-Ft	R/C-Ft/Min	T/C-Mins	NAMT	Fuel Used-Lbs	Gross Wt-Lbs
25000	3960	4.7	33	380	14880
30000	3200	6.2	44	460	14800
35000	2410	7.9	59	530	14730
40000	1530	10.5	78	610	14650
45000	560	15.8	120	760	14500
47300	100	24.5	142	900	14370

A.T.O. Pod and 120 Gallon External Tanks

0	6200	0	0	0	16470
5000	5640	.9	5	95	16380
10000	5060	1.9	12	185	16300
15000	4470	3.0	18	270	16210
20000	3880	4.3	27	360	16110
25000	3300	5.7	35	445	16019
30000	2700	7.5	48	530	15940
35000	2120	9.5	63	610	15870
40000	1280	12.4	83	710	15750
45000	300	20.5	140	920	15550
46000	100	25.0	-	995	-

A.T.O. Pod and 200 Gallon External Tanks

Alt-Ft	R/C-Ft/Min	T/C-Mins	NAMT	Fuel Used-Lbs	Gross Wt-Lbs
0	5310	0	0	0	17820
5000	4820	1.0	6	115	17720
10000	4300	2.2	13	215	17620
15000	3800	3.4	19	320	17520
20000	3300	4.7	31	415	17430
25000	2780	6.5	43	510	17320
30000	2270	8.3	57	615	17210
35000	1750	10.8	74	715	17100
40000	850	14.8	102	845	16980
44000	100	27.0	170	1070	16520

b. The airplane handled well during climbs without the ATO units installed. With these units installed however, the longitudinal control characteristics deteriorated with fuel used so that maintaining a strict airspeed schedule was difficult after approximately 100 gallons were used.

c. At 40,000 ft altitude, the ATO units were fired both simultaneously and in sequence while maintaining a constant airspeed of 276 Knots. During three ATO firings an average of 2000 ft of altitude was gained during the firing interval. If the airplane was pulled up sufficiently, upon firing the augmentation units, to prevent an increase in airspeed a slight buffet was encountered. Consequently the airspeed did increase 4 to 5 knots during the transition period from high speed level flight to climbing attitude. As the augmentation units were fired, the aircraft handling characterics improved with forward movement of the center of gravity.

9. Level Flight:

a. Sufficient level flight data were obtained to present curves of $N/\sqrt{288/T}$ versus Mach Number and RPM versus Calibrated Airspeed in all test configurations. These data were obtained at constant weight/pressure ratio equivalent to 13,350 lbs at 35,000 ft altitude. These data have been corrected to standard day conditions and are presented in Figures 2 & 3, Appendix 1. These data are summarized in the following tables:

Maximum Airspeed 35,000 Ft.

	7950 RPM (100%)		7630 RPM (96%)	
	Vc-Knots	Mach.	Vc-Knots	Mach.
Clean	319	.923	317	.917
Pod On	317	.917	314	.914
Pod & 120 Gal Tanks	302	.880	299	.872
Pod & 200 Gal Tanks	301	.877	297	.867

b. Control forces were very light prior to firing of the A.T.O. units. After firing the augmentation units the center-of-gravity moved forward thus improving the control force characteristics.

c. The A.T.O. units were fired at 40000 ft altitude after stabilizing at maximum level flight speed. These units were fired simultaneously and in sequence. The maximum attainable calibrated airspeed was 276 Knots or 0.90 Mach at 40000 ft altitude without thrust augmentation. Firing the A.T.O. units simultaneously increased the speed to 296 Knots or 0.955 Mach at the end of the firing period. In sequence the assist units provided an airspeed of 291 Knots or 0.94 Mach. The location of the A.T.O. units is such that very little pitching is experienced when firing. A slight wing drop was experienced during the acceleration following ignition of the A.T.O. units. This condition, like the pitching moment, was easily controllable.

10. Descent:

No quantitative descent performance data were obtained. Pilots observations ere that these characteristics were comparable to those presented for the F-86E airplane.

11. Approach & Landing:

Approach and landing characteristics wer normal and acceptable except that the center-of-gravity would be behind the allowable limit with the full A.T.O. units installed and all fuel expended. This condition should rarely, if ever, exist but the limiting aft center-of-gravity condition is approached during any low fuel landing even with empty A.T.O. units installed.

12. A.T.O. Unit Operation:

a. Before firing the A.T.O. units two flights wer made to 40000 ft with instrumentation installed to obtain both A.T.O. compartment and propellent temperatures. These data indicated that the A.T.O. units would remain within the permissable temperature range during a maximum duration flight at this altitude with no external fuel.

b. Following these flights two A.T.O. firings were accomplished at 40000 feet altitude while aircraft structure and skin temperatures were obtained. These data indicated no detrimental temperature conditions existed.

c. During the performance firings however, two units malfunctioned, blowing out the pressure relief valves, which in turn stopped the burning. In an effort to ascertain the cause of those failures six A.T.O. units were taken to Williams AFB and were taken to 45000 ft altitude in the aeromedical altitude chamber at that station. While at 40000 ft in the altitude chamber the firing surface of the units under observation showed a tendency to dome or bulge at the center. Some oil exudation was also indicated by the small drops of oil which appeared on the firing surface. One unit developed a small bubble approximately 1/4 inches in diameter which deflated when the chamber was returned to ground altitude. It is felt that these chamber tests produced no conclusive results but that they did indicate a trend for further investigation.

13. Items of Operation Peculiar to F-86F Airplanes.

a. The most serious maintenance item encountered during these flight tests was the operation of the "Tele-Flex" cable control for the emergency flight control hydraulic system. The "quick" disconnect in this line used during removal and reinstallation of the aft fuselage section is both poorly designed and positioned. The use of a cable system which must operate in compression to turn the emergency hydraulic system off is in itself considered unsatisfactory.

b. The operation of the UHF radio system (AN/ARC-33) was unreliable and inconsistent. On two occasions the dynamotor assembly in this unit burned out and it appeared that the altitude of the aircraft with respect to the receiving station seriously affected the operating characteristics of this radio installation.

c. The light bulb in the alighting gear operating handle failed on two occasions, apparently because of vibration or shock-loads during normal operation of the landing gear operating lever.

C. CONCLUSIONS

14. It is concluded that:

a. The performance characteristics of the F-86F airplane exceed those of earlier series of F-86 type aircraft with the exception of the F-86D which incorporates afterburning for thrust augmentation.

b. Use of the A.T.O. units for thrust augmentation materially improves the performance of the F-86F both in climbs and in level flight for very short periods of time.

c. The flight handling characteristics of the test airplane were materially deteriorated by the aft center-of-gravity location imposed by installation of the A.T.O. units. Before firing these units, the pilot stated that formation flight was difficult.

D. RECOMMENDATIONS

15. It is recommended that:

a. The suitability of this type thrust augmentation for use in combat be properly investigated by a qualified combat suitability evaluation team.

b. The "Tele-Flex" cable system for the emergency flight control hydraulic system be replaced with a more dependable system.

c. Steps be taken to improve the operating characteristics of the AN/ARC-33 radio equipment.

d. The main alighting gear unsafe light installation in the landing gear operating handle be redesigned for greater reliability.

APPENDIX I

1. Discussion:

a. Performance data obtained during these flight tests have been corrected for instrument error and are tabulated in Appendix III. These data have been corrected to standard weight and atmosphere conditions and are presented in the Figures of this Appendix.

b. Sufficient climb performance were obtained to present curves of rate-of-climb, time-to-climb, gross weight, exhaust gas temperature, climbing speeds, fuel flow, fuel used, and nautical air miles traveled versus altitude for the following conditions:

(1) Clean Airplane

(2) Airplane with A.T.O. pod installed

(3) Airplane with A.T.O. pos and 120 gallon wing tanks.

(4) Airplane with A.T.O. pod and 200 gallon wing tanks.

These climb data were obtained at 7950 rpm (100%) and exhaust gas temperatures commensurate with 700°C static exhaust gas temperature settings at sea level on a NACA standard day. The observed data during these tests were corrected to the desired conditions as follows:

$$R/C_{\text{std. day}} = dh/dt \sqrt{T_t/T_s} + \left[\frac{101.2\ Vt\ \text{test}}{Wt} \times \sqrt{T_s/T_t} \times \Delta F_n\right]$$

and corrected to standard weight by the expression ---- ----

$$R/C_{\text{std. wt}} = R/C_{\text{std. day}} + \Delta R/C_{wt}$$

$$\Delta R/C_{wt} = \left[R/C_{\text{std. day}} \times \frac{19018}{V} \times \frac{W}{eb}\right] \frac{\Delta W}{Wt}$$

Where:

dh/dt	= Observed rate-of-climb	ft/min
T_s	= Standard temperature	°K
T_t	= Test day temperature	°K
W_t	= Test Weight	lbs
ΔF_n	= Standard net thrust-test net thrust	lbs
V_i	= Indicated airspeed	knots

σ = Density ratio

e = Oswald's efficiency factor

b = Span ft

W = Test weight-standard weight lbs

c. Stabilized level flight speed versus power data were obtained throughout the entire speed range in all loading conditions at approximately 35000 ft. altitude. These data were flown in such a manner as to produce a constant weight/pressure ratio to obviate the need of weight corrections. As no weight correction to the power required was necessary, standard day rpm was obtained thus: $RPM_{std} = RPM_{test} \sqrt{T_s/T_t}$. These data are presented in this Appendix as curves of $N\sqrt{288/T}$ versus Mach Number and RPM versus Calibrated Airspeed.

d. The performance which can be obtained at 40000 ft altitude utilizing the A.T.O. units has been corrected in the same manner and are spotted in on the 35000 ft curves.

e. Take-off data were obtained during two take-offs with full 200 gallon external wing tanks and three 14-AS-1000 ATO units installed. These data were corrected to standard day, sea level, no wind conditions by the following expressions:

$$S_{gs} = S_{gt}\left(\frac{V_{t.o.} * V_w}{V_{t.o.}}\right)^2 \frac{\left(\frac{P_{at}}{P_{as}}\frac{T_s}{T_t}\right)}{\frac{W_t}{W_s}\left(\frac{94\,F_{gt}}{\left[\frac{W_t\,(V_{t.o.}^2 - V_o^2)}{2g\,S_{gt}}\right]}\right)}$$

$$S_{as} = S_{at}\left(\frac{\frac{W_s}{W_t}\frac{P_{at}}{P_{as}}\frac{T_s}{T_t}\left(\frac{V_{50'}^2 - V_{t.o.}^2}{2g} + 50\right)}{\frac{V_{50}^2 - V_{t.o.}^2}{2g} + 50}\right)\left[\frac{94\,F_{gt}}{W_t\left(\frac{\Delta V^2}{2g} + 50\right)}\left(\frac{W_t}{W_s}\frac{F_{gs}}{F_{gt}} - 1\right) + 1\right]S_{at}$$

Where:

S_{gs} =	Standard day ground roll	ft
S_{gt} =	Test day ground roll	ft
V_w =	Wind component parallel to runway	ft/sec
V_{TO} =	Ground speed at take-off	ft/sec
F_{gt} =	Gross thrust on test day	lbs
F_{gs} =	Gross thrust on standard day	lbs
W_t =	Test gross weight	lbs
S_{as} =	Standard air distance	ft
V_o =	Ground speed at brake release	ft/sec
V_{50}' =	Ground speed at 50 ft height	ft/sec
W_s =	Standard weight	lbs

f. A ground static thrust calibration was accomplished on the Universal Thrust Stand at Edwards AFB. The data obtained during this calibration has been reduced to standard day, sea-level, no-wind conditions and are presented in this Appendix.

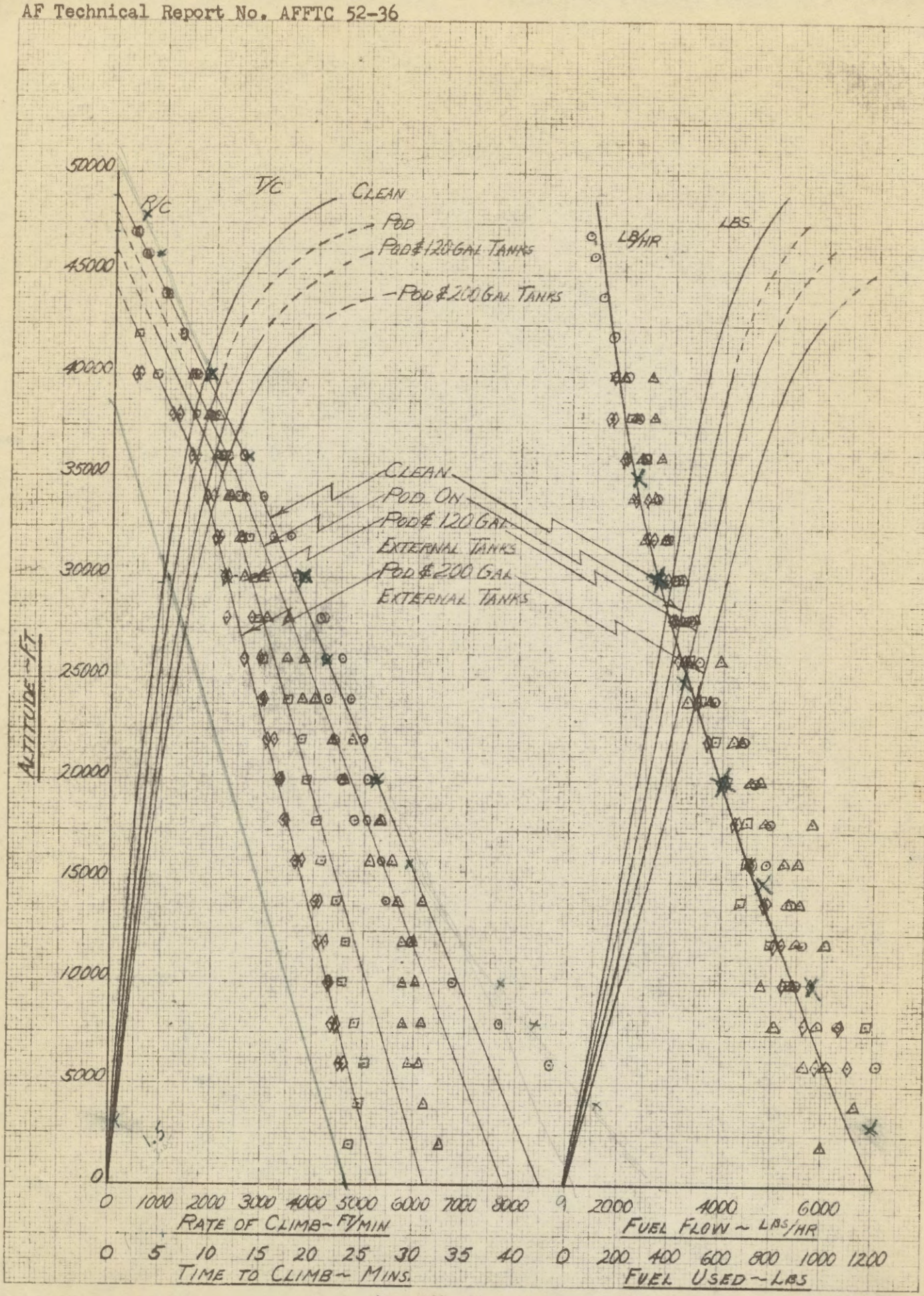

50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
ALTITUDE ~ FT
R/C
T/C
CLEAN
POD
POD & 120 GAL TANKS
POD & 200 GAL TANKS
CLEAN
POD ON
POD & 120 GAL
EXTERNAL TANKS
POD & 200 GAL
EXTERNAL TANKS
LB/HR
LBS
0 1000 2000 3000 4000 5000 6000 7000 8000
RATE OF CLIMB ~ FT/MIN
0 2000 4000 6000
FUEL FLOW ~ LBS/HR
0 5 10 15 20 25 30 35 40
TIME TO CLIMB ~ MINS.
0 200 400 600 800 1000 1200
FUEL USED ~ LBS

FIG NO 1
CLIMB PERFORMANCE
F-86F USAF NO. 51-13071
MILITARY POWER (7950 RPM)

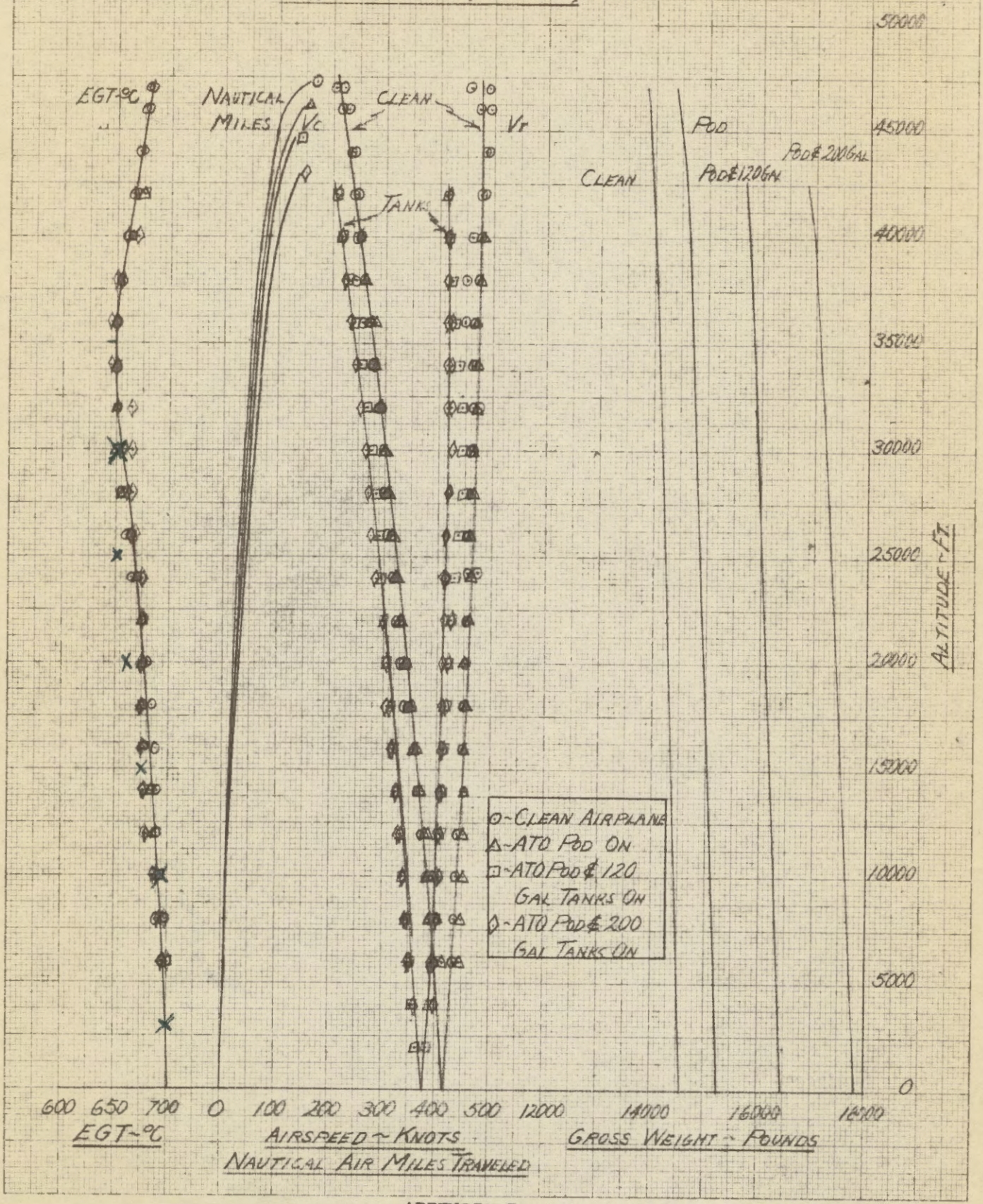


FIG. No. 2
$N\sqrt{288/T}$ VS. MACH
F-86F USAF 51-13071
13350 POUNDS GROSS WEIGHT

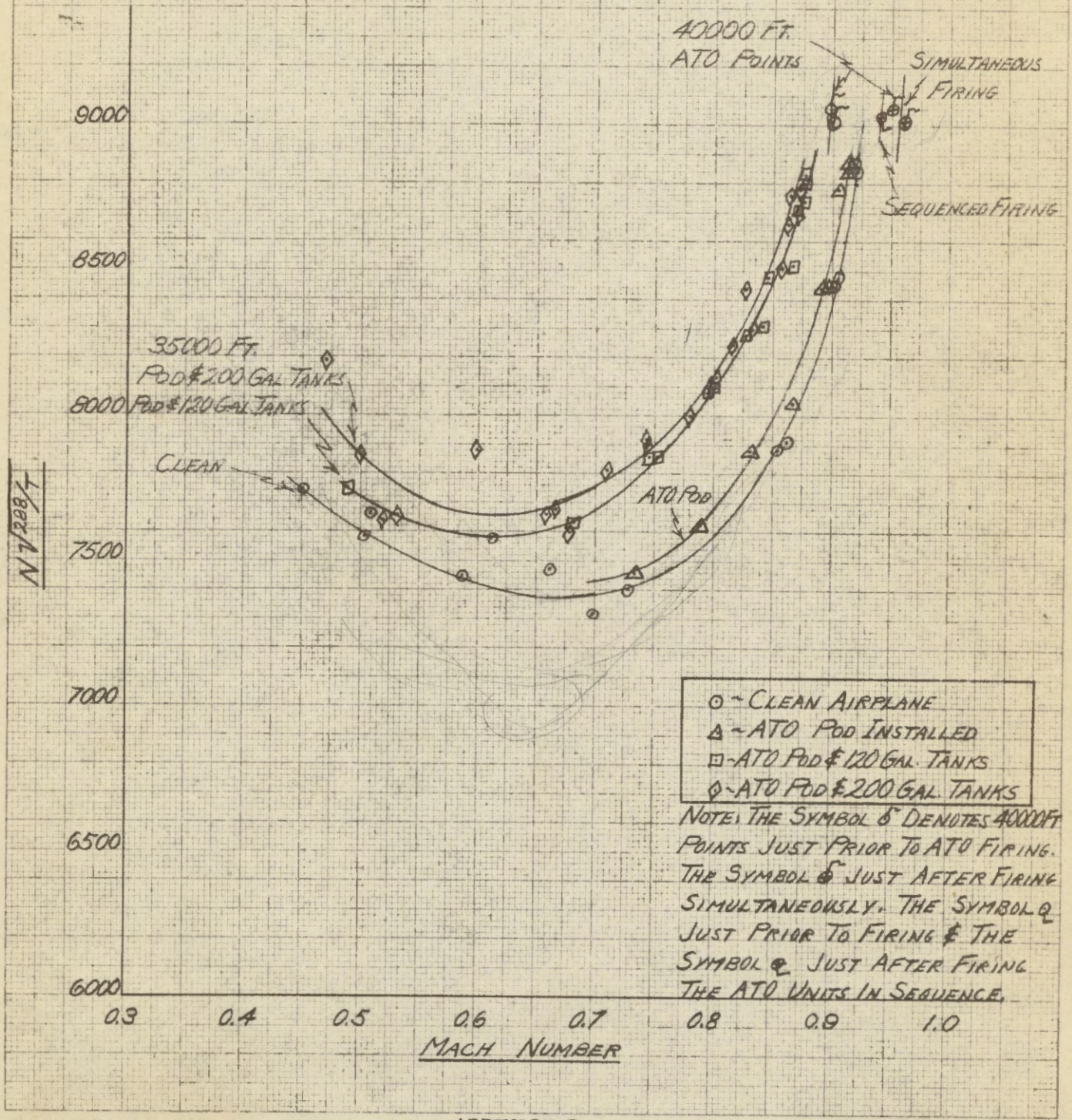


Fig. No. 3
RPM Versus Calibrated Airspeed
F-86F USAF No. 51-13071
13350 Lbs. Gross Weight

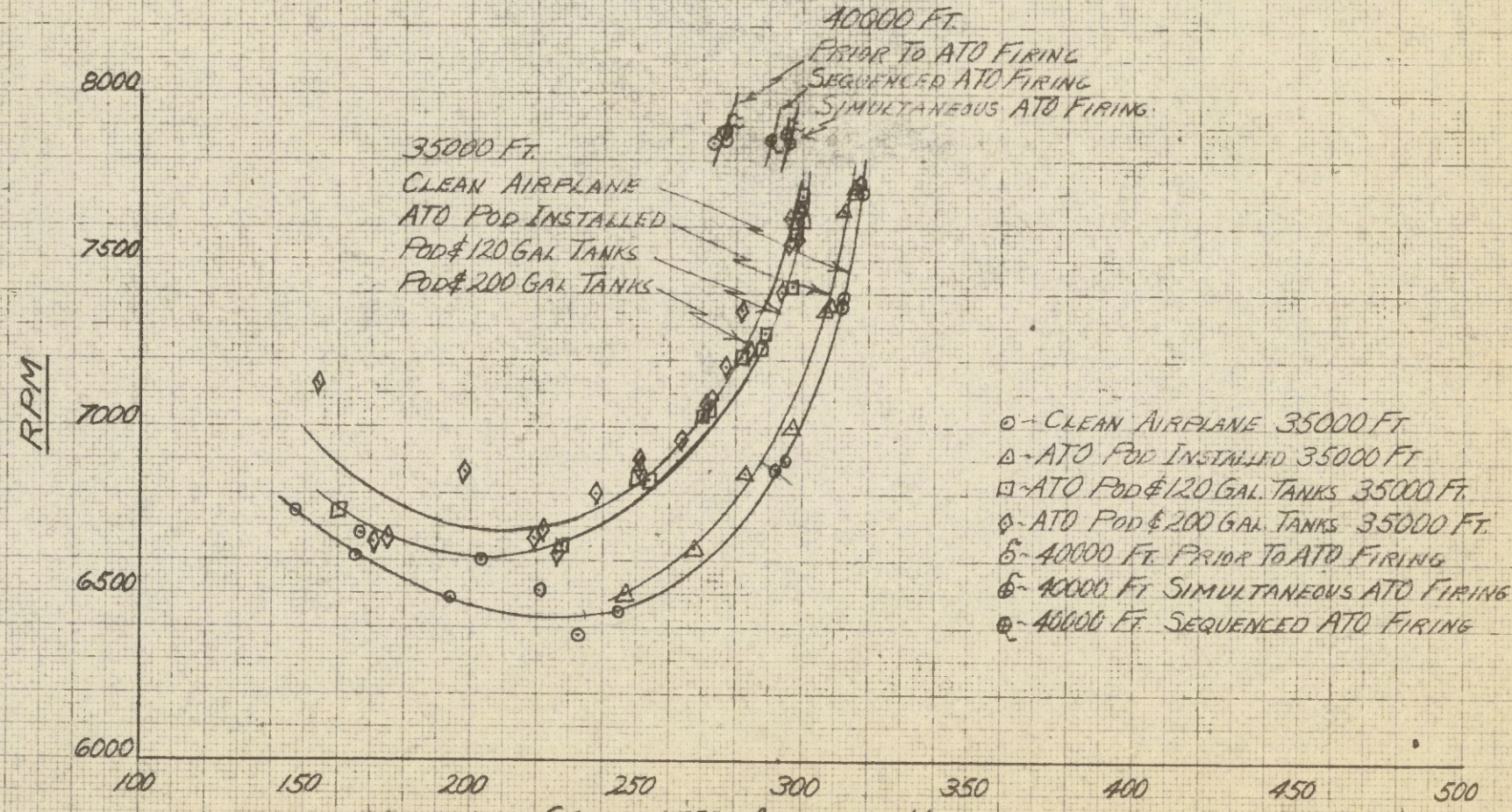
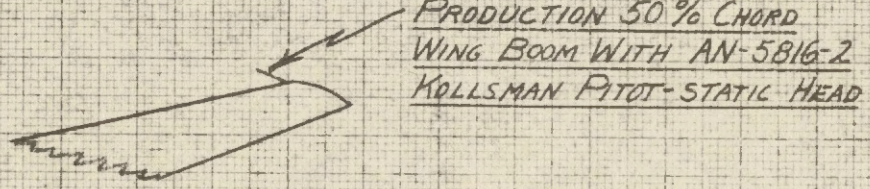
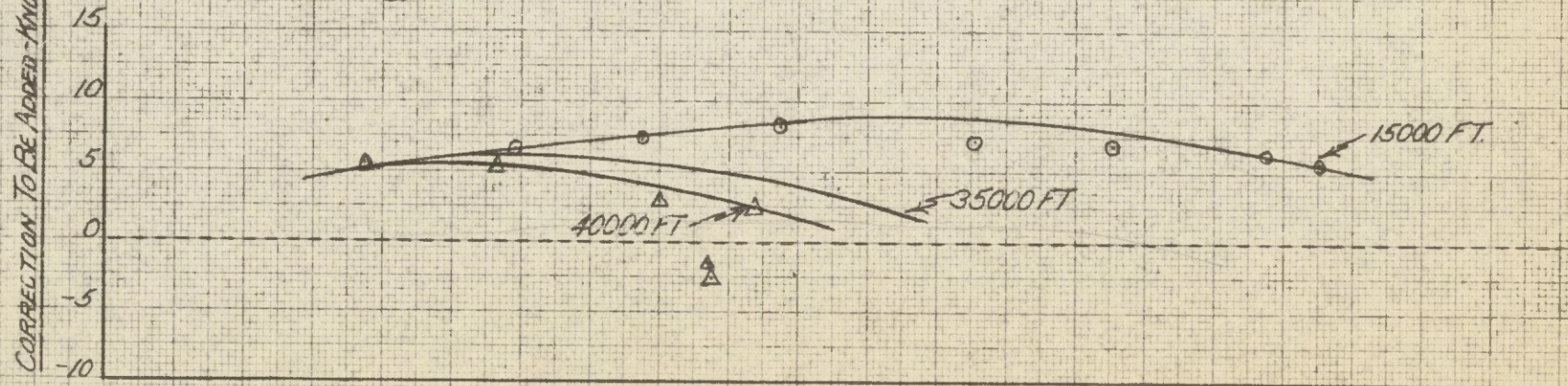


FIGURE NO 4
AIRSPEED CALIBRATION
F-86F USAF 51-13071
WITHOUT EXTERNAL TANKS



PRODUCTION 50% CHORD
WING BOOM WITH AN-5816-2
KOLLSMAN PITOT-STATIC HEAD



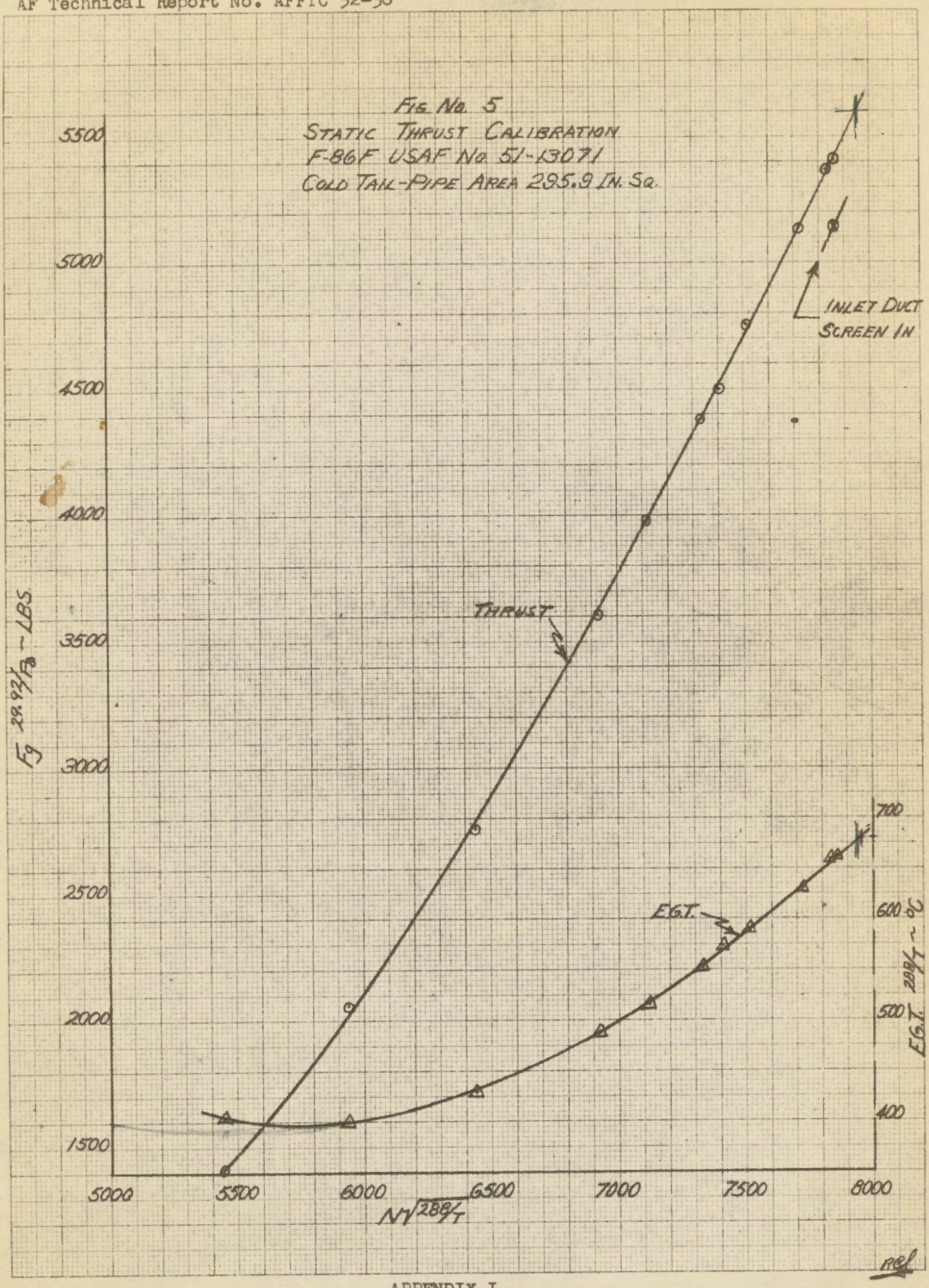
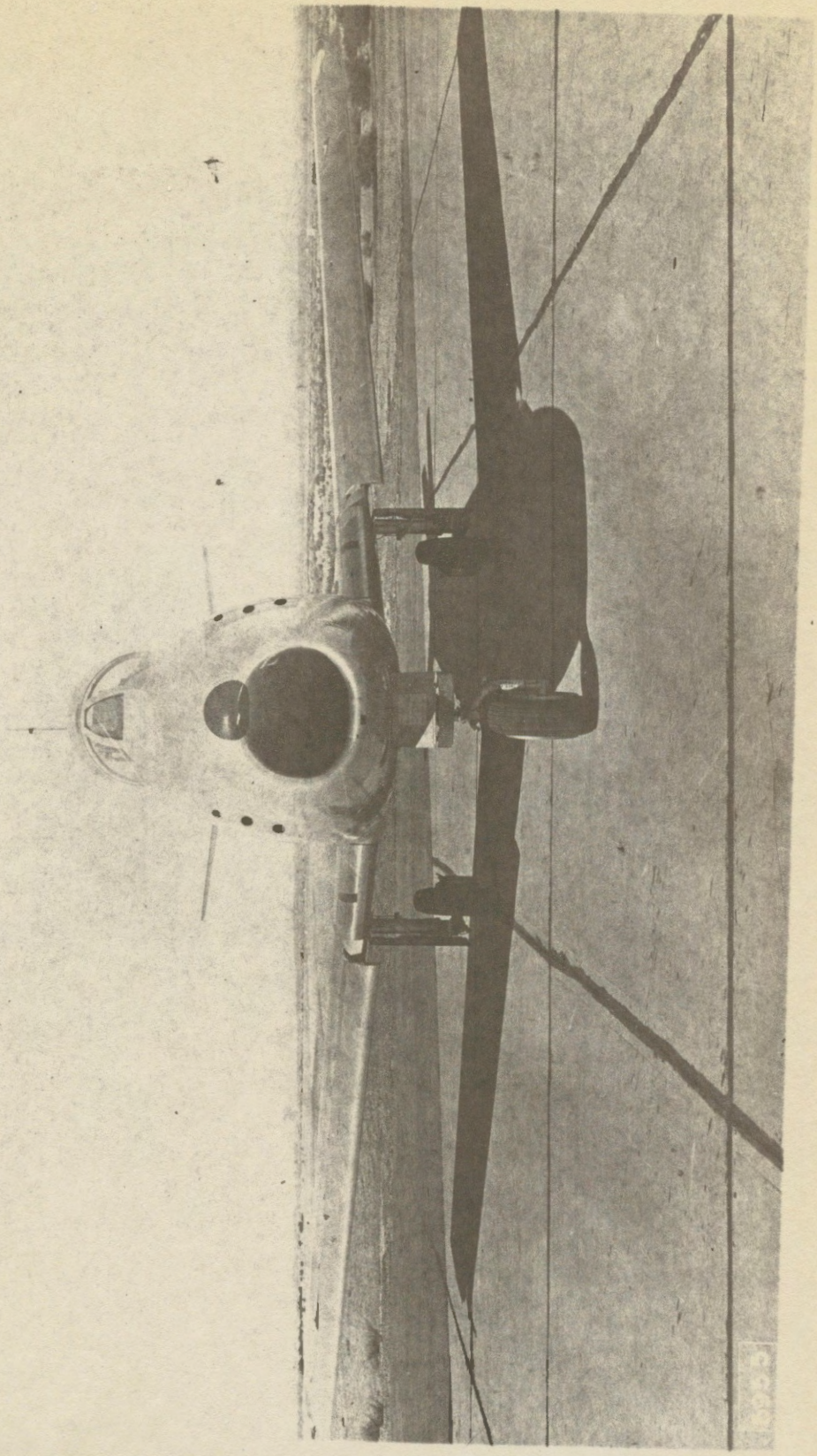
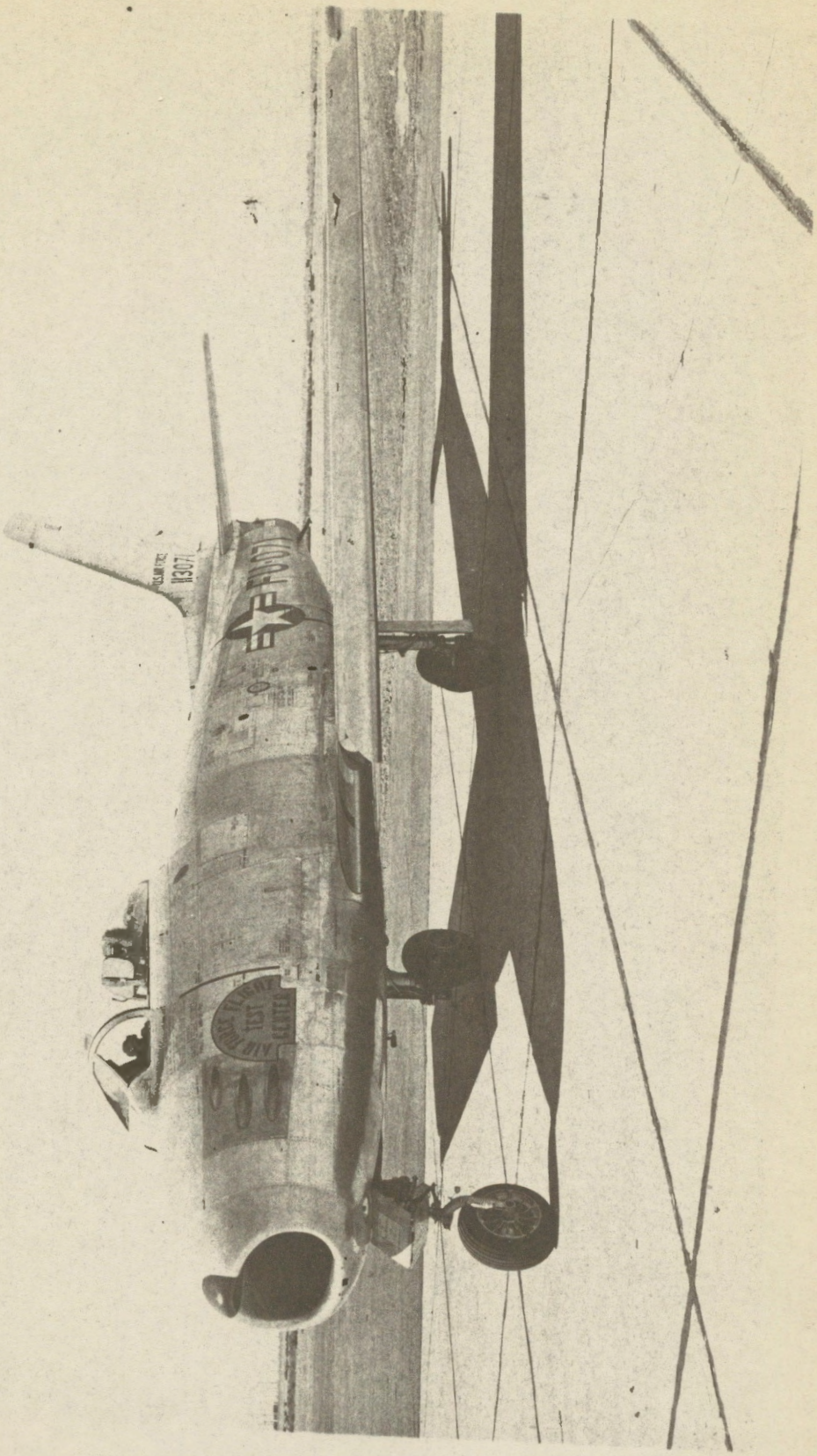


FIG. No. 5
STATIC THRUST CALIBRATION
F-86F USAF No 51-13071
COLD TAIL-PIPE AREA 295.9 IN. SQ.
INLET DUCT SCREEN IN
THRUST
E.G.T.
$F_g \sqrt{\frac{29.92}{P_a}}$ - LBS
E.G.T. $\frac{288}{T}$ - °C
$N\sqrt{\frac{288}{T}}$
5500
5000
4500
4000
3500
3000
2500
2000
1500
700
600
500
400
5000
5500
6000
6500
7000
7500
8000

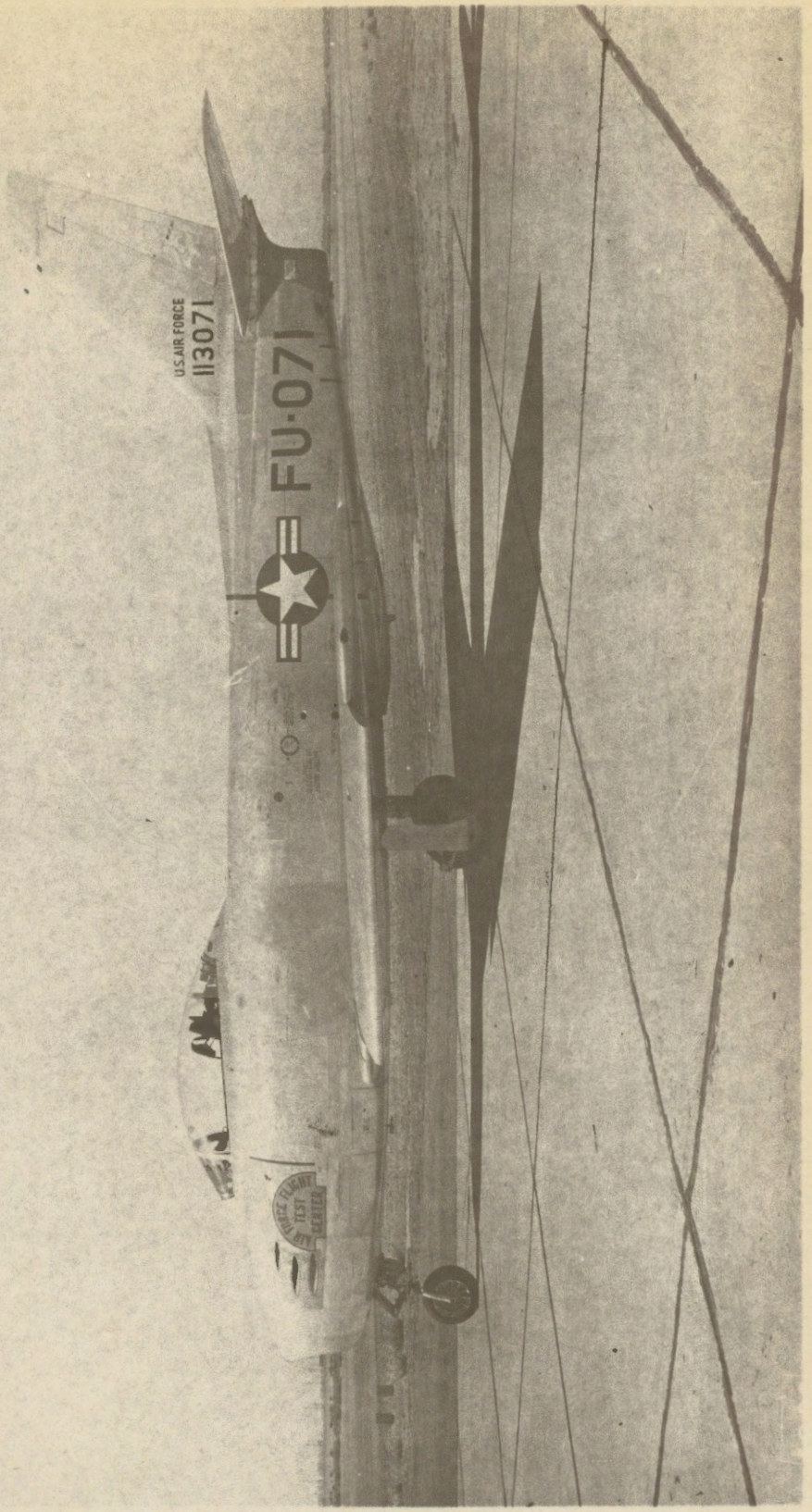
APPENDIX II



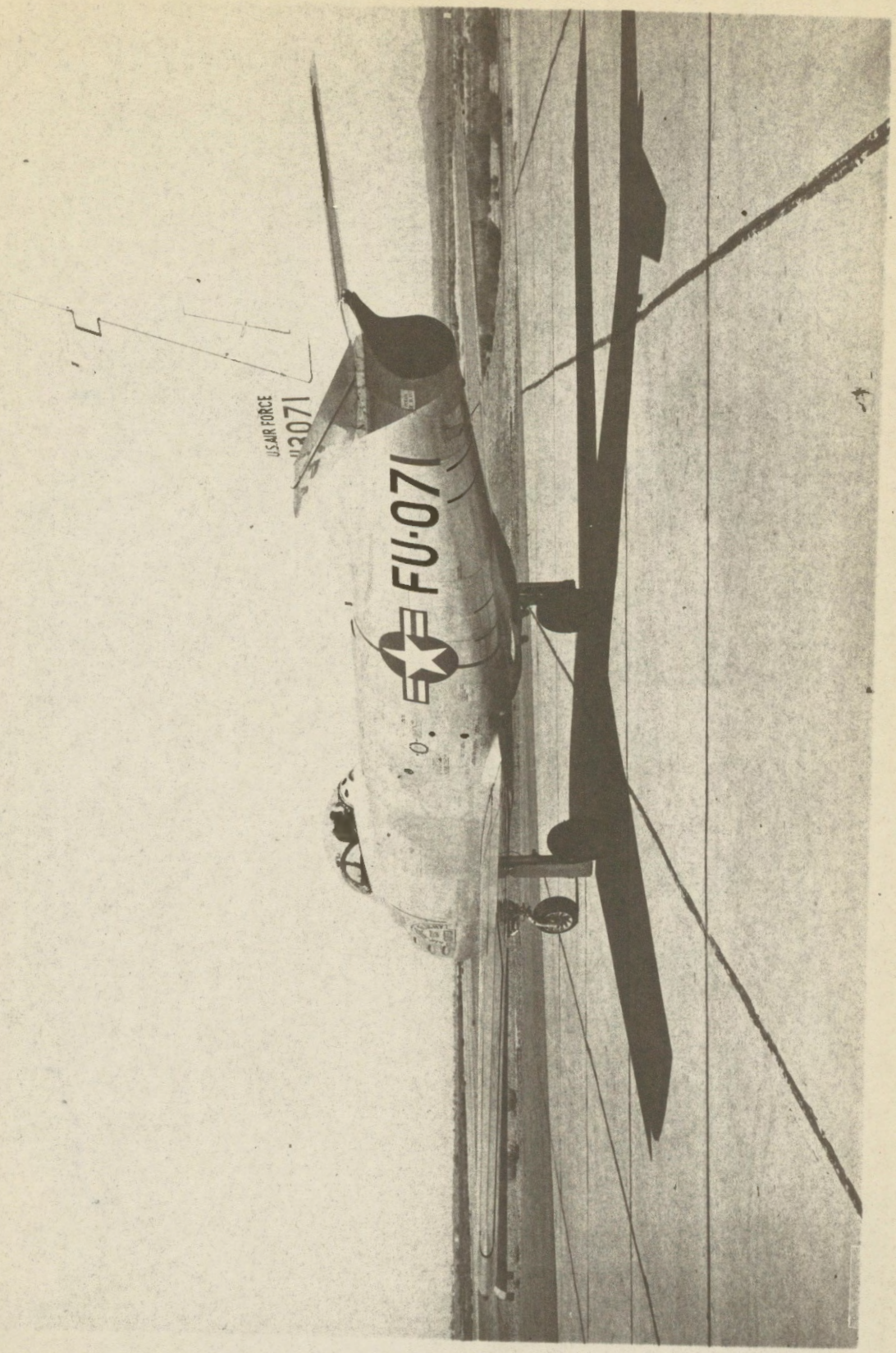
FRONT VIEW



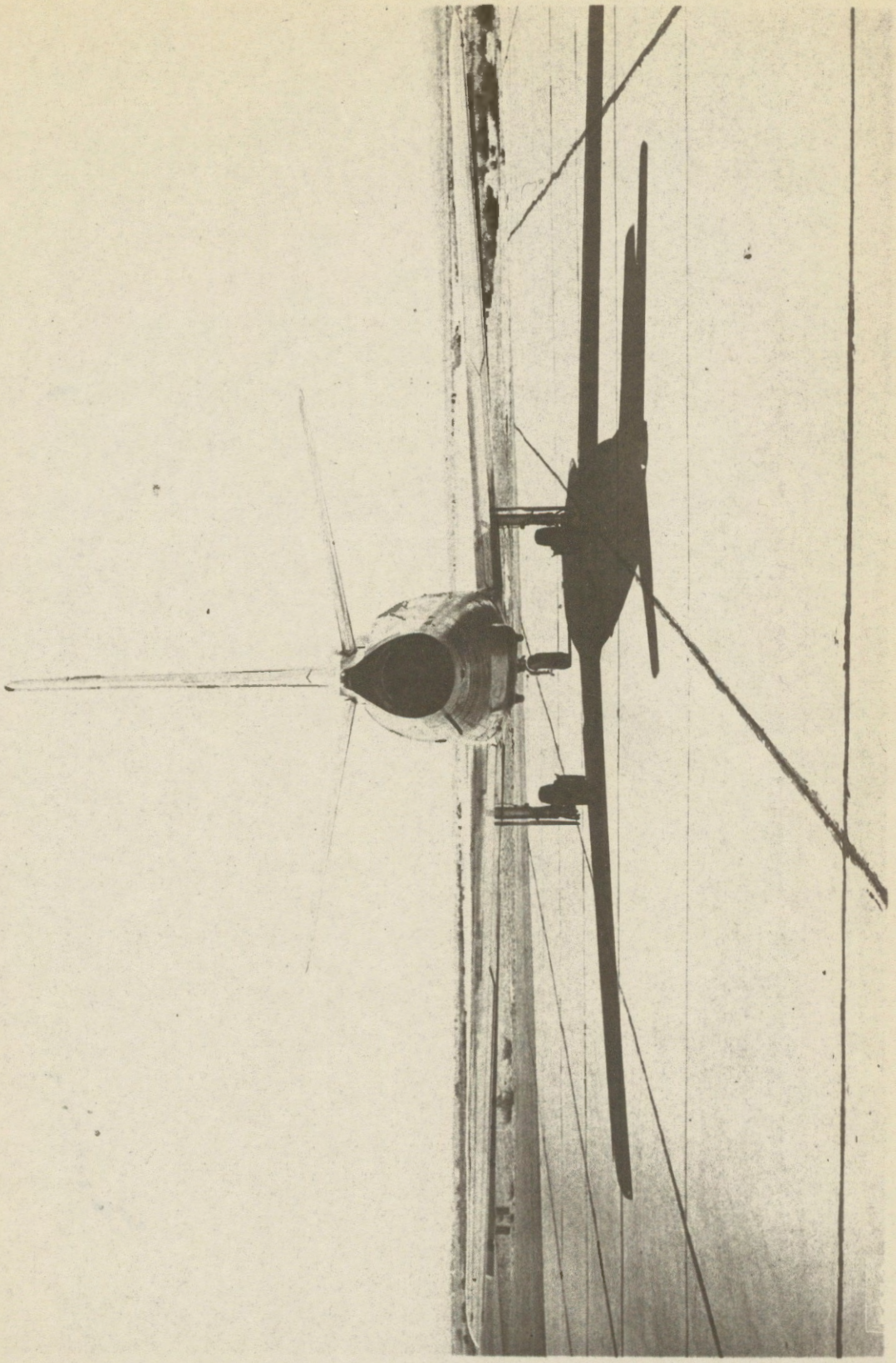
LEFT FRONT VIEW



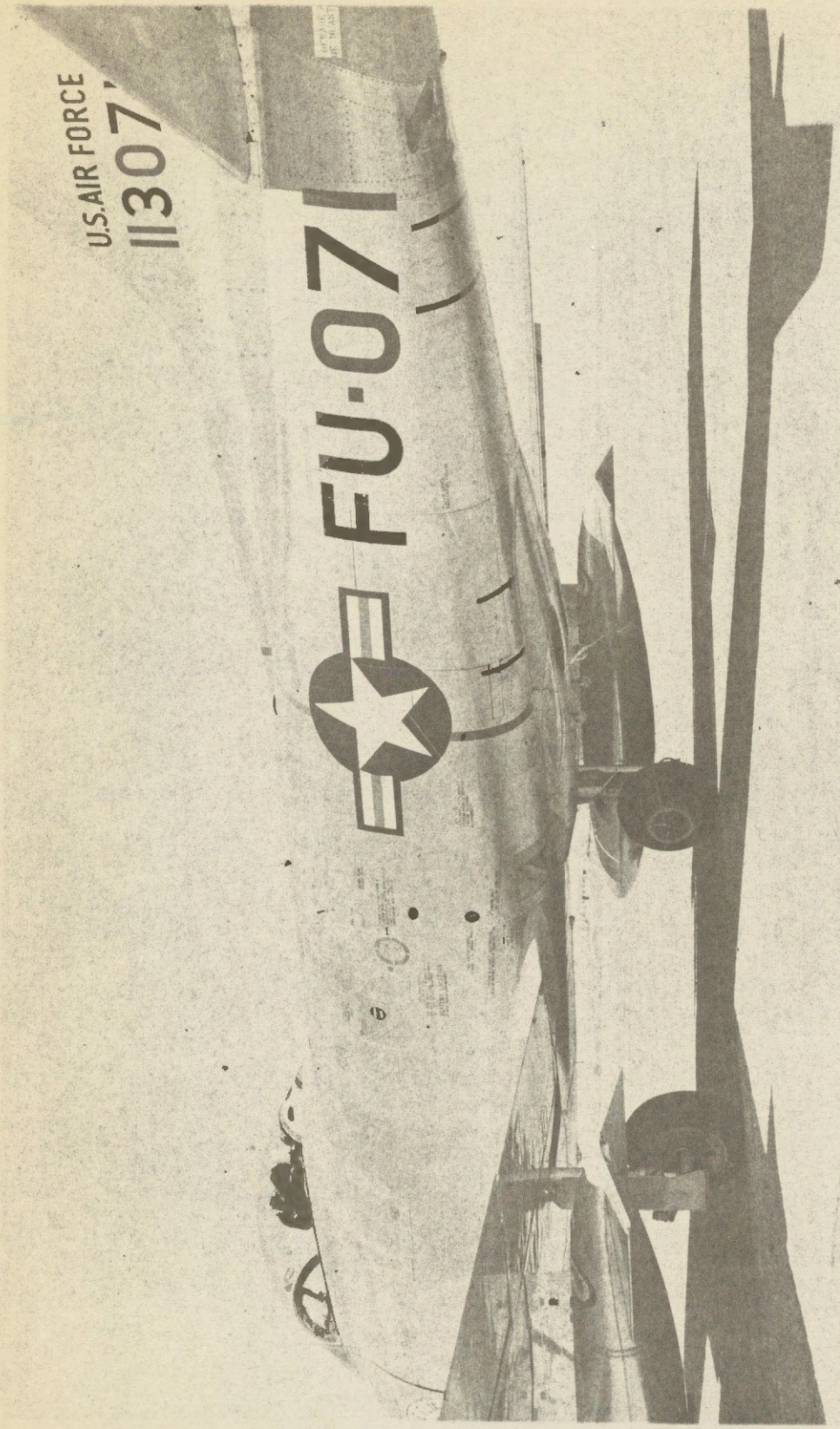
LEFT VIEW



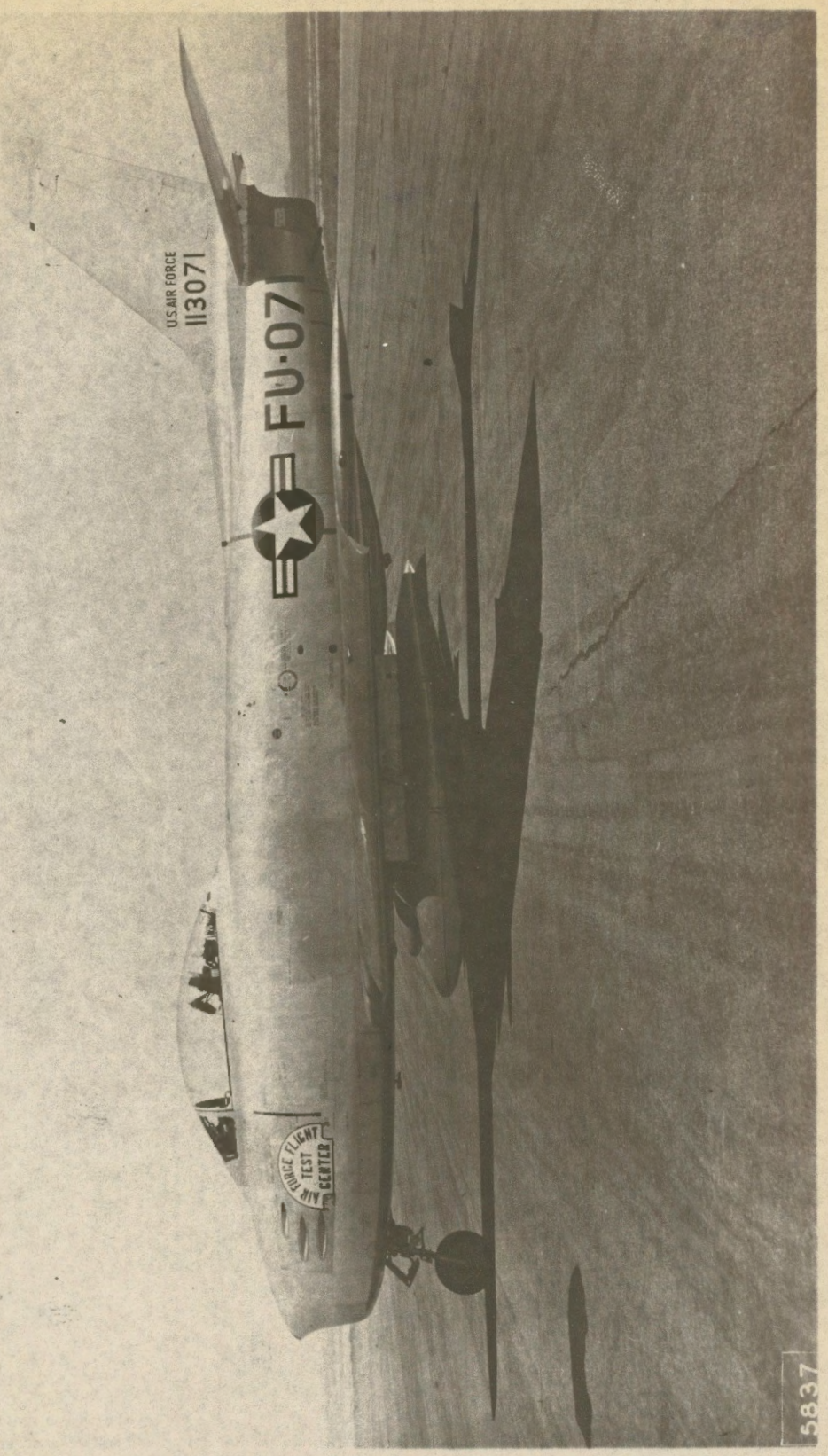
LEFT REAR VIEW



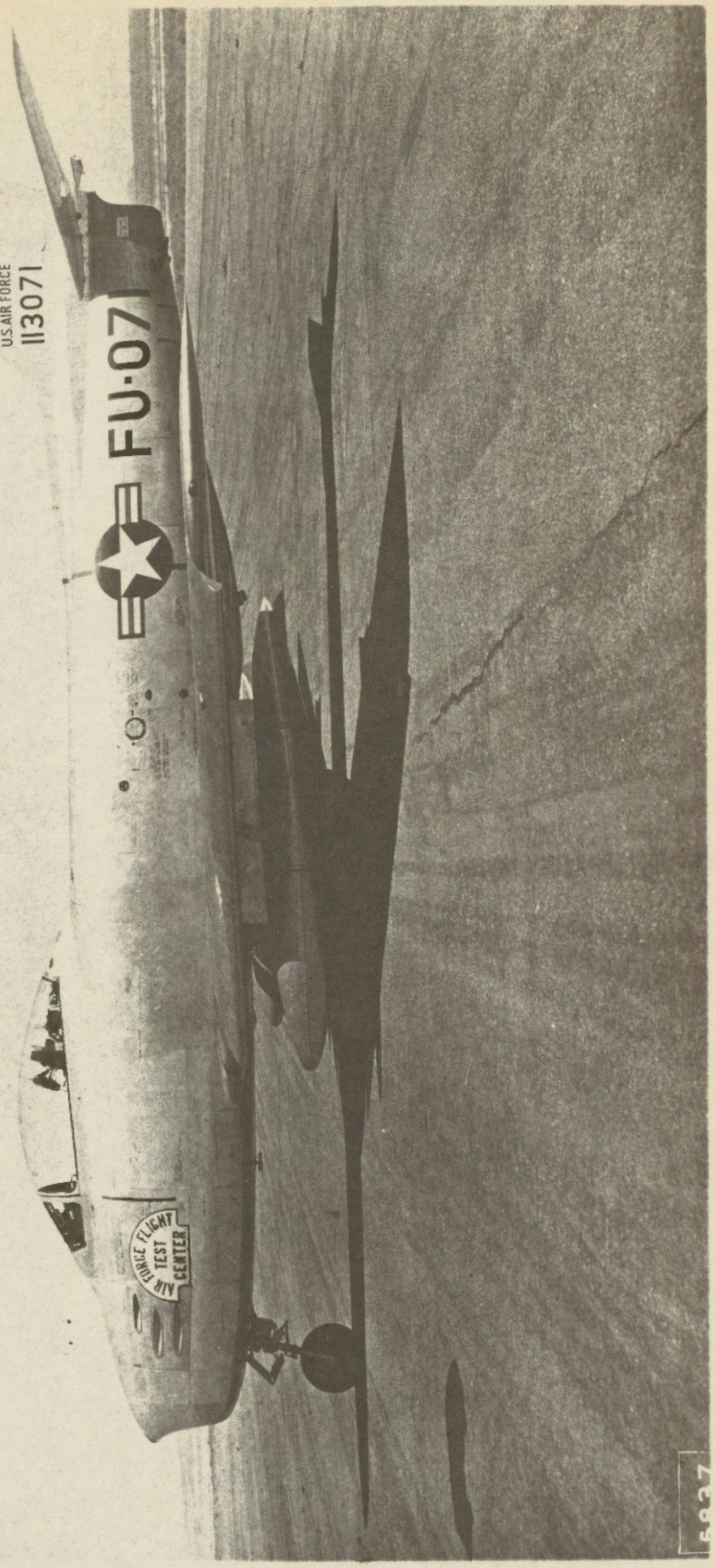
REAR VIEW



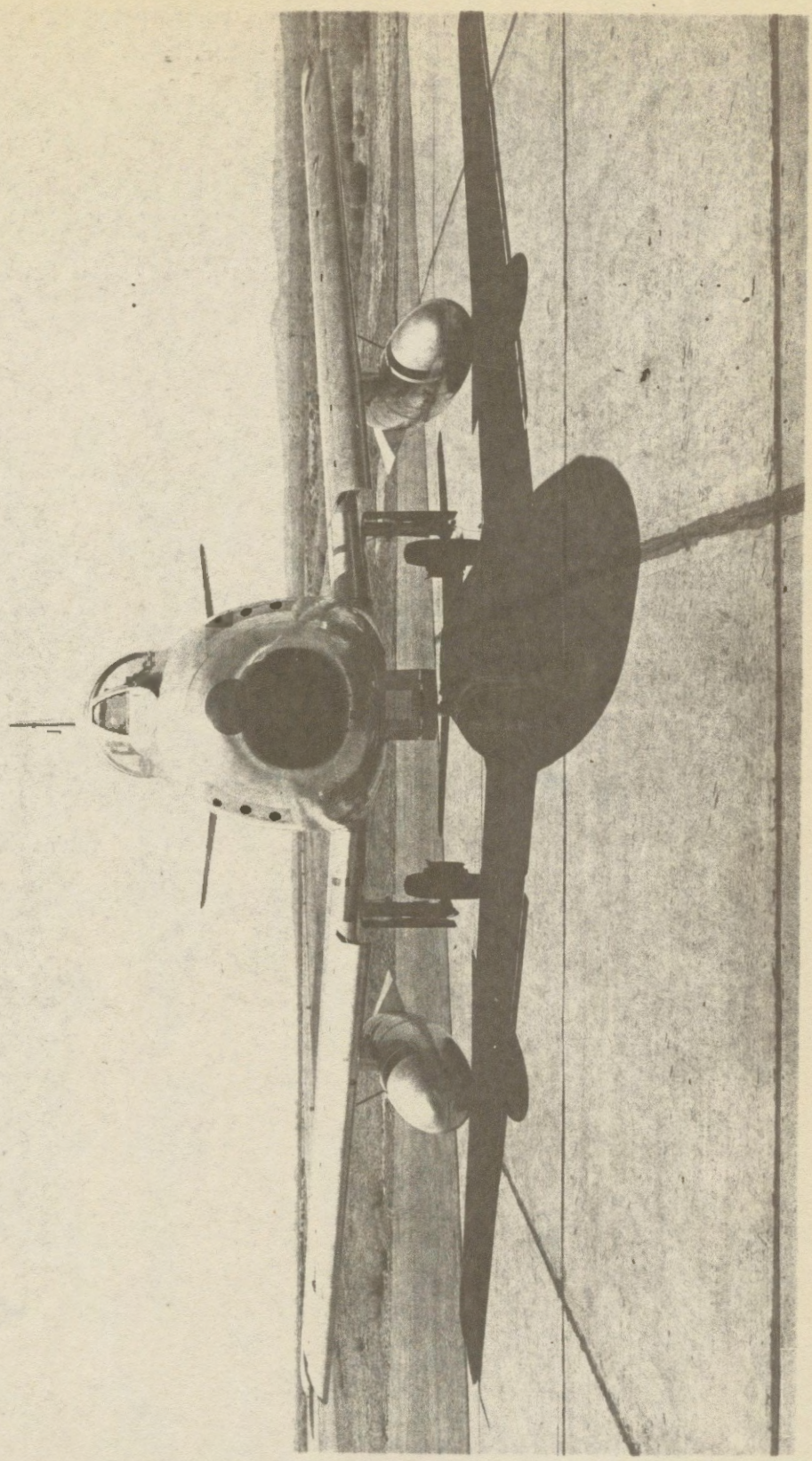
ATO COMPARTMENT



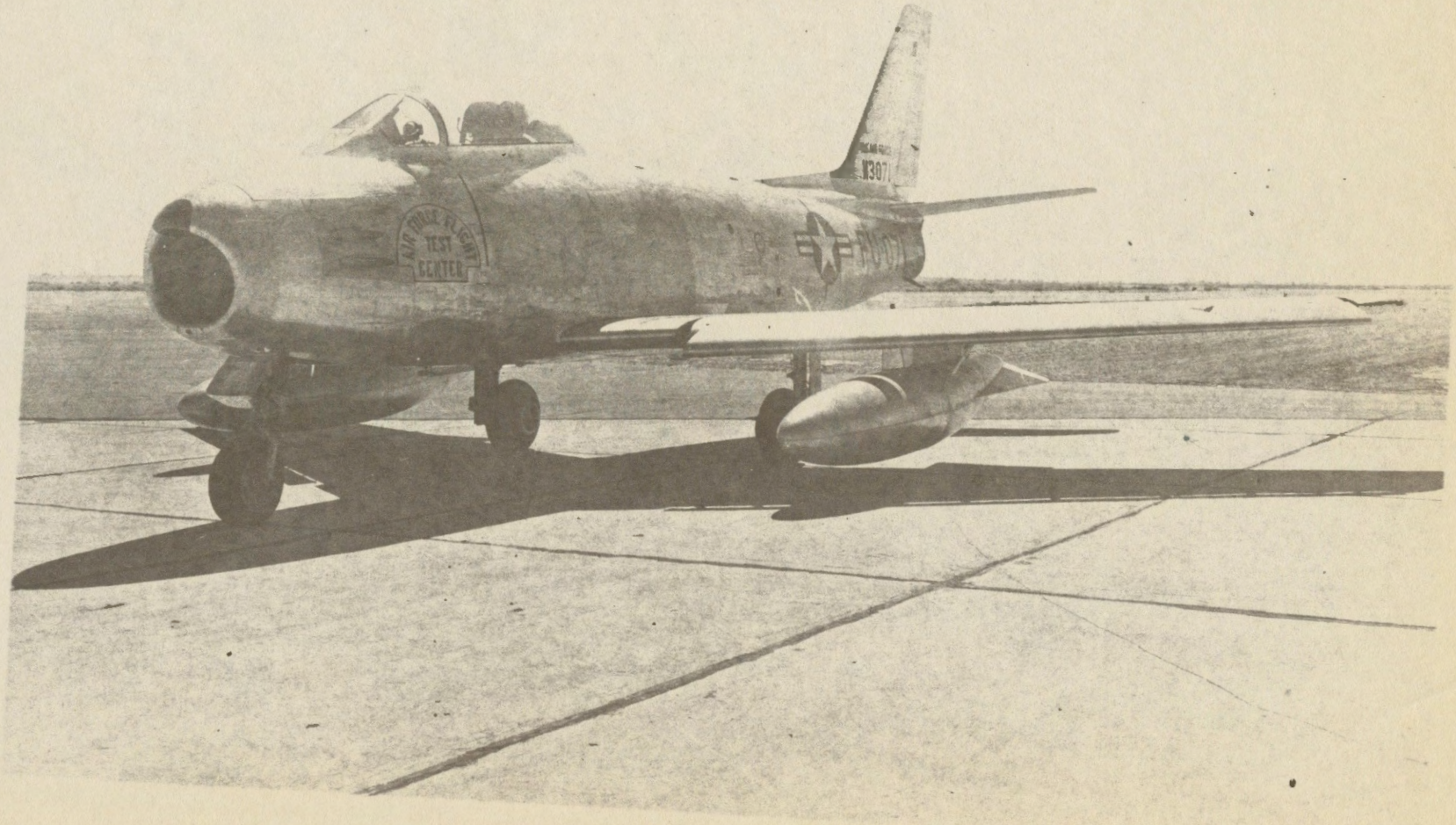
LEFT FRONT VIEW WITH 120 GALLON WING TANKS



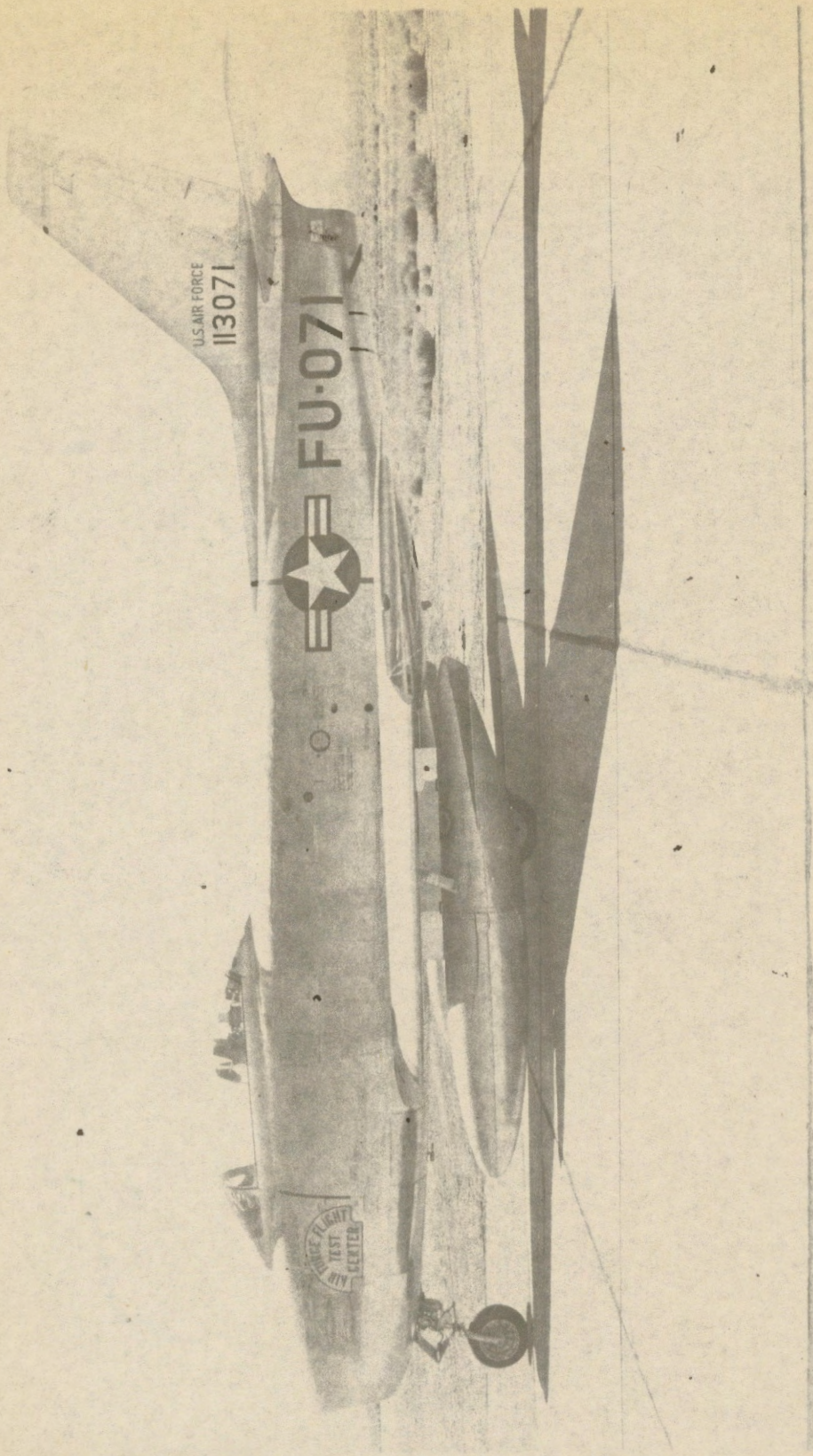
LEFT VIEW WITH 120 GALLON WING TANKS



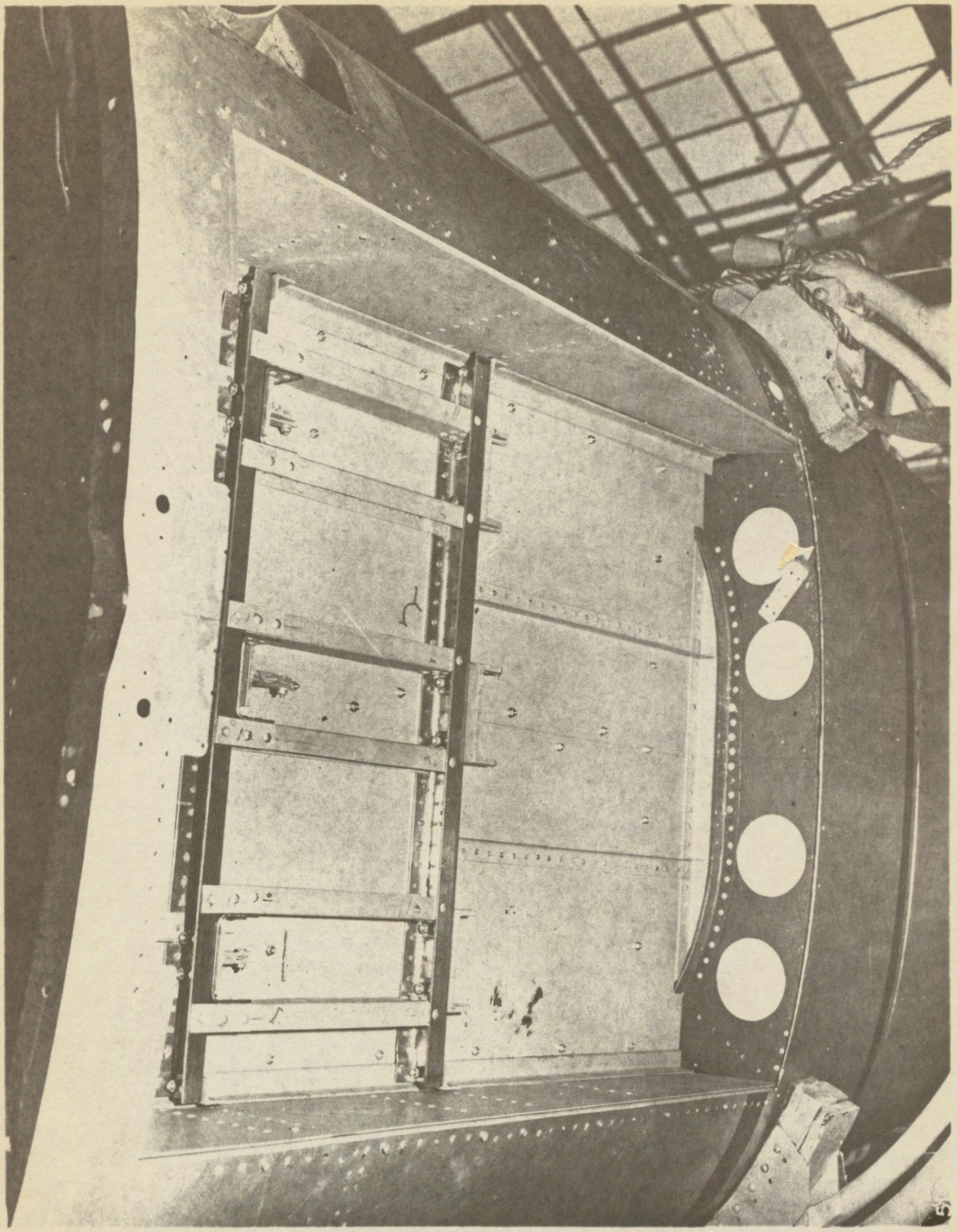
FRONT VIEW WITH 200 GALLON WING TANKS



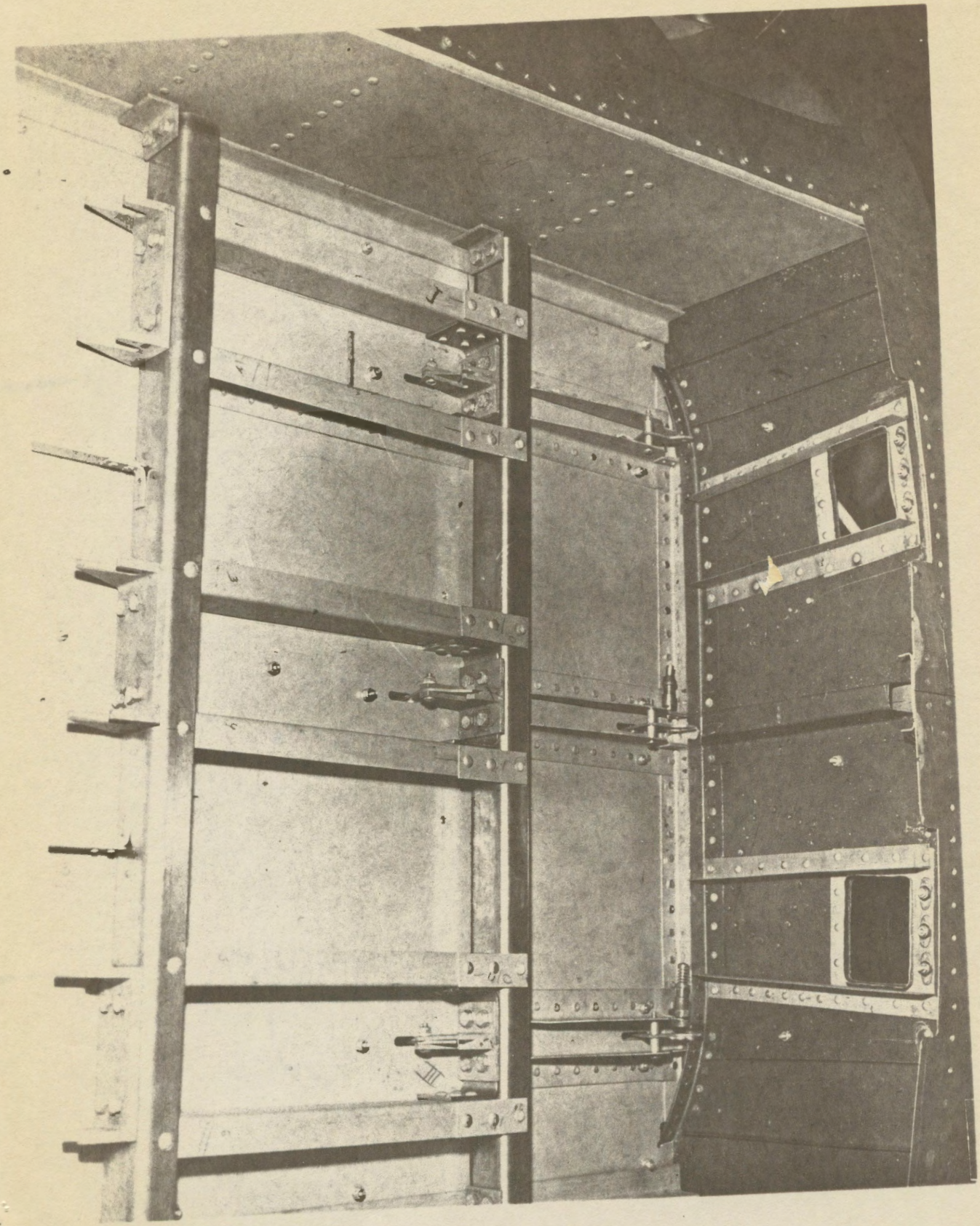
LEFT FRONT VIEW WITH 200 GALLON WING TANKS



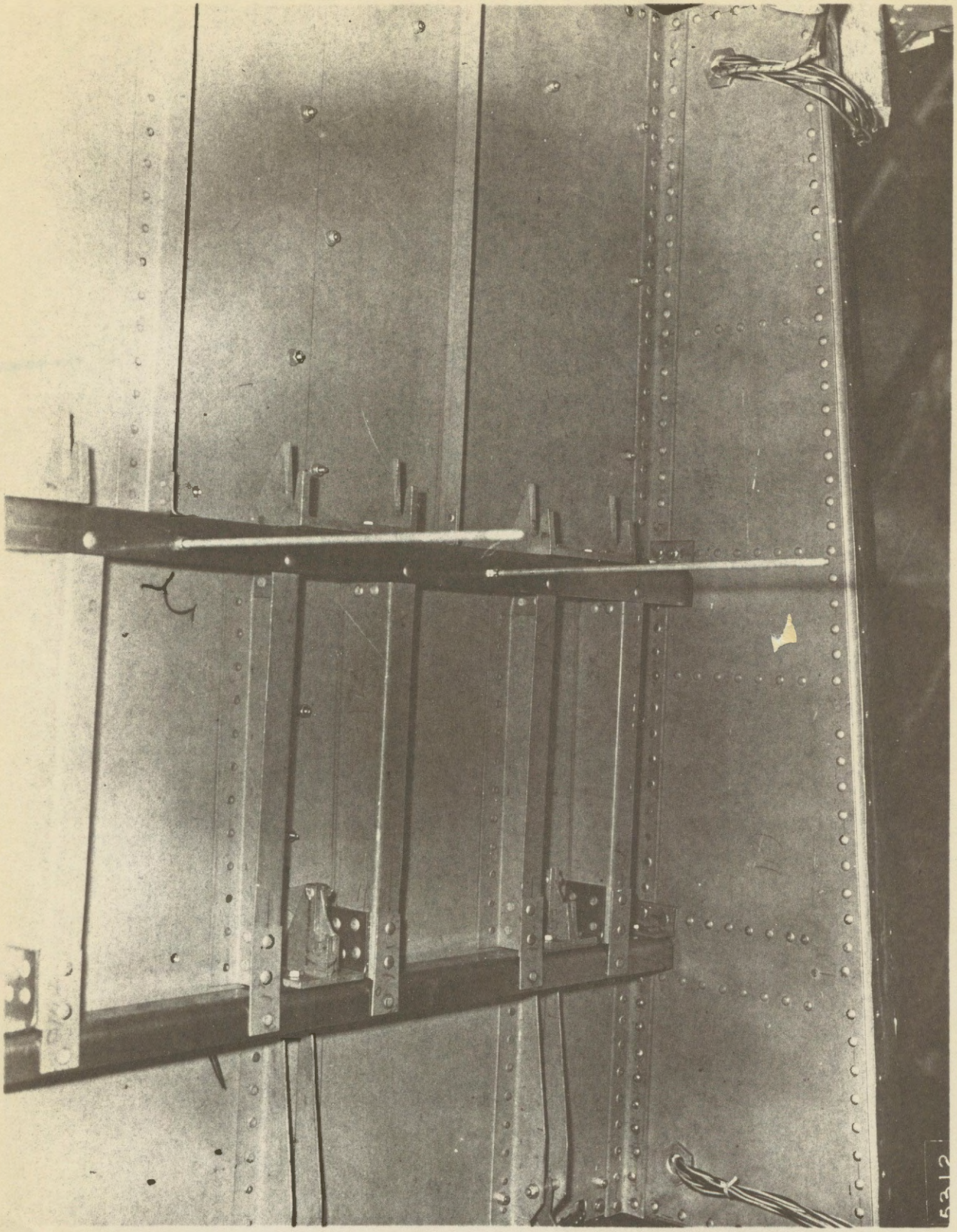
LEFT VIEW WITH 200 GALLON WING TANKS



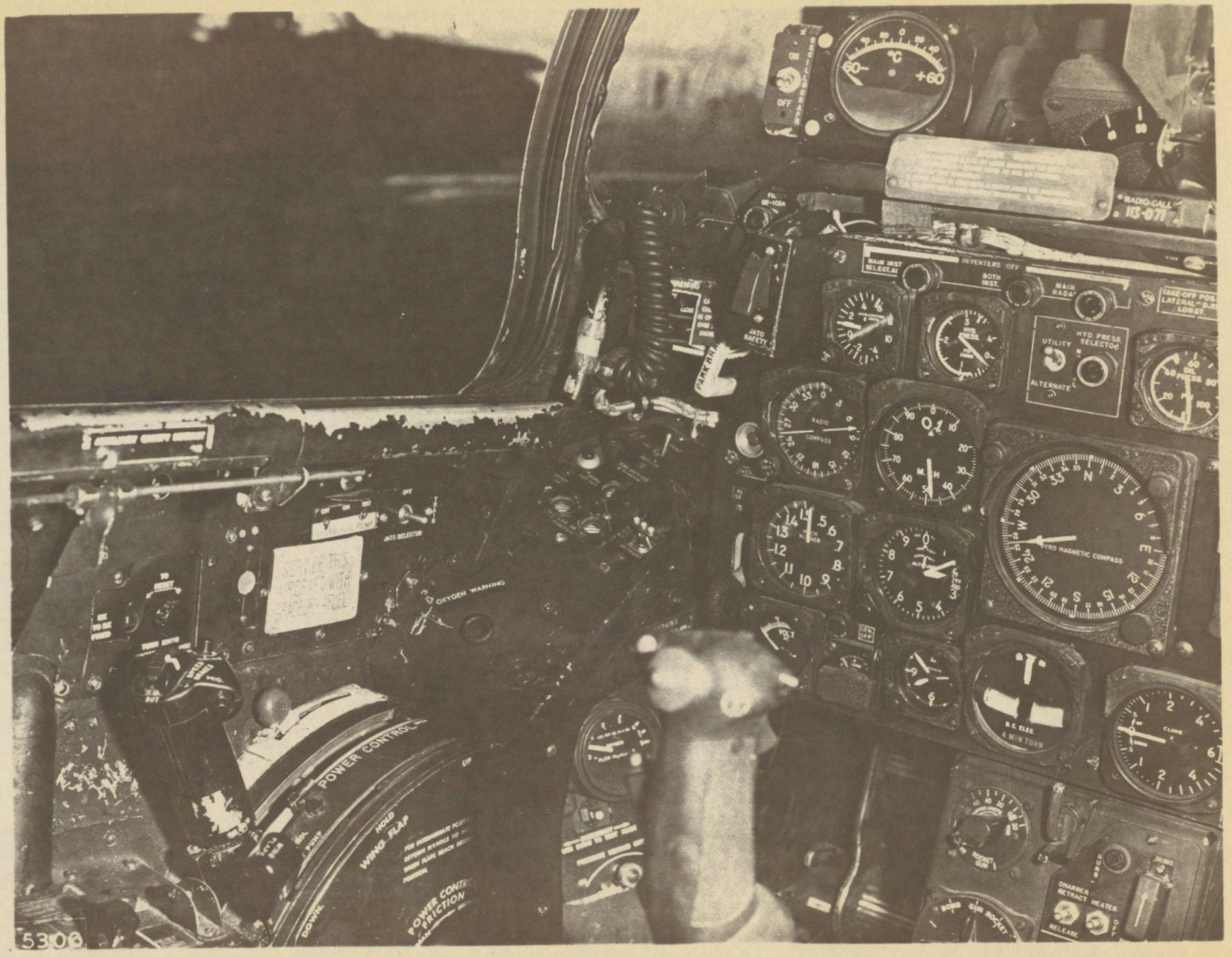
ATO COMPARTMENT LOOKING AFT



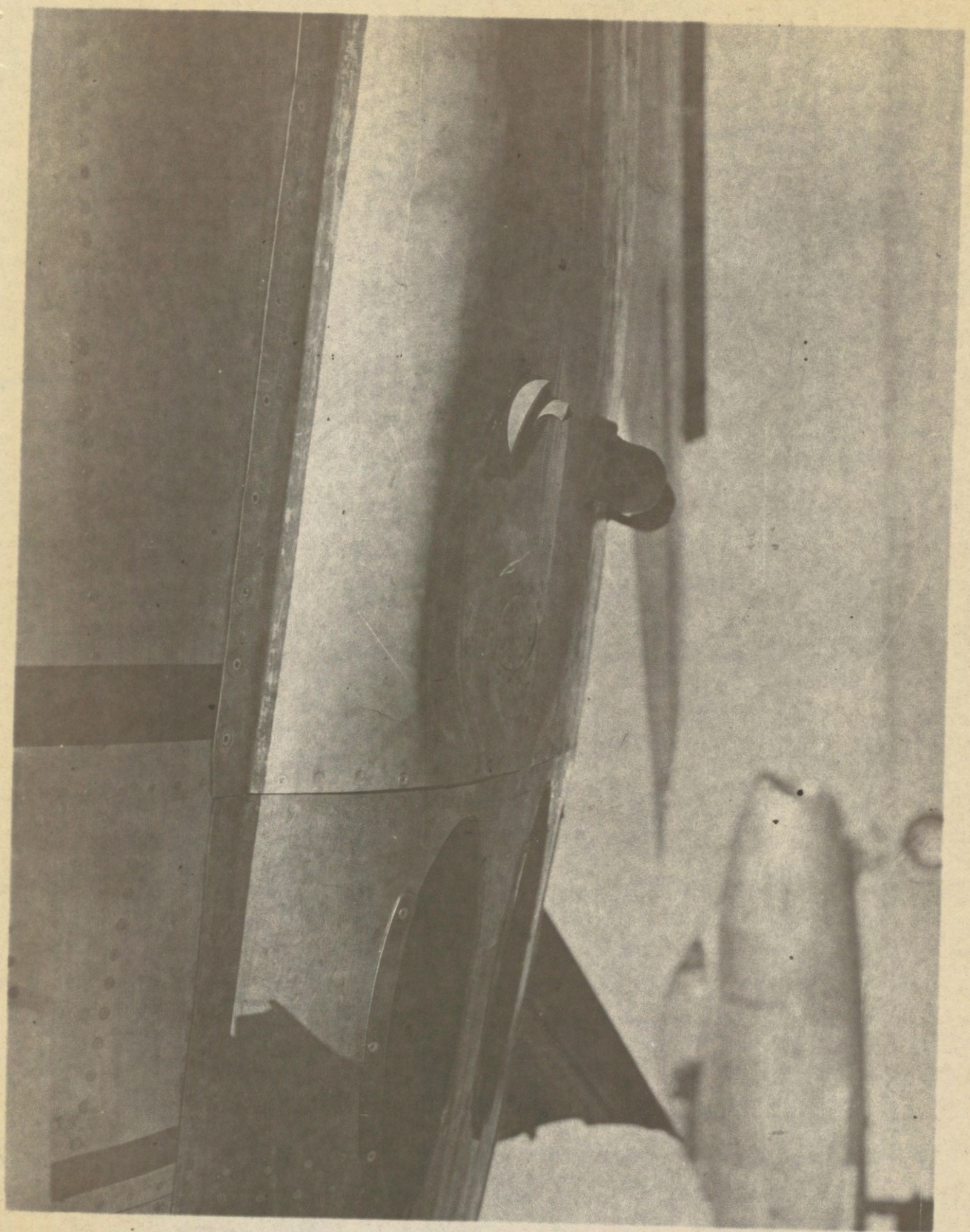
ATO COMPARTMENT LOOKING FORWARD



ATO ATTACHMENT FITTINGS



ATO CONTROLS



EFFECTS OF ATO UNIT MALFUNCTION

APPENDIX III

Original Data

1. In this appendix are presented all of the original test data obtained during these flight tests corrected for instrument error only. These data are preceeded by a flight log of these tests.

FLIGHT LOG

Flight No.	Date	Flt. Time	Test Accomplished
1	17 July	1 + 15	Climb & Level Flight Data Clean Airplane
2	18 July	1 + 15	Climb & Level Flight Data Clean Airplane
3	6 Aug	1 + 00	A.T.O. Compartment Temp. Survey
4	8 Aug	1 + 05	A.T.O. Compartment Temp. Survey
5	15 Aug	1 + 15	A.T.O. Compartment Temp. Survey
6	15 Aug	1 + 10	A.T.O. Compartment Temp. Survey
7	20 Aug	0 + 50	Skin Temperature Survey
8	21 Aug	1 + 05	Skin Temperature Survey
9	21 Aug	1 + 10	Climb, ATO Firing, & Level Flt. Data Pod On
10	22 Aug	0 + 50	Climb, ATO Firing, & Level Flt. Data Pod On
11	22 Aug	0 + 50	Climb, ATO Firing, Evaluation
12	23 Aug	0 + 50	Climb, ATO Firing, Airspeed Calibration
13	25 Aug	1 + 10	Climb, Level Flight with 120 Gal Tanks
14	3 Sept	1 + 55	Climb, Level Flight with 120 Gal. Tanks
15	6 Sept	1 + 55	T.O., Climb, Level Flt. with 200 Gal. Tanks
16	6 Sept	2 + 15	T.O. Climb Level Flt. with 200 Gal. Tanks
17	8 Sept	1 + 15	T.O. Climb, Level Flt. with 200 Gal. Tanks
18	12 Sept	1 + 20	Airspeed Calibration
19	12 Sept	1 + 15	Airspeed Calibration

APPENDIX III

FLIGHT DATA
F-86F, USAF No. 51-13071

Flight No: 1
Type Test: Climb Performance
Configuration: Clean Airplane
Date: 17 July 1952

Altitude-Ft	T-Mins	IAS*MPH	OAT - °C	RPM	EGT - °C	Gross Wt.-Lbs
10870	0	391	21	7900	655	14260
21090	.79	378	18	7850	655	14210
24050	1.63	363	-	7830	655	-
27020	-	348	-	7830	655	-
29940	-	336	-	7840	655	-
32920	-	331	-10	7860	655	14020
35750	5.72	291	-	7860	650	-
38690	7.33	286	-26	7860	650	-
41700	9.57	274	-31	7820	650	13850
44840	12.33	257	-37	7840	660	13770
47000	15.38	230	-40	7860	670	13690

REMARKS: Pilot - Major R. L. Stephens
The A/C appears to climb slightly better than F-86E Airplanes with comparable handling qualities.
Flight Time - 1 + 15

Flight No: 2
Type Test: Climb Performance
Configuration: Clean Airplane
Date: 18 July 1952

Altitude-Ft	T-Mins	IAS-MPH	OAT - °C	RPM	EGT - °C	Gross Wt.-Lbs
5990	0	451	45	7880	690	14460
9020	.49	434	38	7900	690	14420
12030	1.02	418	32	7900	690	14370
15050	1.75	409	30	7880	690	14280
18070	2.58	391	26	7880	685	14250
21090	3.37	377	17	7860	680	14200
24050	4.27	362	11	7840	665	14150
27020	5.08	348	3	7840	655	14100
29940	5.98	337	-3	7840	655	14050
32860	6.99	320	-10	7830	650	14020
35750	8.46	306	-18	7820	650	13960
38690	10.33	291	-24	7820	655	13890
41700	12.44	278	-29	7850	665	13820
44840	15.16	265	-34	7870	675	13750
47540	20.03	249	-38	7895	685	13620

REMARKS: Pilot - Major R. L. Stephens
Flight Time - 1 + 15 hrs.

FLIGHT DATA
F-86F, USAF No. 51-13071

Flight No: 9 — Configuration: A.T.O. Pod Installed
Type Test: Climb Performance — Date: 21 August 1952

Altitude-Ft	T-Min	IAS-MPH	OAT-°C	RPM	EGT - °C	Gross Wt-Lbs
5990	0	463	46	7900	700	15200
9020	.73	445	42	7900	690	15140
15050	2.08	410	28	7890	680	15040
18070	2.78	392	22	7890	680	14990
21080	3.60	378	15	7880	675	14940
24050	4.62	363	10	7870	670	14880
27020	5.65	348	3	7880	665	14830
29940	6.77	335	-4	7870	655	14770
31890	7.75	327	-9	7850	650	14720
33840	8.62	317	-14	7850	650	14700
35750	9.75	305	-18	7850	650	14650
37710	10.98	297	-26	7860	650	14610
39960	12.22	287	-26	7880	660	14570

REMARKS: Pilot: Major R. L. Stephens
Flight Time 1 + 10 hours
C.G. location appears too far aft.

Flight No: 10 — Configuration: A.T.O. Pod Installed
Type Test: Climb Performance — Date: 22 August 1952

Altitude-Ft	T-Min	IAS-MPH	OAT-°C	RPM	EGT - °C	Gross Wt-Lbs
9020	0	435	40	7940	700	15050
12030	.65	423	36	7940	695	15000
15050	1.25	407	28	7940	695	14950
18070	2.05	----	24	7890	675	14890
21090	2.58	377	17	7880	670	14840
24050	3.58	363	10	7870	660	14780
27020	4.58	348	3	7860	655	14730
29940	6.13	337	-4	7860	650	14680
31900	7.00	327	-9	7860	650	14640
33830	7.93	316	-14	7850	650	14600
35750	9.07	306	-18	7840	650	14560
37710	10.33	296	-23	7860	650	14510
39670	11.83	286	-27	7870	655	14460
			Sequential A.T.O. Firings			
39670	0	319	-21	7860	655	14190
41540	.72	315	-23	7890	660	13900

REMARKS: Pilot: Major R. L. Stephens
Flight Time 0 + 50 hours
A.T.O. fired sequentially greatly improves climb performance and c.g. position.

FLIGHT DATA
F-86F, USAF No. 51-13071

Flight No: 14
Type Test: Climb Performance
Date: 3 August 1952
Configuration: A.T.O. Pod & 120 Gal External Tanks

Altitude-Ft	T-Min	IAS-MPH	OAT-°C	RPM	EGT - °C	Gross Wt - Lbs
5990	0	396	41	7900	700	16380
9020	.78	386	37	7890	695	16290
12030	1.70	371	29	7880	690	16230
15050	2.62	361	22	7870	680	16160
18070	3.73	349	16	7860	675	16090
21090	4.73	336	11	7860	675	16020
24050	6.03	329	5	7850	670	15960
27020	7.87	322	-2	7850	660	15870
29940	9.77	309	-10	7840	650	15780
31900	10.82	294	-14	7830	650	15730
33830	12.02	280	-20	7830	650	15690
35750	13.58	269	-25	7830	650	15640
37700	15.50	253	-30	7860	655	15570
39680	18.65	245	-35	7869	665	15480
41700	23.25	230	-39	7880	675	15350

REMARKS: Pilot: Major R. L. Stephens
Flight Time - 1 + 55 hours

Flight No: 15
Type Test: Climb Performance
Date: 6 September 1952
Configuration: A.T.O. Pod & 200 Gal External Tanks

Altitude-Ft	T-Min	IAS-MPH	OAT-°C	RPM	EGT - °C	Gross Wt - Lbs
2980	-	-	-	7900	700	---
5990	0	407	41	7900	700	17550
9020	.88	395	35	7890	695	17510
12030	1.83	385	27	7880	685	17460
15050	2.83	373	20	7870	675	17410
18070	4.02	360	13	7860	675	17370
21080	5.35	348	7	7850	675	17320
24050	6.68	336	1	7840	670	17270
27020	8.57	314	-6	7860	660	17220
29940	10.23	303	-13	7860	655	17170
31900	12.00	295	-16	7850	650	17110
33840	14.02	282	-21	7840	650	17060
35750	16.50	272	-26	7840	650	17000
37710	19.42	265	-31	7850	655	16950
38690	22.12	251	-33	7880	665	16880
39670	25.48	248	-34	7880	670	16820
41690	-	233	-	-		

REMARKS: Pilot: Major R. L. Stephens
Flight Time: 1 + 55 hours

FLIGHT DATA
F-86F, USAF No. 51-13071

Flight No: 16
Type Test: Climb Performance
Date: 6 September 1952
Configuration: A.T.O. Pod & 200 Gal. External Tanks

Altitude-Ft	T-Mins	IAS-MPH	OAT-°C	RPM	EGT - °C	Gross Wt.-Lbs
5990	0	393	41	7870	695	17,730
9020	.95	384	34	7880	690	17,670
12030	1.85	370	27	7880	680	17,590
15050	2.85	358	20	7860	675	17,530
18070	4.07	346	12	7860	675	17,450
21090	5.40	336	7	7850	670	17,380
24050	6.77	314	1	7860	670	17,290
27020	8.68	300	-5	7860	650	17,200
29940	10.95	291	-11	7850	650	17,100
31900	12.68	284	-16	7840	650	17,030
33835	14.57	272	-20	7840	645	16,950
35750	17.43	266	-26	7840	645	16,860
37710	20.17	251	-30	7850	650	16,750
38690	21.85	248	-32	7870	655	16,650
39675	26.60	245	-34	7880	660	16,550

REMARKS: Pilot: Major R. L. Stephens
Flight Time: 2 + 15 hours

FLIGHT DATA
F-86F, USAF No. 51-13071

Flight No: 1 Date: 17 July 1952
Type Test: Level Flight Power Required Configuration: Clean-No Tanks, No ATO Pod

Altitude-Ft	IAS-MPH	OAT - °C	RPM	EGT - °C	Gross Wt-Lbs
34750	361	-6.5	7890	650	13460
34980	352.5	-7.5	7510	555	13320
35260	327	-11.5	7010	460	13180
35370	260	-23.5	6510	350	13100
35790	221	-31.0	6710	390	12900
35890	182	-35.0	6810	395	12780
36090	161	-38.0	6860	445	12690

REMARKS: Pilot: Major R. L. Stephens
Flight Test: 1 + 15 hours
Ground Block Alt: Take-off 2385'
Landing 2445'
Outside Air Temp: TO 42.5° Lng. 36°C

Flight No: 2 Date: 18 July 1952
Type Test: Level Flight Power Required Configuration: Clean-No Tanks, No ATO Pod

Altitude-Ft	IAS-MPH	OAT - °C	RPM	EGT - °C	Gross Wt-Lbs
34890	361.5	-9	7870	645	13410
35170	351	-10.5	7510	565	13250
35630	326	-14	7010	455	13050
35710	268.5	-26	6515	350	12990
35820	241	-30	6590	365	12890
35890	211	-33.5	6615	380	12780
36100	180	-37.5	6690	395	12680

REMARKS: Pilot: Major R. L. Stephens
Flight Time: 1 + 15 hours
Ground Block Alt: TO 2320 Lng. 2345
Outside Air Temp: TO 23.5°C Lng. 27°C

Flight No: 9 Configuration: ATO Pod On-Bottles Empty
Type Test: Level Flight Power Required

Altitude-Ft	IAS-MPH	OAT - °C	RPM	EGT - °C	Gross Wt-Lbs
33850	366	-5	7900	660	13760
34200	353.5	-8.5	7510	560	13520
34500	338	-11	7160	480	13360
34800	300	-18.5	6810	415	13220
35300	273	-22.5	6610	375	13130

REMARKS: Pilot: Major R. L. Stephens

FLIGHT DATA
F-86F, USAF No. 51-13071

Flight No: 10 — Date: 21 August 1952
Type Test: Level Flight Power Required — Configuration: ATO Pod on-Bottles Empty

Altitude-Ft	IAS-MPH	OAT - °C	RPM	EGT - °C	Gross Wt-Lbs
33950	366	-6	7900	660	13690
34300	362	-7.5	7800	630	13510
34700	351	-9	7510	560	13370
35000	317	-14	7010	450	13210

REMARKS: Pilot: Major R. L. Stephens — Ground Block Alt: TO 2240' Lng: 2280'
Flight Time: 1 + 10 hours — Outside Air Temp: TO 36°C Lng: 34°C

Flight No: 13 — Date: 25 August 1952
Type Test: Level Flight Power Required — Configuration: 120 Gal Aluminum Tanks - ATO Pod On, Empty

Altitude-Ft	IAS -MPH	OAT - °C	RPM	EGT - °C	Gross Wt-Lbs
33650	351	-7	7910	660	13740
34000	347	-8.5	7800	625	13490
34300	339	-10	7600	575	13290
34600	325	-12	7420	530	13140
34800	305	-15.5	7210	500	13030
35050	282	-19.5	7010	460	12900

REMARKS: Pilot: Major R. L. Stephens — Ground Block Alt: TO 2185 Lng. 2220
Flight Time: 1 + 10 hours — Outside Air Temp: TO 28°C Lng. 30°C

Flight No: 14 — Date: 3 September 1952
Type Test: Level Flight Power Required — Configuration: 120 Gal Aluminum Tanks - ATO pod On, Bottles Empty

Altitude-Ft	IAS-MPH	OAT - °C	RPM	EGT - °C	GRoss Wt-Lbs
32000	364.5	-4	7920	665	15000
32300	358	-6.5	7800	630	14740
32550	346	-9	7600	580	14540
32960	332	-11	7420	535	14310
33250	314.5	-14.5	7220	505	14090
33550	290	-19	7010	455	13860
33950	260	-23	6810	425	13640
34700	180	-35	6890	390	13280

REMARKS: Pilot: Major R. L. Stephens — Ground Block Alt: TO 2210 Lng. 2260
Flight Time: 1 + 55 hours — Outside Air Temp: TO 28.5°C Lng. 34.5°C

FLIGHT DATA
F-86F, USAF No. 51-13071

Flight No: 15
Type Test: Level Flight Power Required
Date: 6 September 1952
Configuration: 200 Gal. Aluminum Tanks - ATO Pod On-Full

Altitude-Ft	IAS-MPH	OAT - °C	RPM	EGT - °C	Gross Wt-Lbs
30950	367.5	-3	8780	675	15970
31300	369	-5	8660	645	15730
31600	348	-7	8440	595	15430
31850	334	-10	8245	550	15220
32200	313	-14	8000	500	14970
32500	280.5	-18.5	7810	460	14780
32600	265.5	-21	7600	425	14610
33150	200	-30	7660	385	14330

REMARKS: Pilot: Major R. L. Stephens
Flight Time: 1 + 55 hours
Ground Block Alt: TO 2200 Lng. 2215
Outside Air Temp: TO 31°C Lng. 33°C

Flight No. 16
Type Test: Level Flight Power Required
Date: 6 September 1952
Configuration: 200 Gal. Aluminum Tanks - ATO Pod On-Full

Altitude-Ft	IAS-MPH	OAT - °C	RPM	EGT - °C	Gross Wt - Lbs
30650	370	0	7900	665	16160
31000	359	-3	7710	625	15990
31200	345.5	-6	7510	570	15780
31400	329	-10	7320	525	15630
31600	301.5	-14.5	7110	480	15430
31850	261	-20	6910	405	15230
32650	200	-29.5	6860	425	14680
32950	191	-31	7050	475	14410
33350	178.5	-33	7320	525	14110

REMARKS: Pilot: Major R. L. Stephens
Flight Time: 2 + 15 hours
Ground Block Alt: TO 2235 Lng. 2290
Outside Air Temp: TO 36.5°C Lng. 36°C

Flight No: 17
Type Test: Level Flight Power Required
Date: 8 September 1952
Configuration: 200 Gal Aluminum Tanks - ATO Pod On.-Empty

Altitude-Ft	IAS-MPH	OAT - °C	RPM	EGT - °C	Gross Wt-Lbs
33900	342.5	-10.5	8760	645	13590
34100	308.0	-17.5	8110	505	13460
34250	284	-22.5	7920	460	13360
34350	250	-27.5	7680	425	13280
34600	221.5	-32.0	7880	430	13160

REMARKS: Pilot: Major R. L. Stevens
Flight Time: 1 + 15 hours
Ground Block Alt: TO 2280' Lng. 2330'
Outside Air TempL To 34°C Lng. 34.5°

FLIGHT DATA
F-86F, USAF No. 51-13071

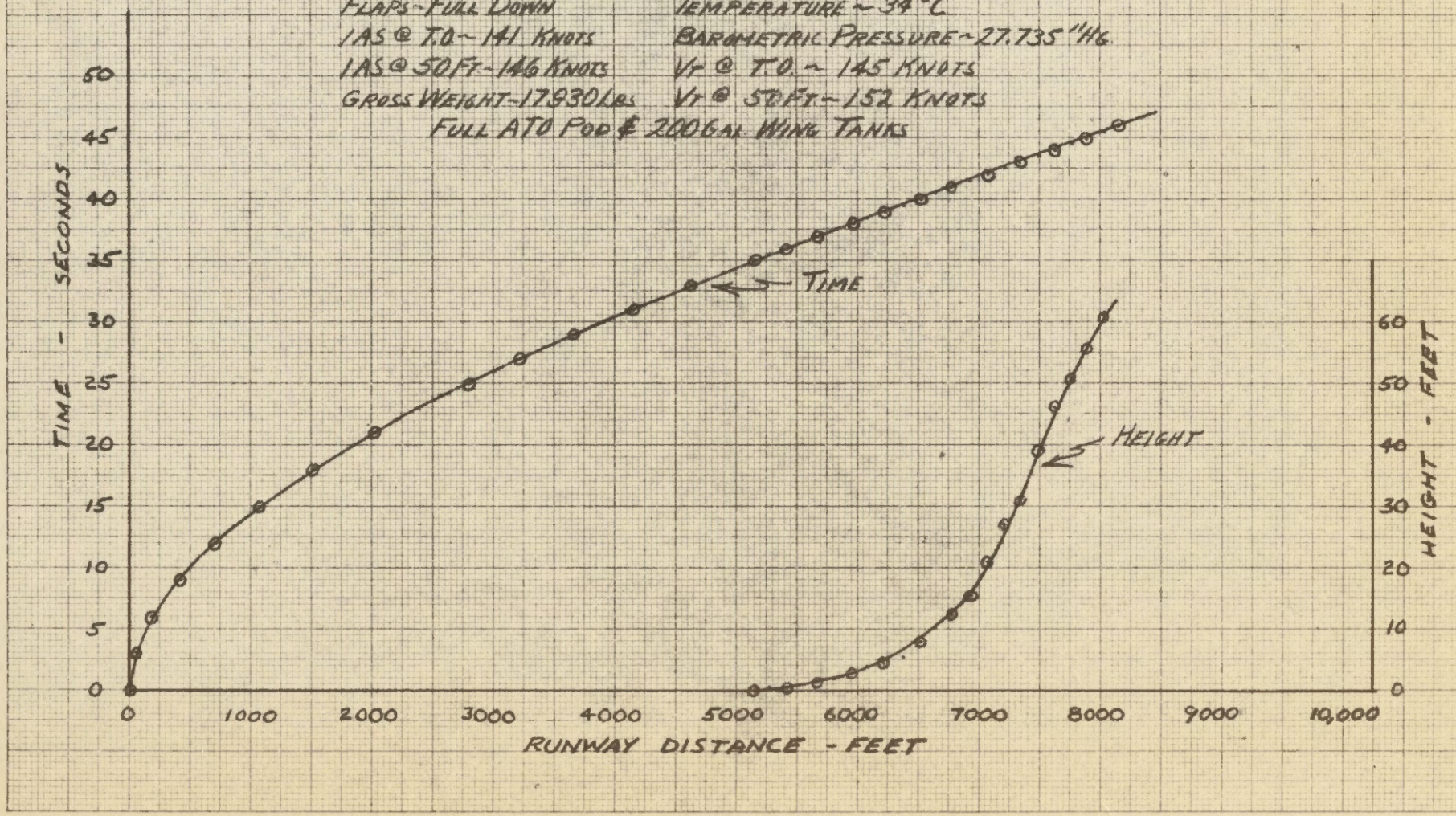
Type Test: A.T.O. Firing Tests
Configuration: A.T.O. Pod Installed

Altitude-Ft.	T-Mins	IAS-MPH	OAT-°C	RPM	EGT - °C	Gross Wt.-Lbs
39680	.24	314	-20	7850	680	
Simultaneous Firing		341	-15	7850	680	13500
39680	.24	315	-21	7880	690	
Simultaneous Firing		340	-18	7880	690	13250
39680	.60	315	-20	7860	680	
Sequenced Firing		331	-17	7860	680	13600
		A.T.O. CLIMBS				
39670	0	319	-21	7860	655	14190
41540	.70	315	-23	7890	660	13900
39680	0	315	-21	7880	655	14160
41700	.26	310	-25	7880	665	13890

REMARKS: During the A.T.O. Climbs the airspeed increased approximately 5 mph immediately after firing before the airplane could attain climb attitude without encountering buffet.

TAKE-OFF No 1
F-86F USAF 51-13071

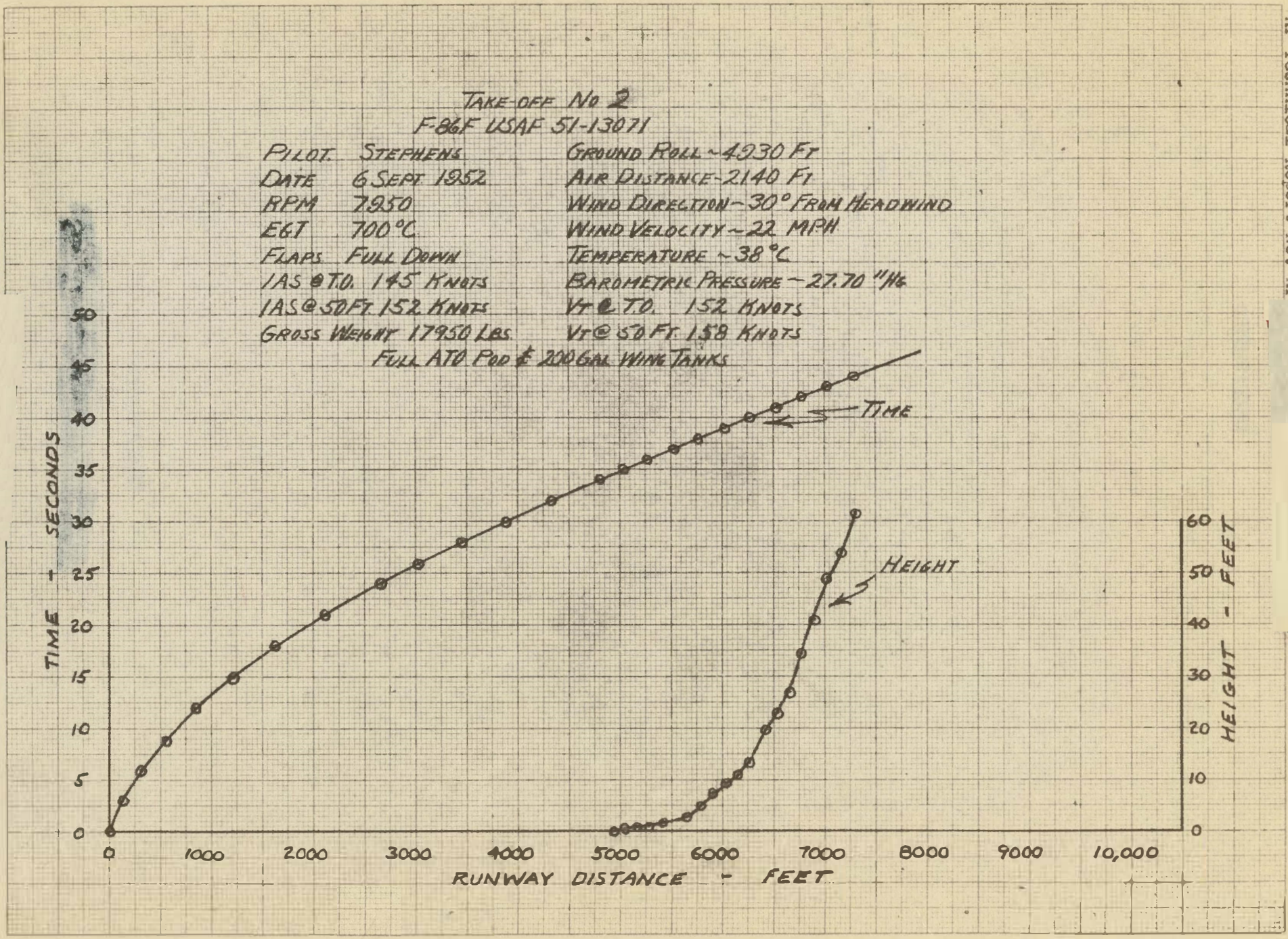
PILOT - STEPHENS
DATE - 6 SEPT 1952
RPM - 7950
EGT - 695 °C
FLAPS - FULL DOWN
IAS @ T.O. - 141 KNOTS
IAS @ 50 FT - 146 KNOTS
GROSS WEIGHT - 17,930 Lbs
GROUND ROLL - 5150 FT
AIR DISTANCE - 2600 FT
WIND DIRECTION - 40° FROM TAILWIND
WIND VELOCITY - 4 MPH
TEMPERATURE - 34 °C
BAROMETRIC PRESSURE - 27.735 "Hg
Vr @ T.O. - 145 KNOTS
Vr @ 50 FT - 152 KNOTS
FULL ATO Pod & 200 Gal WING TANKS



TAKE-OFF No 2
F-86F USAF 51-13071

PILOT STEPHENS	GROUND ROLL ~ 4930 FT
DATE 6 SEPT 1952	AIR DISTANCE - 2140 FT
RPM 7950	WIND DIRECTION ~ 30° FROM HEADWIND
EGT 700°C	WIND VELOCITY ~ 22 MPH
FLAPS FULL DOWN	TEMPERATURE ~ 38°C
IAS @ T.O. 145 KNOTS	BAROMETRIC PRESSURE ~ 27.70 "Hg
IAS @ 50 FT. 152 KNOTS	Vr @ T.O. 152 KNOTS
GROSS WEIGHT 17950 LBS.	Vr @ 50 FT. 158 KNOTS

FULL ATO POD & 200 GAL WING TANKS



DISTRIBUTION LIST

	No. of Cys
Hq, USAF; Washington 25, D.C.	
Attn: Deputy Chief of Staff, Development; Director of Requirements	1
Attn: Asst for Atomic Energy; Deputy Chief of Staff, Operations	1
Attn: Director of Manpower and Organization	1
Attn: Asst for Programming; Deputy Chief of Staff, Operations	1
Attn: Directorate of Intelligence; Deputy Chief of Staff, Operations: Attn: AFOIN-C/DD	1
Attn: AFOIN-E	
Attn: AFOIN-V/TC	1
Attn: Directorate of Operations; Deputy Chief of Staff, Operations	4
Attn: Directorate of Maintenance-Engineering, DCS/M	1
Attn: Directorate of Procurement and Production Engineering; Production Engineering Division	1
Attn: Directorate of Maintenance Engineering	2
Attn: Aircraft Division; Deputy Chief of Staff, Development	1
Attn: AFMPE-EN-1	1
Hq, AMC, Wright-Patterson AFB, Dayton, Ohio	
Attn: MCE Inspector General's Office	1
Attn: MCF Public Information Office	1
Attn: MCLAFS Deputy Insp Gen for Tech Insp & Flt Safety Research Liaison Office	1
Attn: MCMM Maintenance Division Supply & Maint. Directorate	2
Attn: MCMMXOG Deputy for Operations, Maint. Div.	1
Attn: MCMS Supply Div., Supply Maint. & Services Directorate	1
Attn: MXMZ Program Monitoring, Office Supply, M & S Directorate	1
Attn: MCPBXA Administration Office, Industrial Resources Division	1
Attn: MCPLXA Aircraft Section, Quality Control Division	1
Attn: MCPPXO Plans & Operations, Procurement Division	1
Attn: MCPPAA Aircraft Section, Procurement Division	1
Attn: MCPPAAB Operations Office, Acft Sec., Proc. Div.	1
Attn: MCPPAA3 Bombardment Br., Acft Sec., Procurement Div.	1
Attn: MCPPAA4 Fighter Branch, Acft Sec., Procurement Div.	1
Attn: MCPPAA6 Trng, Transport & Special Acft Branch, Acft Sec., Procurement Division	1
Attn: MCPPAE Aeronautical Equip. Sec., Procurement Div.	1
Attn: MCPPAE2 Access. Br., Aero Equip. Sec., Proc. Div.	2
Attn: MCPPMG Materiel Section, Procurement Division	1
Attn: MCPPMG2 Development Br., Materiel Sec., Proc. Div.	2
CG, ARDC, Box 1395, Baltimore 3, Maryland	
Attn: Deputy for Development	1

DISTRIBUTION LIST
(Continued)

	No. of Cys
CG, WADC, Wright-Patterson AFB, Dayton, Ohio	
Attn: WCAPD	21
Attn: WCSFP, Performance Analysis Sec., Weapons Systems Div	3
Bureau of Aeronautics General Representative, Central District, Wright-Patterson AFB, Dayton, Ohio	4
Director, Air University Library, Maxwell AFB, Alabama	1
Commandant, USAF Institute of Technology, WPAFB, Dayton, Ohio	1
CG, Hq Strategic Air Command: Attn: Operations Analysis; Offutt AFB; Omaha, Nebraska	1
ASTIA, Document Service Center; U.B. Building: 4th and Main St. Dayton 2, Ohio	6
CG, SBAMC; Deputy Inspector General for Technical Inspection and Flight Safety Research; Norton AFB, California	3
CO, Air Technical Intelligance Center; Attn: AFOIN-ATISD-1B; Wright-Patterson AFB, Dayton, Ohio	1
CO, Hq 4925th Test Group (Atomic); Kirtland AFB, New Mexico	1
National Advisory Committee for Aeronautics; Attn: Office of Aeronautical Intelligance; 1724 F Street N.W.; Washington 25, D.C.	5
NACA Liaison Office; Wright-Patterson AFB; Attn: MCLANA; Dayton, Ohio	1
NACA Attn: Mr. Walter C. Williams, High Speed Flight Research Station, P.O. Box 273, Edwards, California	1
CG, Operations Analysis, Hq Strategic Air Command, Offutt AFB; Omaha, Nebraska	2
Hqs, Alaskan Air Command, APO #942, c/o Postmaster, Seattle, Wash	1
AF Engineering Field Representative at the NACA, Ames Aeronautical Laboratory, Moffett Field, California	1
CG, Air Proving Ground Command, Eglin AFB, Florida; Attn; Classified Technical Data Branch, D/01	1
Hq, Military Air Transport Service, Andrews AFB, Washington, 25, D.C.; Attn: Maintenance-Engineering Division, Technical Publications	1
Office, Chief of Ordnance, Ordnance Research and Development Division, Washington 25, D.C.; Attn: ORDTB	3
Hq, AFFTC	
Attn: FTDTF Performance Engineering Branch	1
Attn: FTDTP Robert C. Jackson, Project Engineer	2
Attn: FTDA Flight Test & Development Division	5