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CF-105

MONTHLY PERFORMANCE REPORT

ANALYZED

NO. 8

May, 1956

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by (Name): J.M.D. HENRIE

(Dept.): DND COORDINATE, ACCESS TO INFORMATION

Date: Aug 4, 1992

Renee Auger
Signature

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

PERFORMANCE

AIRCRAFT: CF-105

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May 1956

CF-105 MONTHLY PERFORMANCE REPORT - 8

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PERFORMANCE

Introduction:

This is the eighth of a series of monthly performance reports for internal usage, to be issued from the Aerodynamics Department.

Only the performance with Orenda P.S. 13 engines has been revised, based on new engine data. The performance with Pratt and Whitney J-75 engines, given in monthly report 6 is included again in this report for completeness.

The pertinent changes are noted in their appropriate sections.

Successive reports will present the latest data, with the alterations from the previous report noted. The report is divided into three major sections.

1. CF-105 Performance
2. CF-105 Drag
3. Propulsion.

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PERFORMANCE

1. CF-105 PERFORMANCE

The performance in this issue is sub-divided into two parts:

1A. CF-105 Performance with Pratt and Whittney JT4A-25 Engines

1B. CF-105 Performance with Orenda PS 13 Engines

March, 1956.

1A: CF-105 PERFORMANCE WITH PRATT AND WHITNEY (J.75) JT4A-25 ENGINES

(C.G. = 29.5% M.A.C.)

The following CF-105 - (J-75) JT4A-25 performance estimate is based on the wind tunnel configuration designated $B_2\ V_1\ W_1\ E_{10}\ N_5\ D_{8-4}$ (except that the nose cone angle has been reduced to 30°). The particular feature of this configuration is the extended, notched and cambered leading edge of the wing.

The drag of this configuration has been summarized (extract P/Perf/112) and is presented in Section 2 of the previous monthly report. However, this has been revised slightly because of shifting the c.g. from 29% MAC to 29.5% MAC. This is in accordance with the planned fuel sequencing to give a c.g. position of 31% MAC on firing the Sparrow II missiles.

The CF-105 operational weight empty has increased approximately 1,400 lbs. since the previous report due to Sparrow II missile installation in place of Falcons.

No revision has been made to the installed engine data other than the extension required to revise the mission profiles.

The overall effect is one of only slightly degraded performance.

LOADING AND PERFORMANCE - 6

March 1956.

Performance Under N.A.C.A. Standard Atmospheric Conditions

To R.C.A.F. Specification AIR 7-4

(With 2 J-75 Engines)

WEIGHT:

Take-Off Weight with 15,673 Lb. Fuel (78.9% Max.)	Lb.	60,927
Operational Weight Empty	Lb.	45,254
Combat Weight (1/2 Fuel)	Lb.	53,090
Landing Weight (With Reserve Fuel + Missiles)	Lb.	45,224
Wing Loading at Normal Take-Off Weight	Lb./sq /Ft.	48.5
Power Loading at Normal Take-Off Weight	Lb./Lb. Thrust	1.64

SPEED

True Air Speed in Level Flight
At Sea Level at Combat Weight

Maximum Thrust	Kts.	V 800
Military Thrust	Kts.	640

True Air Speed in Level Flight
At 50,000 Ft. at Combat Weight

Maximum Thrust	Kts.	1,075

CEILING

Combat Ceiling at Combat Weight, Rate of Climb = 500 F.P.M.

Maximum Thrust at 1.5 M.N.	Ft.	56,400

RATE OF CLIMB

Steady Rate of Climb at Sea Level, Combat Weight

Maximum Thrust at M.N. = .92	F.P.M.	46,500
Military Thrust at 530 Kts.	F.P.M.	15,500

Steady Rate of Climb at 50,000 Ft., Combat Weight

Maximum Thrust at M.N. = 1.5	F.P.M.	5,900

TIME TO HEIGHT

Time to 50,000 Ft. M.N. = 1.5 from Engine Start at Take-Off Weight

Maximum Thrust	Mins.	5.1

MANOEUVRABILITY

Combat Load Factor at Combat Weight
Maximum Thrust at M.N. = 1.50 at 50,000 Ft. 1.46

V Placard Speed = 720 Kts. E.A.S.

TAKE-OFF DISTANCE

Take-Off Distance over 50 Ft. Obstacle at Sea Level Take-Off Weight

Maximum Thrust	Ft.	3,500
Military Thrust	Ft.	6,400
Maximum Thrust, Hot Day	Ft.	4,900

LANDING DISTANCE

Landing Distance over 50 Ft. Obstacle at Sea Level at Combat Wt. Ft. 5,400

STALLING SPEED

True Stalling Speed in Landing Configuration at Combat Weight at Sea Level ..... Kts. 112

RANGE

Combat Radius of Action at 50,000 Ft., Climb at M.N. = .92, Cruise out at M.N. = 1.5, Combat for 5 Mins. at M.N. = 1.50, Cruise back at M.N. = .92, 15 Min. Stack at 40,000 Ft., 5 Min. Fuel Reserve on Landing

High Speed Mission with 15,673 Lb. Fuel	N.M.	200
High Speed Mission with Full Internal Fuel	N.M.	295

Combat Radius of Action at 50,000 Ft., Mission as above except climb at 530 Kts. and cruise out at M.N. = .92

Maximum Range Mission with 15,673 Lb. Fuel	N.M.	380
Maximum Range Mission with Full Internal Fuel	N.M.	545

Ferry Range Mission at Economical Cruise Speed (M = .92 and Height, including 15 Mins. Stacking at 40,000 Ft., 5 Min. Fuel Reserve on Landing

Range with Full Internal Fuel and 500 Gal. - External Tank	N.M.	1,678
Range with Full Internal Fuel	N.M.	1,444

CF 105

JY5 - JT4A-25 ENGINES

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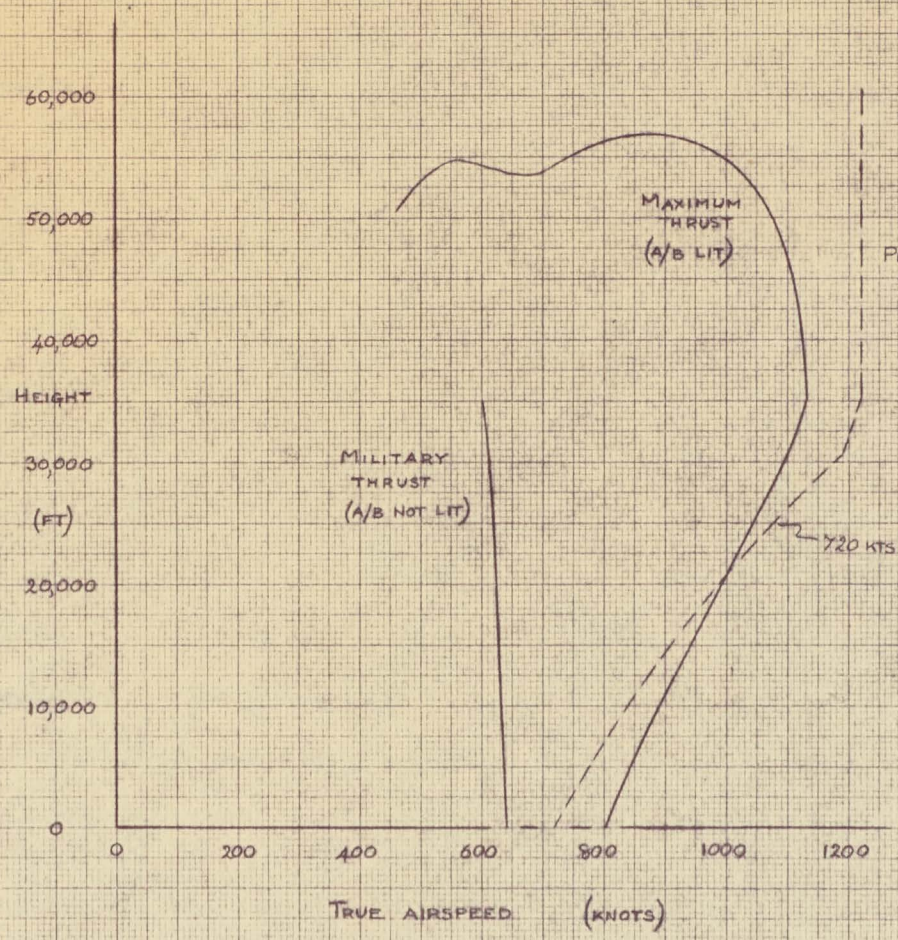
$h = 295$ WEIGHT = 53,090 LB

MAXIMUM TRUE AIRSPEED IN LEVEL FLIGHT



J. DUBBURY
MARCH 58

CF-105

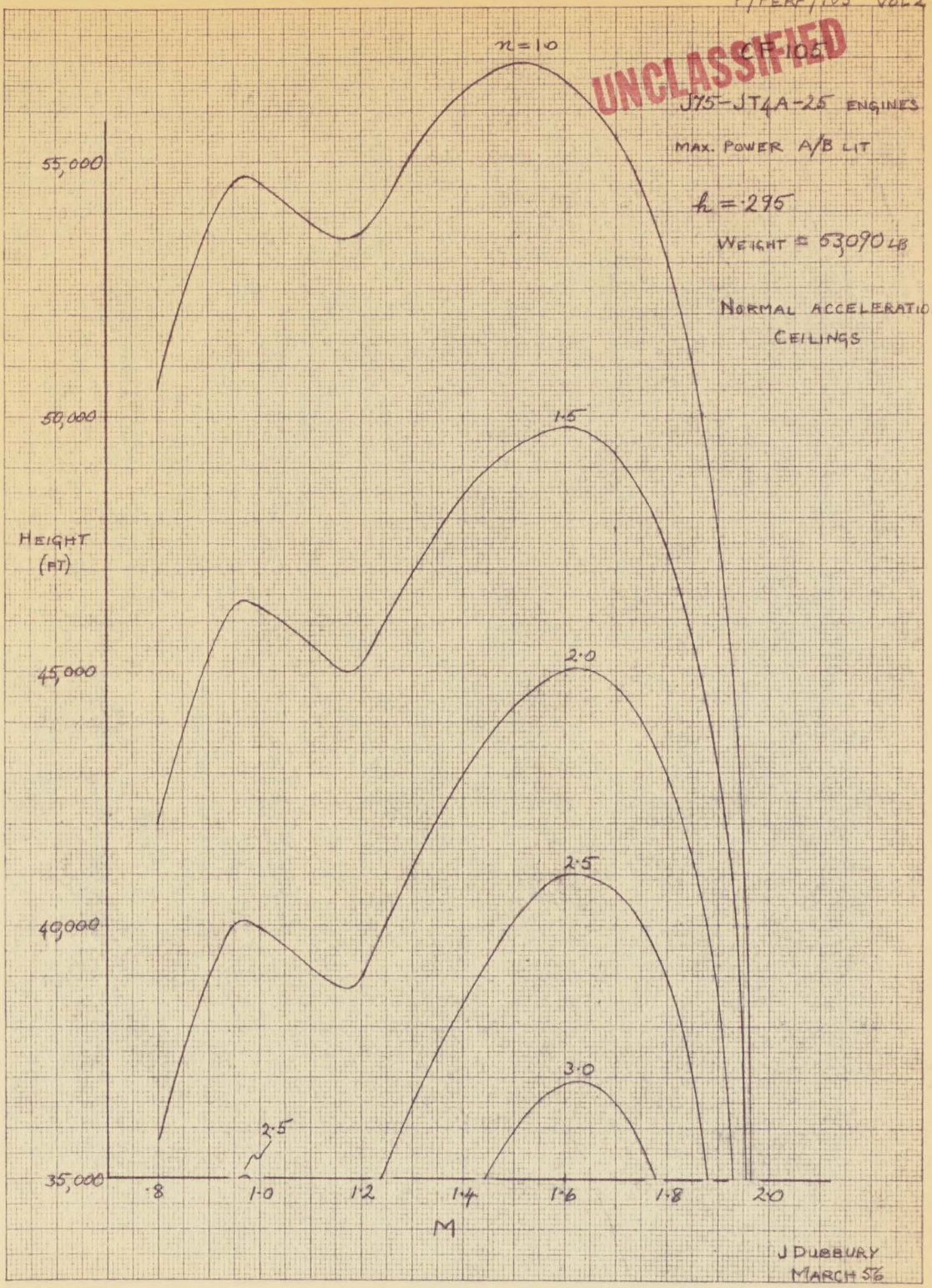
J75-JT4A-25 ENGINES

MAX. POWER A/B LIT

$h = 295$

WEIGHT = 53090 LB

NORMAL ACCELERATION CEILINGS



J DUBBURY
MARCH 56

P/PERF/105 VOL 2

CF 105

UNCLASSIFIED

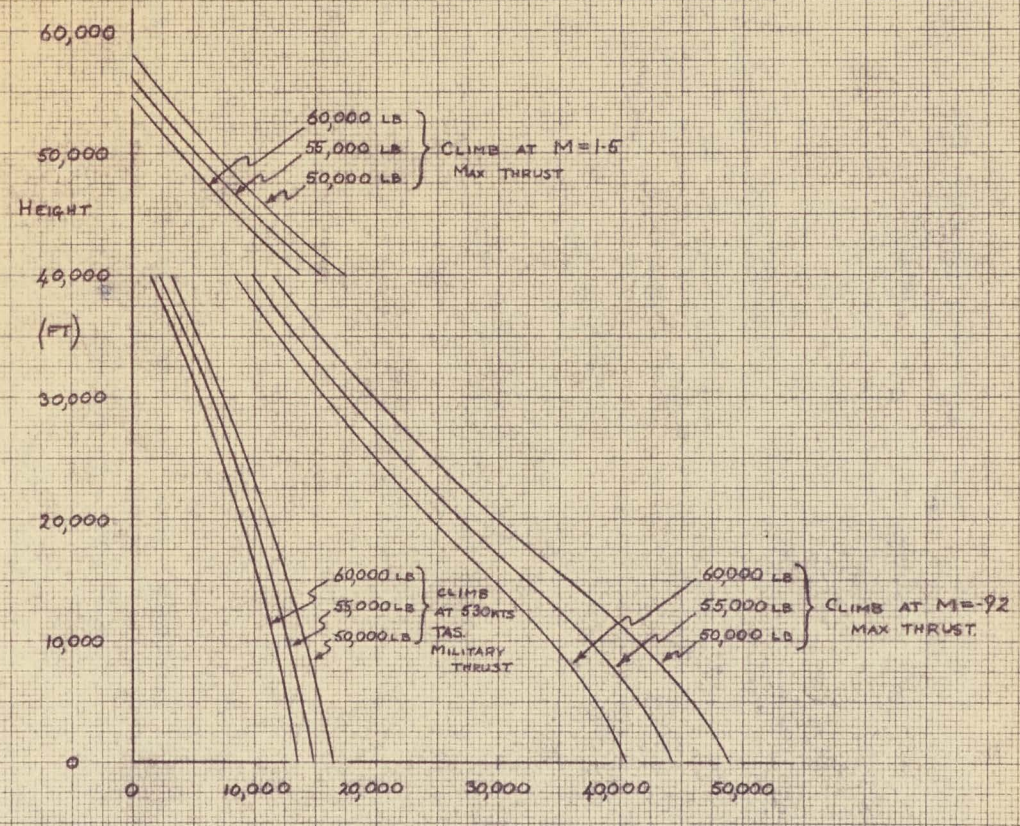
J75-JT4A-25 ENGINES

$k = .295$

STEADY STATE RATE OF CLIMB

BASED ON FORMULA

$$R/C = 60 M a \left(\frac{E-D}{W}\right) \text{ FT/MIN}$$



STEADY STATE RATE OF CLIME (FT/MIN)

MARCH 56
J. DUBBURY

May, 1956.

1B: CF-105 PERFORMANCE WITH ORENDA PS 13 ENGINES

(C.G. = 29.5% M.A.C.)

The following CF-105 - Orenda P.S. 13 performance estimate is based on the wind tunnel configuration designated B_2^V, W, E_{10} N_S D_{8-4} (except that the nose angle has been reduced to 30°) The particular feature of this configuration is the extended, notched and cambered leading edge of the wing.

The drag of this configuration has been summarized in previous monthly reports. The drag used is that given in monthly report 6 with the C.G. at 29.5% M.A.C. in accordance with the planned fuel sequencing to give a C.G. position of 31% M.A.C. on firing the Sparrow II missiles.

The increased weight of the Sparrow II pack over that of the Falcon pack is largely responsible for the 1187 lb. increment in operational weight empty since the 4th monthly report (the last CF-105 Orenda PS 13 performance issue)

The Orenda PS 13 engine data has been completely revised. See Section 3. The most significant change has been the slightly decreased thrust in altitude below 1.5 M.N. and a considerable increase in thrust at the higher Mach numbers. The specific fuel consumptions are improved approximately 10%.

The pertinent CF-105 - Orenda PS 13 performance changes are listed below:

Δ	Combat 'g' at 1.5 M.N. at 50,000 ft.	= -.11
Δ	Maximum speed at 50,000 ft.	= + 120 Kts.
Δ	Combat ceiling at 1.5 M.N.	= - 1500 ft.
Δ	Combat mission fuel (200 NM radius)	= - 957 lb.

Performance Under I.C.A.O. Standard Atmospheric Conditions May, 1956.

To R.C.A.F. Specification AIR 7-4

With Two PS 13 Engines

WEIGHT:

Take-Off Weight with 14,553 Lb. Fuel (73.3% Max)	Lb.	56,119
Operational Weight Empty	Lb.	41,566
Combat Weight (1/2 Fuel)	Lb.	48,843
Landing Weight (With Reserve Fuel + Missiles)	Lb.	43,356
Wing Loading at Normal Take-off Weight	Lb/Sq.Ft.	44.7
Power Loading at Normal Take-off Weight	Lb/Lb. Thrust	1.25

SPEED

True Air Speed in Level Flight At Sea Level at Combat Weight Maximum Thrust A/B Lit	Kts.	* 720
Maximum Thrust A/B Not Lit	Kts.	670
True Air Speed in Level Flight at 50,000 Ft. at Combat Weight Maximum Thrust A/B Lit	Kts.	1,260

CEILING

Combat Ceiling at Combat Weight, Rate of Climb = 500 F.P.M. Maximum Thrust at 1.5 MN. A/B Lit	Ft.	62,500

RATE OF CLIMB

Steady Rate of Climb at Sea Level, Combat Weight Maximum Thrust at M.N. = .92 A/B Lit	F.P.M.	61,500
Maximum Thrust at 530 Kts. A/B Not Lit	F.P.M.	23,800
Steady Rate of Climb at 50,000 Ft., Combat Weight Maximum Thrust at M.N. = 1.5 A/B Lit	F.P.M.	12,400

TIME TO HEIGHT

Time to 50,000 Ft. M.N. = 1.5 from Engine Start at Take-Off Weight Maximum Thrust A/B Lit	Mins.	3.9

MANOEUVRABILITY

Combat Load Factor at Combat Weight Maximum Thrust at M.N. = 1.50 at 50,000 Ft. A/B Lit		1.88

* Placard Speed = 720 Kts.

TAKE-OFF DISTANCE

Take-Off Distance over 50 Ft. Obstacel at Sea Level at .....
Take-Off Weight = 56,119 Lb

Maximum Thrust A/B Lit	Ft.	2,420
Maximum Thrust A/B Not Lit	Ft.	3,640
Maximum Thrust Hot Day A/B Lit	Ft.	3,000

LANDING DISTANCE

Landing Distance over 50 ft. Obstacle at Sea Level at Combat Weight Ft. 5,060

STALLING SPEED

True Stalling Speed in Landing Configuration at Combat Weight at Sea Level ..... Kts. 105.5

RANGE

Combat Radius of Action at 50,000 Ft., Climb at M.N. = .92, Cruise out at M.N. = 1.5, Combat for 5 mins. at M.N. = 1.50, Cruise Back at M.N. = .92, 15 Min. Stack at 40,000 Ft., 5 Min. Fuel Reserve on Landing

High Speed Mission with 14,553 Lb. Fuel	N.M.	200
High Speed Mission with Full Internal Fuel	N.M.	381

Combat Radius of Action at 50,000 Ft. Mission as above except Cruise Out at M.N. = .92

Maximum Range Mission with 15,396 Lb. Fuel	N.M.	300
Maximum Range Mission with Full Internal Fuel	N.M.	510

Ferry Range Mission at Economical Cruise Speed (M = .92 and Height, including 15 Mins. Stacking at 40,000 Ft., 5 Min. Fuel Reserve on Landing

Range with Full Internal Fuel and 500 Gal. - External Tank.	N.M.	1,738

CF105 MAX. LEVEL SPEED

PS-13 ENGINES

COMBAT WEIGHT

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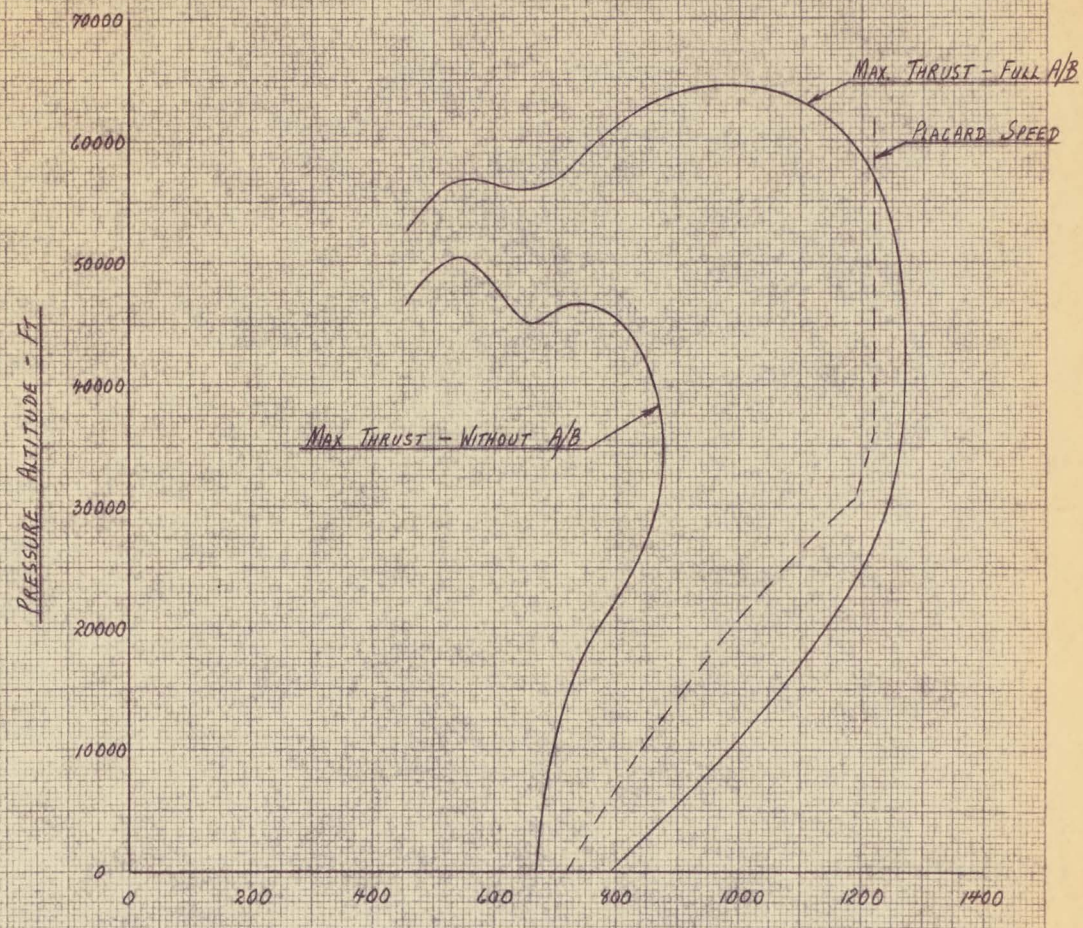


MAY 1956

CF-105

P/PERF/102 vol II

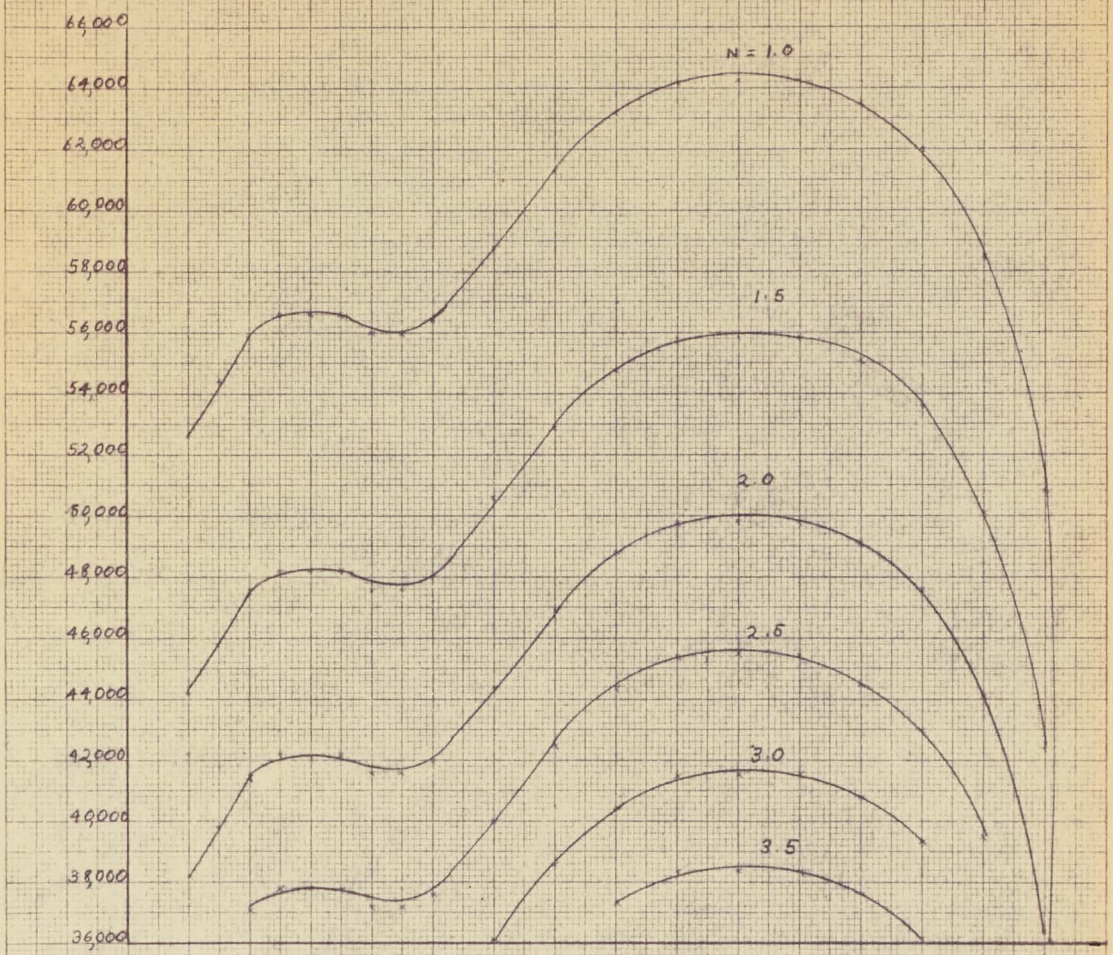
MAY/56

PS-13 ENGINES

WITH AFTERBURNERS LIT

AVAILABLE STEADY G's

COMBAT WEIGHT

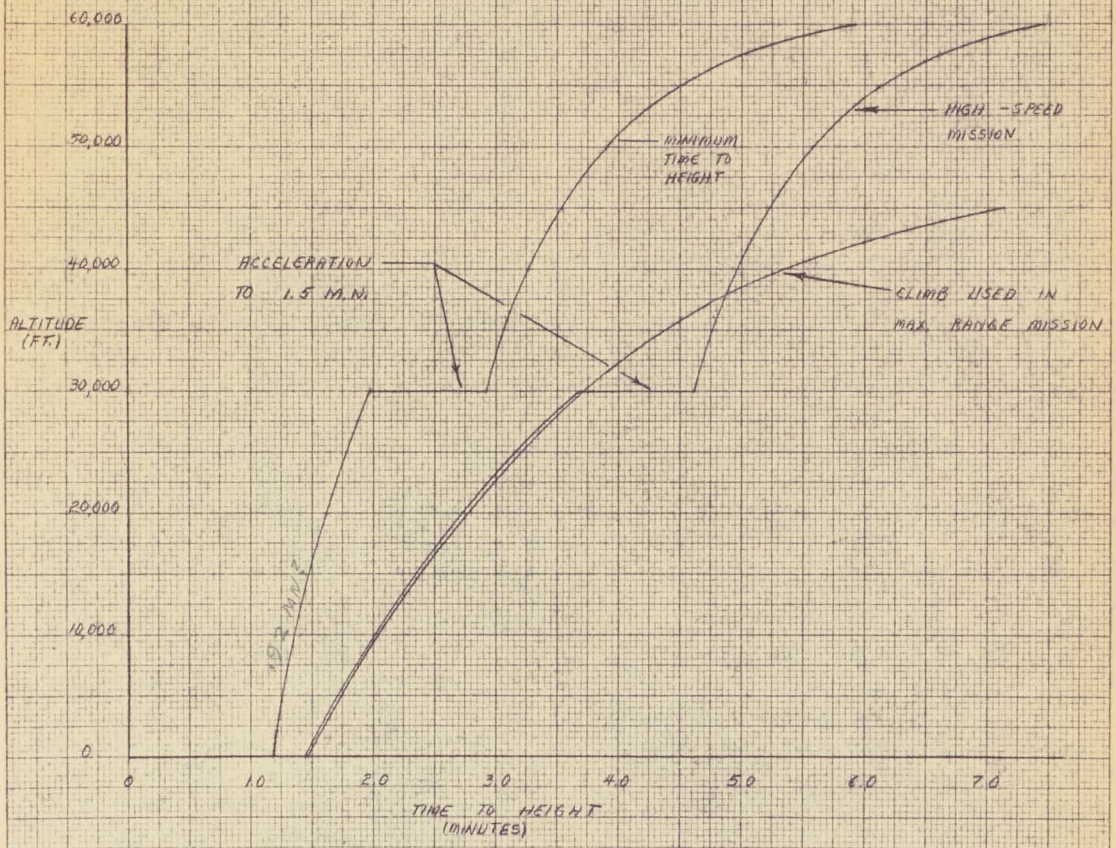


T. MURPHY

CF 105
P5-13 ENGINES

TIME TO HEIGHT

NOTE: ½ MINUTE ALLOWED FOR ENGINE START TO MAXIMUM THRUST



D. PERIGAN MAY/56

CF-105
PS-13 ENGINES

AVRO/REF/102. VOL. II
MAY/56

RATE OF CLIMB (STEADY STATE)

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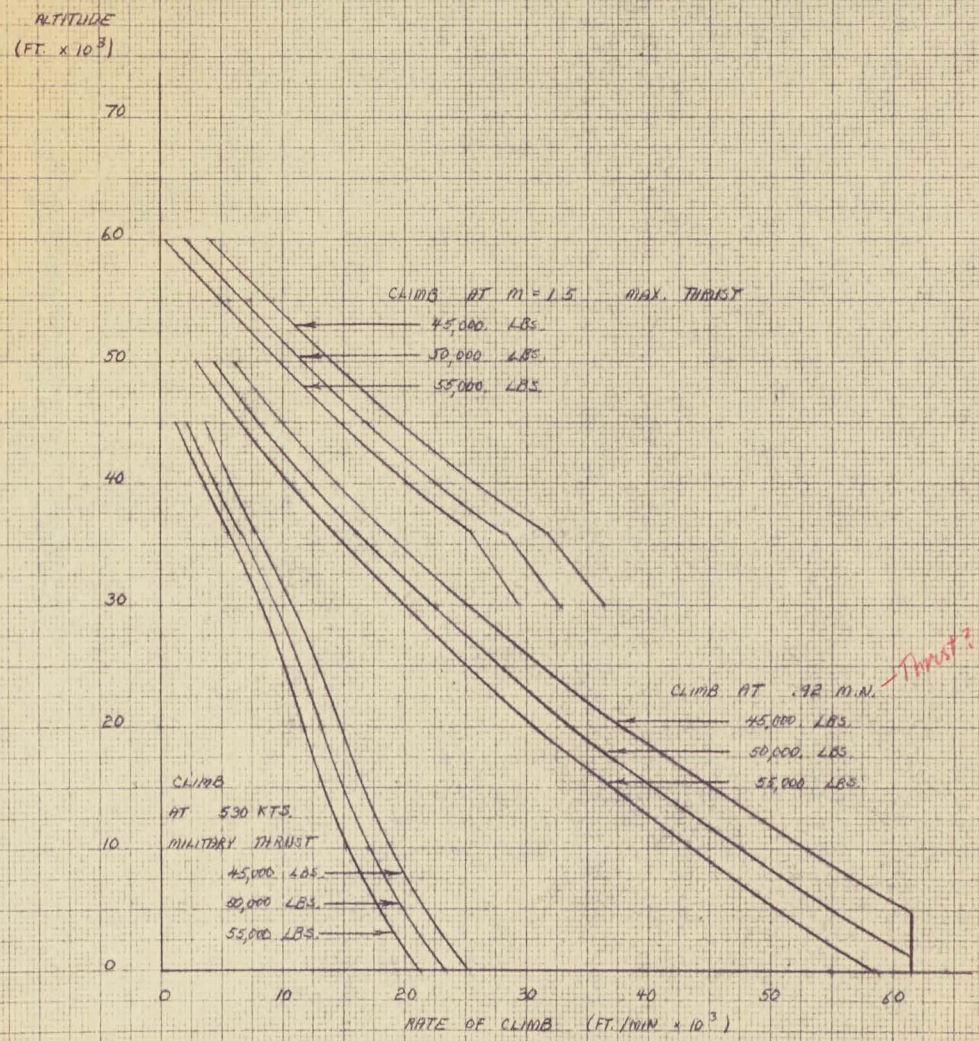


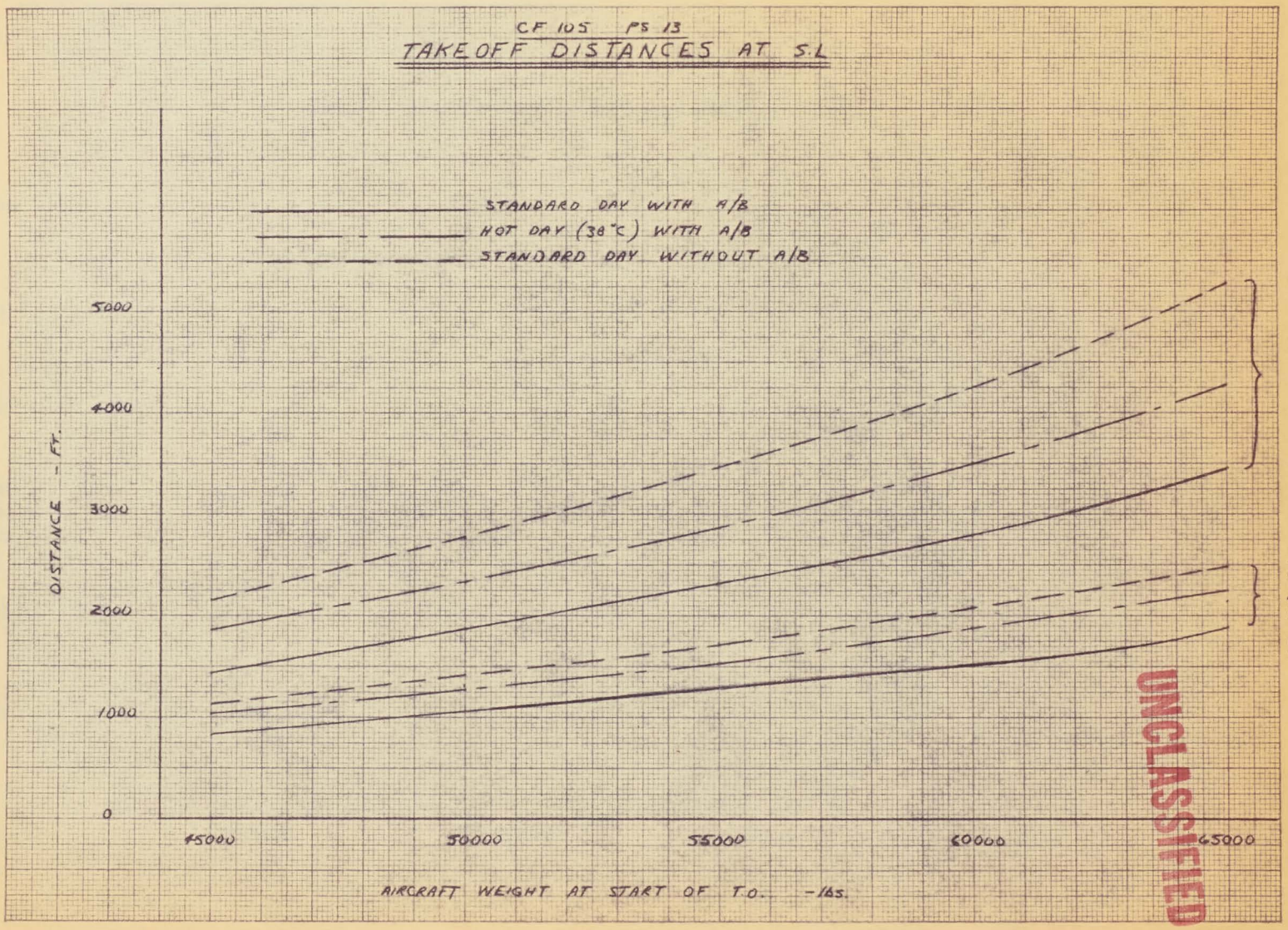
B. TARIGIAN MAY/56

DRAG

PROPULSION

CF 105 PS 13

TAKEOFF DISTANCES AT S.L



REPORT # P/PERF/102 VOL II

PROPULSION

DRAG

May, 1956

2: CF-105 DRAG NOTE

No drag revision has been made since monthly report No. 6

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PROPULSION

3: PROPULSION

No revision has been made to the JT4-A-25 (J-75) engines.

The Orenda P.S. 13 engine data has been completely revised. The revision has been based on P.S. 13 engine non-dimensional performance data (reference B12-56 dated April, 1956) Installation corrections applied to this are discussed briefly below.

The total pressure recovery for the P.S. 13 was estimated on the basis of the Lewis Laboratory tests with the J-75 configuration. (Ref: P/Power/60) The only geometry change necessitated by the P.S. 13 engine was the 7.1% increase in intake throat area faired within a length of 49" into the initial diffuser. It is considered to be within ± .5%.

The spillage drag was estimated on the basis of the Lewis laboratory tests. Because it is dependent only on the geometry forward of the inlet lip face and the external lip shape, it is identical at the same inlet mass flow ratio.

The ejector performance is for a 40" diameter (1256sq. in) secondary shroud with a 60 sq. in. b/pass inlet area. Pumping characteristics are obtained from NACA RM E52L24. The thrust (nozzle chocked) is then calculated in the usual manner from

$$F_{ne} = P_a A_p \left[\left\{ \frac{P_p}{P_a} \frac{2^{\frac{\gamma}{\gamma-1}}}{(1+\gamma)^{1/\gamma-1}} - 1 \right\}_{\gamma_{HOT}} + \left(\frac{1256}{A_p} - 1 \right) \left\{ \frac{P_s}{P_a} \frac{1+\gamma M_s^2}{\left(1+\frac{\gamma-1}{2} M_s^2\right)^{\frac{\gamma}{\gamma-1}}} - 1 \right\} \right]$$

less inlet momentum $\left(\frac{WV}{g}\right)$ less spillage drag

where:-

P_a = ambient air pressure
A_p = effective primary nozzle area
P_p = primary nozzle total pressure
P_s = secondary total pressure
M_s = secondary mach no.

A further small correction is made for an air bleed of 70 lb/min/eng for air conditioning. No correction has been made at the present time for horsepower extraction due to insufficient data from Orenda. However, from past experience this correction is small.

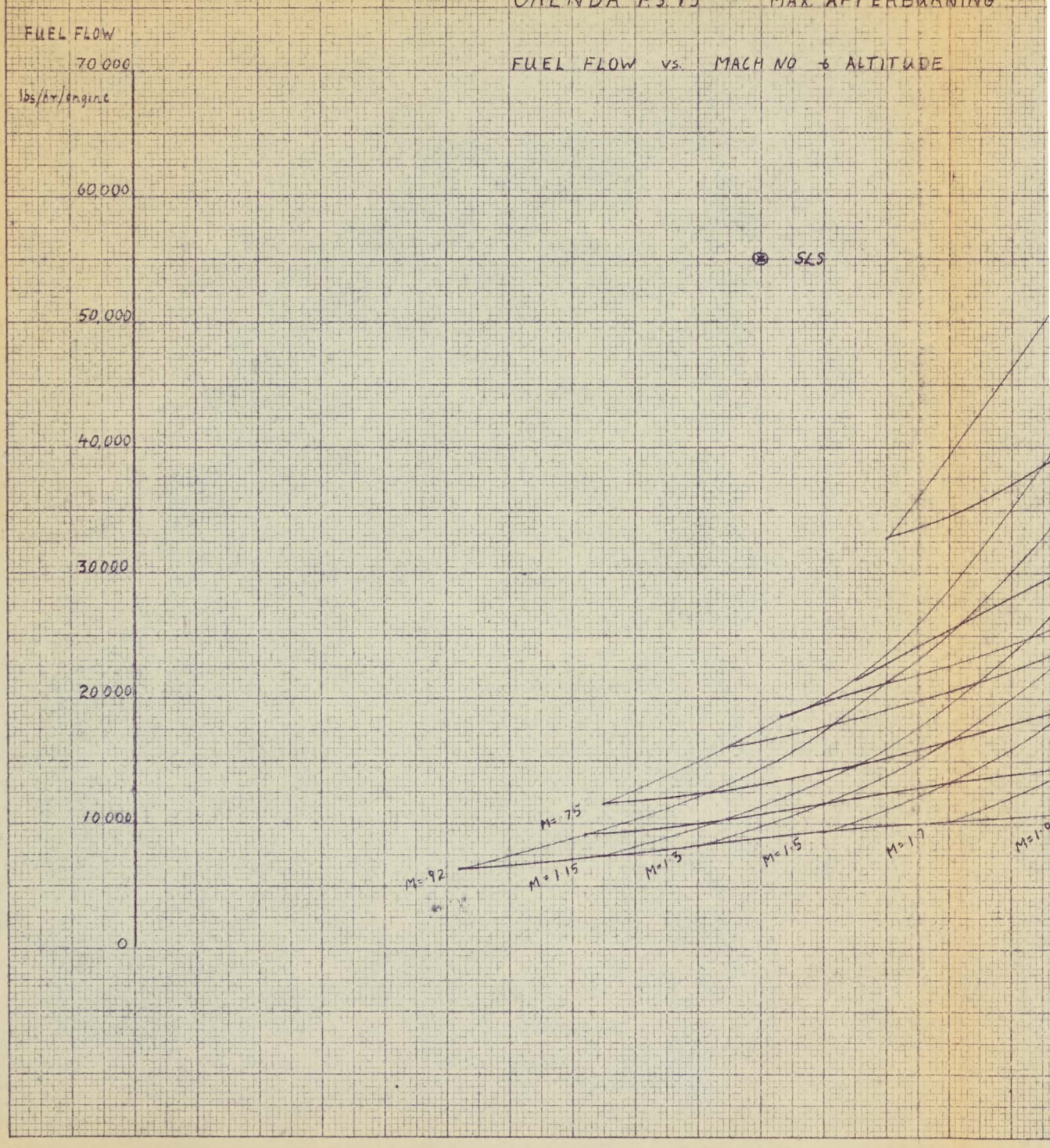
Based on the above data then the following curves are presented for the Orenda P.S. 13 engine.

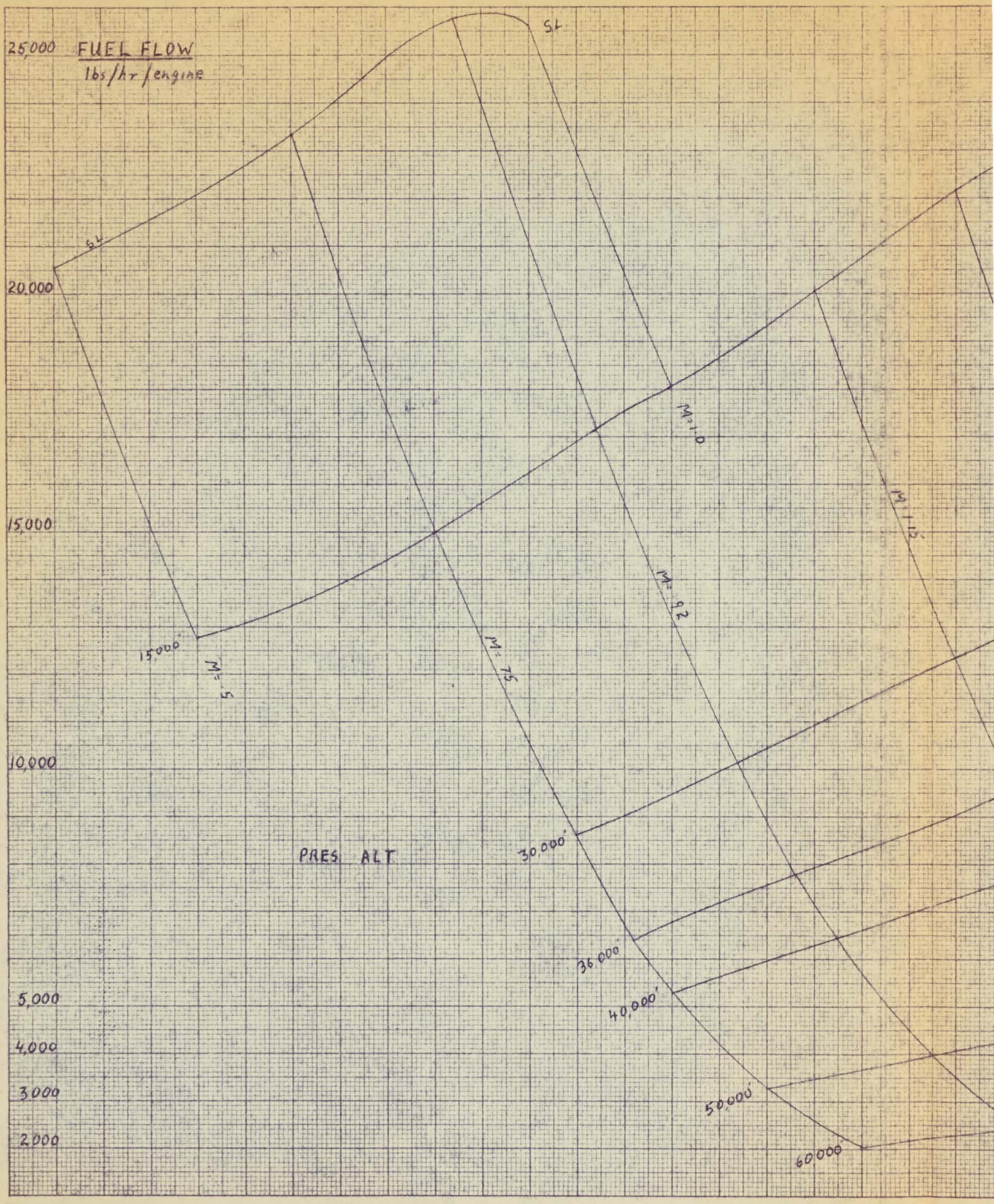
- Maximum thrust (full afterburning) vs speed, altitude
- Maximum fuel flow (full afterburning) vs speed, altitude
- Maximum thrust (no afterburning) vs speed, altitude
- Maximum fuel flow (no afterburning) vs speed, altitude
- Partial afterburning at 1.5 M at 50,000 ft.
- Partial non afterburning at .92M at 40,000 ft.

P/Power/56

ORENDA PS.13 — MAX. AFTERBURNING

FUEL FLOW vs. MACH NO & ALTITUDE





TOTAL AIRCRAFT THRUST (2 × PS.13) vs FUEL FLOW

NO AFTERBURNING

M.N. = .92 @ 40000'