

UNCLASSIFIED

ARROW

PERIODIC PERFORMANCE REPORT

NO. 11

74
Oct. 1957.

CIRCULATION LIST

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ARROW PERIODIC PERFORMANCE REPORT - 11

INTRODUCTION

This is the eleventh of a series of periodic performance reports for internal usage, to be issued from the Technical Design Department.

This report is divided into three major sections :-

- 1) Performance
- 2) Drag
- 3) Propulsion

PERFORMANCE

1 : ARROW 1 PERFORMANCE WITH J 75 ENGINES

C.G. AT 29.5% M.A.C.

The following Arrow 1 performance estimate is based on drag data of Periodic Performance Report No. 9, see section 2, and revised J 75 installed engine data, see section 3. It should be noted that the performance shown is for an aircraft fitted with a 45" divergent ejector, and 4° up-aileron deflection above 45,000 ft. The 45" divergent was selected, instead of the 39" cylindrical, since it is intended to equip the aircraft with this ejector for the major part of the test programme, subsequent to the first few flights. The 4° up-aileron deflection above 45,000 ft. has been shown since it is planned to fix the ailerons in this position for the high altitude portion of the test programme, in order to evaluate the effect and behaviour of this aileron deflection prior to the installation of the more complex system on the Arrow 2.

Aircraft weights used in this report are from Weights Report No. 7-0400-44, issue 10, suitably modified for the divergent ejector. This includes test equipment and ballast to limit the aft C.G. to 31% M.A.C., and is therefore applicable to the early stages of the "Phase 1" test programme.

Since the Arrow 1 is a test vehicle, rather than operational, the form of presentation has been altered from previous reports, in the interests of flight programming and correlation of results.

ARROW 1 PERFORMANCE - 11

PERFORMANCE UNDER I.C.A.O. STANDARD ATMOSPHERIC CONDITIONS

WEIGHT:-

Take-off Weight with full Internal Fuel.....	LB.	68,765
Operational Weight Empty.....	LB.	48,922
Half Fuel Weight.....	LB.	58,892
Normal Design Landing Gross Weight AIR 7-4 : MIL-5-5701...	LB.	53,892
Wing Loading at Take-off Weight with full Internal Fuel.....	LB/SQ.FT.	56.1
Power Loading at Take-off Weight with full Internal Fuel.....	LB/LB.Thrust.	1.82

SPEED:-

True Airspeed in Level Flight at Sea Level at Half Fuel Weight		*
Maximum Thrust (A/B Lit).....	KTS.	700
Military Thrust (A/B Not Lit).....	KTS.	645
Max True Airspeed in Level Flight at 40,000' at Half Fuel Weight		
Maximum Thrust (A/B Lit).....	KTS.	1,040

CEILING:-

500 F.P.M. Rate of Climb Ceiling at Half Fuel Weight		
Maximum Thrust at 1.5 M.N. (A/B Lit).....	FT.	50,300

RATE OF CLIMB:-

Steady Rate of Climb at Sea Level Half Fuel Weight		
Maximum Thrust at .92 M.N. (A/B Lit).....	F.P.M.	37,600
Military at 527 KTS.(A/B Not Lit).....	F.P.M.	10,530
Steady Rate of climb at 50,000 ft. Half Fuel Weight		
Maximum Thrust at 1.5 M.N. (A/B Lit).....	F.P.M.	800

TIME TO HEIGHT:-

Time to Reach 45,000 ft. and 1.5 M.N. from Engine Start at Take-off Weight with full Internal Fuel		
Maximum Thrust (A/B Lit).....	MINS.	6.0

MANOEUVRABILITY:-

Combat Load Factor at Half Fuel Weight		
Maximum Thrust at M.N. = 1.5 at 45,000 ft.(A/B Lit)		1.52

TAKE-OFF DISTANCES:-

Take-off Distances over 50 ft. Obstacle at Sea Level at Take-off Weight with full Internal Fuel		
Maximum Thrust (A/B Lit).....	FT.	4,700
Military Thrust(A/B Not Lit).....	FT.	11,800
Maximum Thrust Hot Day(A/B Lit).....	FT.	7,500

*
PLACARD SPEED OF AIR 7-4

LANDING DISTANCES:-

Landing Distance over 50 ft. Obstacle at Sea Level at Normal Design Landing Gross Weight.....	FT.	6,600
--	-----	-------

STALLING SPEED:-

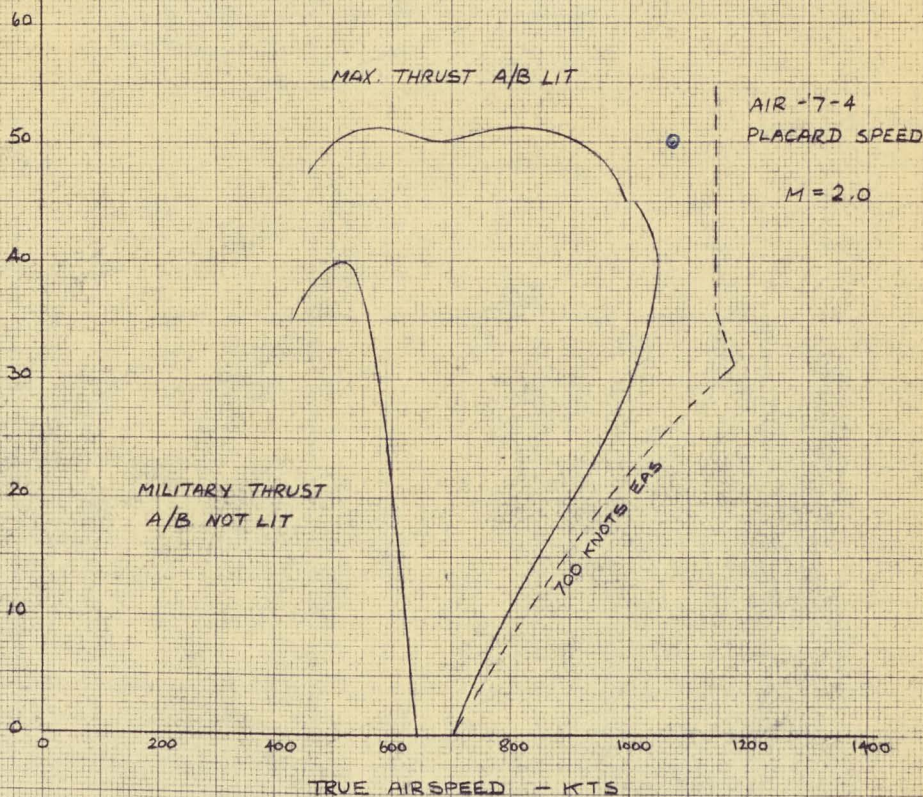
True Stalling Speed in Landing Configuration at Half Fuel Weight at Sea Level.....	KTS.	119
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ARROW I

71/PERF/3

MAX. LEVEL SPEED AT HALF FUEL WEIGHT

STANDARD ALTITUDE — THOUSANDS OF FT.



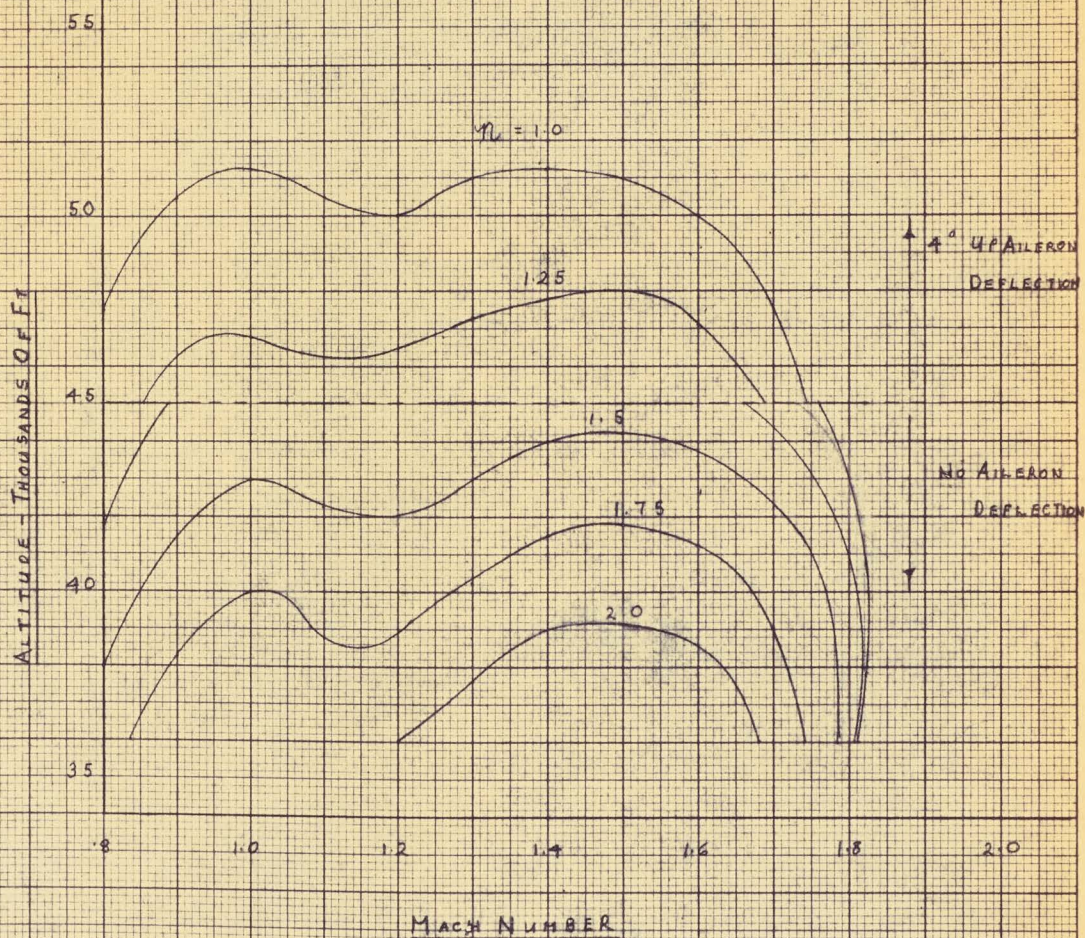
71/PEAF/3

ARROW I

MANOEUVRABILITY

AVAILABLE STEADY g 's AT HALF FUEL WEIGHT

J 75 ENGINES WITH MAXIMUM THRUST



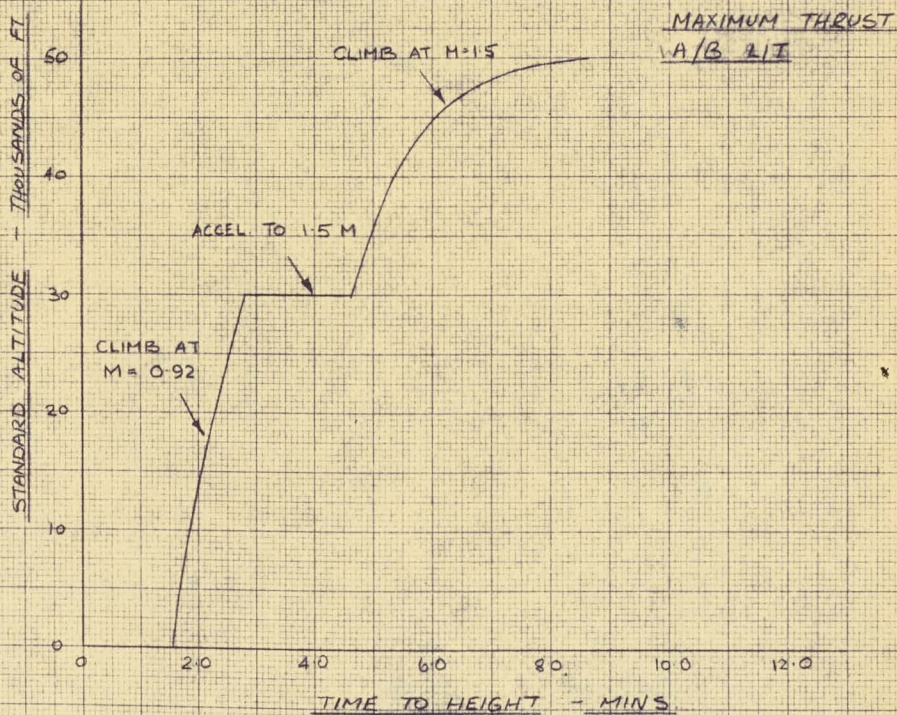
OUT 10

71/PERF/3

ARROW I TIME TO HEIGHT

STARTING WEIGHT: 68,765 LB

ONE HALF MINUTE ALLOWED FROM
ENGINE START TO START OF TAKE-OFF



PH NOV '57

K.E
10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

71/200013

Arrow 1

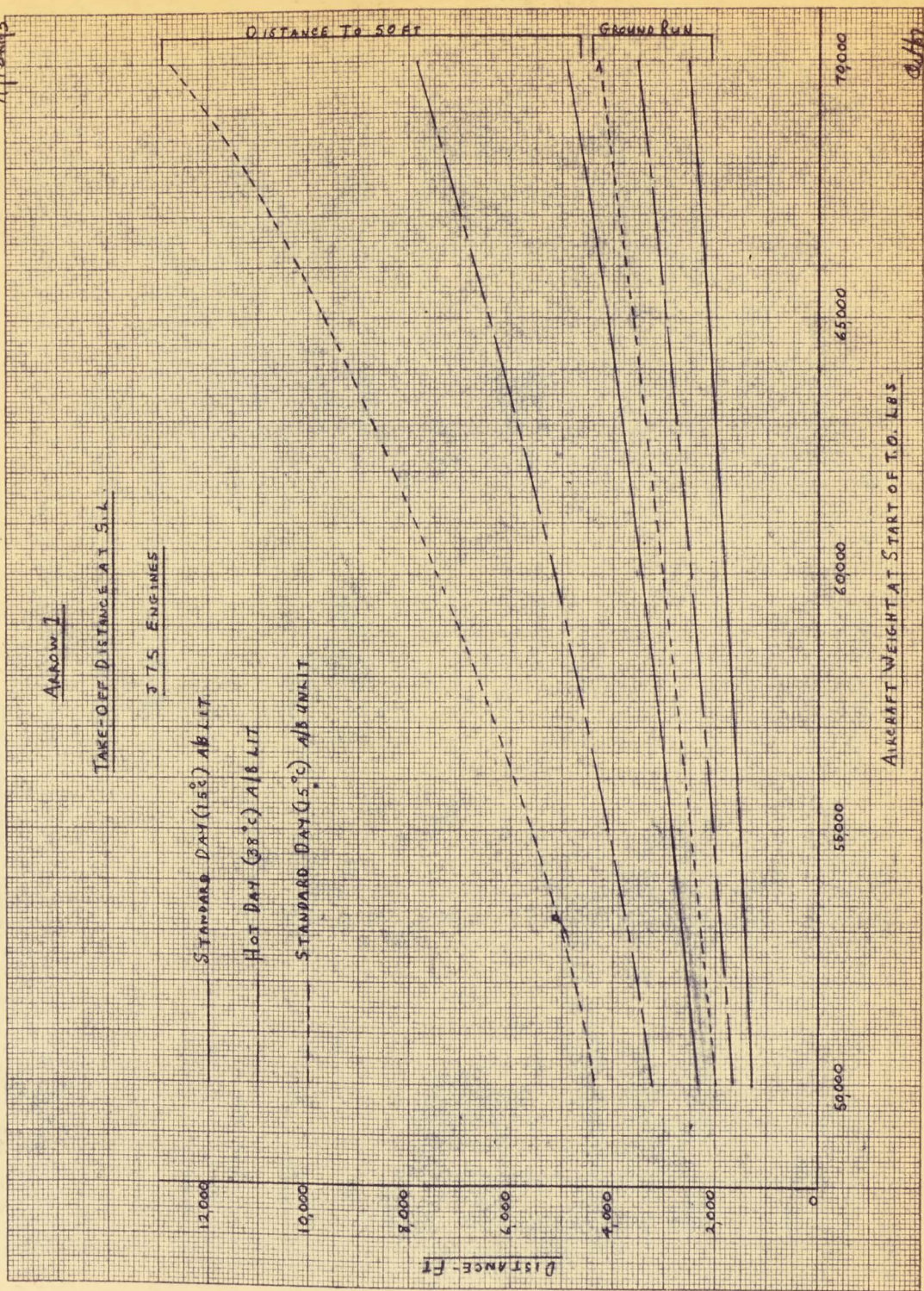
TAKE-OFF DISTANCE AT S.L.

375 ENGINES

STANDARD DAY (15°C) A/B LIT

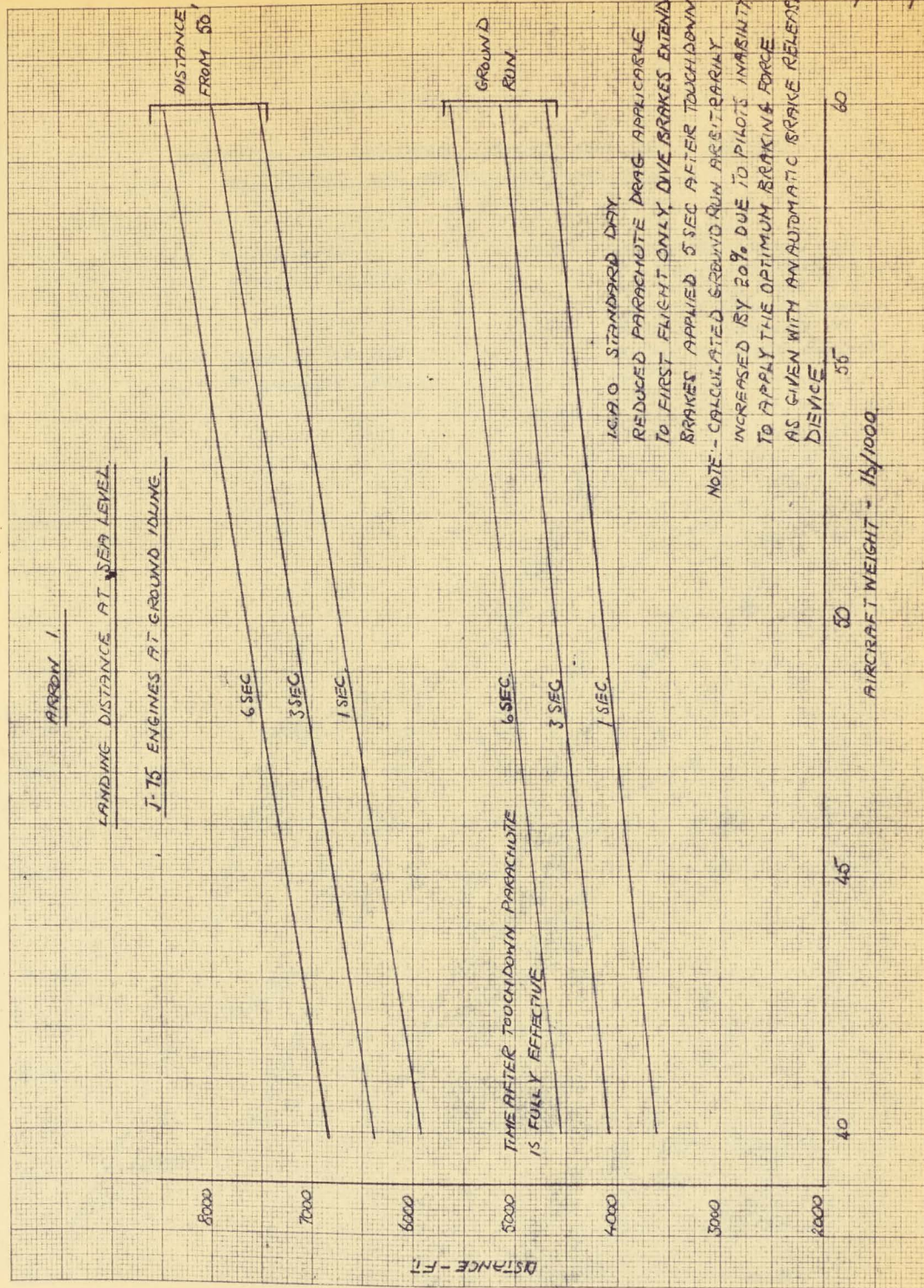
HOT DAY (38°C) A/B LIT

STANDARD DAY (15°C) A/B UNLIT



AIRCRAFT WEIGHT AT START OF T.O. LBS

0.67



71/PERF/3

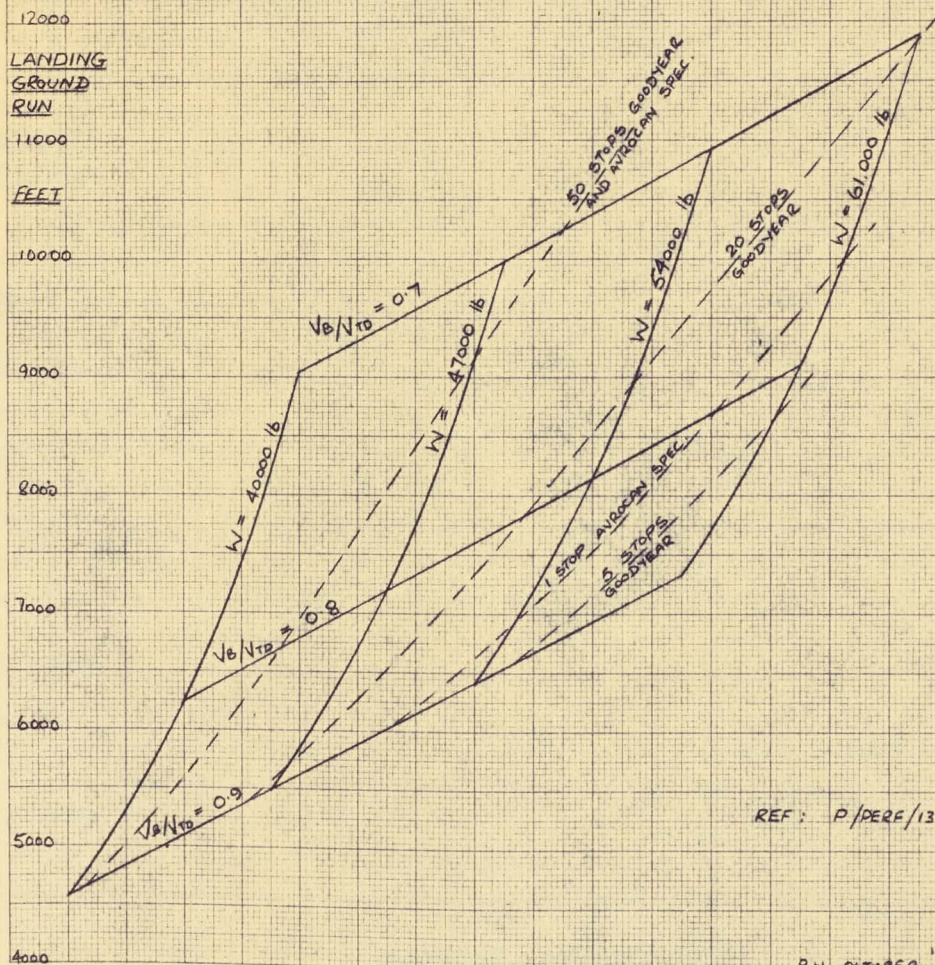
ARROW I

VARIATION OF LANDING GROUND RUN WITH WEIGHT AND POINT OF BRAKE APPLICATION

NO PARACHUTE
DIVE BRAKES EXTENDED

V_B = BRAKING SPEED
 V_{TD} = TOUCHDOWN SPEED

NOTE - CALCULATED GROUND RUN
ARBITRARILY INCREASED BY 20%
DUE TO PILOTS INABILITY TO
APPLY THE OPTIMUM BRAKING
FORCE AS GIVEN WITH AN
AUTOMATIC BRAKE RELEASE
DEVICE



KOE 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

71 PERCENT

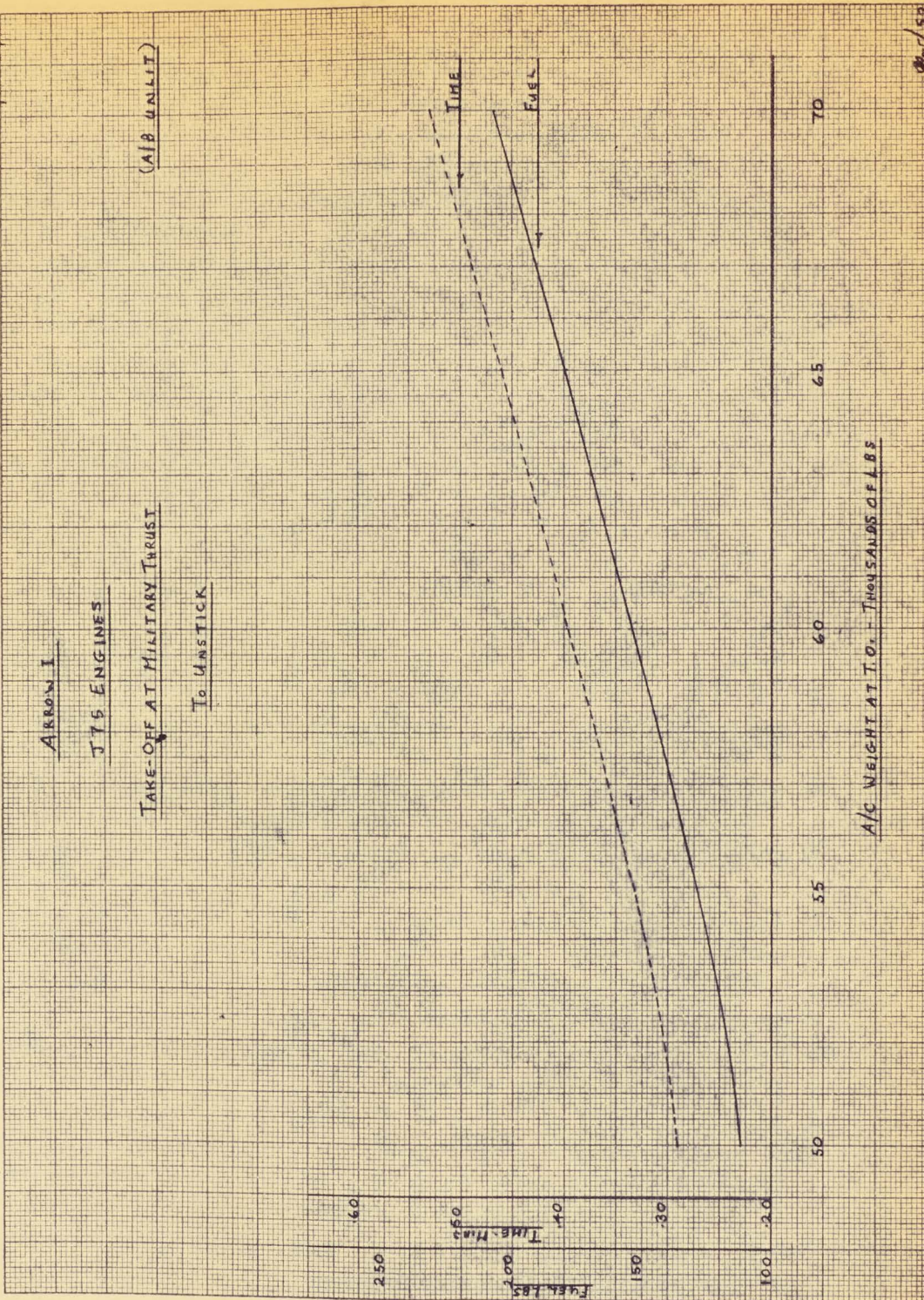
ARROW I

J75 ENGINES

TAKE-OFF AT MILITARY THRUST

TO UNSTICK

(A/B UNIT)



A/C WEIGHT AT T.O. - THOUSANDS OF LBS

8/1/52

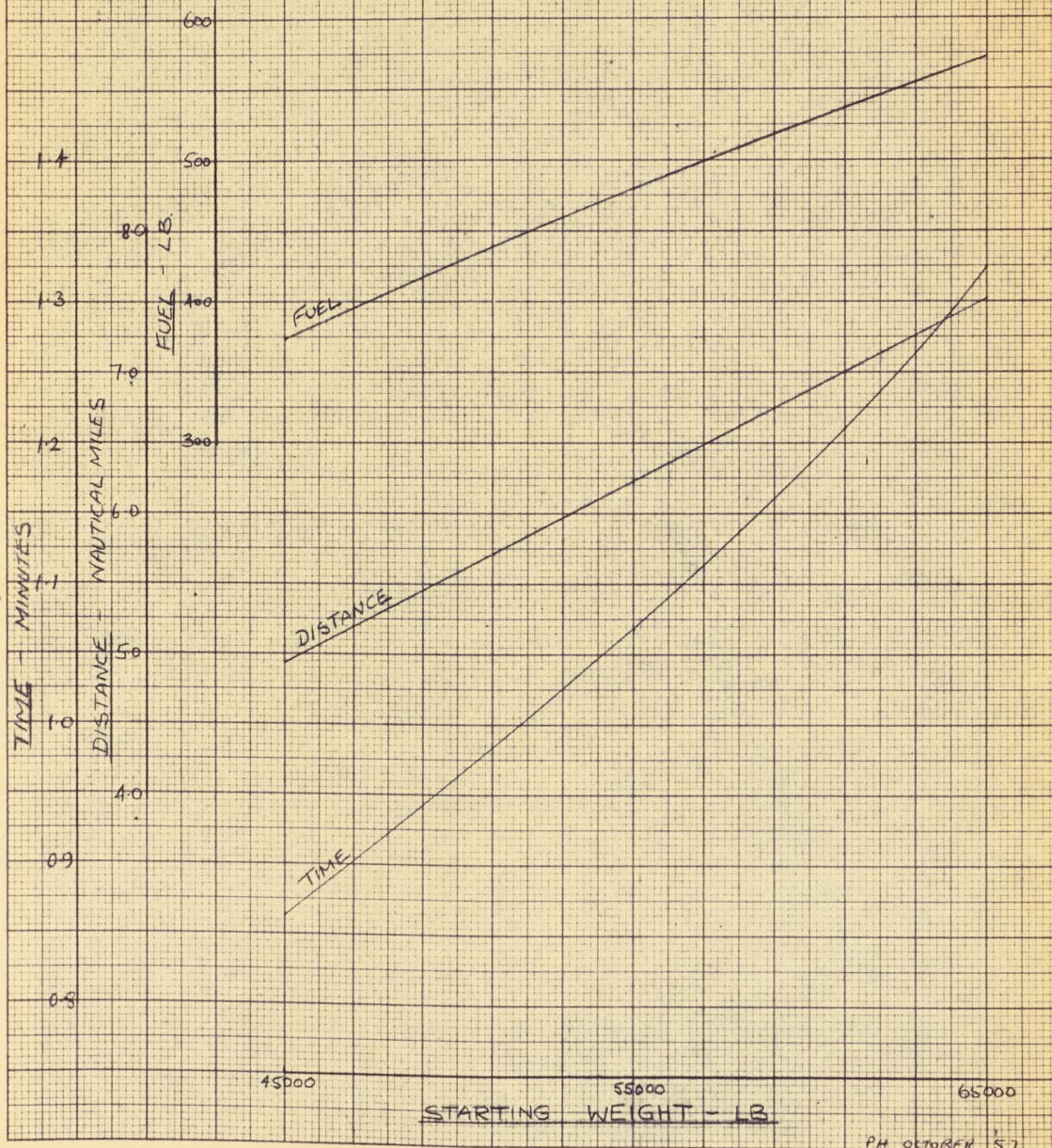
71/PERF/3

ARROW I ACCELERATION

UNSTICK TO 527 KNOTS TAS AT S.L.

A/B OFF

MILITARY THRUST



PM OCTOBER 57

71/PERER

ARROW I

J 75 ENGINES

TAKE-OFF AT MAX THRUST

TO UNSTICK

(A/B ON)

FUEL

TIME

450 3.5
400 3.0
350 2.5
300 2.0
250 1.5

50,000

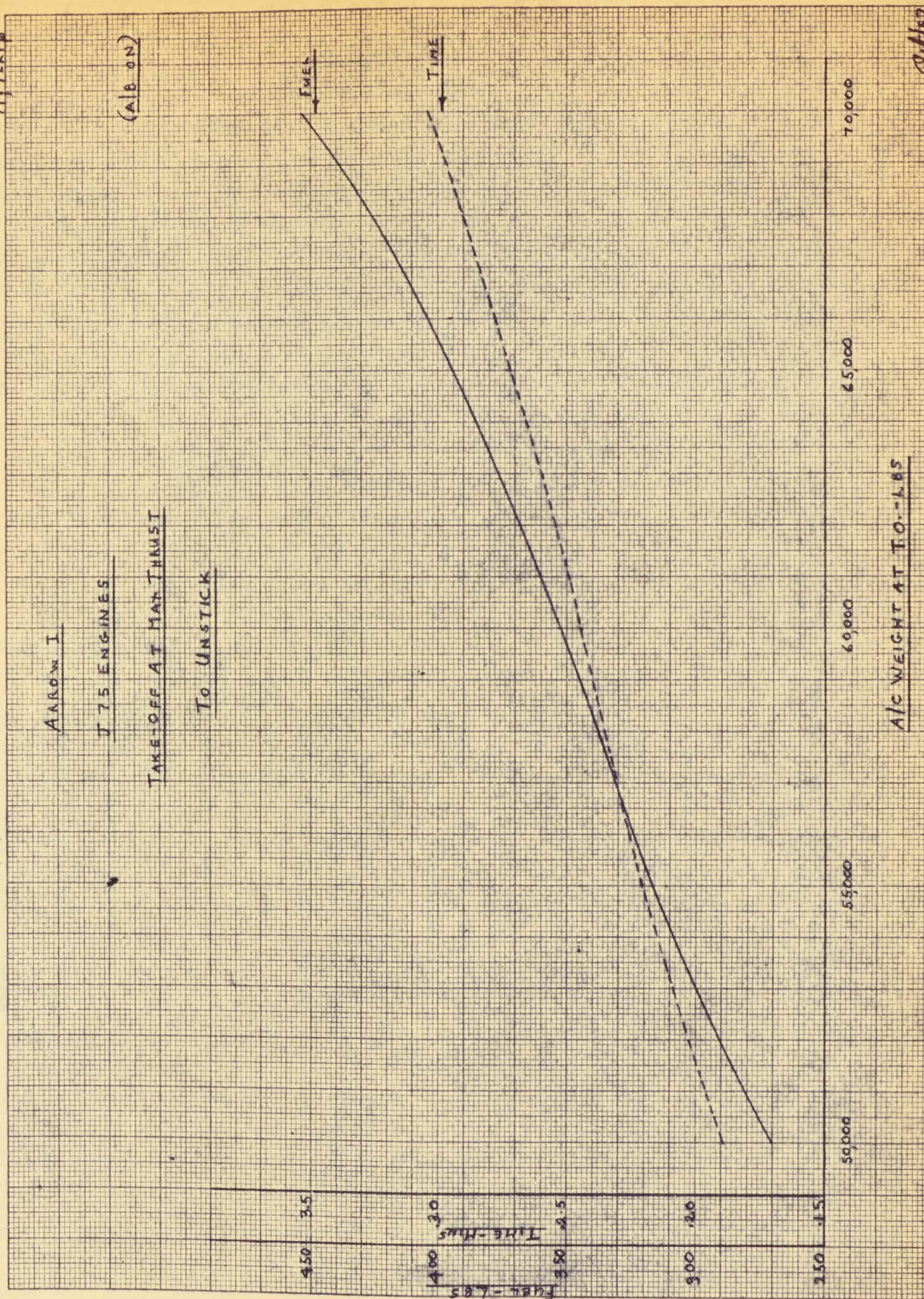
60,000

65,000

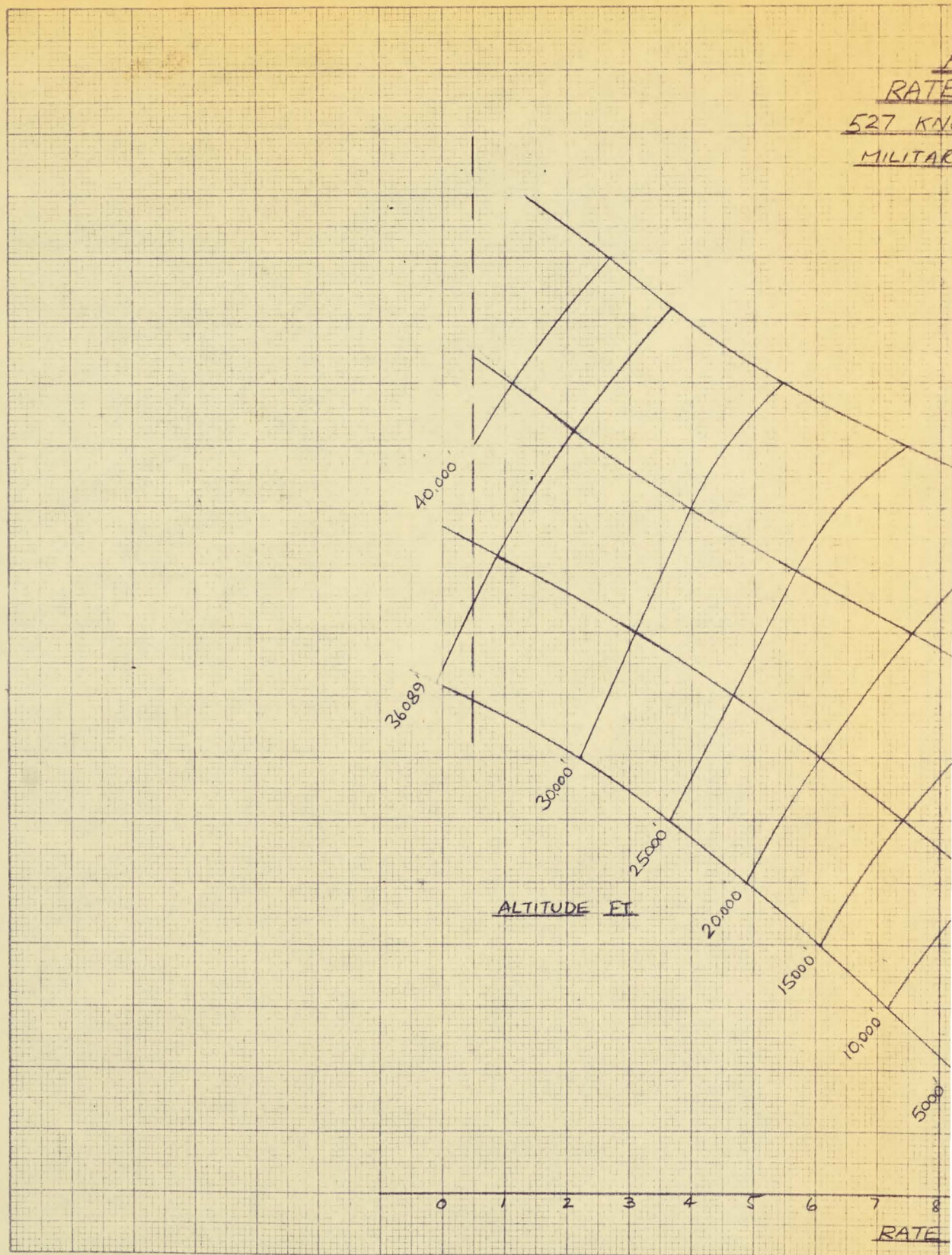
70,000

A/C WEIGHT AT T.O. - LBS

28/52



KE 10 X 10 TO THE 1/2 INCH 359-11L
KEUFFEL & ESSER CO. MADE IN U.S.A.



ARROW I TIME TO HEIGHT

527 KNOTS TAS. A/B OFF
MILITARY THRUST

AIRCRAFT WEIGHT

W.L.B.

40,000

50,000

60,000

70,000

SL.

5,000'

10,000'

15,000'

20,000'

25,000'

ALTITUDE

40,000'

TIME (MIN)

ARROW I
FUEL TO HEIGHT
527 KNOTS TAS. A/B OFF.
MILITARY THRUST

AIRCRAFT WEIGHT

W LB.

40,000

50,000

60,000

70,000

S.L.

20,000'

15,000'

10,000'

5,000'

0

200

400

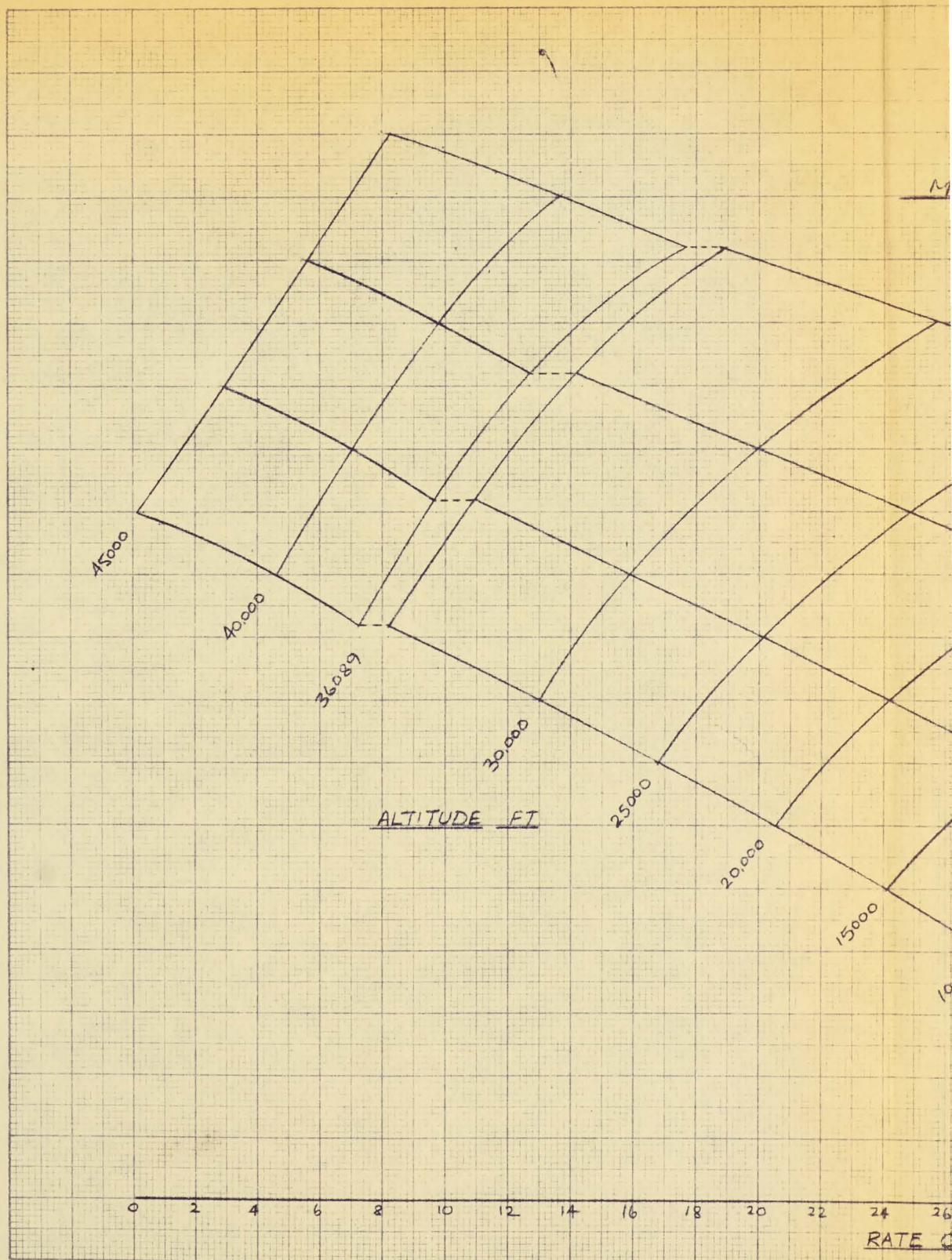
600

800

1000

1200

K&E
10 X 10 TO THE 1/2 INCH
KEUPPEL & ESSER CO.
MADE IN U.S.A.



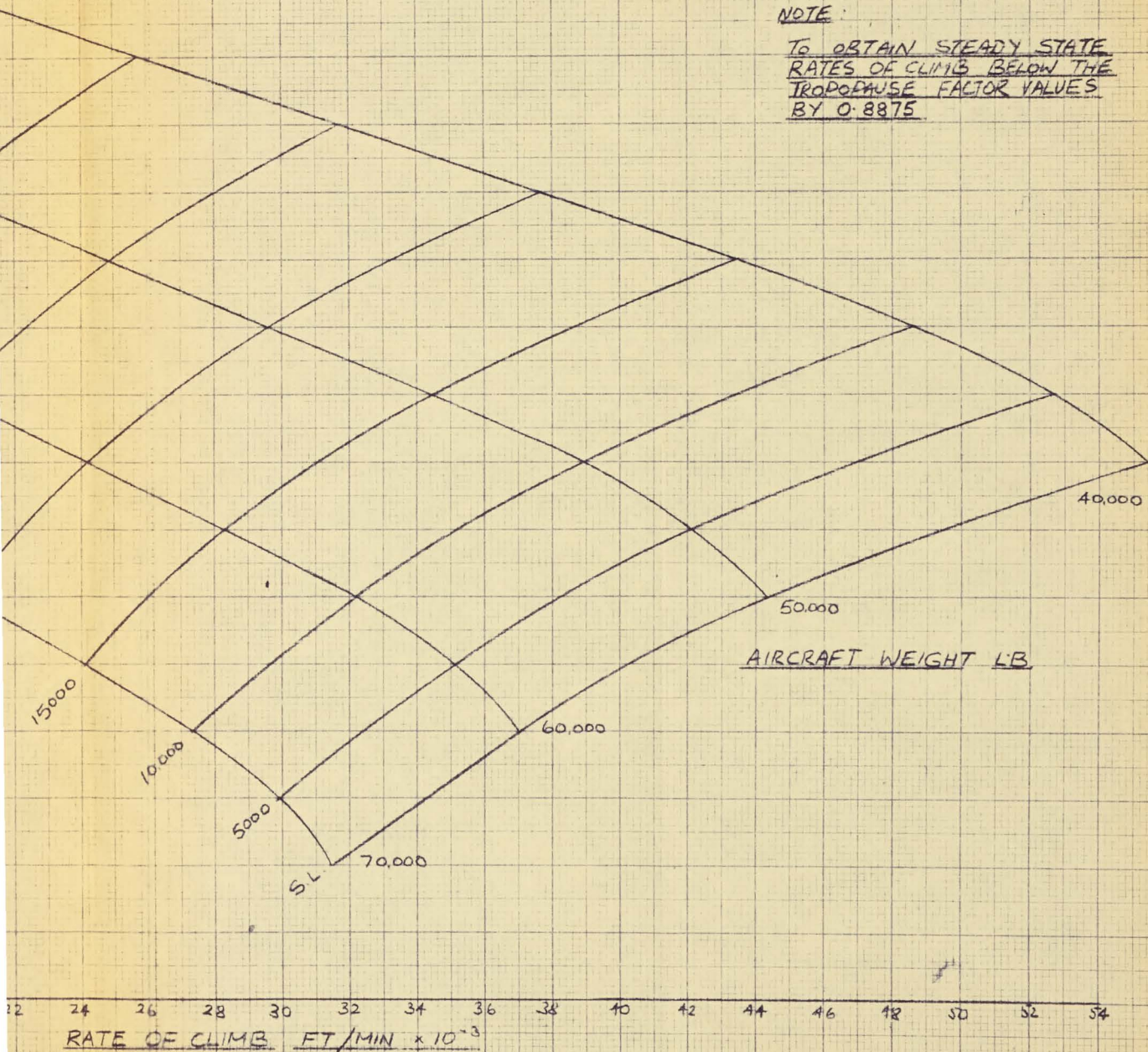
71/PERF/3

ARROW I
RATE OF CLIMB

M = 0.92, A/B ON, MAXIMUM THRUST

NOTE:

TO OBTAIN STEADY STATE
RATES OF CLIMB BELOW THE
TROPOPAUSE FACTOR VALUES
BY 0.8875



10 X 10 TO THE 1/2 INCH 359.11L
KEUFFEL & ESSER CO. MADE IN U.S.A.

AIRCRAFT
WEIGHT LB.

40,000

50,000

60,000

70,000

SL

0

1.0

2.0

TIME

36089

ALTITUDE FT

30,000

25,000

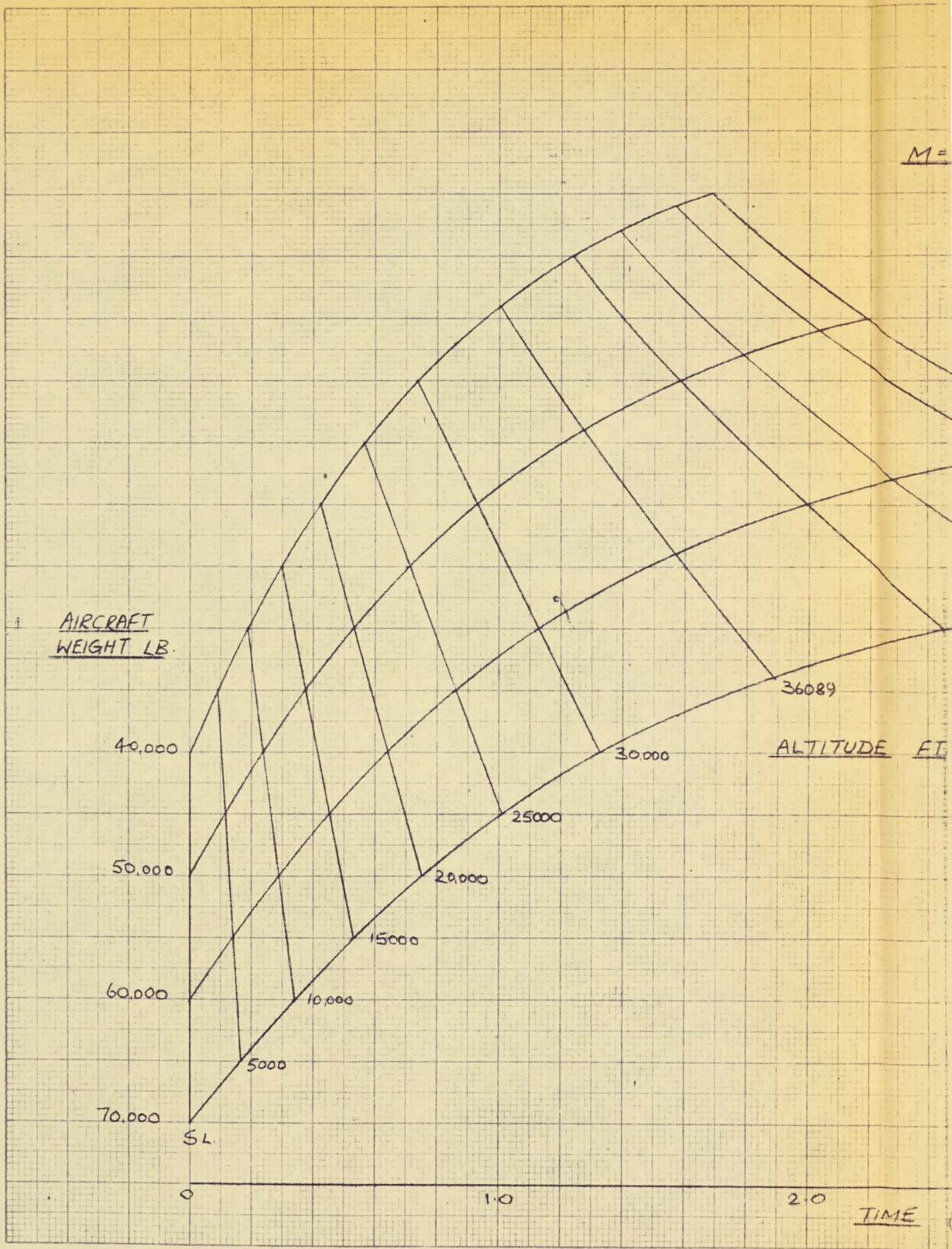
20,000

15,000

10,000

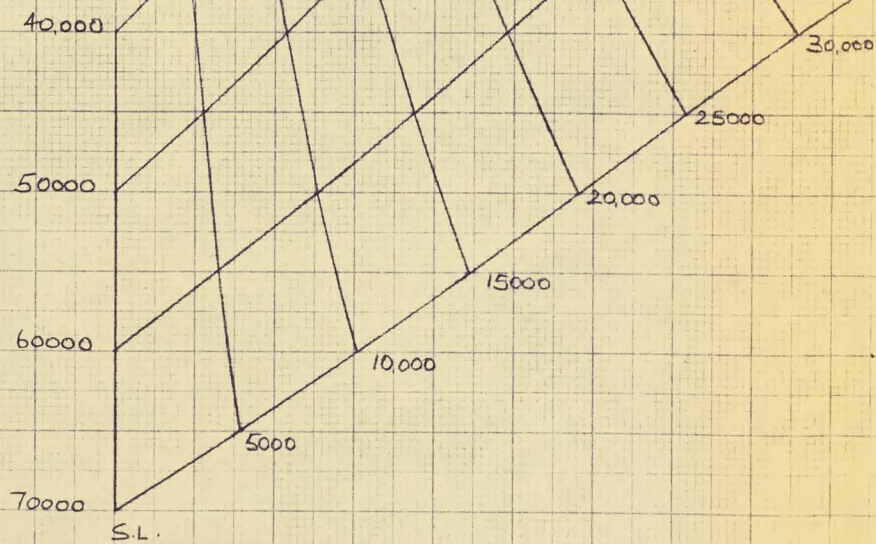
5,000

M=



KE 10 X 10 TO THE 1/2 INCH 359 11L
KEUFFEL & ESSER CO. MADE IN U.S.A.

AIRCRAFT
WEIGHT
LB.



10 X 10 TO THE 1/2 INCH 359-111L
KEUFFEL & ESSER CO. MADE IN U.S.A.

AIRCRAFT
WEIGHT
LB.

40,000
50,000
60,000
70,000
SL.

5,000

10,000

15,000

20,000

25,000

30,000

36,089

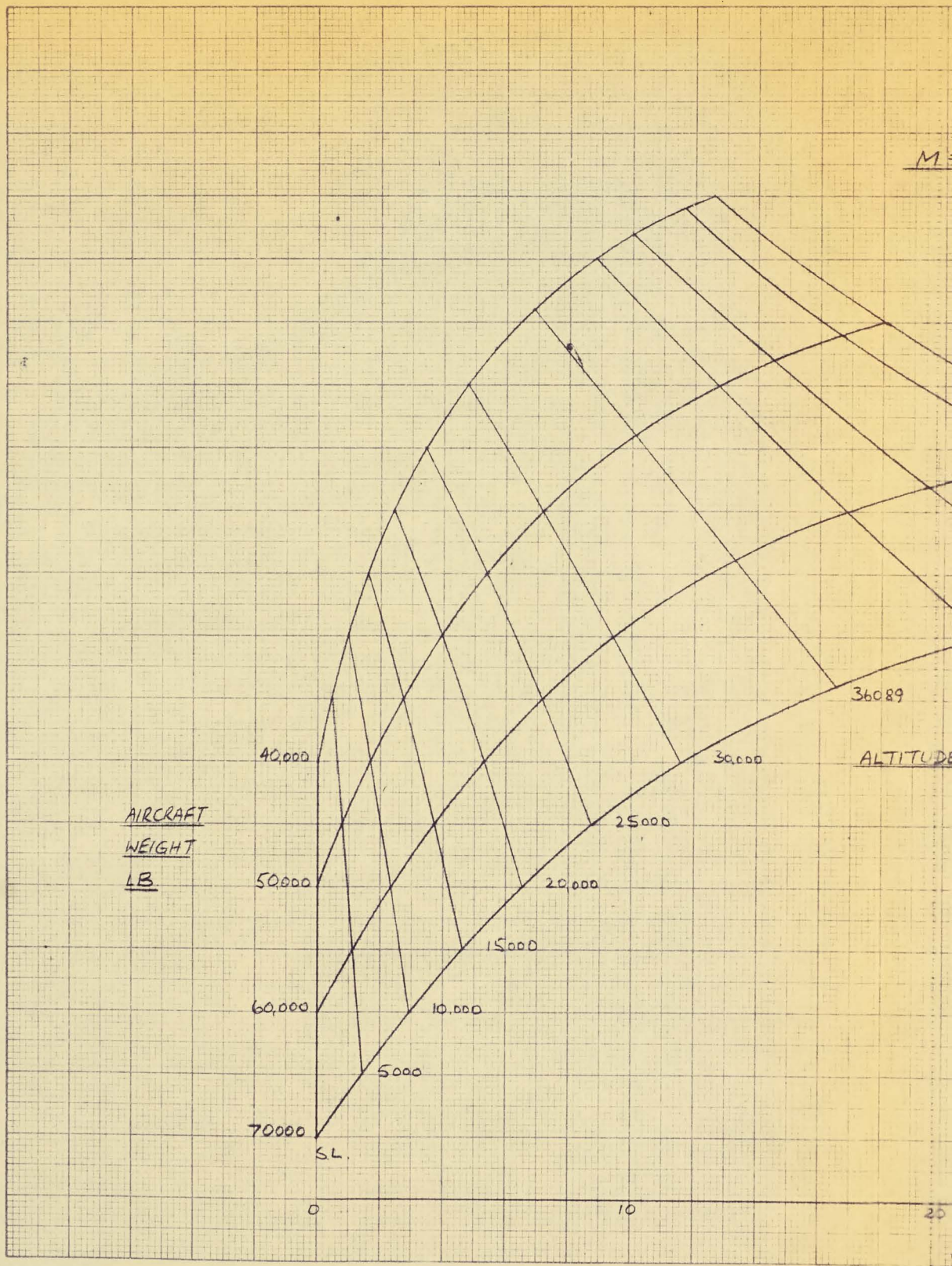
ALTITUDE

0

10

20

M

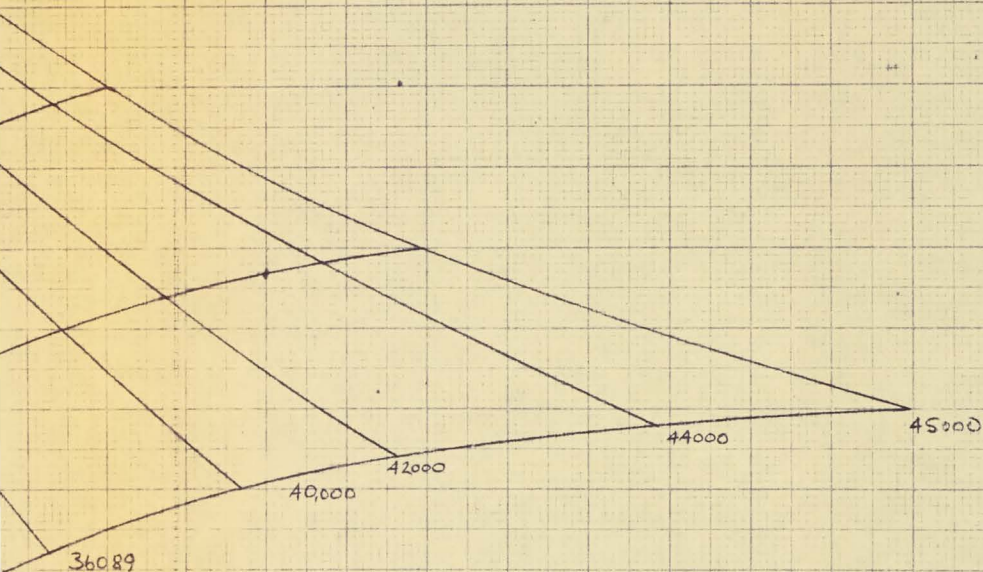


71/PERF/3

ARROW I

DISTANCE TO HEIGHT

M = 0.92 A/B ON MAXIMUM THRUST

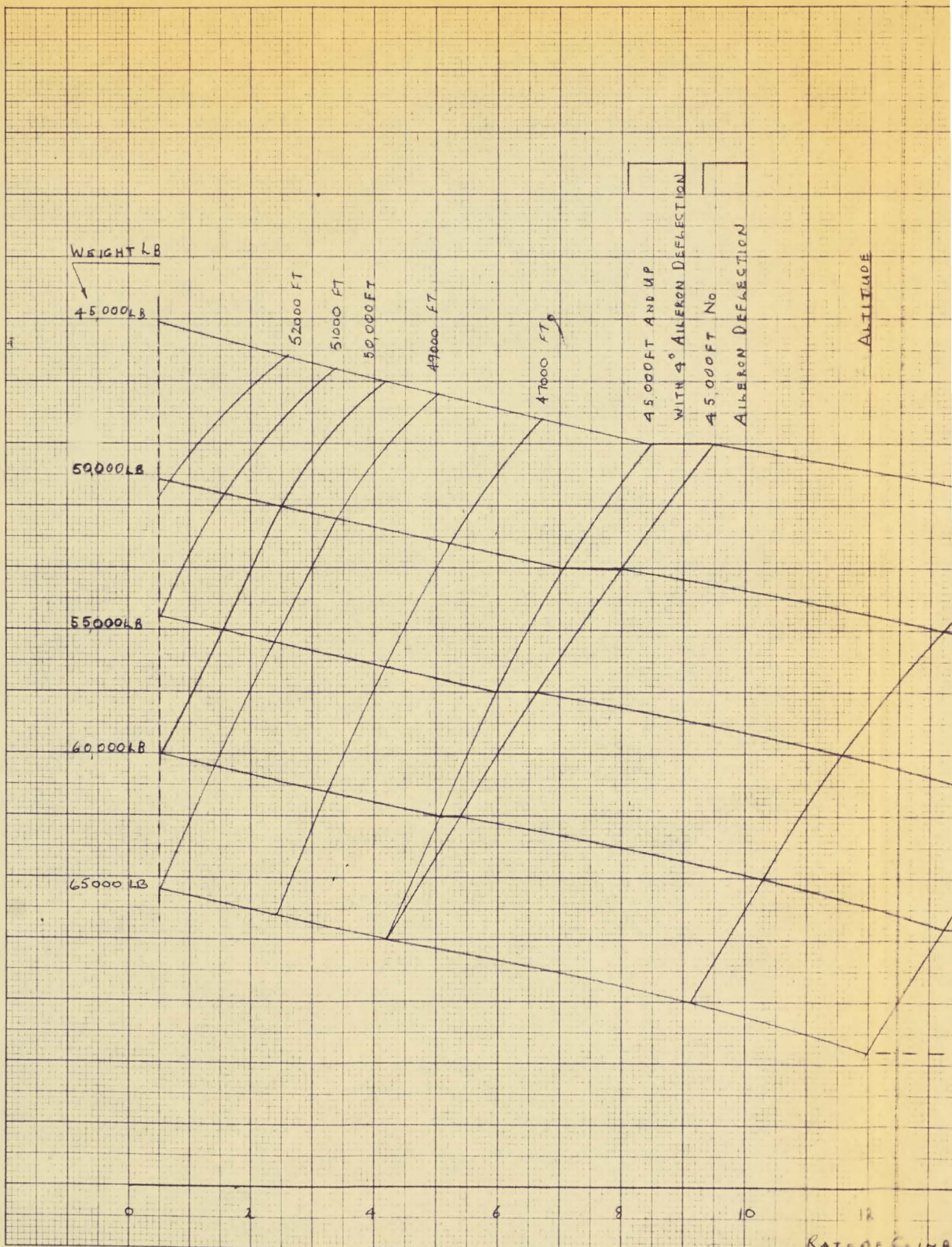


ALTITUDE FT.

DISTANCE
NAUTICAL MILES

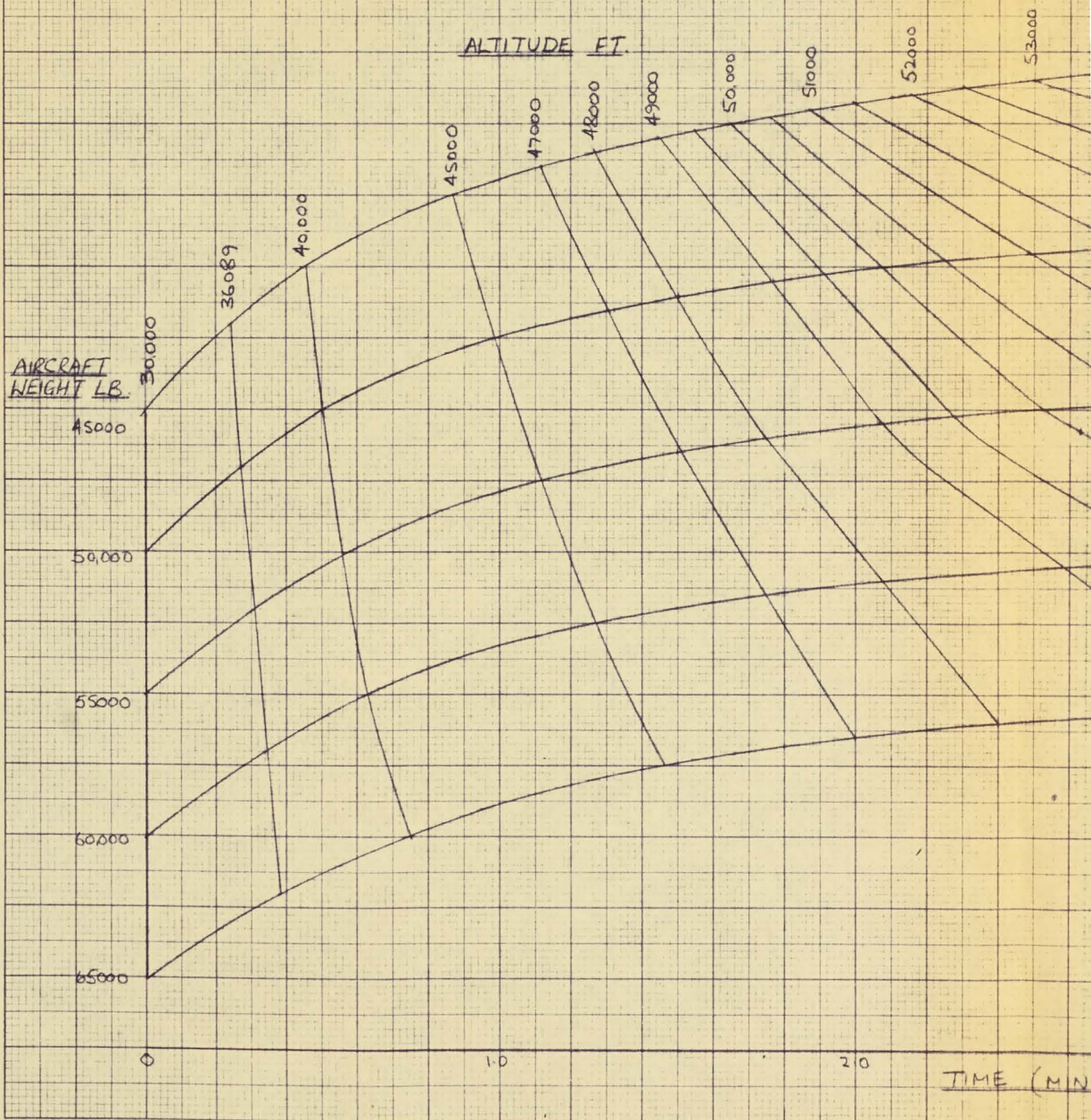
PH OCTOBER 57

G9-11L
10 X 10 to the 1/2 inch, 5th lines accented
MADE IN CANADA



G 9-11 L
10 X 10 to the 1/2 inch, 5th lines accented
MADE IN CANADA

ARROW I
TIME TO HEIGHT
M=15, A/B ON, MA

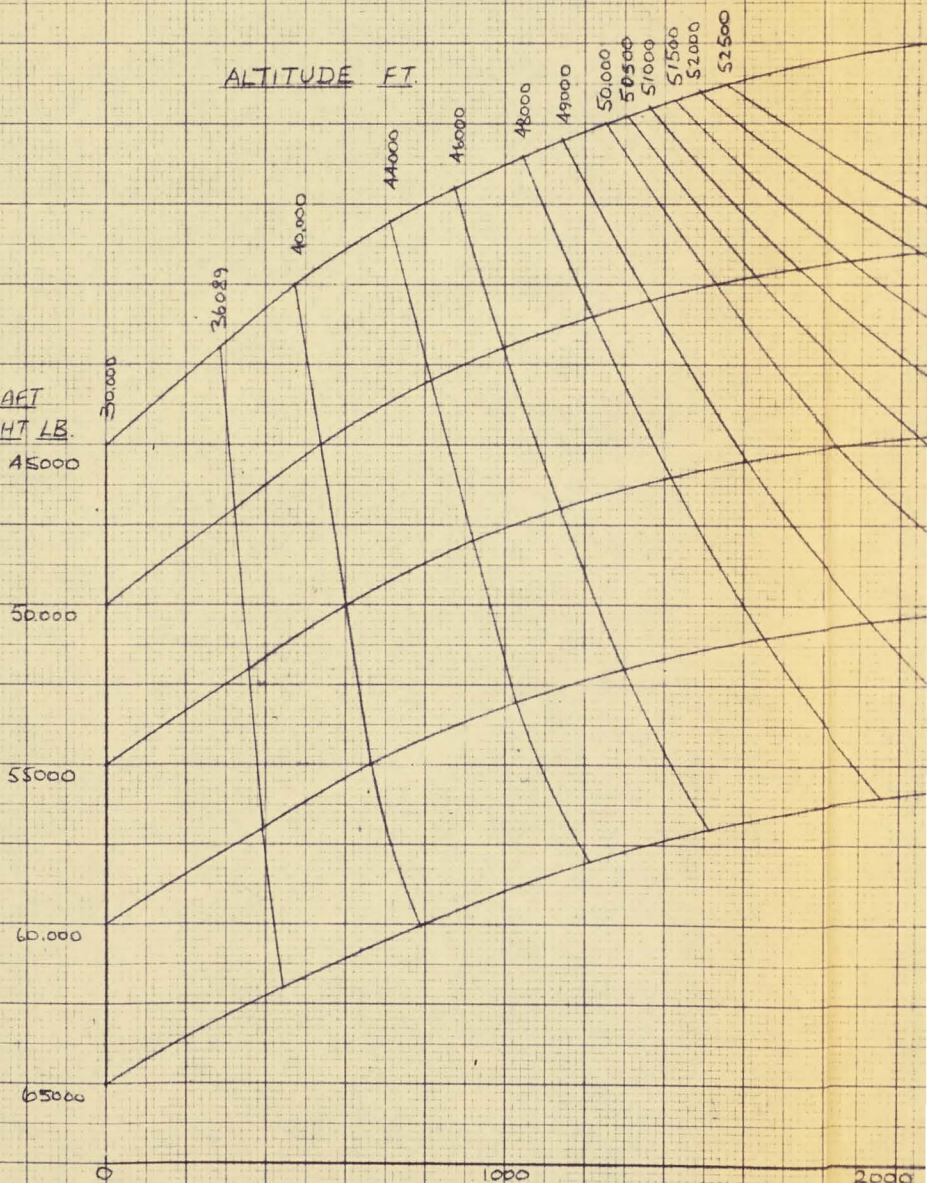


G 9-11L
10 X 10 to the 1/2 inch, 5th lines accented
MADE IN CANADA

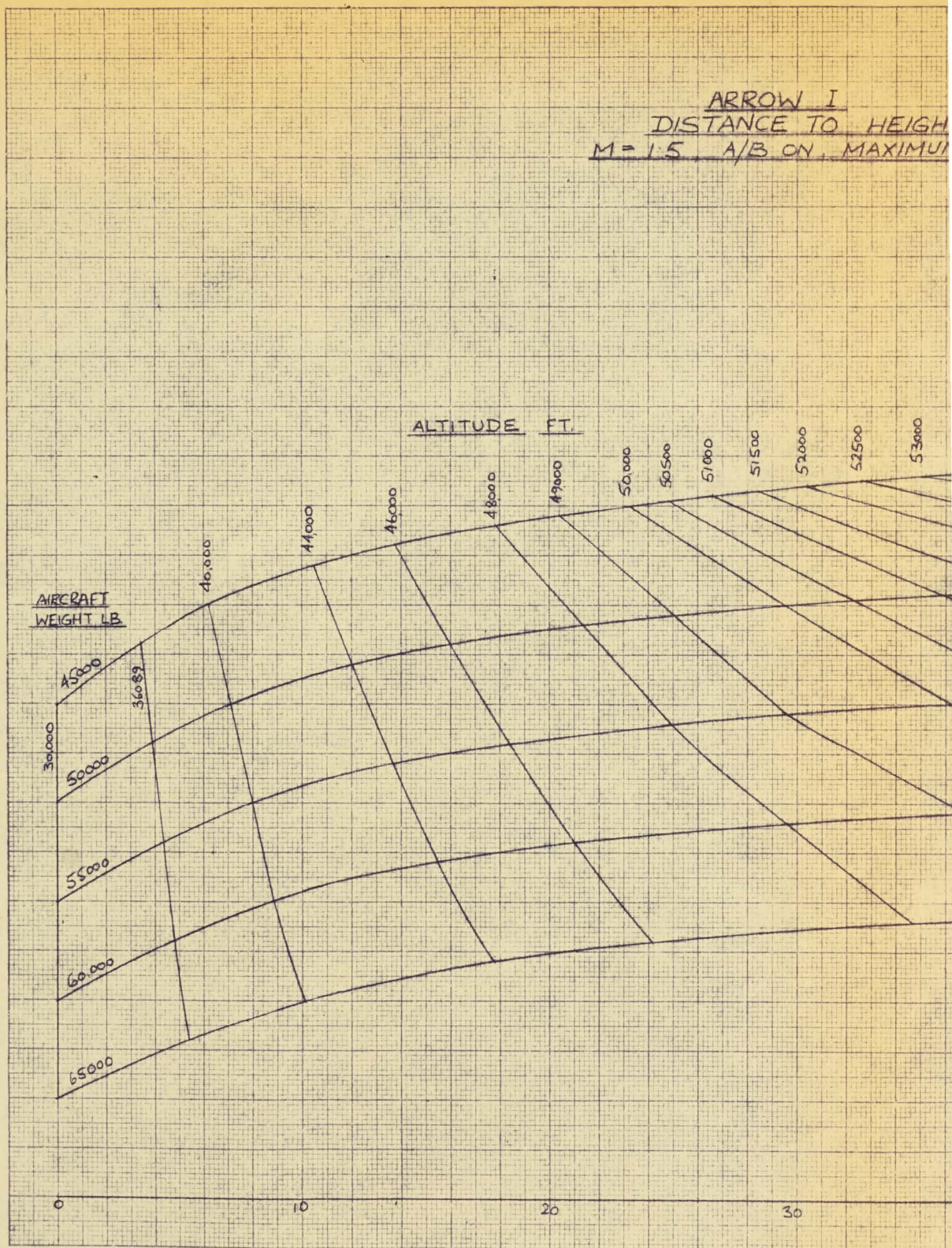
ARROW I
FUEL TO HEIG
M=1.5, A/B ON, M

AIRCRAFT
WEIGHT LB.

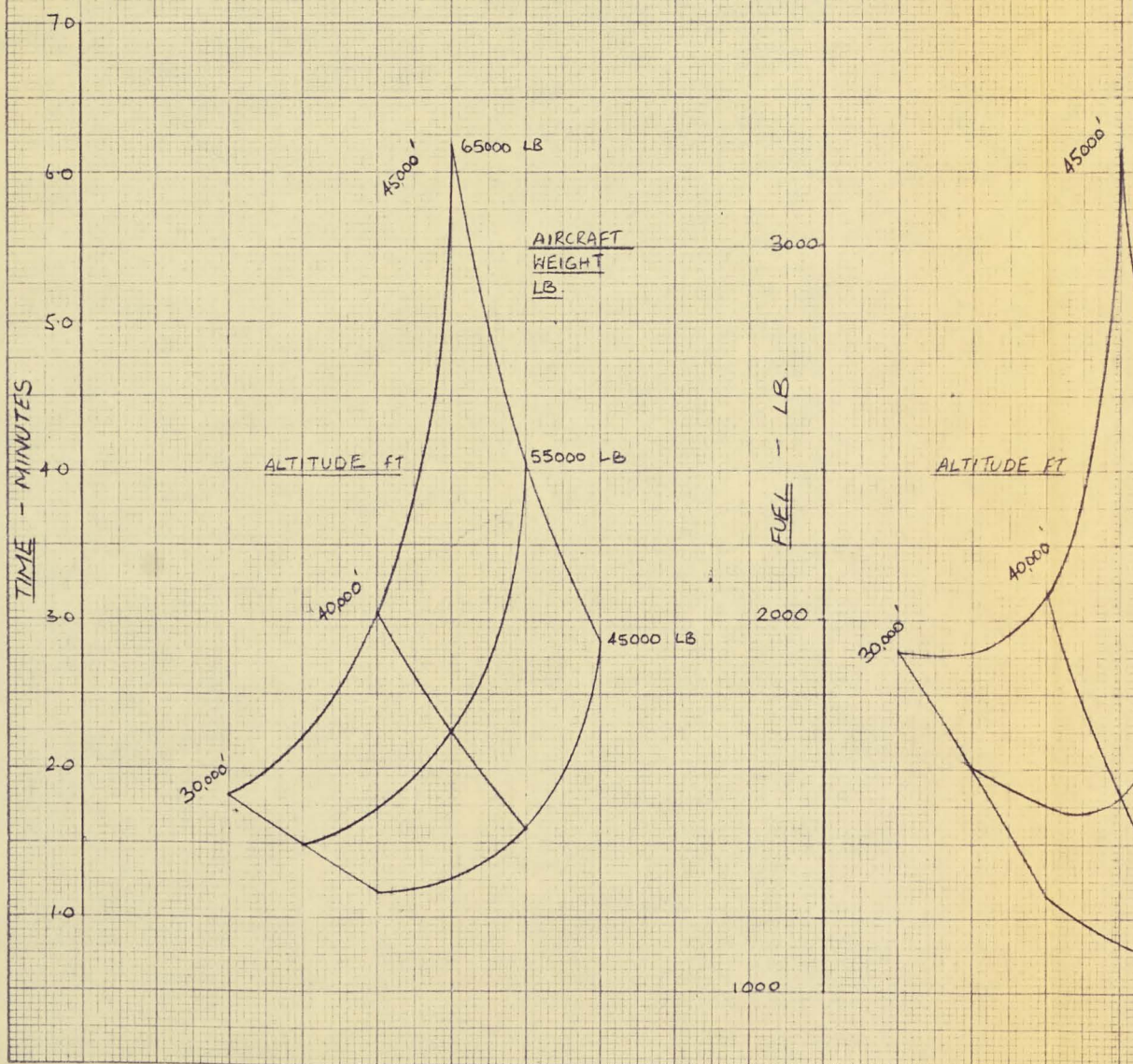
ALTITUDE FT.



K&E 10 X 10 TO THE CM. 359-141L
KEUFFEL & ESSER CO. NEW YORK, N.Y.

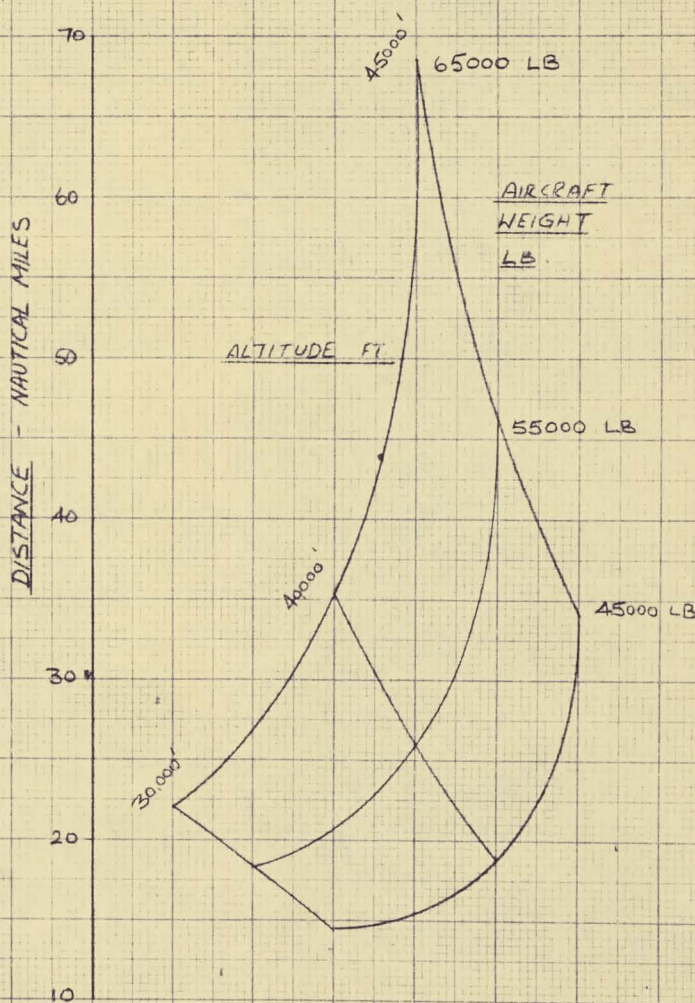
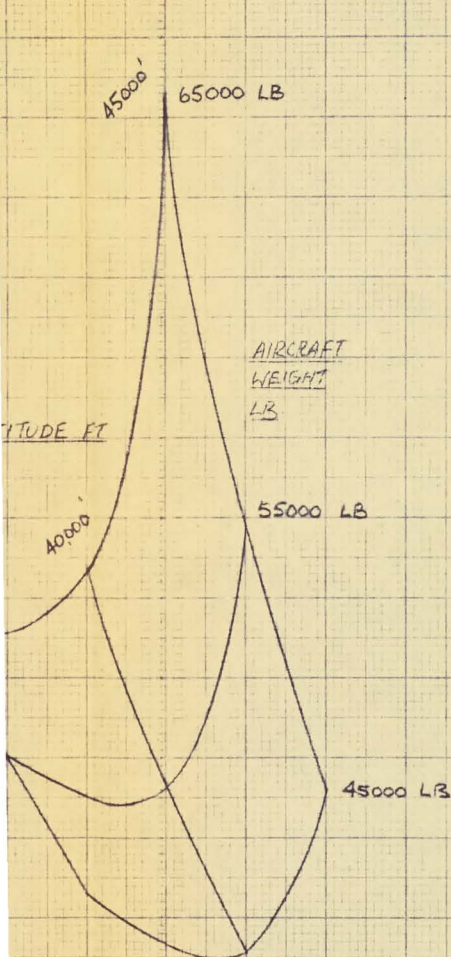


ARROW I
ACCELERATION
TIME, FUEL AND DISTANCE
FROM M = .92 TO M = 1.5
MAXIMUM THRUST



71/PERF/3

ROW I
ERATION
TO M=1.5, A/B ON
THRUST

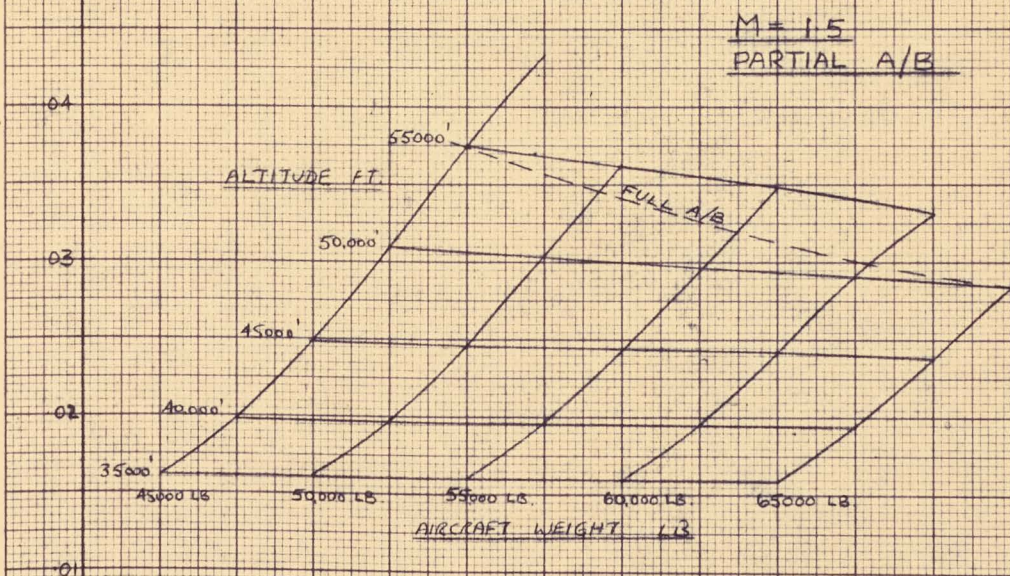
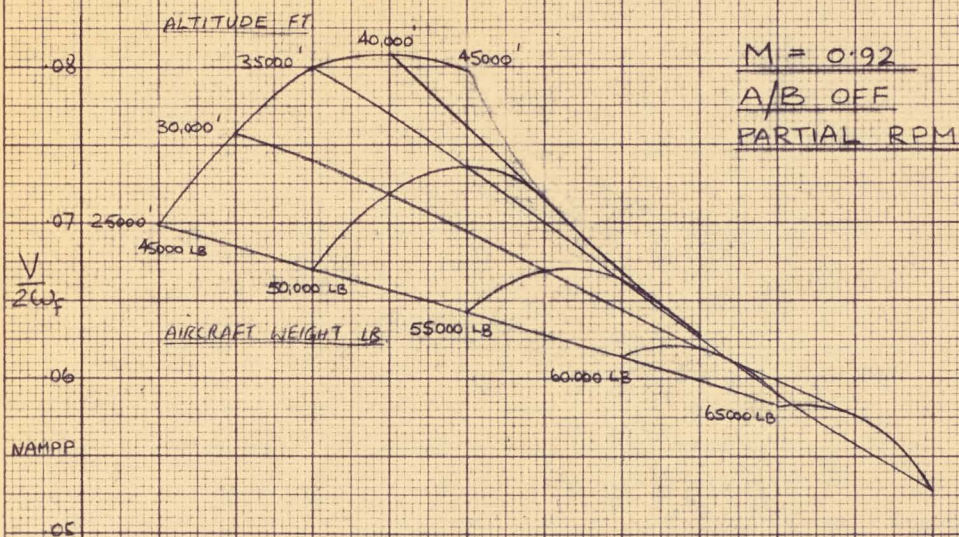


P.H. OCTOBER, 57

71/PERF/3

ARROW I CRUISE NAMPP

NOTE: 4° UP AILERON USED ABOVE 45000'



P.H. OCTOBER '57

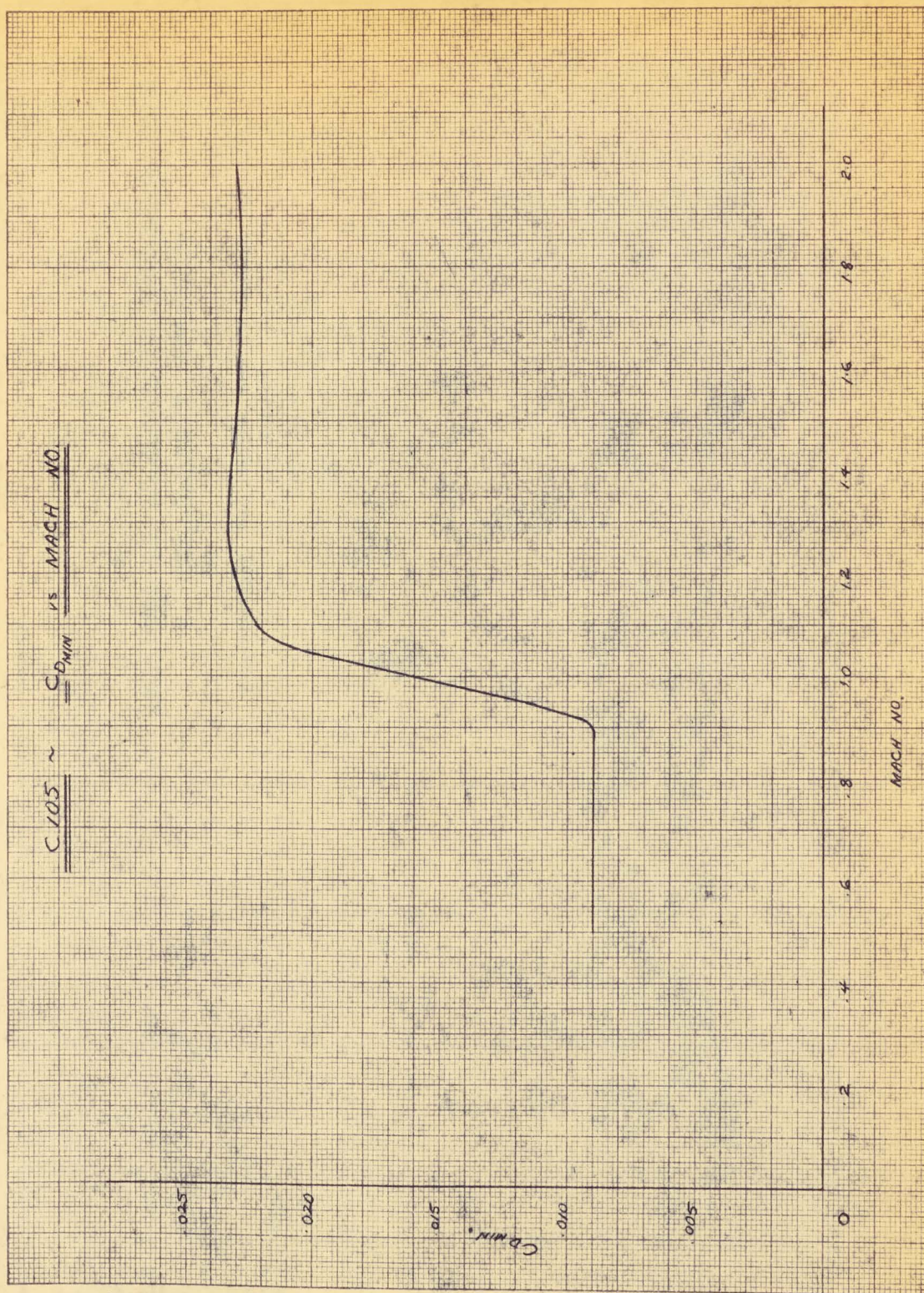
DRAG

2 : ARROW DRAG DATA

No drag revision has been made since periodic performance report No. 9. For the user's convenience this data has been reproduced in this report.

KE
10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

P/AERO DATA/74



$C_{105} \sim C_2 \sim C_0 \quad \theta \text{ of } 20^\circ$

$C_0 = 29.9\% \text{ MFC}$

MECH. NO.

CONSOLE UNITARY W/T, JUNE 1956

EXPERIMENTAL W/T MARK 156

1.41

1.23

1.15

1.10

1.05

1.0

.95

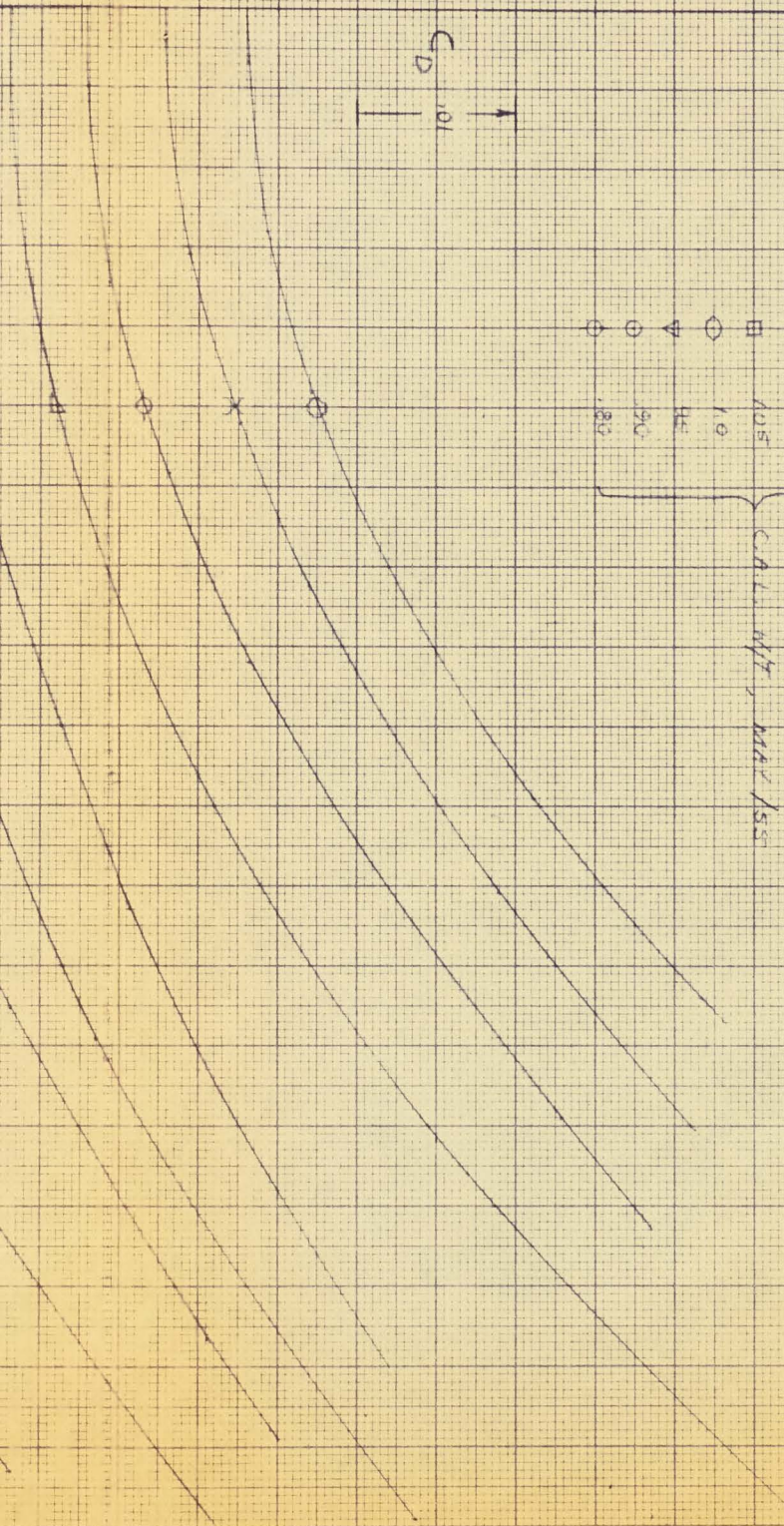
.90

.85

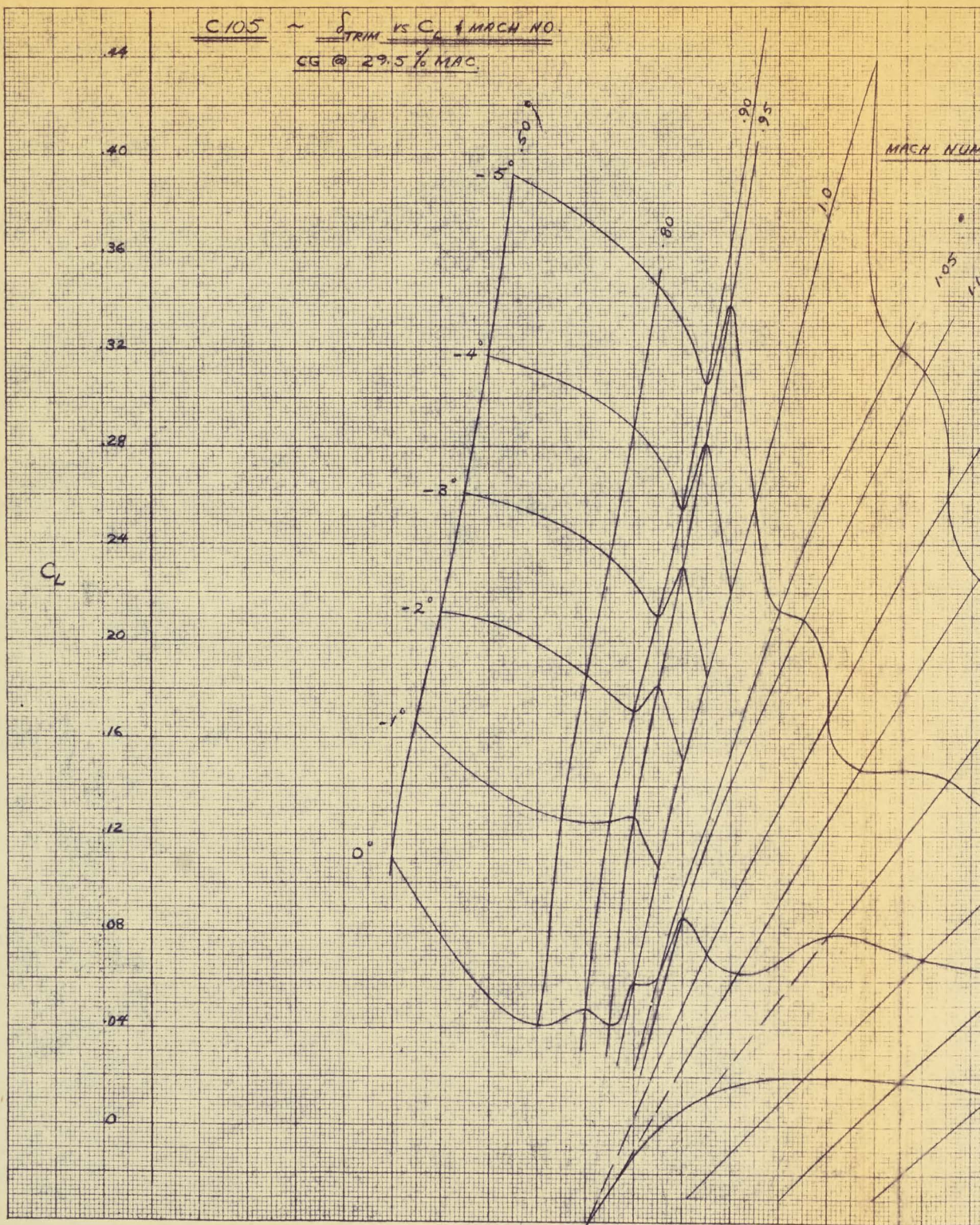
CALC. W/T, MAY 1955

C_D

1



10 X 10 TO THE CM.
 359-14L
 KRUEFFEL & ESSER CO.
 WAGNER, S.A.



K&E 10 X 10 TO THE CM. 359-14L
KEUFFEL & ESSER CO. MADE IN U.S.A.

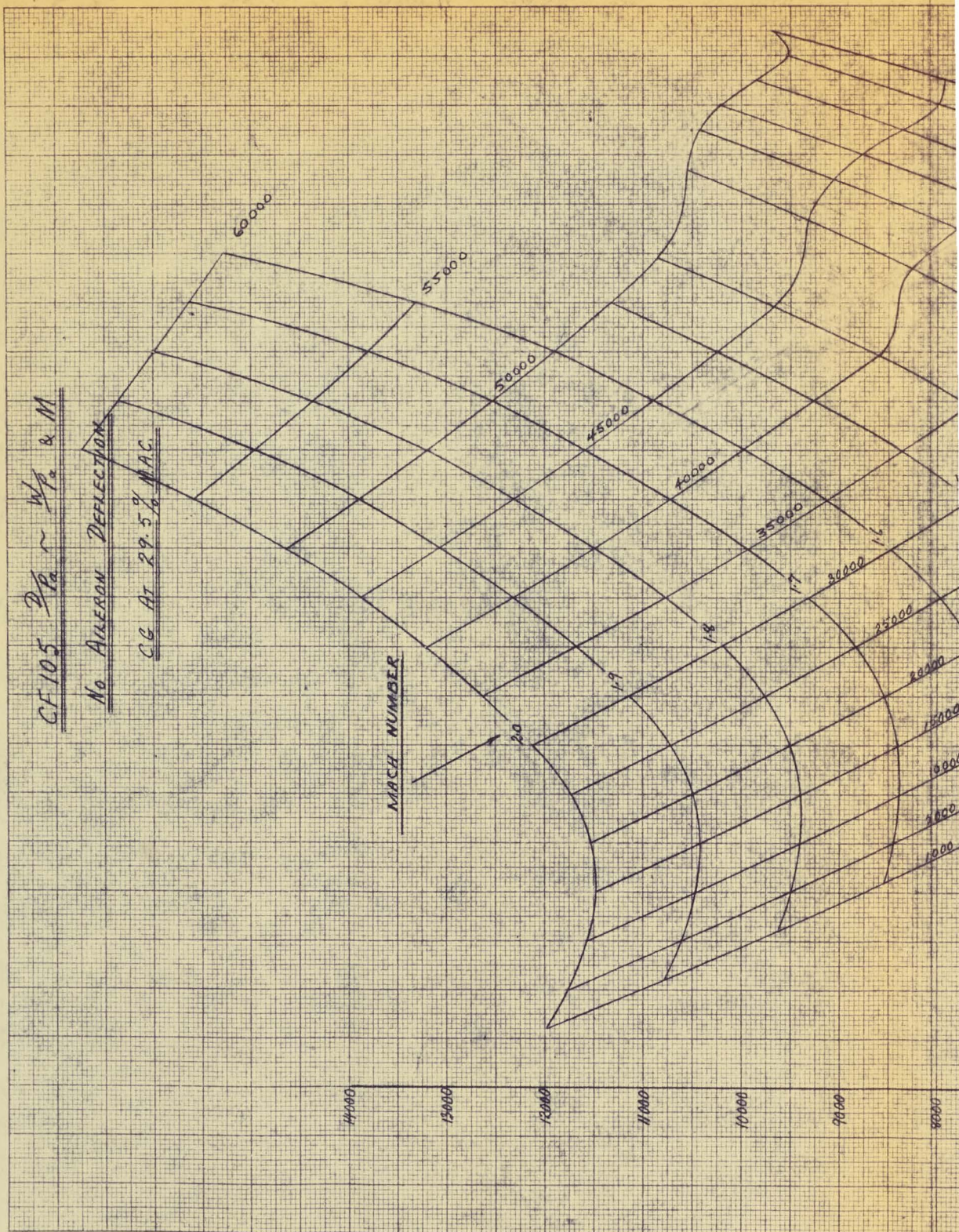
CF105 $\frac{3}{4}$ ~ $\frac{1}{2}$ & M

NO AILERON DEFLECTION

CG AT 29.5% MAC

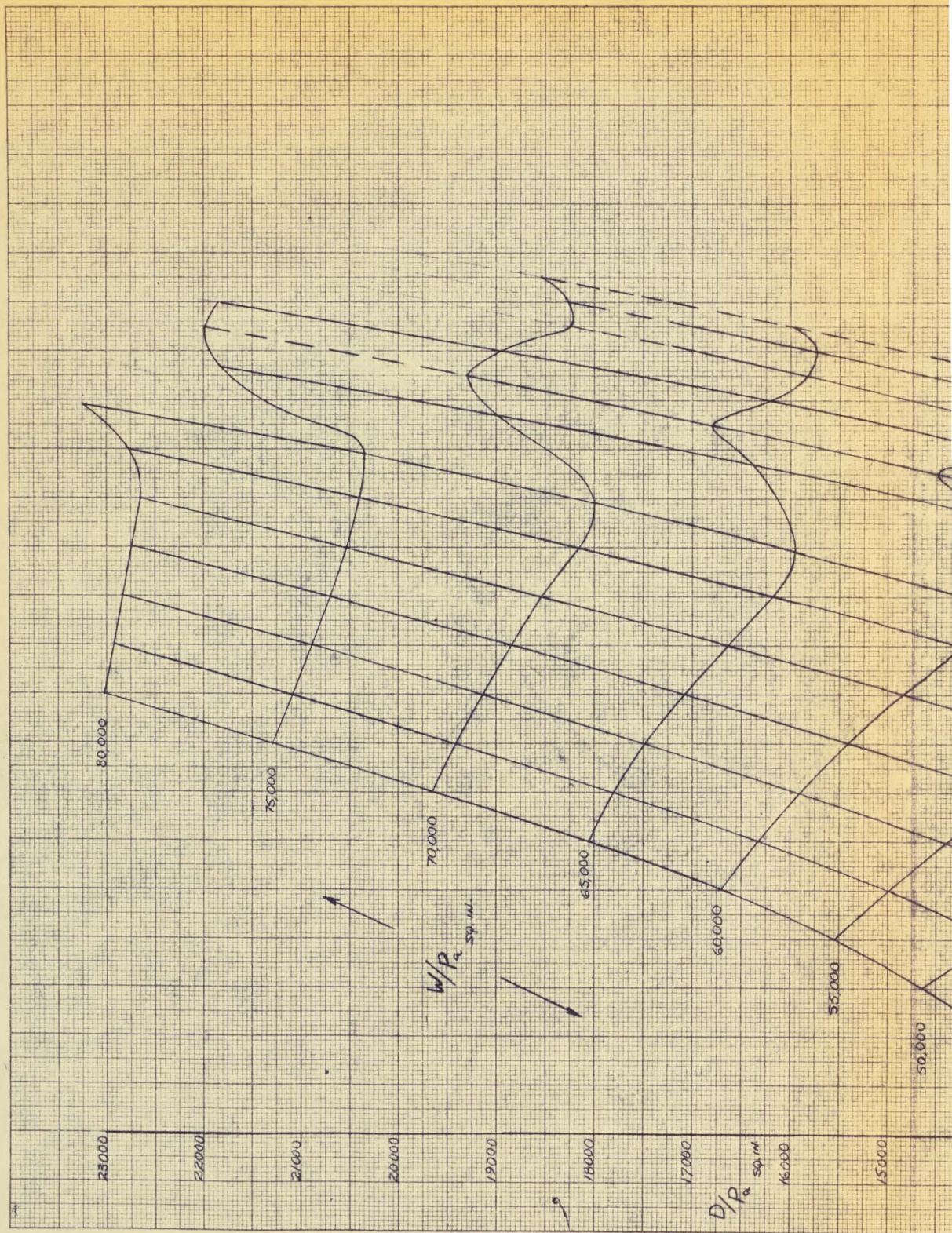
MACH NUMBER

14000
15000
16000
17000
18000
19000
20000

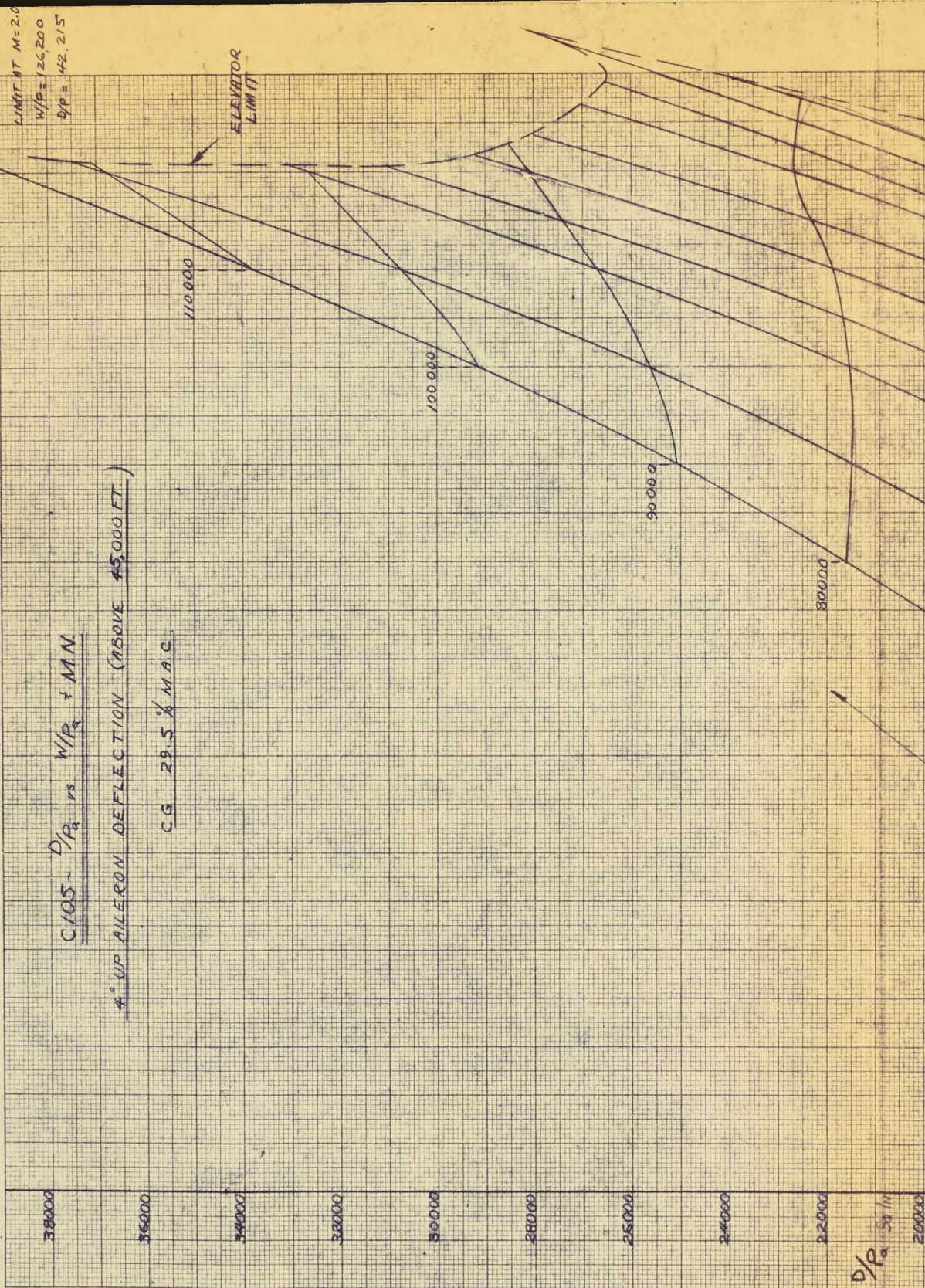


Nov 1956

KE 10 X 10 TO THE CM. 359-14L
KEUFFEL & ESSER CO. MADE IN U.S.A.



KE 10 X 10 TO THE CM. 359-14L
KEUFFEL & ESSER CO. MADE IN U.S.A.

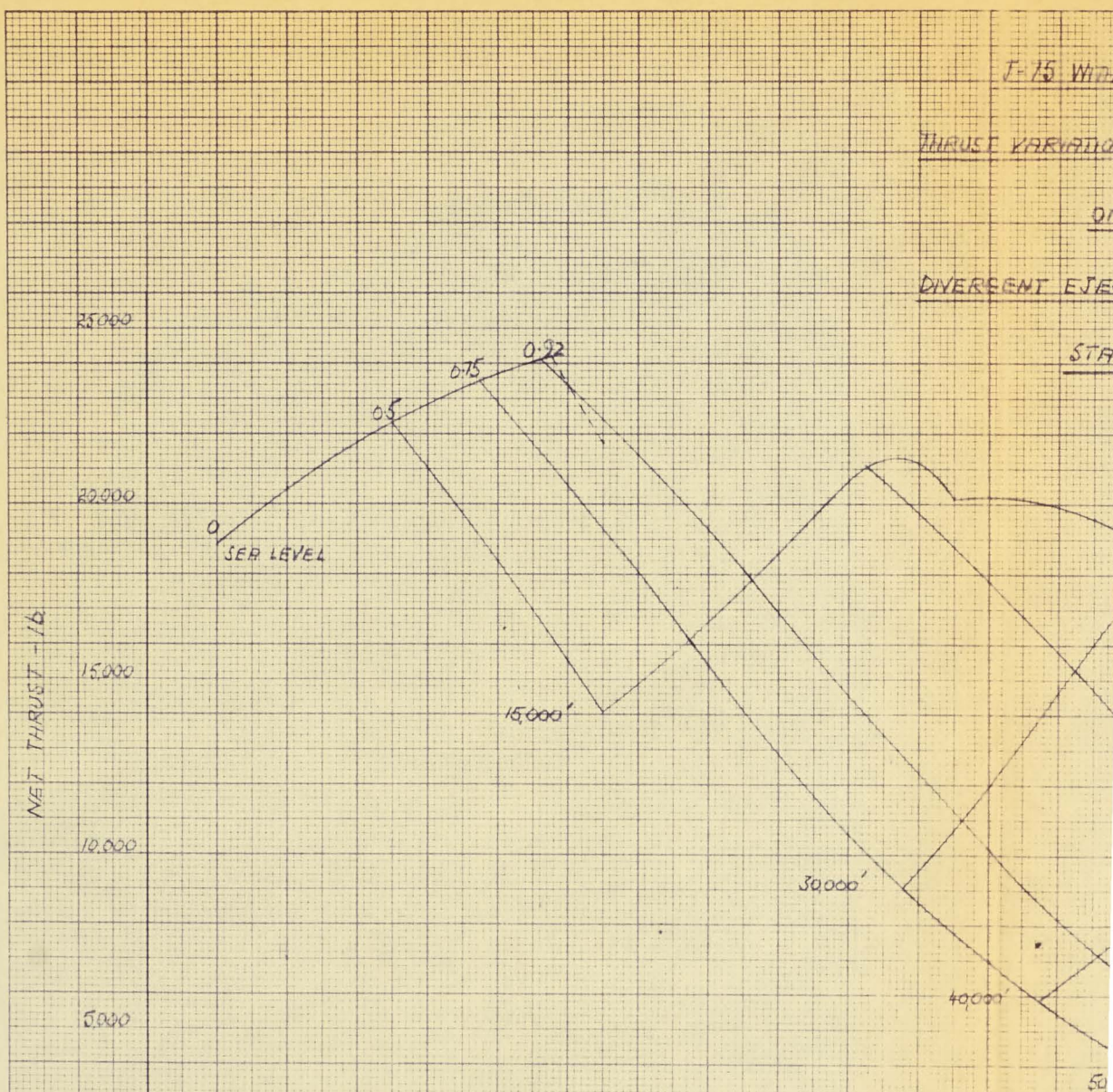


3 : ARROW 1 PROPULSION DATA

The installed J 75 engine data has been revised. Essentially the change is to a 45" divergent ejector instead of a 39" cylindrical ejector.

This revised estimate utilizes experimental ejector pumping and thrust characteristics from Nobel, with the exception of afterburner unlit thrust characteristics which have been obtained from N.A.C.A. experimental data, as the Nobel showed too much scatter to correlate. The geometry of the tests differs slightly from the actual installation particularly in the afterburner unlit cases

This leads to some doubt as to whether the discharge flow is attached or unattached, notably at $M = .92$ at 40,000 ft. In the present estimate the more conservative value obtained with attached flow has been used.



NOTE - THIS THRUST INCLUDES ALLOWANCES FOR -

1. CONSTANT ENGINE AIRSPEED OF 133 ft/SEC
2. POWER EXTRACTION OF 50HP FROM HIGH PRESSURE RO
3. POWER EXTRACTION OF 32HP FROM LOW PRESSURE RO

SEPT/57

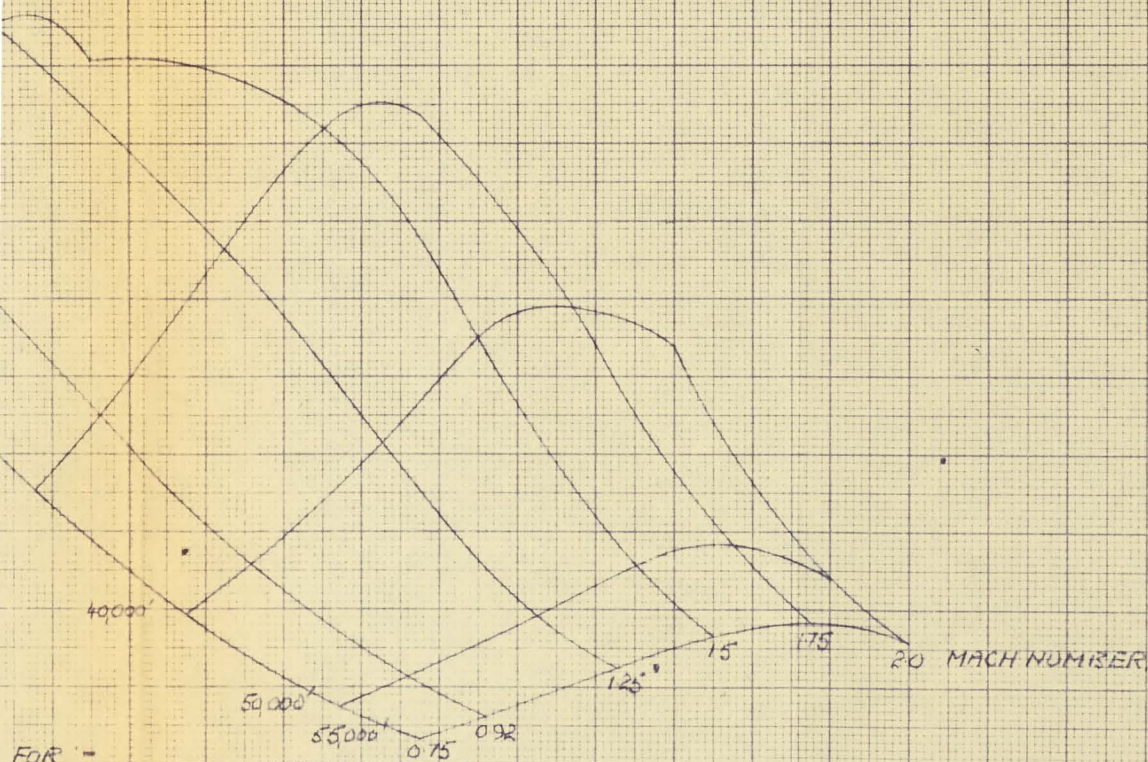
F-15 WITH FULL AFTER BURNER MAX THRUST

THRUST VARIATION WITH MACH NUMBER AND ALTITUDE

ONE ENGINE

DIVERGENT EJECTOR WHERE $D_2 = 34.2"$ AND $D_2/D_1 = 1.312$

STANDARD DAY



FOR -

16/SEC

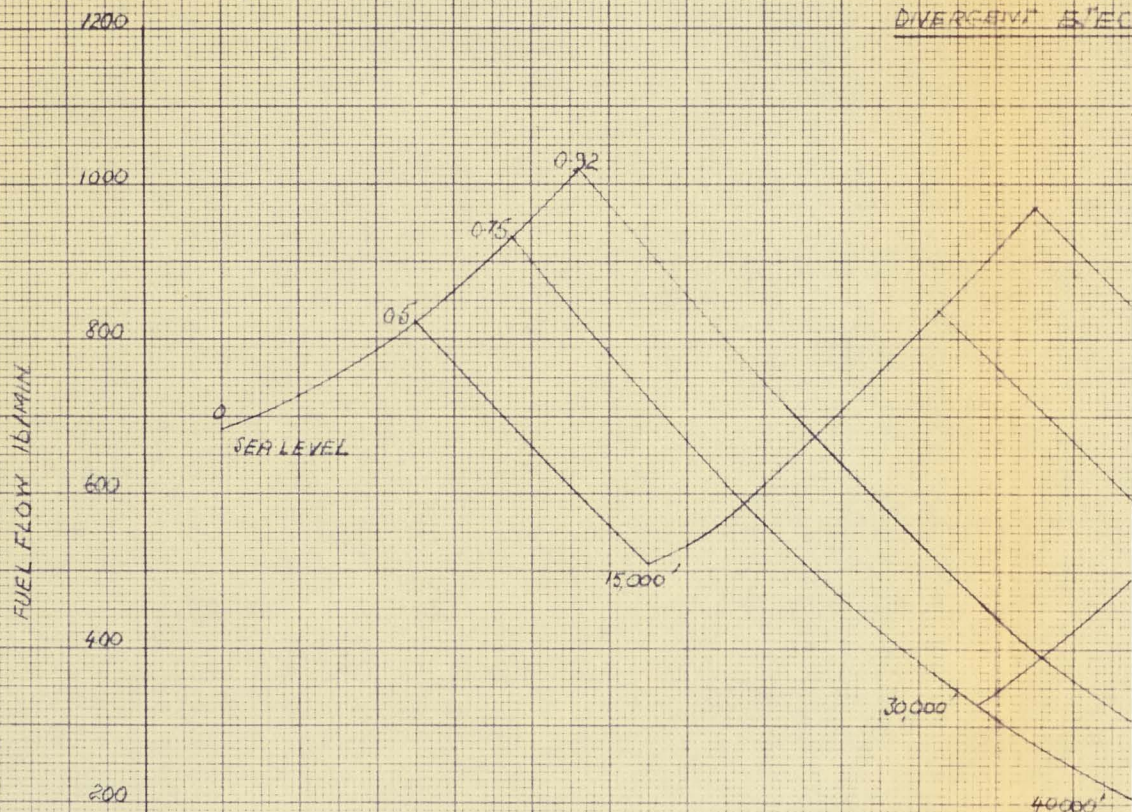
HIGH PRESSURE ROTOR FOR HYDRAULIC SERVICES

LOW PRESSURE ROTOR FOR ELECTRICAL SERVICES

J-75 W1

FUEL FLOW VARIATION

DIVERGENT EFFECT



NOTE - THIS FUEL FLOW INCLUDES ALLOWANCES FOR -

1. CONSTANT ENGINE AIR BLEED OF 133 lb/sec
2. POWER EXTRACTION OF 50 H.P. FROM HIGH PRESS
3. POWER EXTRACTION OF 32 H.P. FROM LOW PRESS

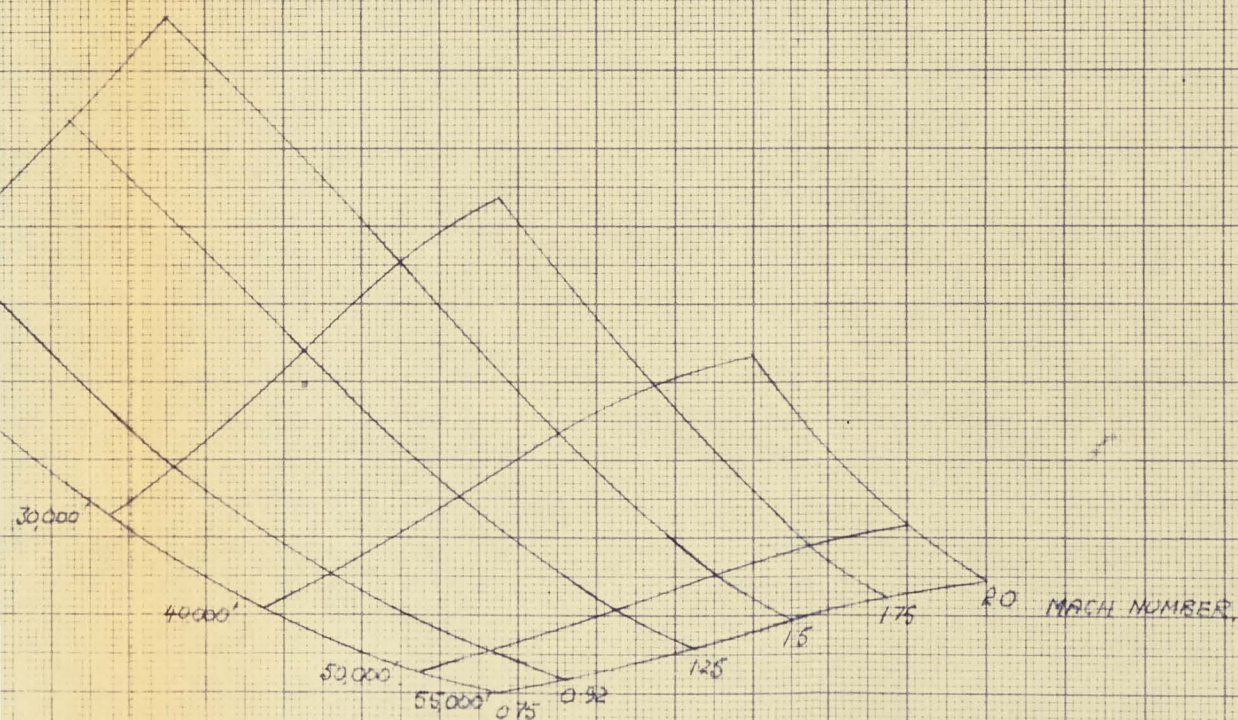
F-75 WITH FULL AFTERBURNER MAX THRUST

PL FLOW VARIATION WITH MACH NUMBER AND ALTITUDE

ONE ENGINE

DIVERGENT SECTION WHERE $D = 34.2"$ AND $A_0/A^* = 1.512$

STANDARD DAY



ORANKER FOR -

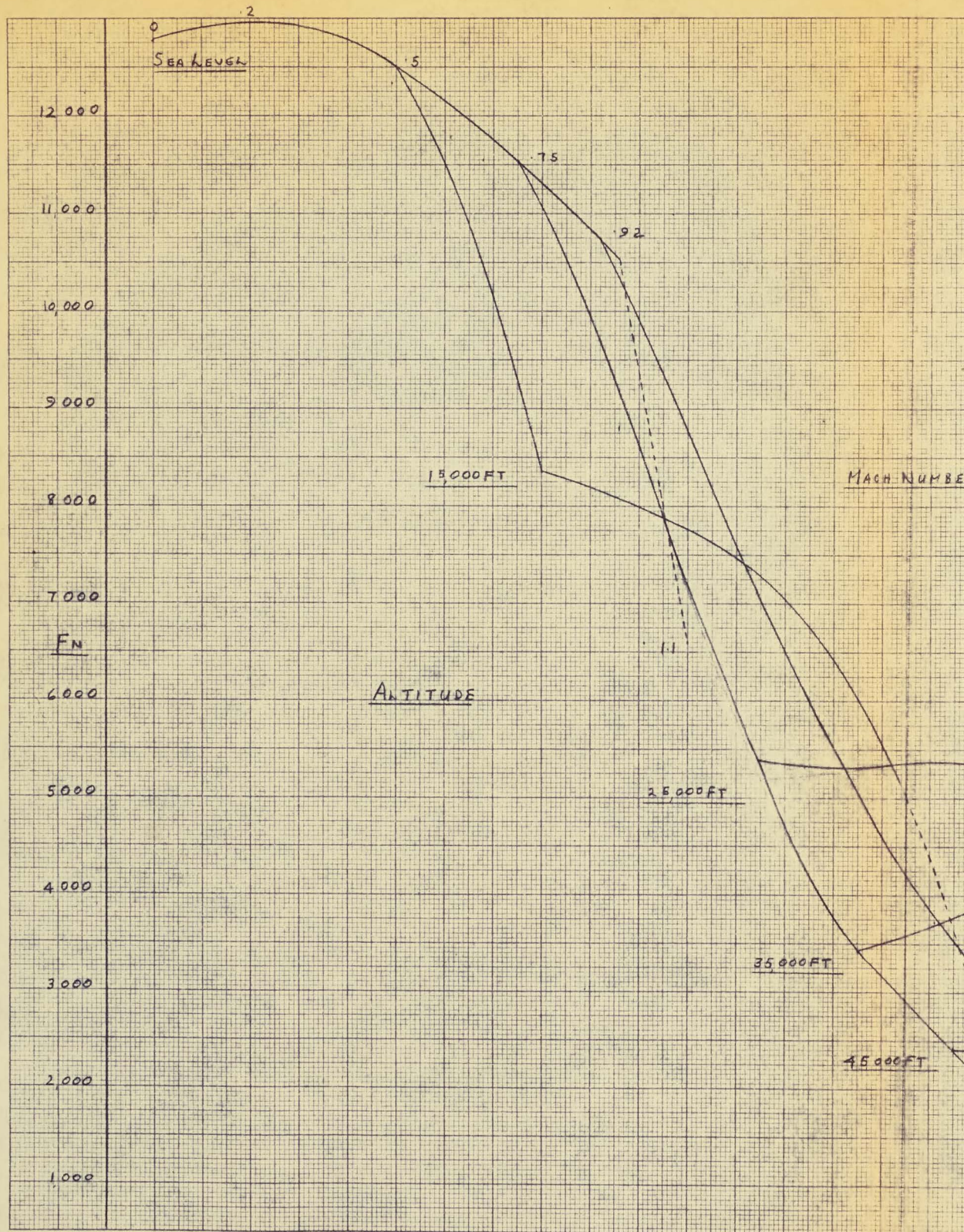
D OF 133 16/SEC

P FROM HIGH PRESSURE ROTOR FOR HYDRAULIC SERVICES

P FROM LOW PRESSURE ROTOR FOR ELECTRICAL SERVICES,

10 X 10 TO THE CM.
KEUFFEL & ESSER CO.
MADE IN U.S.A.

K·E



71/POWER/1

J 75 WITHOUT AFTERBURNER MILITARY THRUST

THRUST VARIATION WITH MACH NUMBER AND ALTITUDE

ONE ENGINE

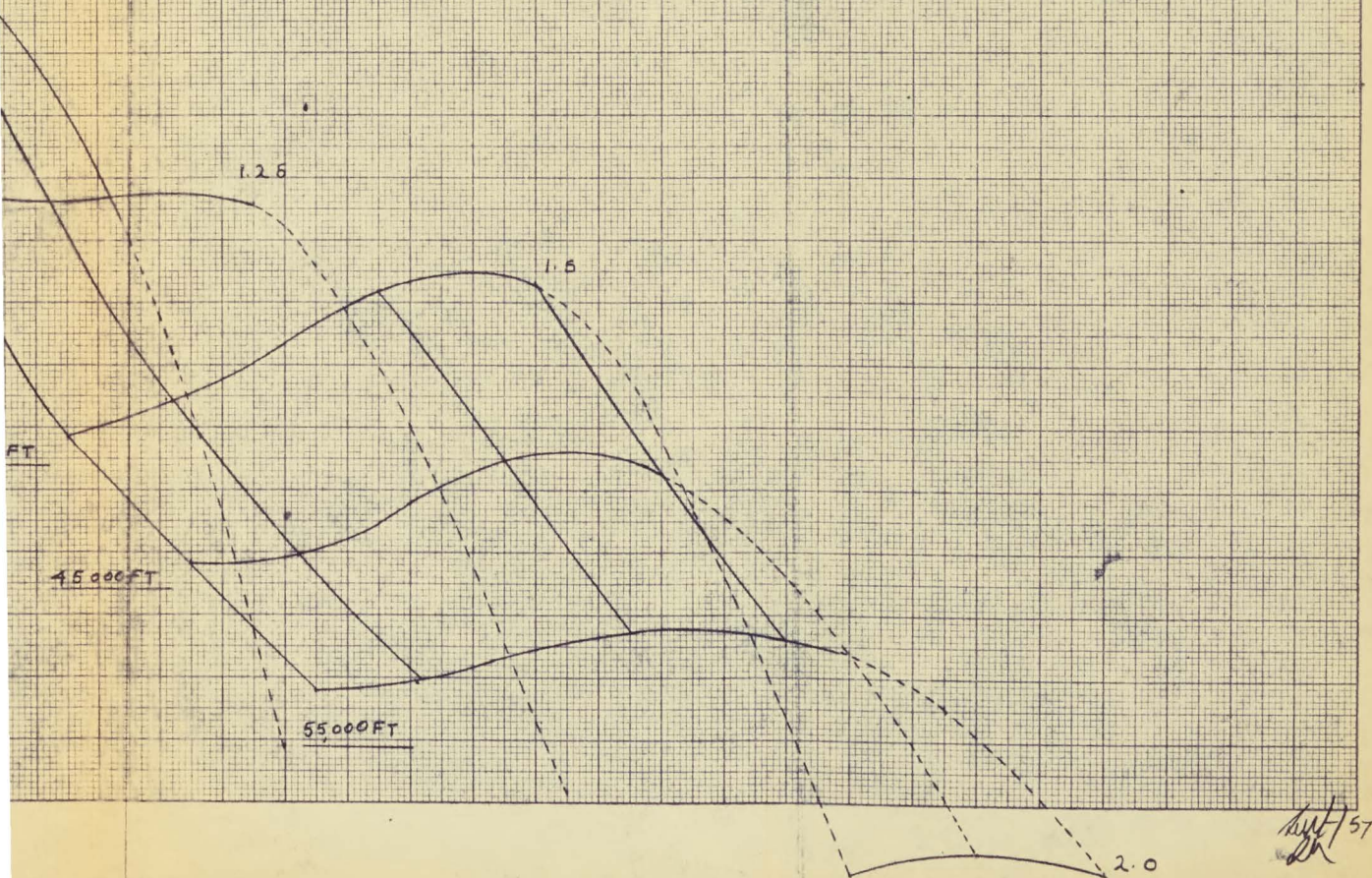
DIVERGENT EJECTOR WHERE $D_e = 25.6"$ AND $D_e/D_p = 1.756$

STANDARD DAY

NOTE:- THIS THRUST INCLUDES ALLOWANCE FOR

- (1) CONSTANT ENGINE AIRBLEED OF 1.33 LB/Sec
- (2) POWER EXTRACTION OF 50 H.P. FROM HIGH PRESSURE ROTOR FOR HYDRAULIC SERVICES
- (3) POWER EXTRACTION OF 32 H.P. FROM LOW PRESSURE ROTOR FOR ELECTRICAL SERVICES

MACH NUMBER



1/57

T75 WITHOUT AFTERBURNER MILITARY THRUST

FUEL FLOW VARIATION WITH MACH NUMBER AND ALTITUDE

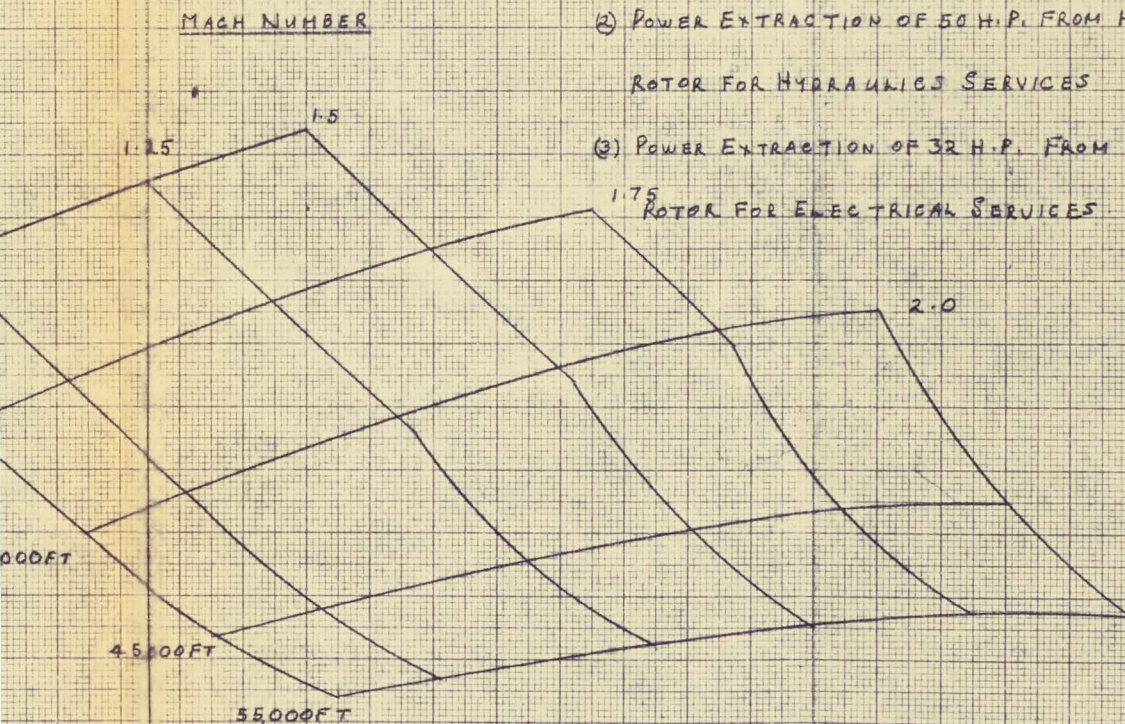
ONE ENGINE

DIVERGENT EJECTOR WHERE $DP = 25.6''$ AND $DE/DP = 1.756$

STANDARD DAY

NOTE:- THIS FUEL FLOW INCLUDES ALLOWANCES FOR:-

- (1) CONSTANT AIRBLEED OF 1.38 LB/SEC
- (2) POWER EXTRACTION OF 50 H.P. FROM HIGH PRESSURE ROTOR FOR HYDRAULICS SERVICES
- (3) POWER EXTRACTION OF 32 H.P. FROM LOW PRESSURE ROTOR FOR ELECTRICAL SERVICES



8/6 57
JW

71/POWER/1

J75 INSTALLED THRUST V FUEL FLOW

PARTIAL R P M AFTERBURNER UNLIT

MASH NUMBER .92

