PART 5. TACTICAL

PART 5 TACTICAL

Supersonic data for the T Mk.4 are given on the coloured sheets placed opposite the corresponding data on white sheets for the F Mk.1 & 2 and 1A when the refuelling probe is not fitted. The T Mk.4 figures are distinguished by the affix T to the figure number. The white figures 5.3, 5.20 & 5.21 apply to the T Mk.4 as well as to the other Marks.

LIST OF FIGURES

1. Acceleration

1.1 Low levels (without reheat)

Data for low level accelerations, including acceleration from take-off to climb-away speed without reheat, are given in 5.1 and 5.2. These show time, distance, and fuel from .3M to .6M and to .9M over a range of O.A.T. and heights up to 10,000 ft.

Example:

Initial condition M 0.3, 0°C, 10,000 ft
final M 0.6.

5.1 gives time 0.5 min. fuel 140 lb,
distance 2.5 a.n.m.

1.2 High levels (with reheat)

Time, distance and fuel in accelerating from 0.85M *(or above)* with full reheat, for three isothermal atmospheres -36.5, -56.5 and -66.5°C, starting at 30,000 ft, are given in 5.3 to 5.9.

Example:

Starting speed 1.0M at 30,000 ft and -36.5°C, with all stores.

5.7 gives at 1.6M

Time 2.8 min, fuel 1600 lb, distance 37 a.n.m.

These figures apply to 31,000 lb. Correction for weight can be made from 5.3. For an extra 2000 lb the percentage corrections on time, distance and fuel are 2 x 5 = 10% giving 3.1 min, 1760 lb and 41 a.n.m.

2. Deceleration

Data for deceleration in level flight with engines set at idle/fast idle and with air brakes both IN and OUT are given for 2 configurations at a mean weight, at standard temperature *(variation with temperature can be neglected).*

2.1 Low levels up to 10,000 ft (5.10 to 5.13)

Example:

Initial M 0.8 at 5,000 ft. Final M 0.4 with ventral tanks.

5.10 and 5.11 give for times, distance and fuel with air brakes IN and OUT

1.4 min IN and .75 min OUT
8 a.n.m. IN and 4.5 a.n.m. OUT
65 lb IN and 35 lb OUT

2.2 Higher altitudes down to 30,000 ft (5.14-5.17)

Example:

Initial M 1.3 at 50,000 ft. Final M 1.0 with all stores.

5.16 and 5.17 give for times, distance and fuel with air brakes IN and OUT

0.9 min IN and 0.6 min OUT
10 a.n.m. IN and 7 a.n.m. OUT
22 lb IN and 16 lb OUT

3. Turning performance

3.1 Accelerated turns (5.18, 5.19)

These data show 180° accelerated turns with full reheat at 30,000 ft and above. Entering with the value of the initial Mach number you can read off the following conditions at the end of the 180° turn; time elapsed, fuel used, final Mach number, and the longitudinal and lateral displacements from the initial position *(that is, the a.n.m. along and across the initial flight path, after 180°, measured from the initial position).*

Example:

Initial Mach No. 1.45 at 45,000 ft
From 5.18 final Mach No. 1.32, fuel used 350 lb time 1.3 min, longitudinal displacement + 0.6 a.n.m. lateral 11 a.n.m.

(The positive sign of the longitudinal displacement means that the aircraft is upstream of the initial position in the direction of the initial flight path).

3.2 Steady turns (5.20-5.22)

5.20 and 5.21 are universal relationships; that is, they apply to all aircraft. This is because the curvature of any path or orbit depends only upon speed and acceleration and the radius of steady turn depends only upon T.A.S. and the g load applied *(or the angle of bank)*. Since the T.A.S. can be expressed in terms of Mach number and temperature we can plot the relation between radius of steady turn, Mach No., g, and O.A.T. (5.20). Also since the time taken in turning depends upon the radius and the T.A.S. we can similarly express the time for an 180° turn in terms of M, g, and O.A.T. (5.21).

The fuel used for 180° depends, of course, upon the aircraft and upon the altitude. It is shown in 5.22.

Example:

At 1.3M, 2g, and -56.5°C *(the stratospheric temperature in I.S.A.)*

5.20 gives a radius of turn of 4.6 a.n.m.

5.21 gives a time for 180° of 1.2 min.

5.22 gives for fuel used at a height of 40,000 ft under these conditions 560 lb

None of these figures shows the **limiting** turns which can be made on Lightning with full reheat. For this information we have to refer to 5.23-5.25 giving the manoeuvre boundaries of the aircraft in two configurations, clean and ventral tank + 2 Firestreaks. *(The values for the ventral tank only case will be between these two)*. Manoeuvres are, of course, always limited by the thrust available or by the control available. The thrust boundaries in 5.23-5.25 are the limits of manoeuvre in level flight.

Example:

On the clean aircraft a 2g turn can be made at 1.3M up to 40,000 ft. With all stores, such a turn can only be made up to 37,000 ft.

The buffet regions to be expected if you fly at low speeds are also indicated.

5.24 gives the same thrust boundary data as 5.23 *(but plotted in a different form)* with the addition of the trim or control limits.

For the clean aeroplane flying at 1.3M at 40,000 ft you can pull up to 4.3g *(in a descending turn)* with the control available compared with 2g in level flight. There will thus be a considerable margin of control in a level turn under these conditions.

3.3 Nomogram of Turning Performance

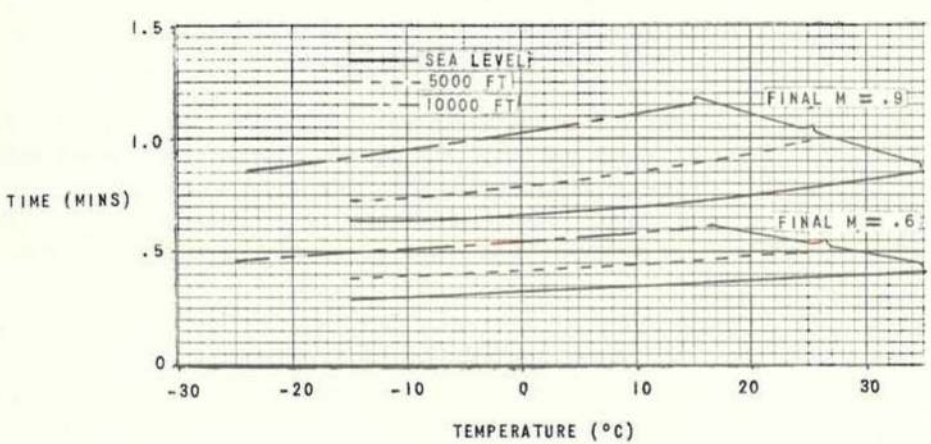
Figure 5.26 reproduces for ready reference the Nomogram of Turning Performance from A.P.129, Vol.1, Section 1, Chapter 12, fig.8.

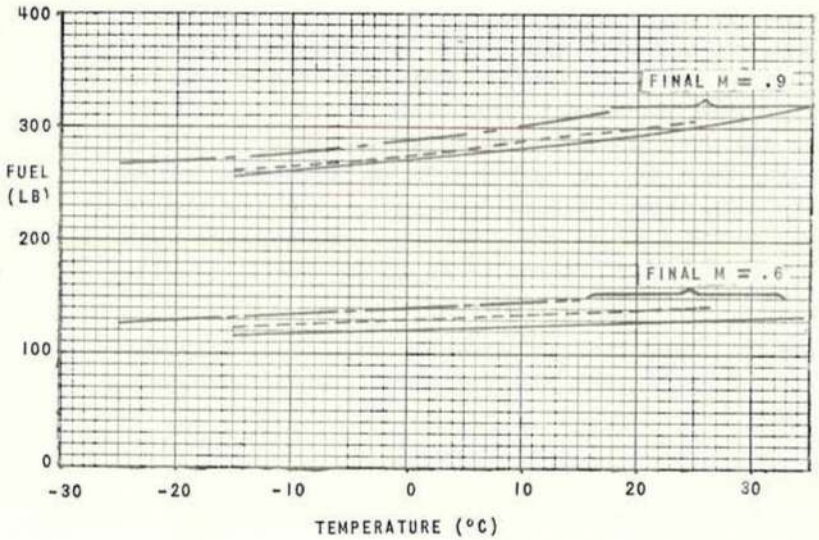
This is applicable to any aircraft and gives considerable information on turning performance. Some examples of the use of the Nomogram are given below.

If the T.A.S. and bank angle are known, then the rate of turn can be found. Assume a T.A.S. of 400 knots and an angle of bank of 60° and read off from the dashed line the rate of turn of 284°/min *(about rate 1½)*. The bank scale also shows the g realised in a sustained turn at that angle of bank., *(in this example 2g)*.

The Mach scale has no significance in this example. Any two known factors can be aligned to determine the unknown third factor.

The Nomogram shows clearly that as speed increases the angle of bank must be increased to maintain a constant rate of turn. It should be noted that the nomogram is applicable to any atmosphere with the exception of the Mach number scale which applies to the standard (I.C.A.O.) atmosphere only.





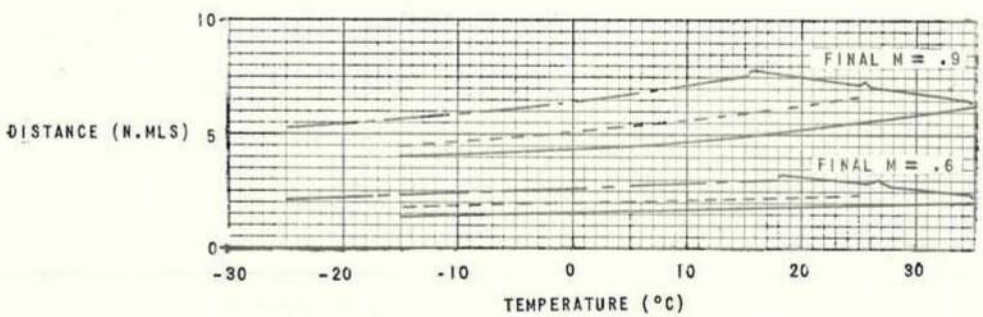


FIG. 5·1. ACCELERATIONS FROM ·3M NO REHEAT - MAX.R.P.M. - 31000 LB

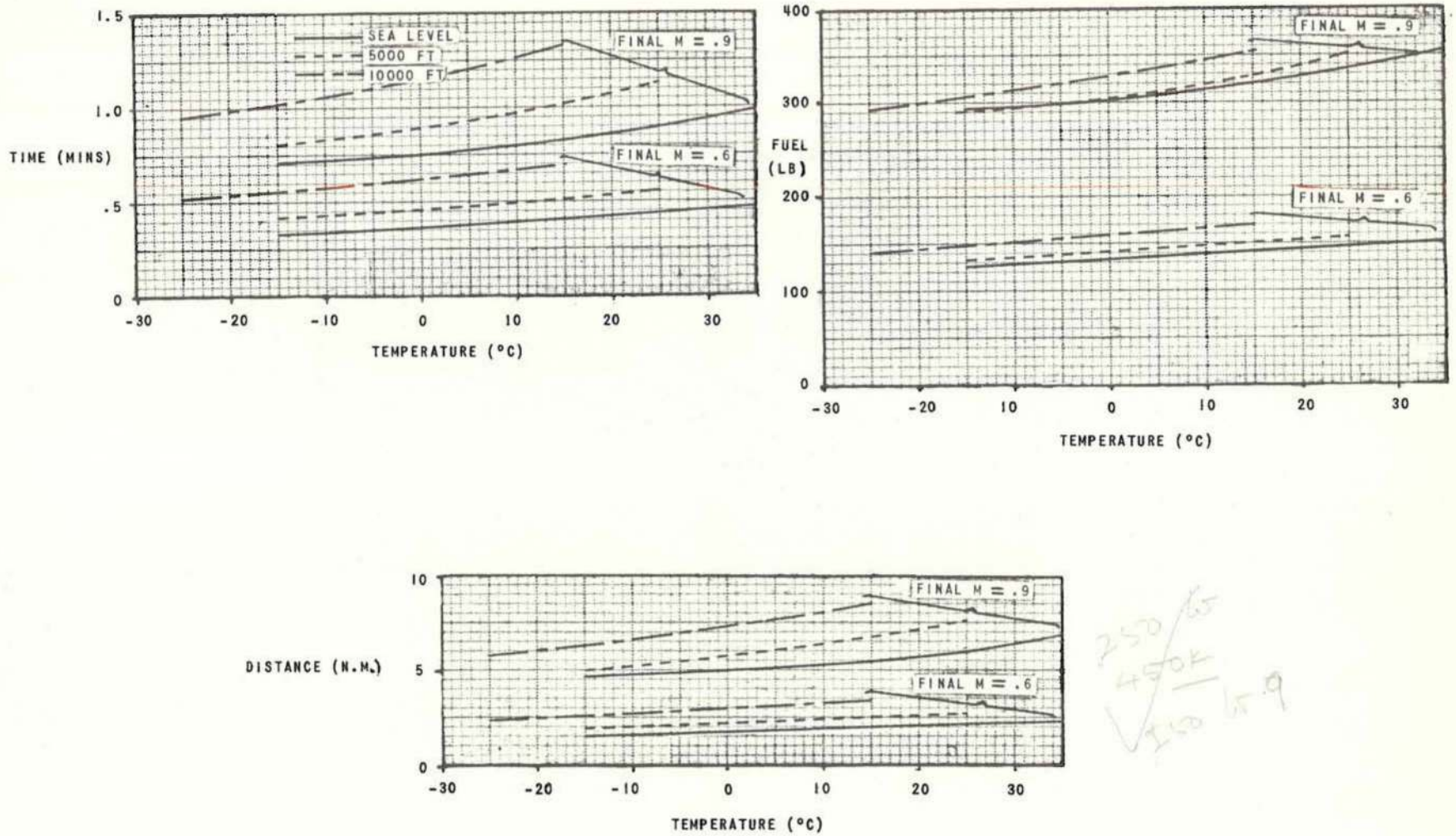


FIG. 5·2. ACCELERATIONS FROM ·3M. NO REHEAT - MAX. R.P.M. 33,000 LB

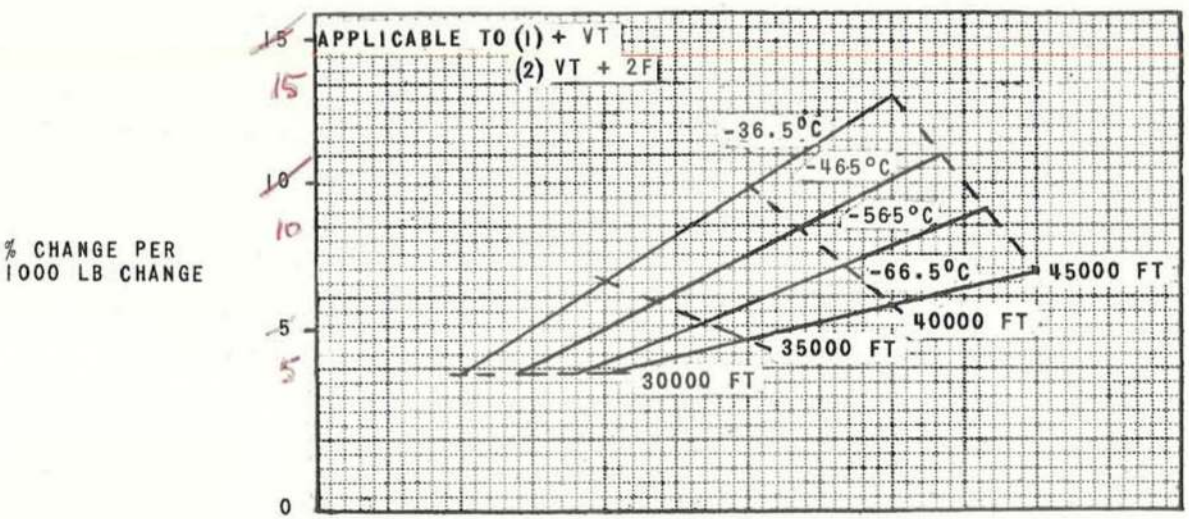
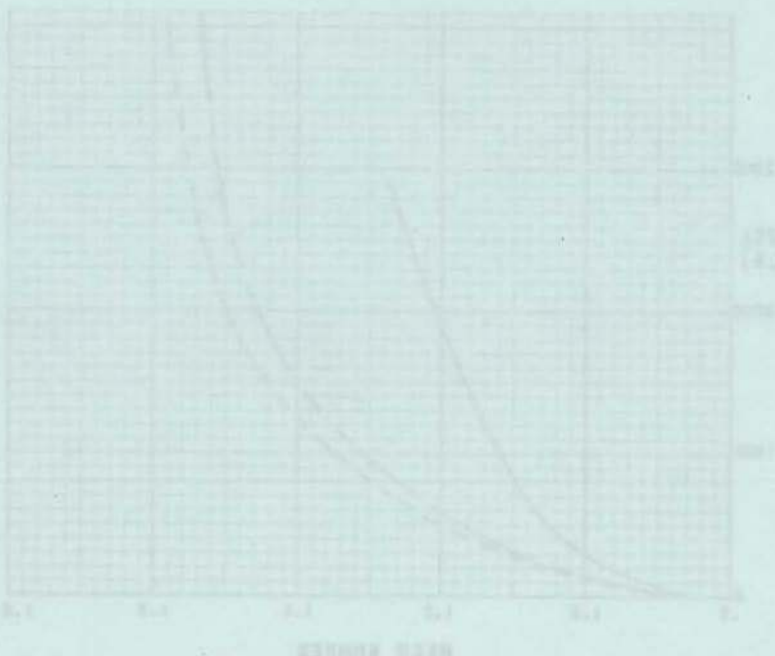


FIG. 5-3. FULL REHEAT ACCELERATIONS. EFFECT OF WEIGHT ON TIME, DISTANCE & FUEL. MAX R.P.M.



LIGHTNING T MK. 4 ONLY

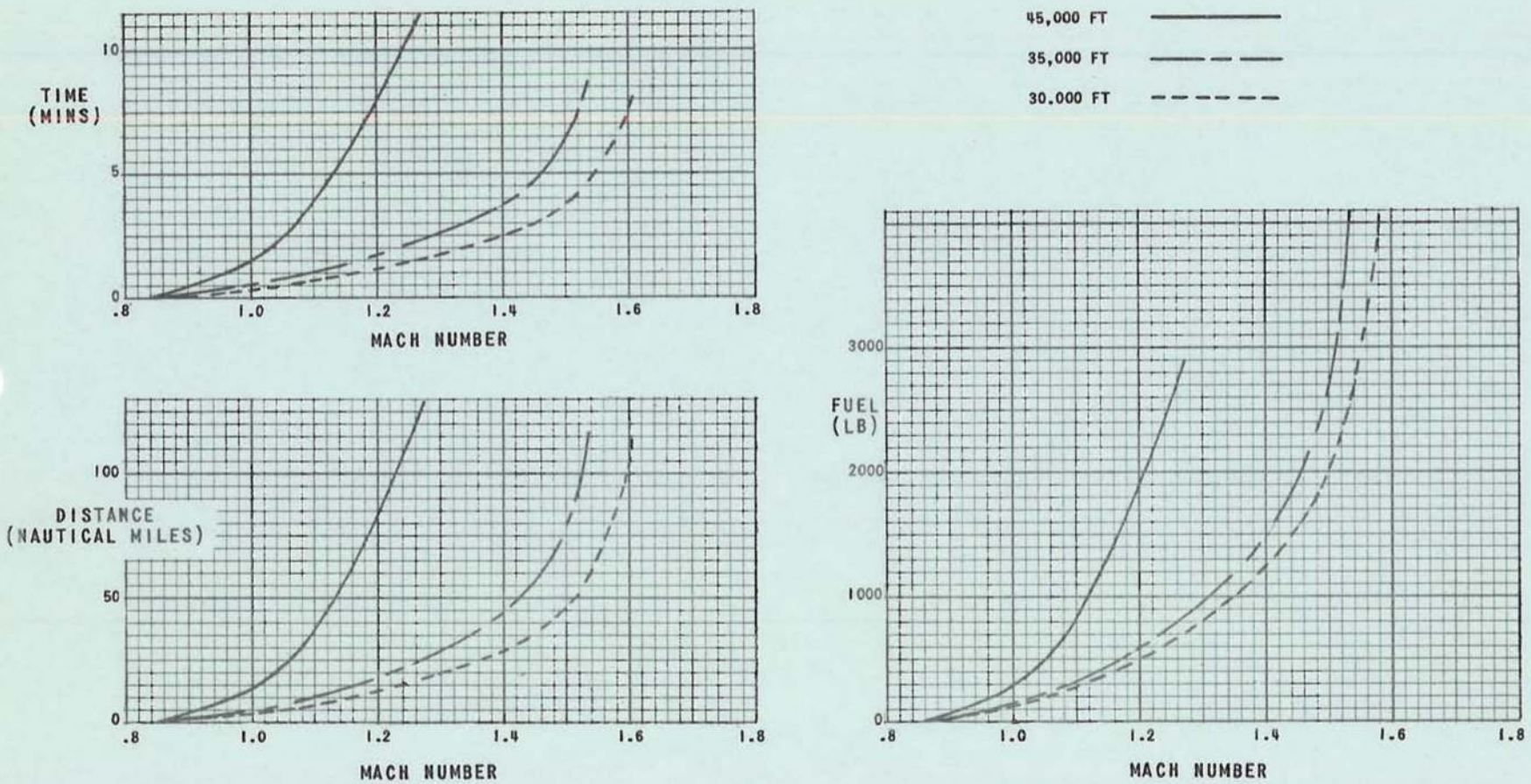


FIG. 5·4T. FULL REHEAT ACCELERATIONS., −36·5°C — MAX. R.P.M. — 31,000LB

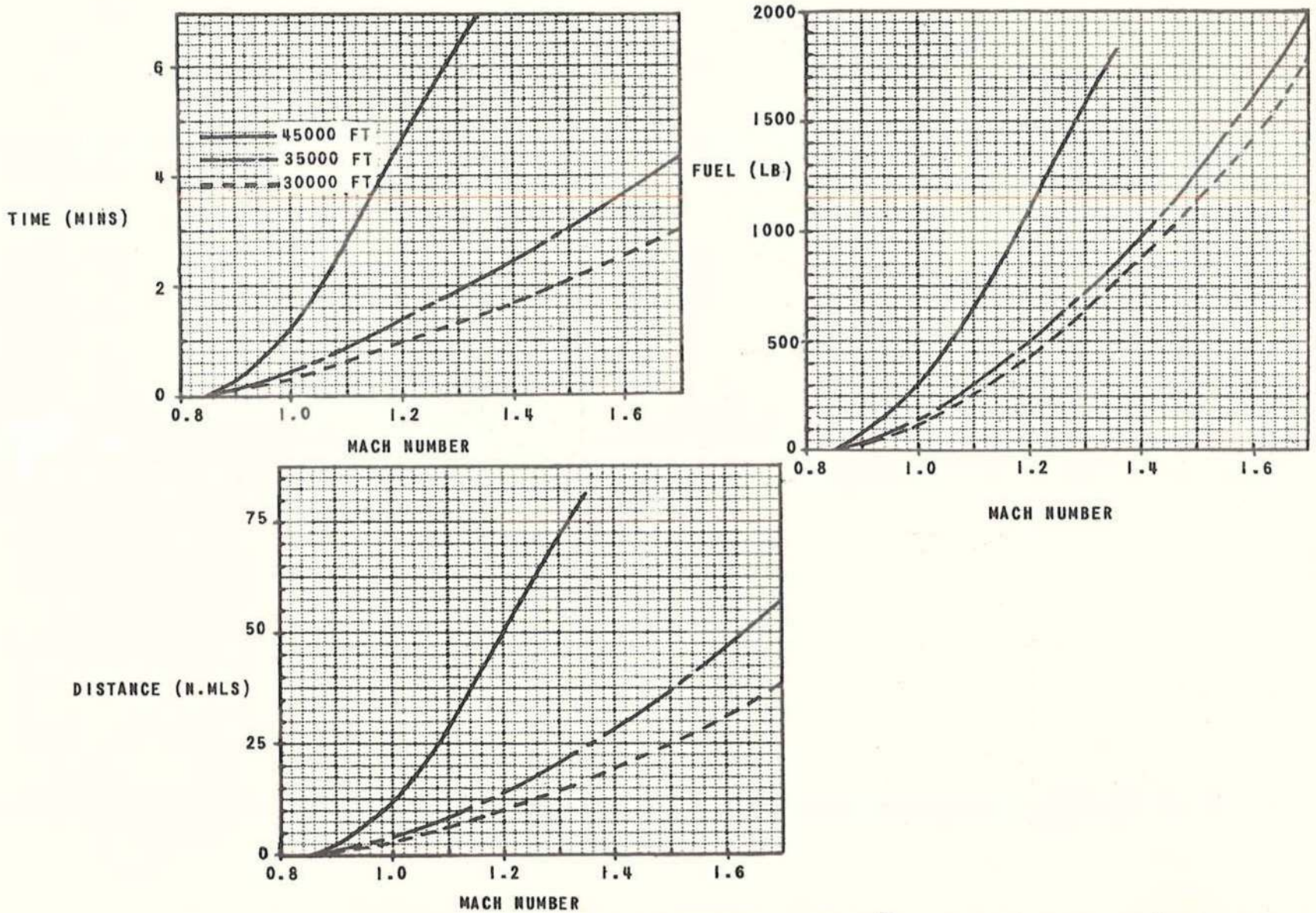
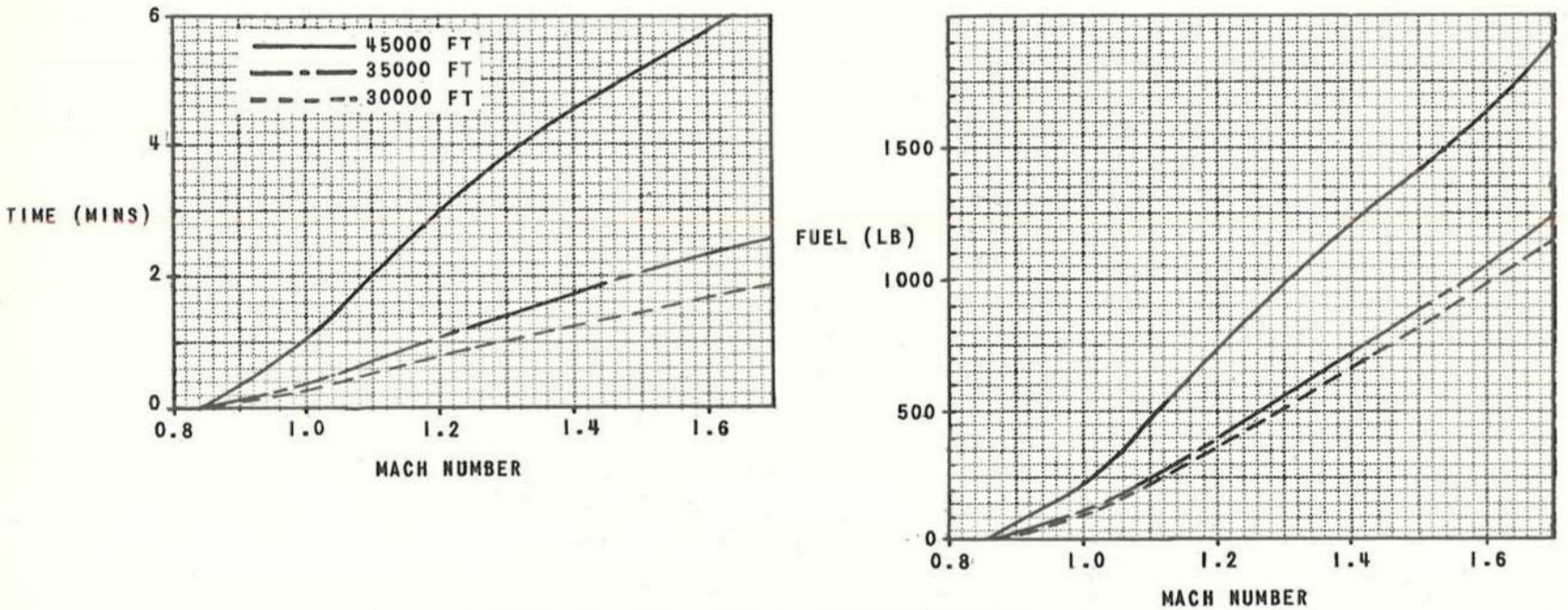


FIG. 5·4. FULL REHEAT ACCELERATIONS – 36.5°C. – MAX.R.P.M. – 31,000 LB



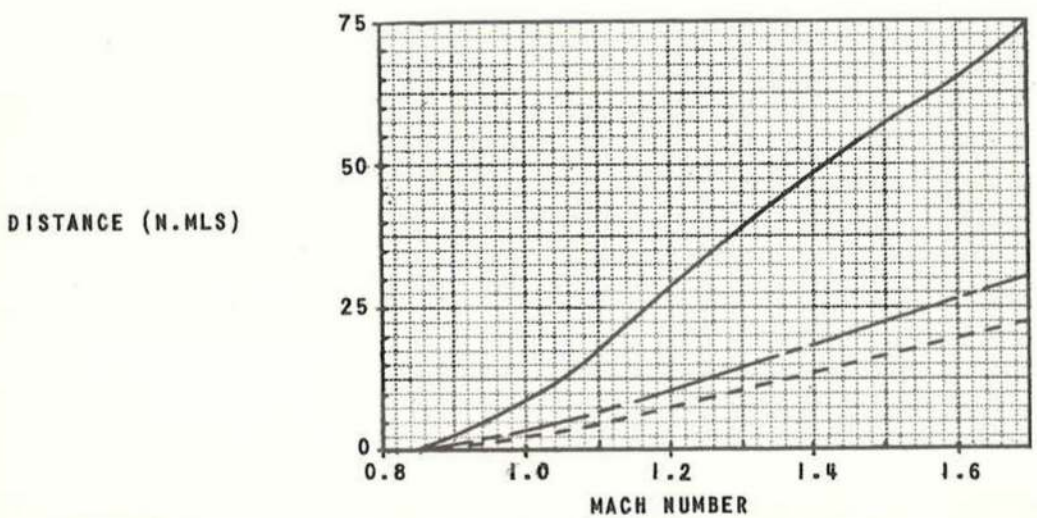


FIG. 5·5. FULL REHEAT ACCELERATION – 56.5°C. MAX.R.P.M.- 31,000 LB

LIGHTNING T MK. 4 ONLY

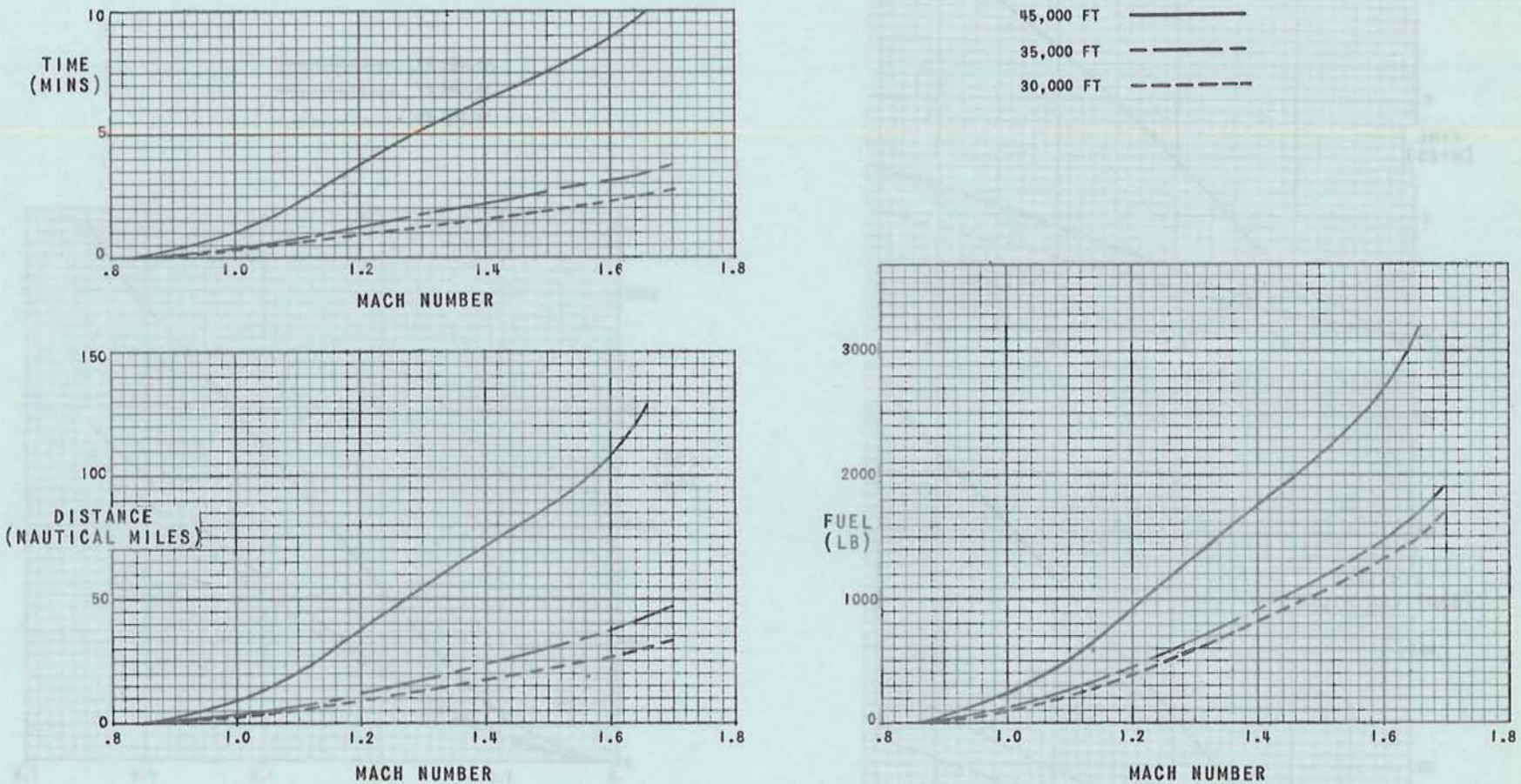


FIG. 5·5T. FULL REHEAT ACCELERATIONS., -56 · 5°C — MAX. R. P. M. — 31,000LB

LIGHTNING T MK. 4 ONLY

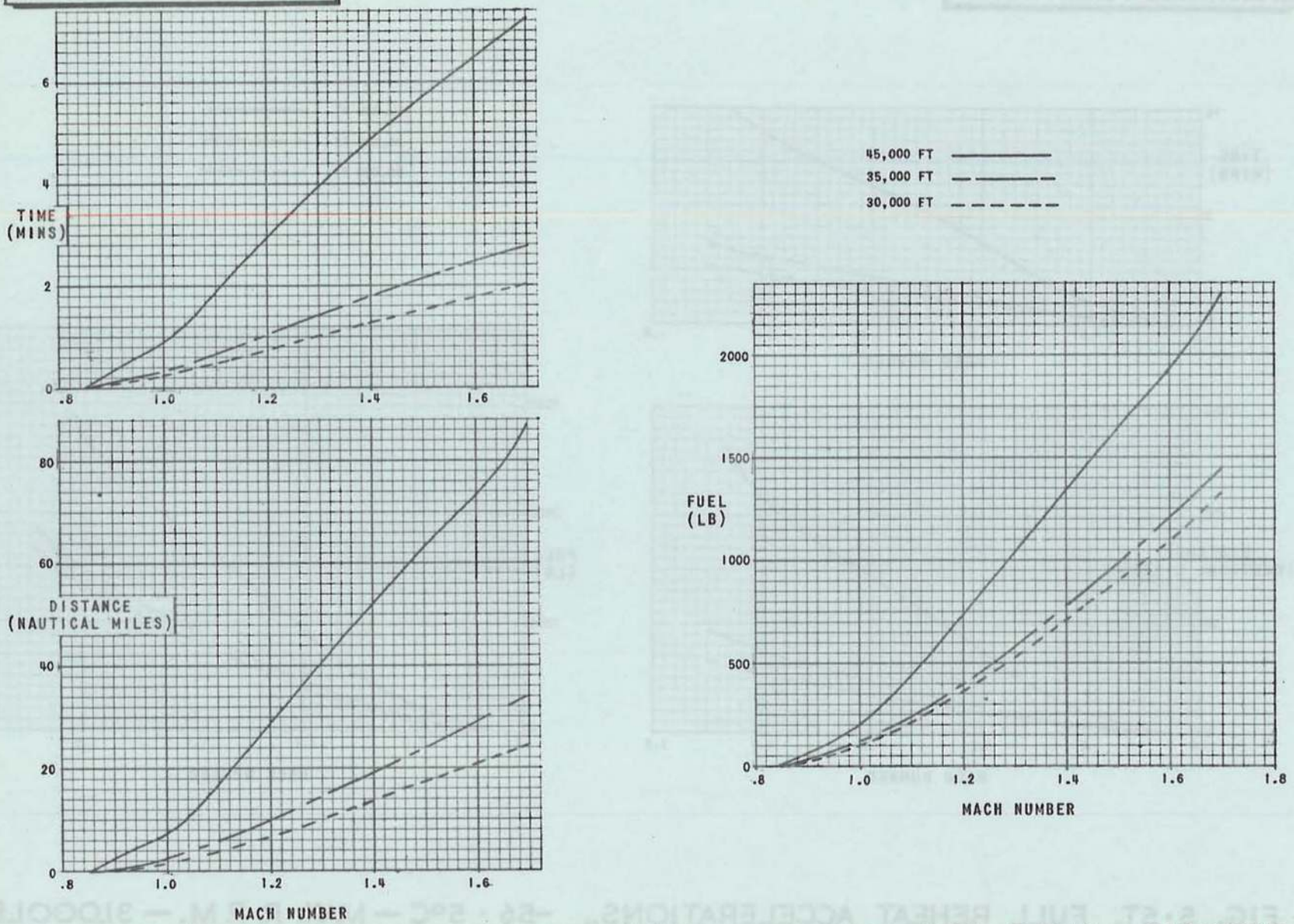
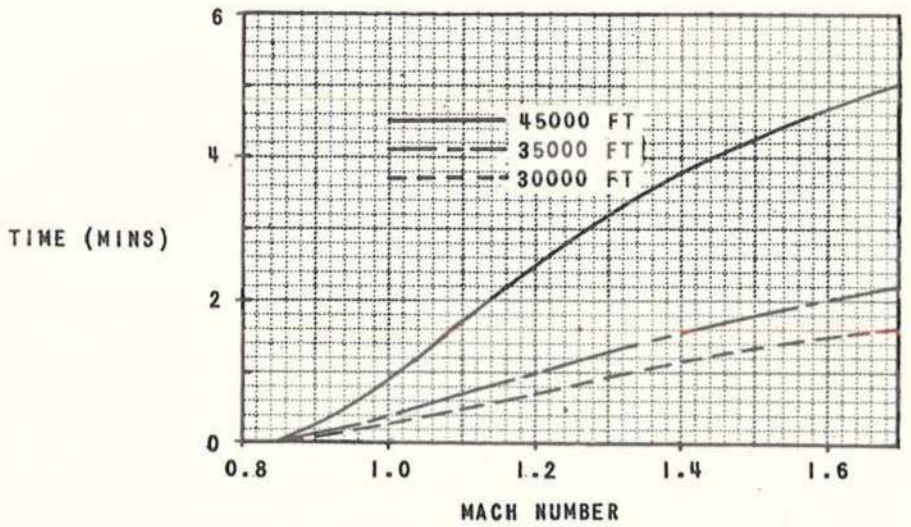
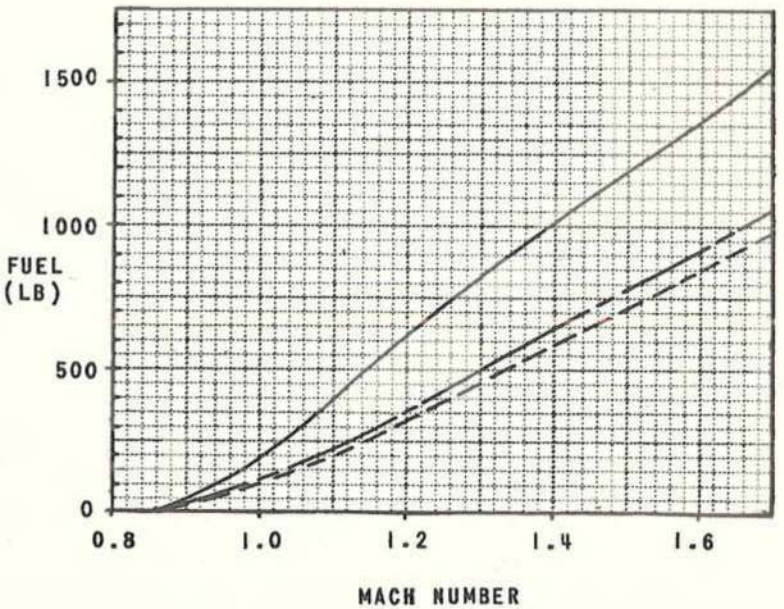
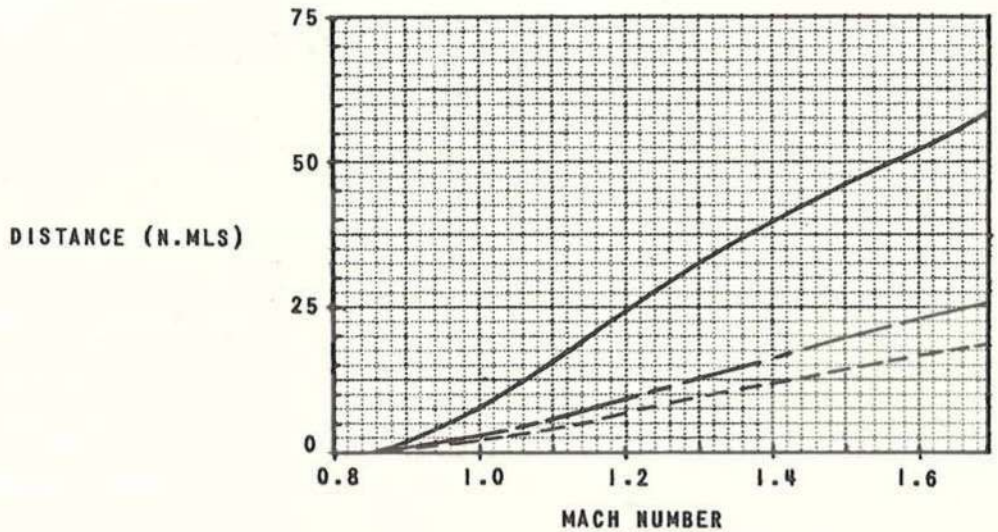


FIG. 5·6T. FULL REHEAT ACCELERATIONS., -66 · 5°C — MAX. R.P.M. — 31,000LB

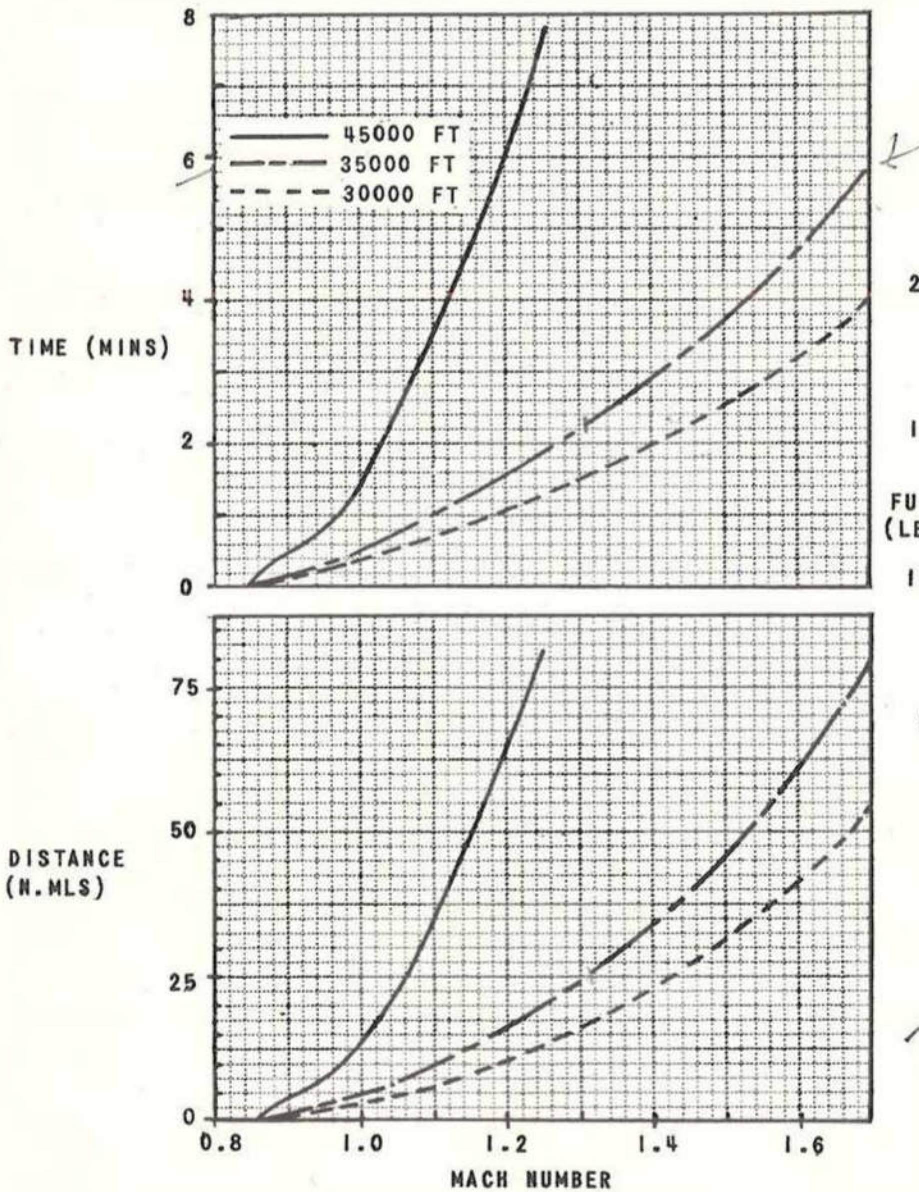


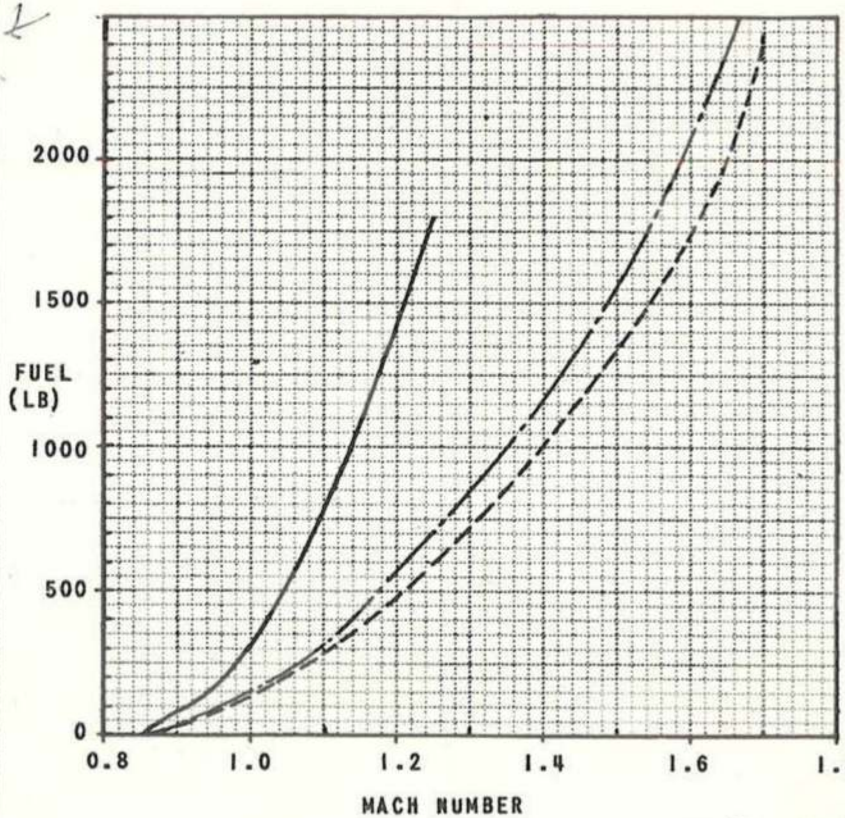




$\frac{58}{15} = 4$

FIG. 5·6. FULL REHEAT ACCELELERATIONS —66.5°C. MAX.R.P.M.-31,000LB.





785

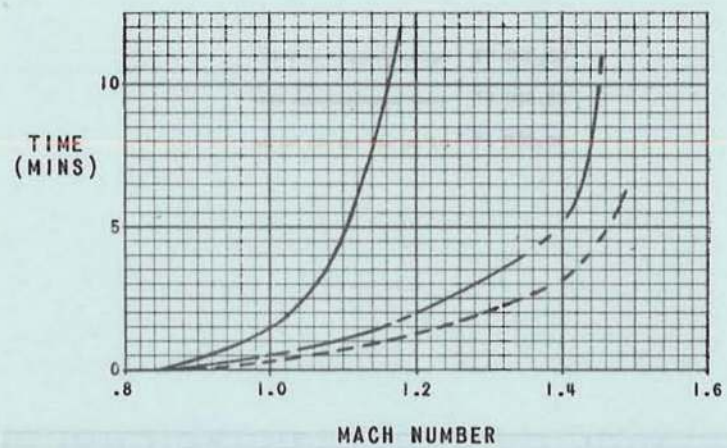
Check at 25 n.m. at 35000' -54°C
Time 2.3 mins
accel from .85M = 510K to 1.26M = 755K
510
ΔV = 245

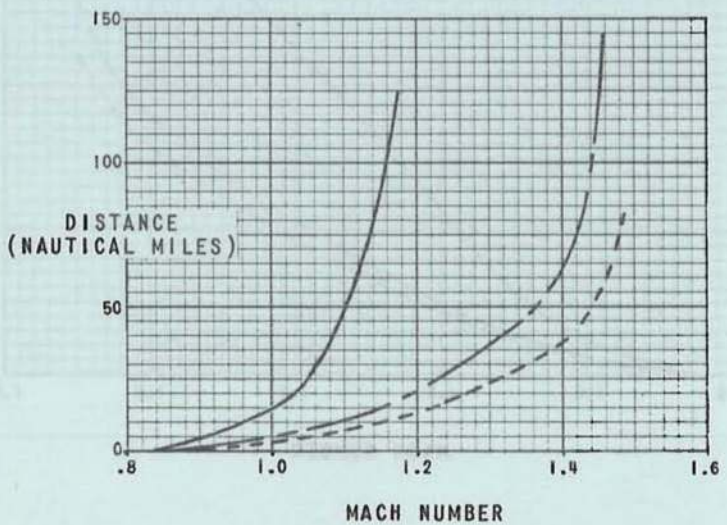
273

FIG. 5·7. FULL REHEAT ACCELERATIONS -36.5°C.- MAX.R.P.M. 31,000 LB

$\theta = \frac{236.5}{288} = .82 \quad \sqrt{\theta} = .905 \quad a = 598$

LIGHTNING T MK. 4 ONLY





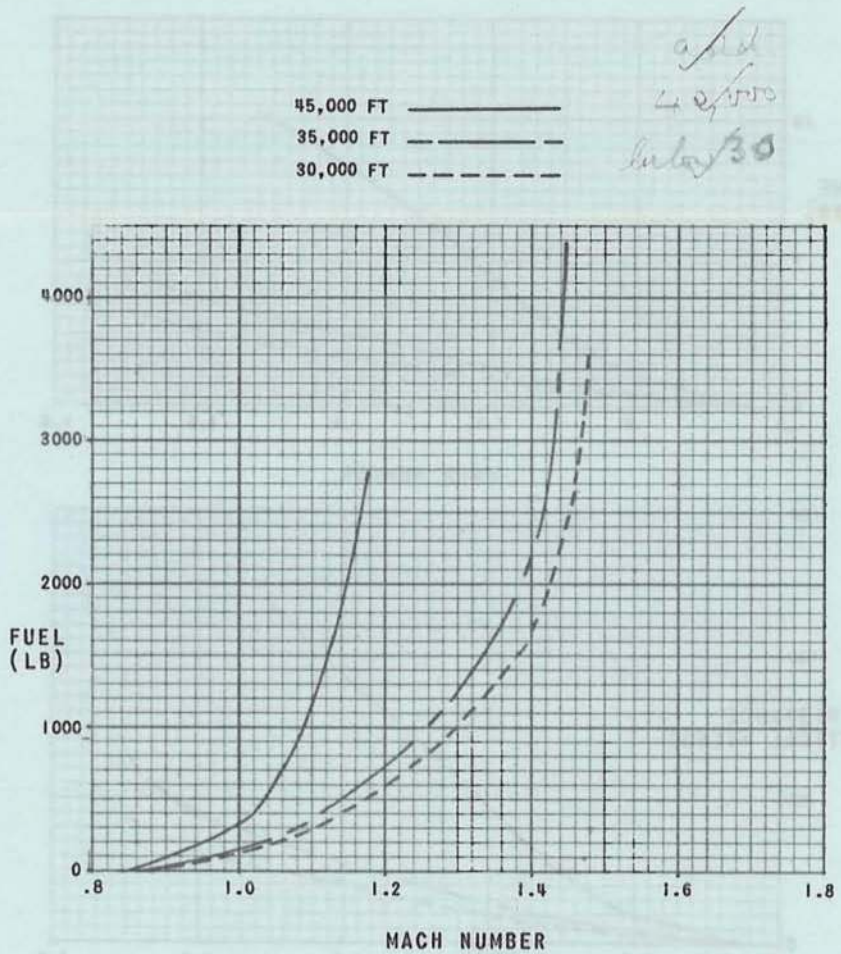


FIG. 5·7T. FULL REHEAT ACCELERATIONS., −36·5°C—MAX. R.P.M.—31,000LB

LIGHTNING T MK. 4 ONLY

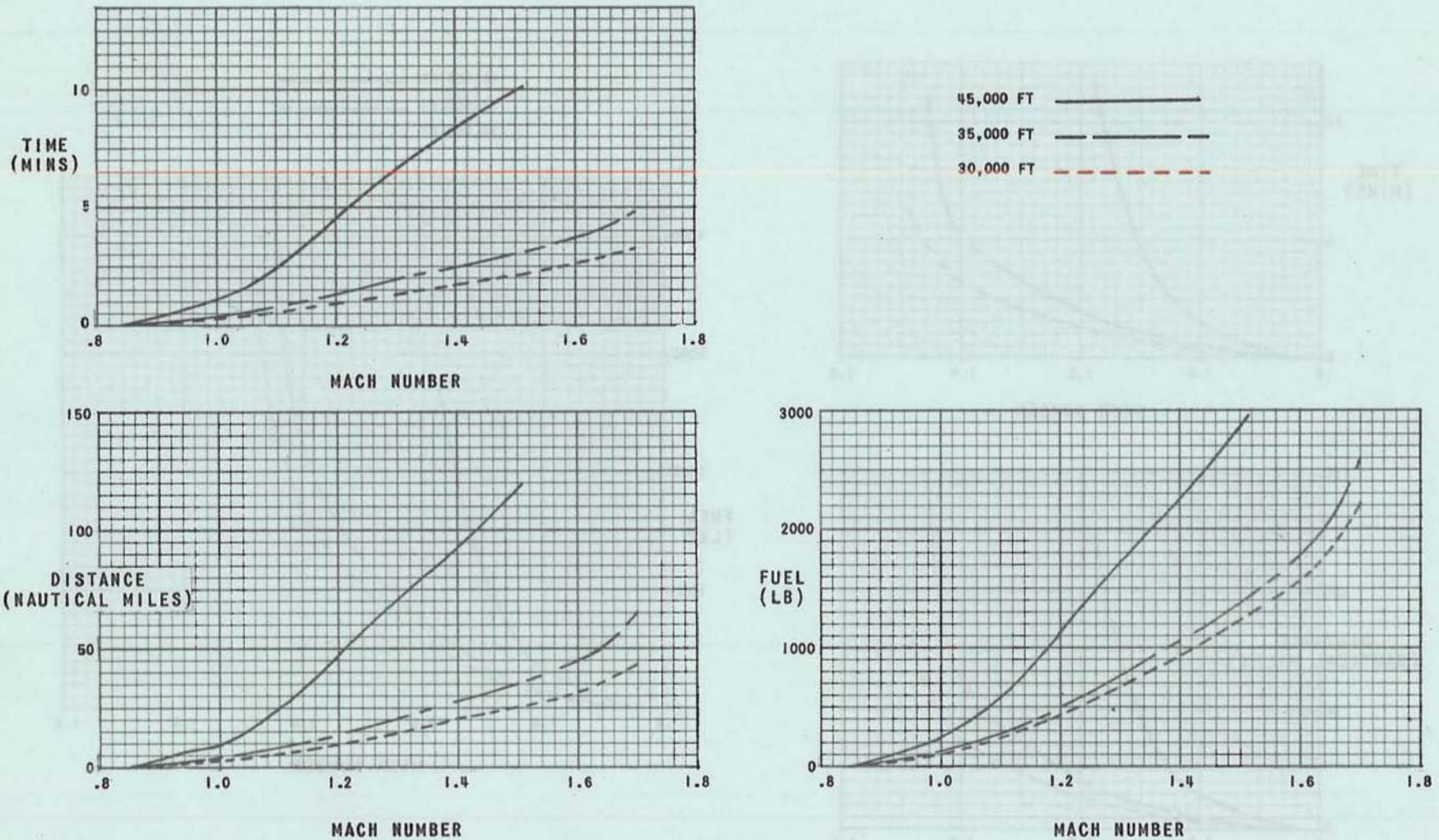
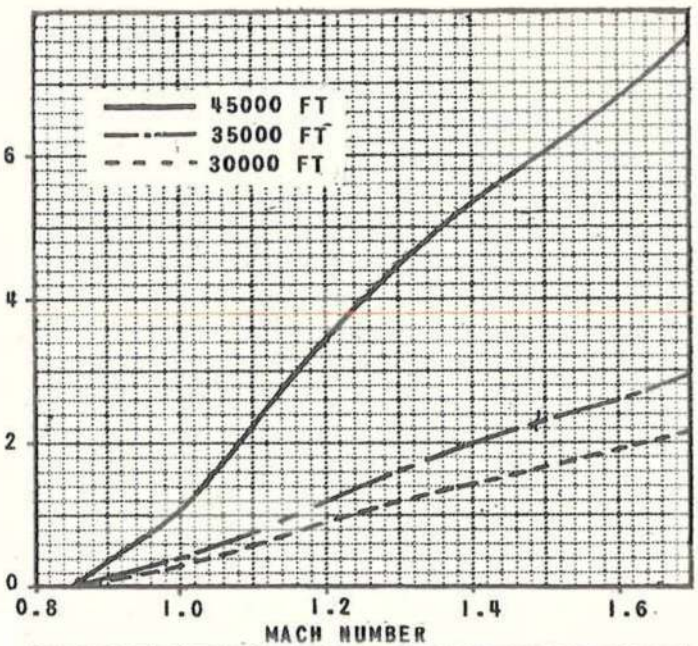
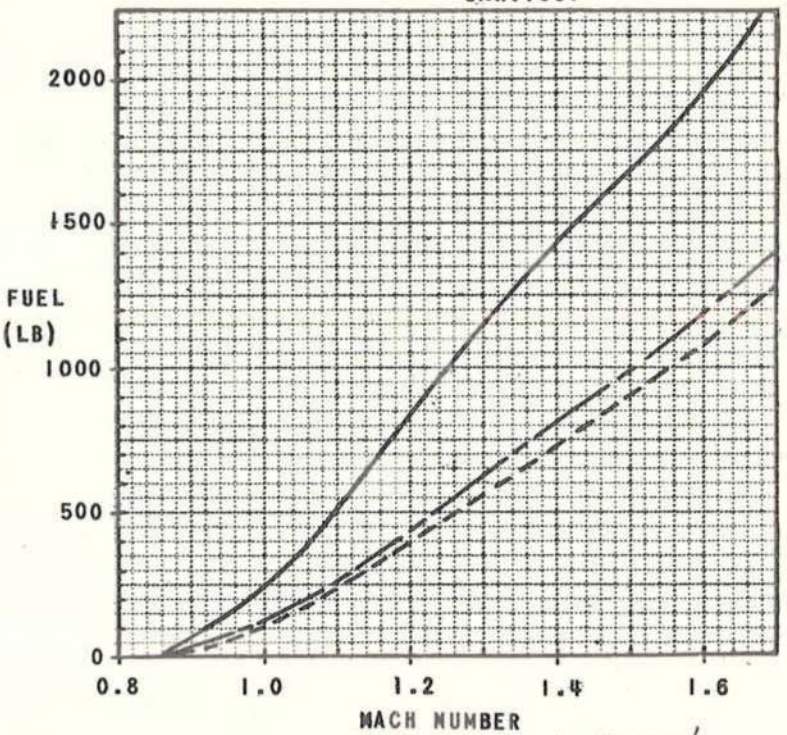


FIG. 5·8T. FULL REHEAT ACCELERATIONS., -56·5°C — MAX.-R.P.M.-31,000 LB

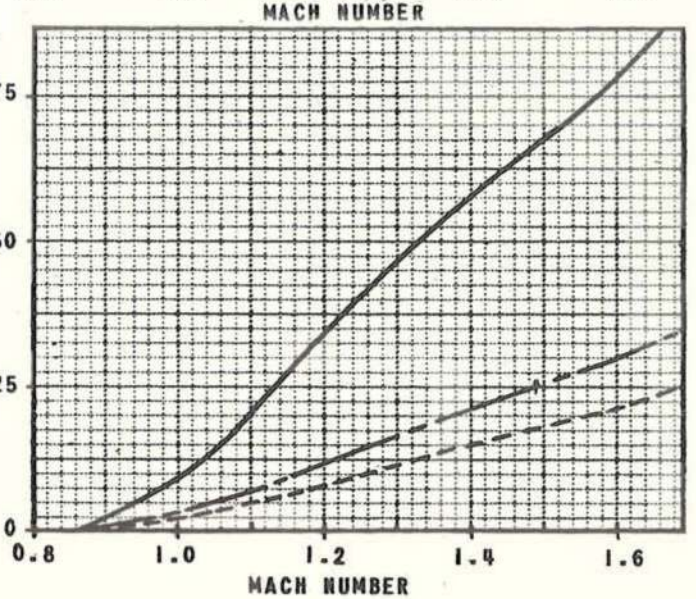


~~DISTANCE (N.MLS)~~ Time (Min).



Check. 25 a.n.m. at 35000'
Time 2.3 mins
accel^n from appn .85M=486k to 1.49M. 854k
486
368

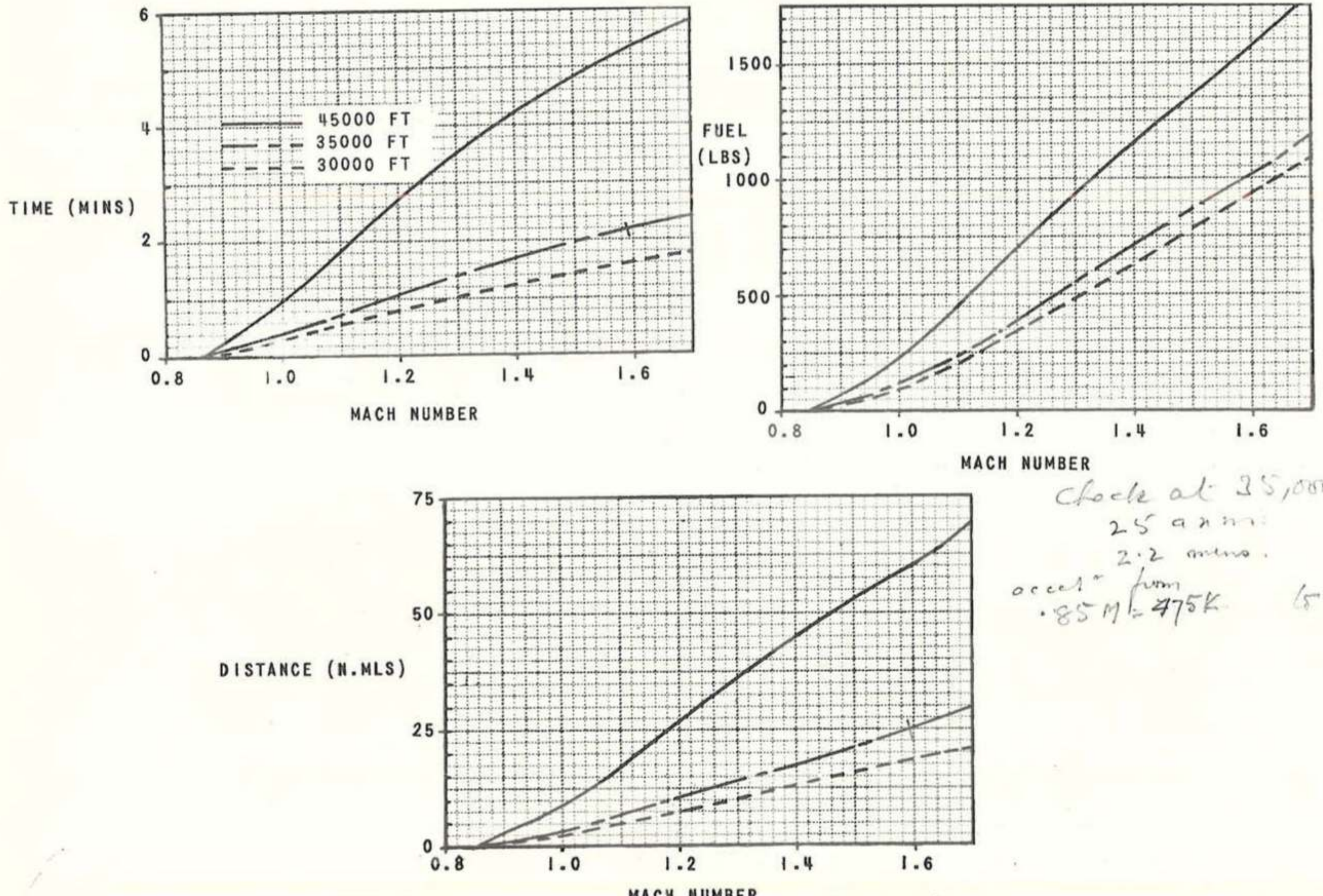
Distance (n mls) ~~TIME (MINS)~~



854 KTAS

FIG. 5·8. FULL REHEAT ACCELERATIONS – 56.5°C. – MAX.R.P.M. – 31,000 LB

273
θ = 246.5°K = .755 √θ = .869
288



Check at 35,000'
25 anm
2.2 mins.
accel^n from
·85 M = 475K to 1.59M = 890
475
415

FIG. 5·9. FULL REHEAT ACCELERATIONS, -66.5°C.- MAX.R.P.M.-31,000 LB

ISA-10°
273
$\theta = \frac{206.5}{288} = \cdot 717$ $\sqrt{\theta} = \cdot 847$ $a = 559$

LIGHTNING T MK. 4 ONLY

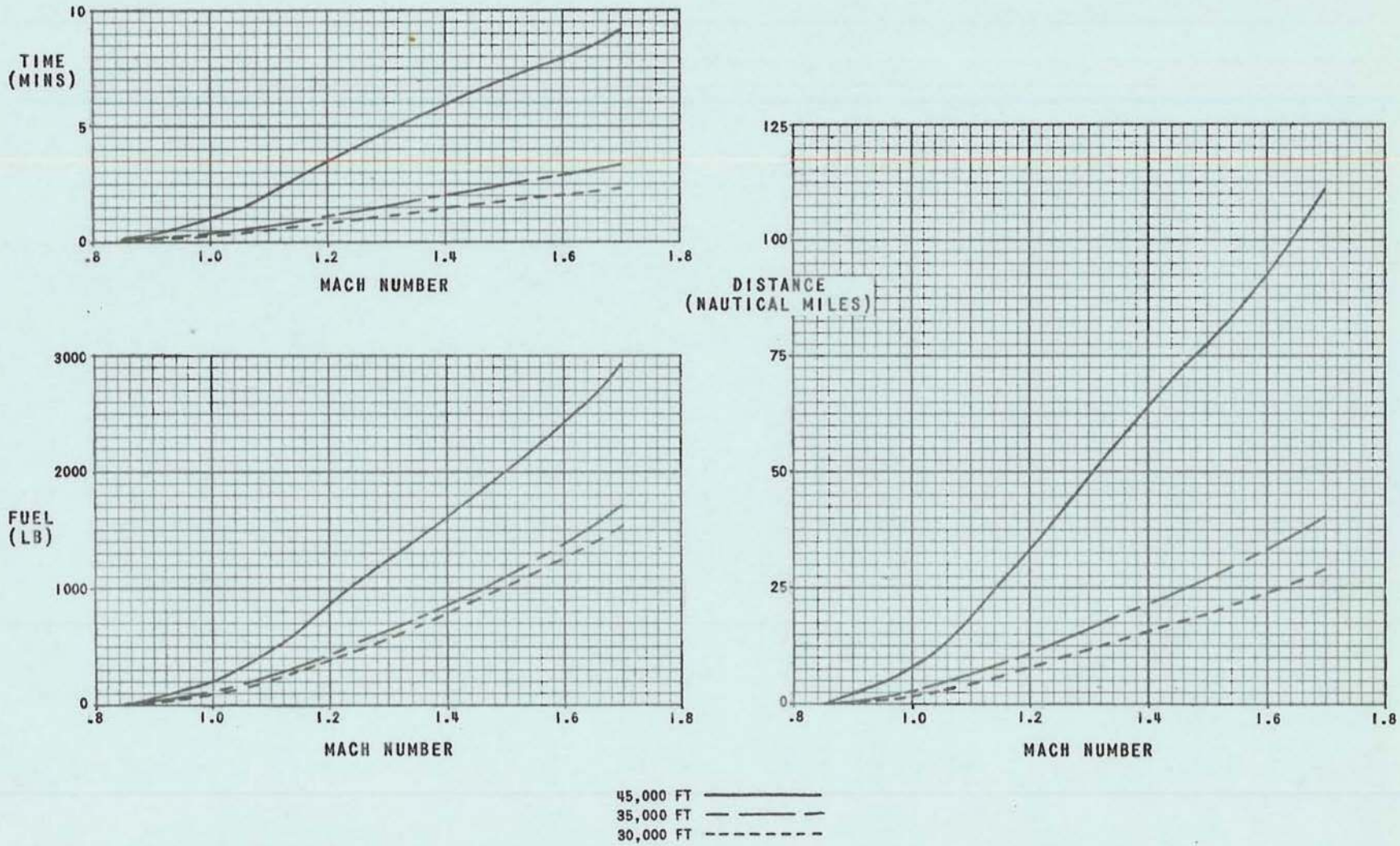


FIG. 5·9T. FULL REHEAT ACCELERATIONS., -66·5°C—MAX. R.P.M.—31,000LB

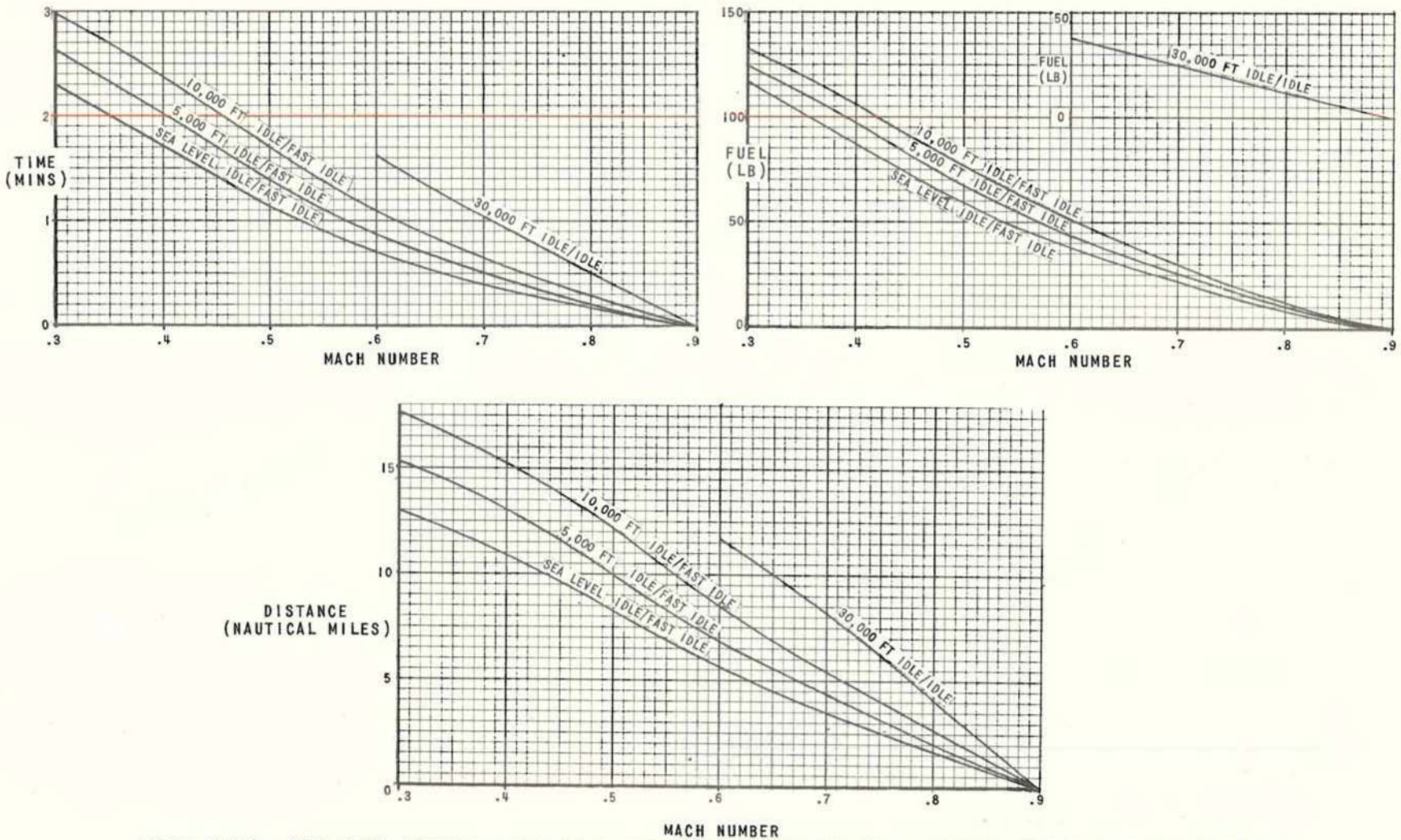
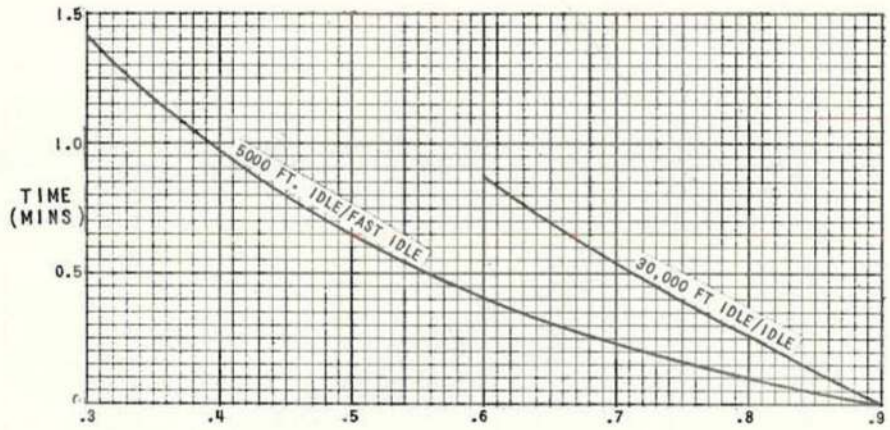
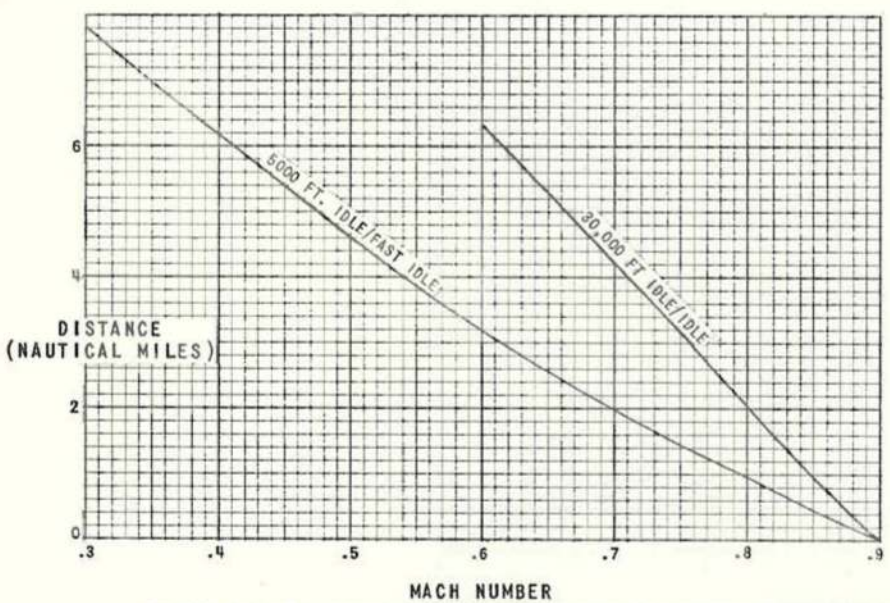


FIG. 5·10. IDLING DECELERATION IN LEVEL FLIGHT—AIRBRAKES IN—27,500 LB
INTERNATIONAL STANDARD ATMOSPHERE





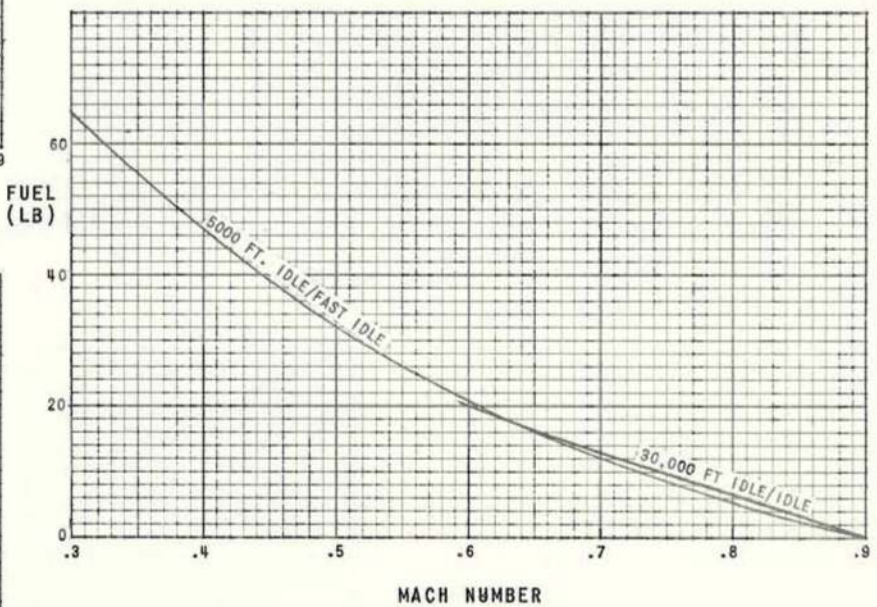


FIG. 5·11. IDLING DECELERATION IN LEVEL FLIGHT—AIRBRAKES OUT—27,500 LB
INTERNATIONAL STANDARD ATMOSPHERE

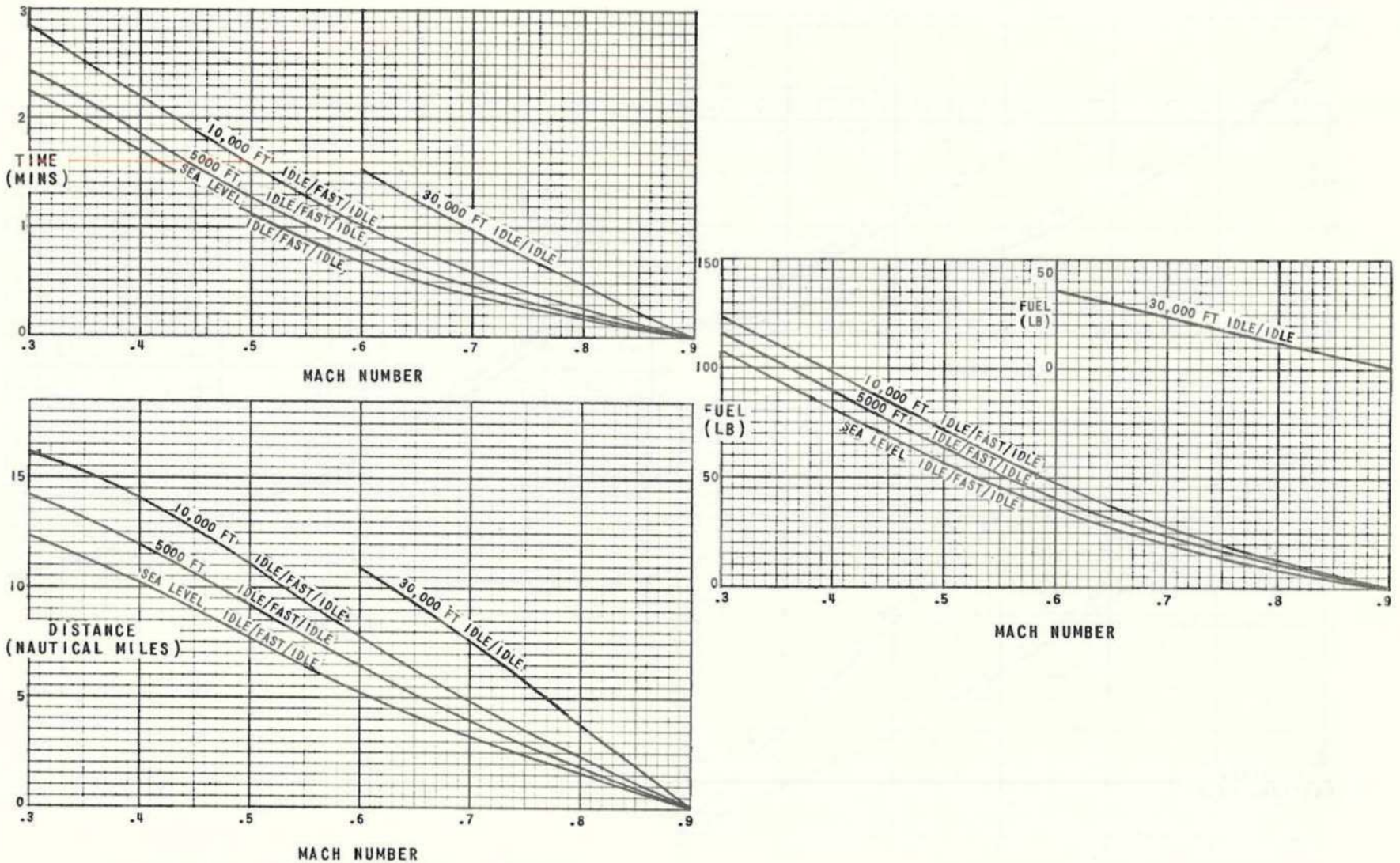


FIG. 5·12. IDLING DECELERATION IN LEVEL FLIGHT — AIRBRAKES IN — 27,500 LB
INTERNATIONAL STANDARD ATMOSPHERE

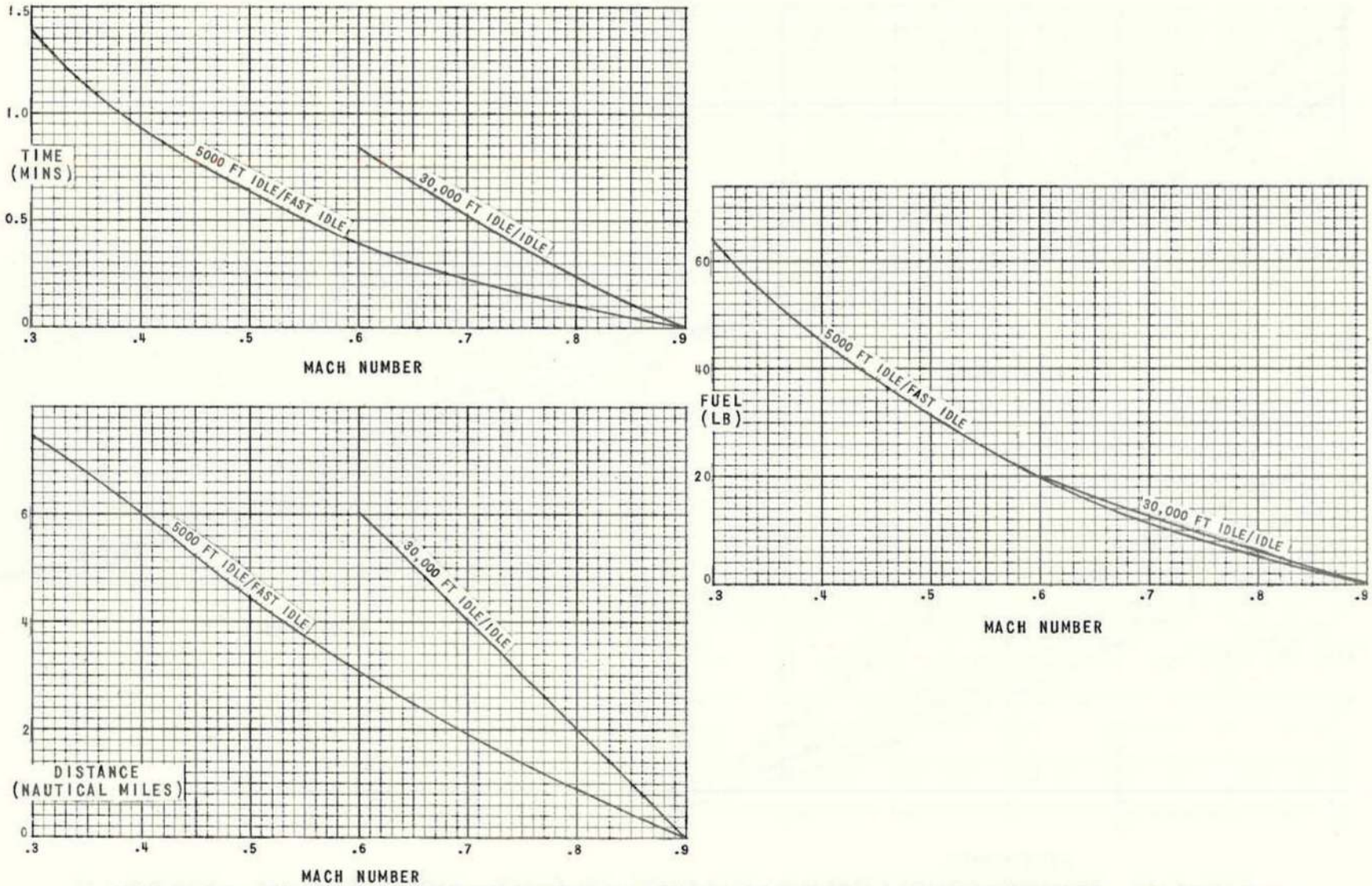


FIG.5·13. IDLING DECELERATION IN LEVEL FLIGHT — AIRBRAKES OUT — 27,500 LB — INTERNATIONAL STANDARD ATMOSPHERE

LIGHTNING T MK. 4 ONLY

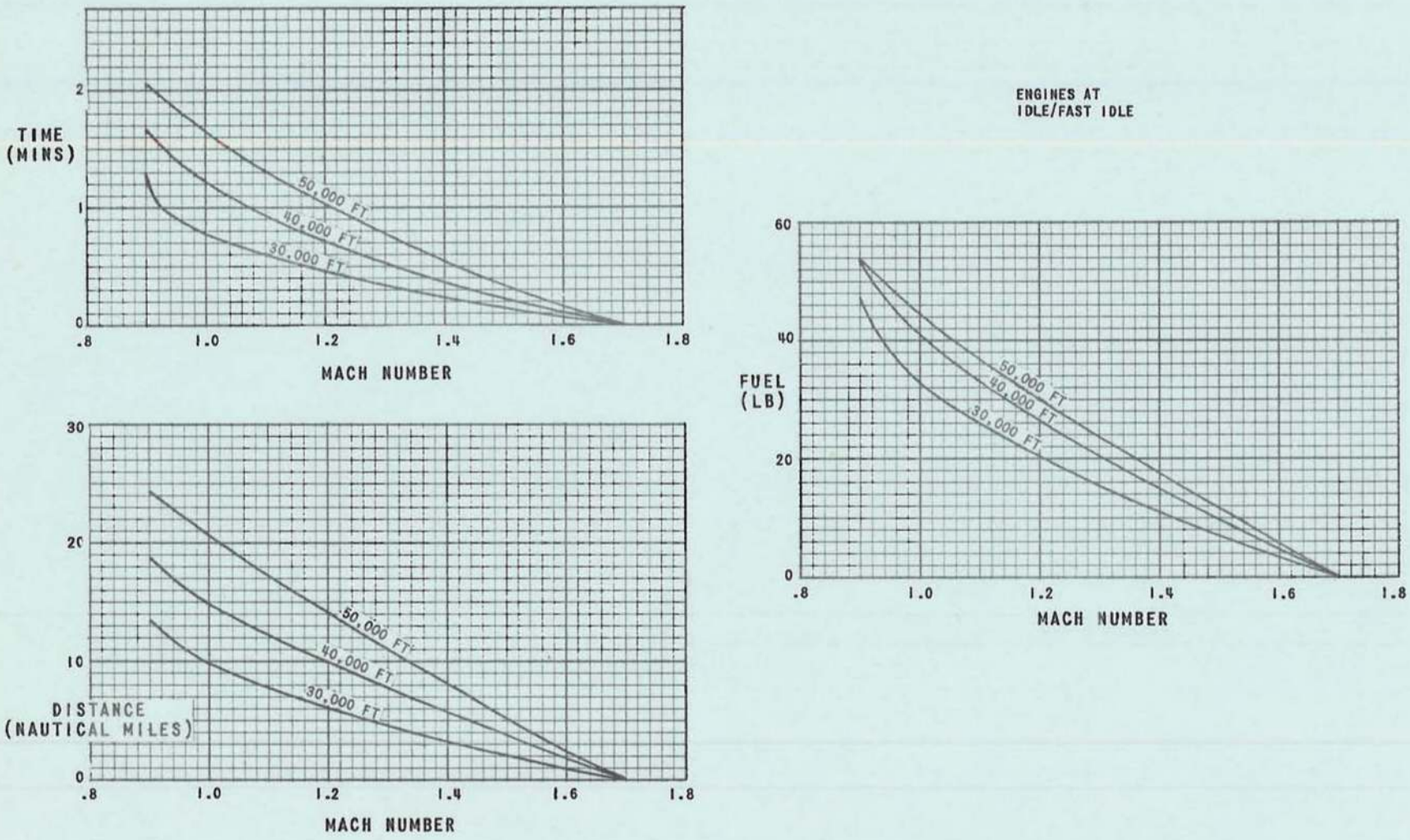
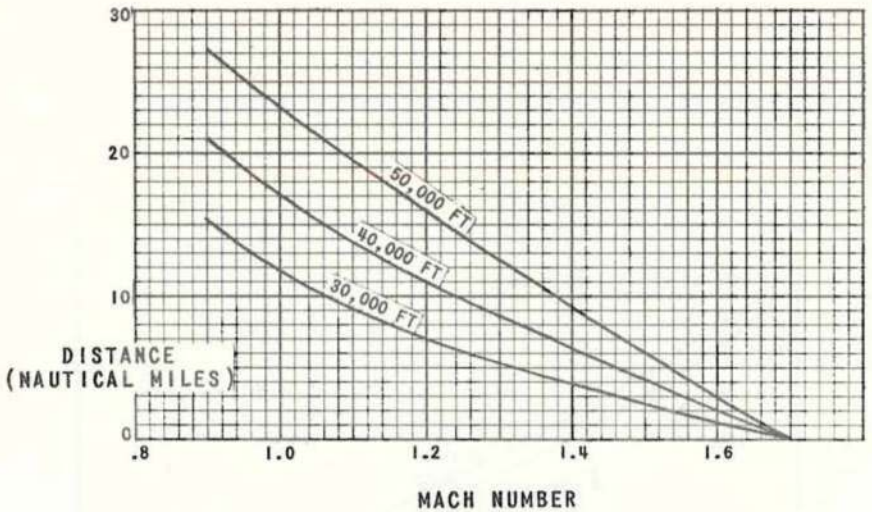
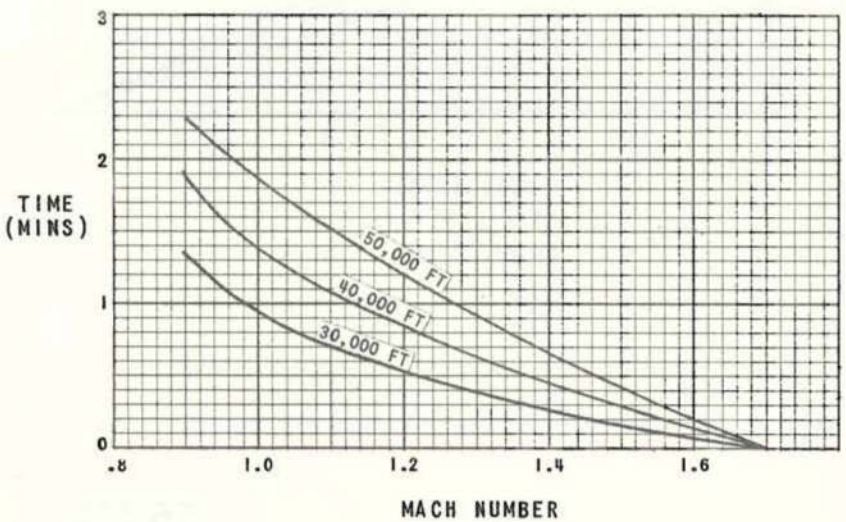
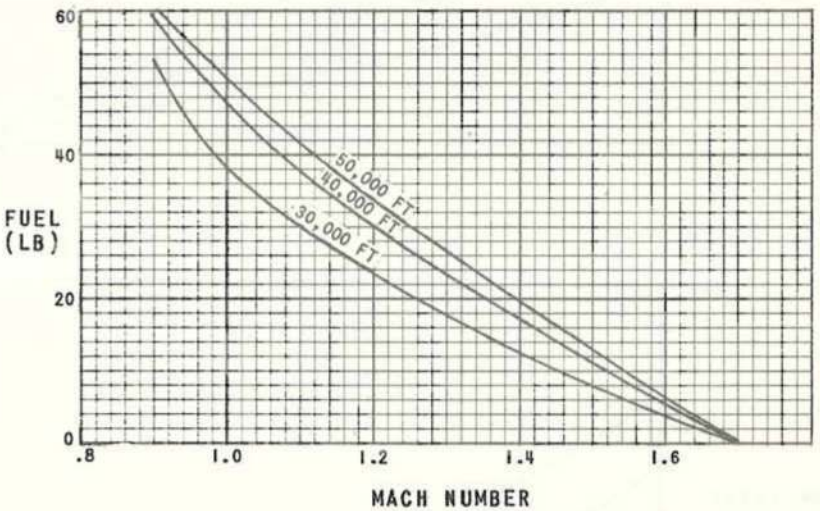


FIG. 5·14T. IDLING DECELERATIONS IN LEVEL FLIGHT
–AIRBRAKES IN– 31,000LB., –56·5°C

NOT T MK.4

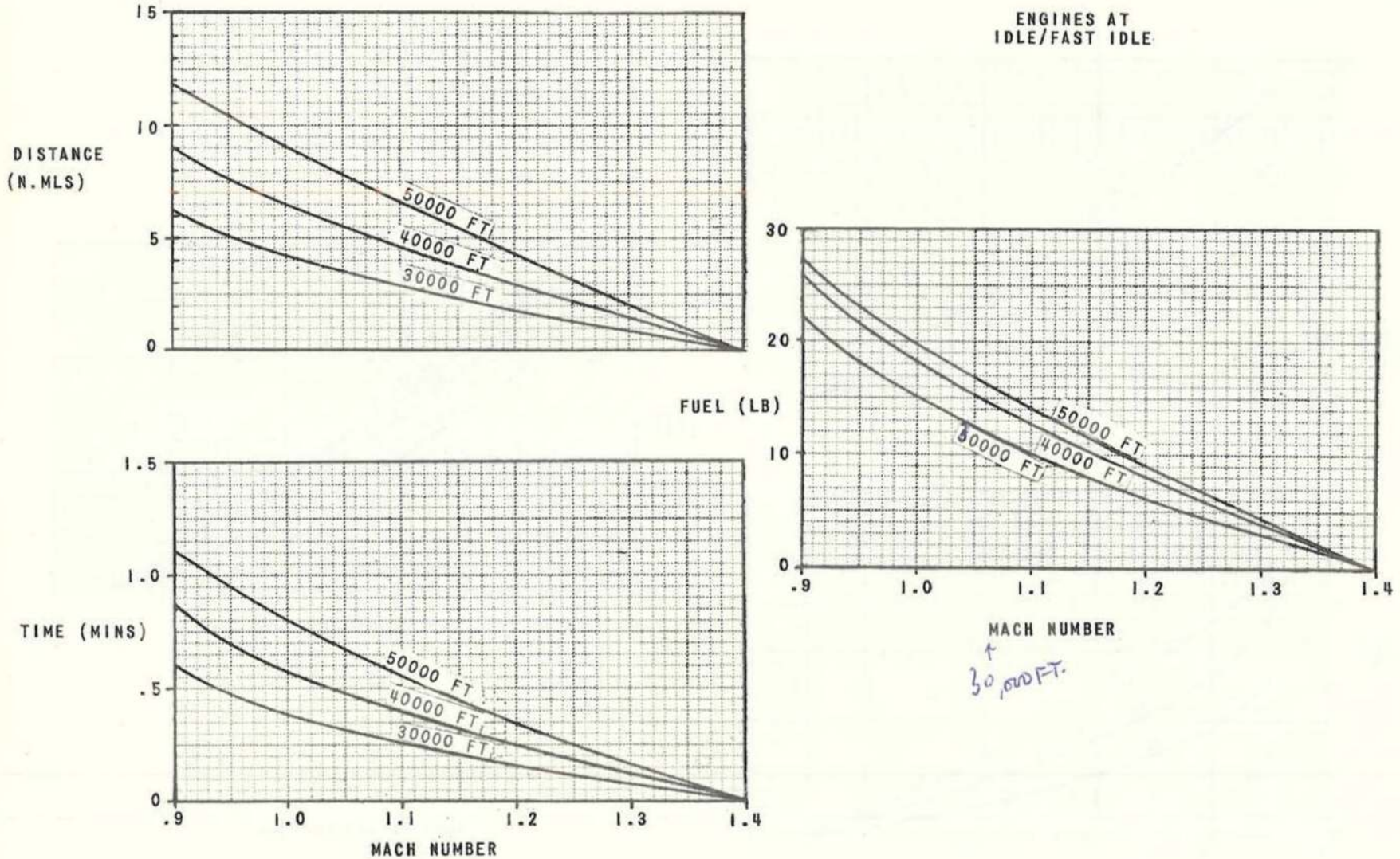






ENGINES AT IDLE/FAST IDLE

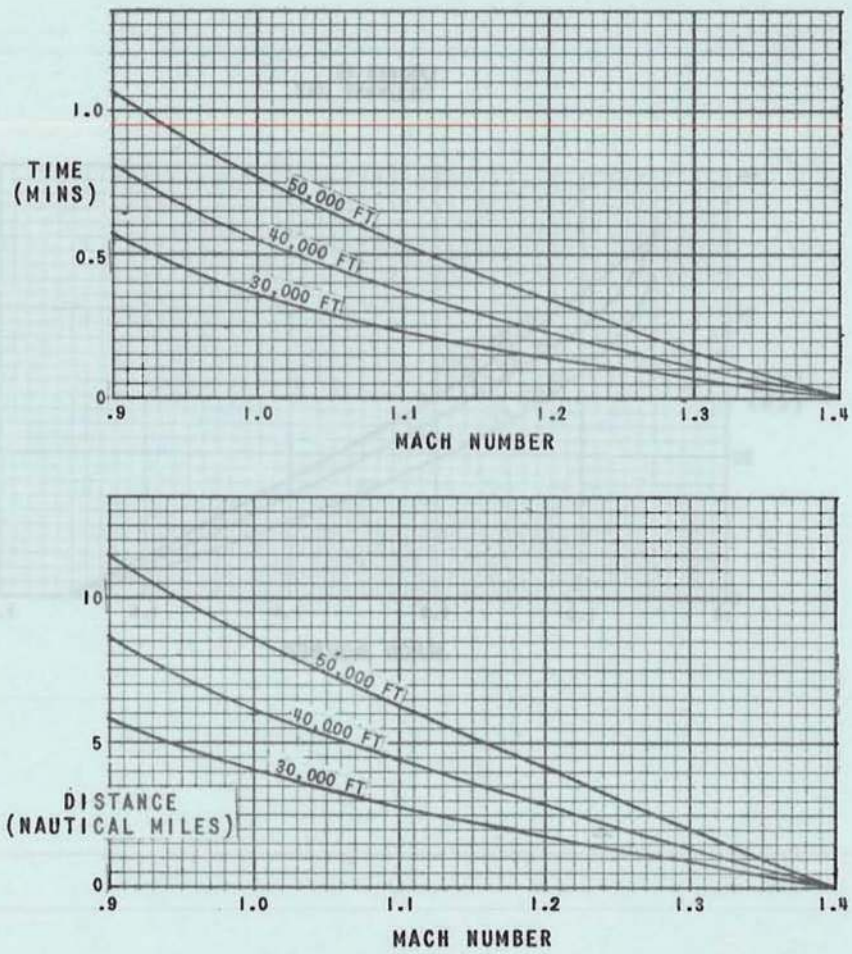
FIG. 5·14. IDLING DECELERATION IN LEVEL FLIGHT — AIRBRAKES IN — 31,000 LB., −56·5°C



-56·5°C

FIG.5·15. IDLING DECELERATION IN LEVEL FLIGHT. AIRBRAKES OUT. 31,000 LB

LIGHTNING T MK. 4 ONLY



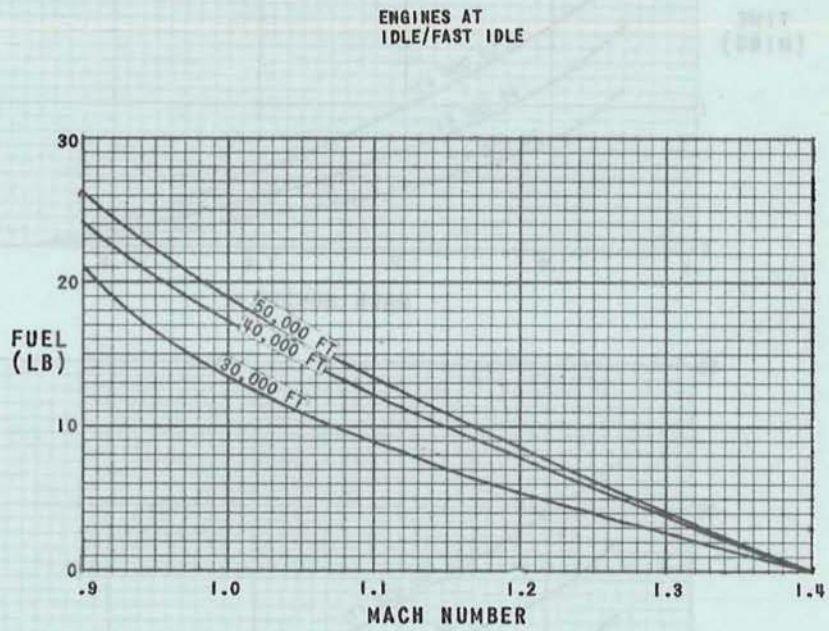
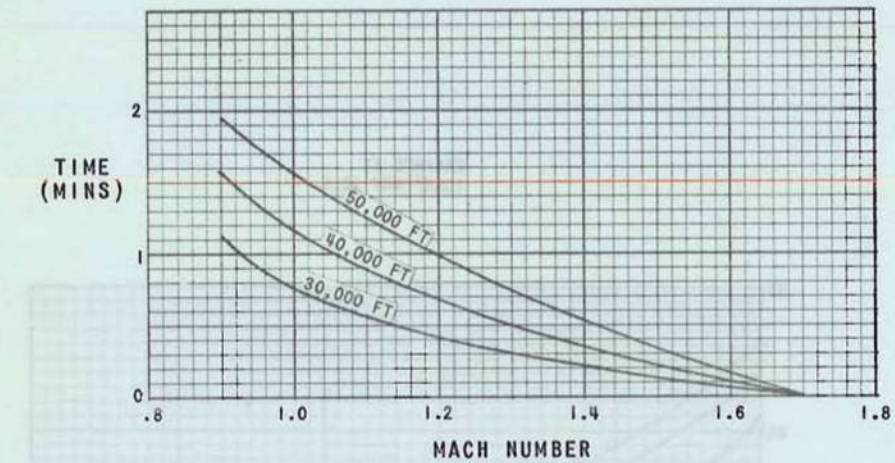
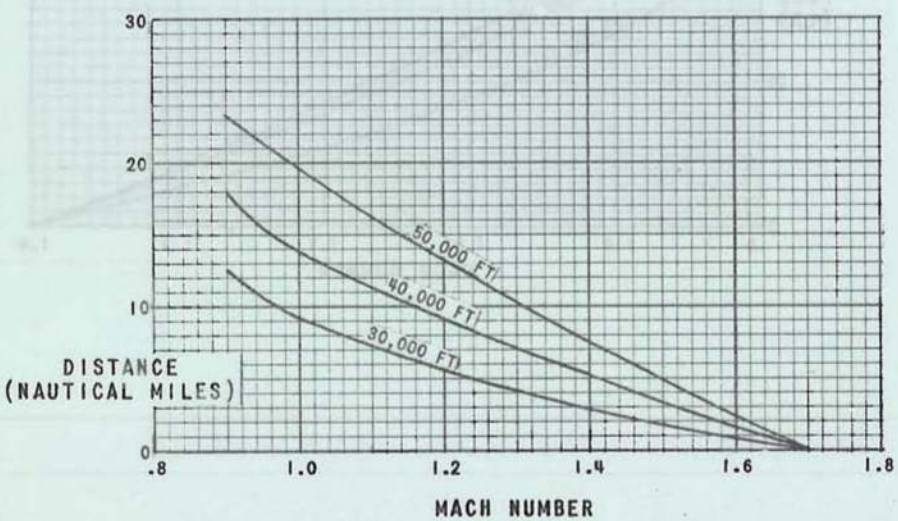


FIG. 5·15T. IDLING DECELERATIONS IN LEVEL FLIGHT
–AIRBRAKES OUT– 31,000LB., –56·5°C

LIGHTNING T MK. 4 ONLY





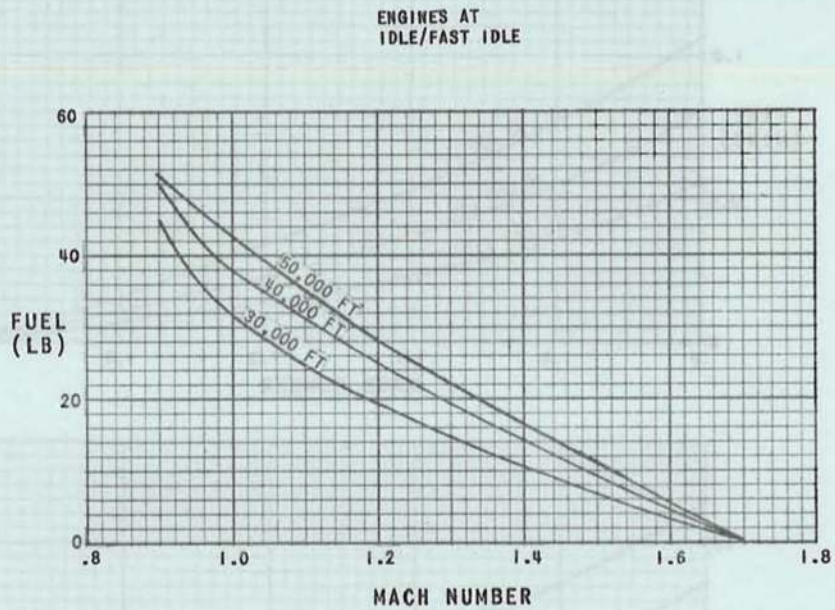


FIG. 5·16T. IDLING DECELERATION IN LEVEL FLIGHT
—AIRBRAKES IN — 31000LB., -56·5°C

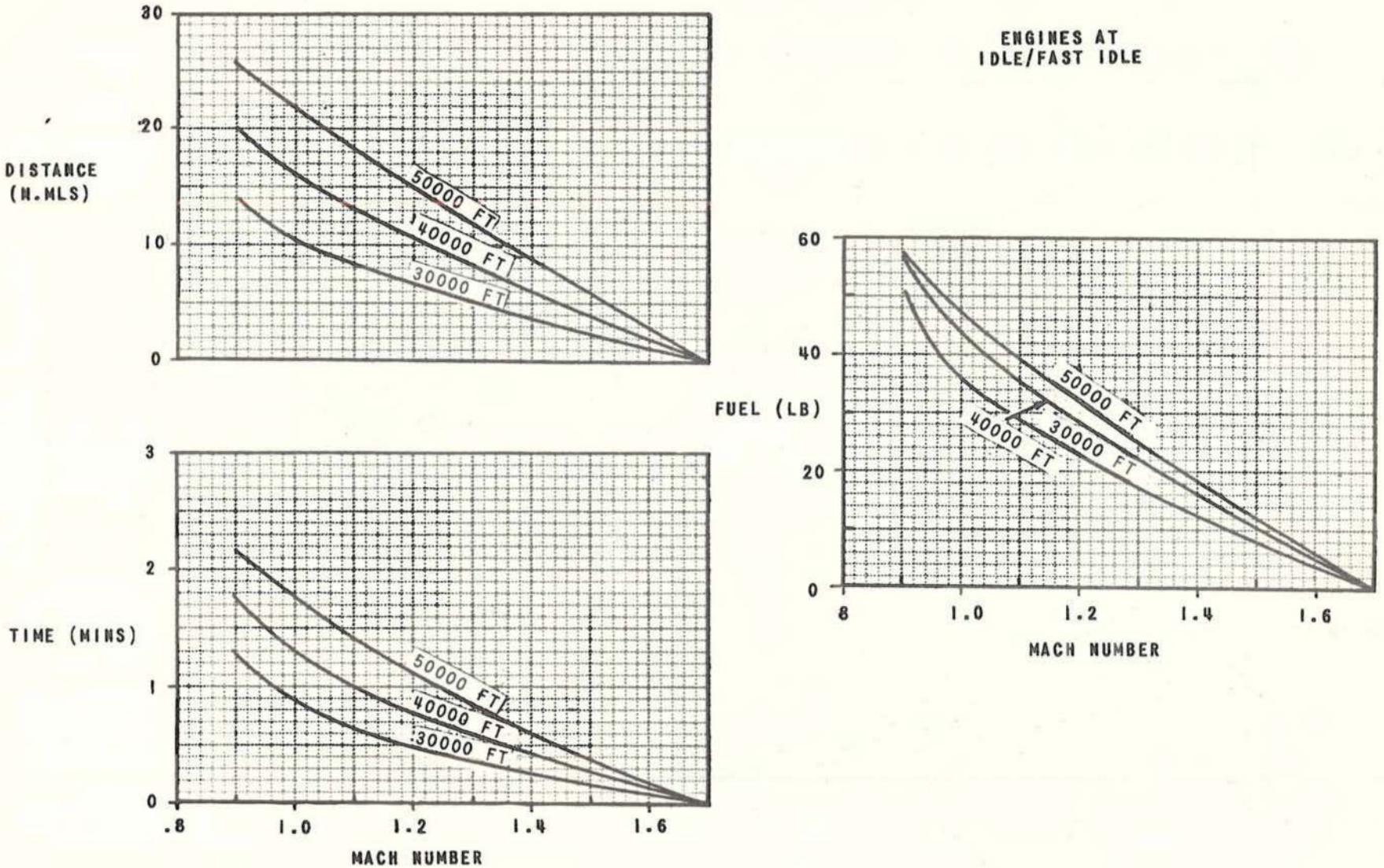
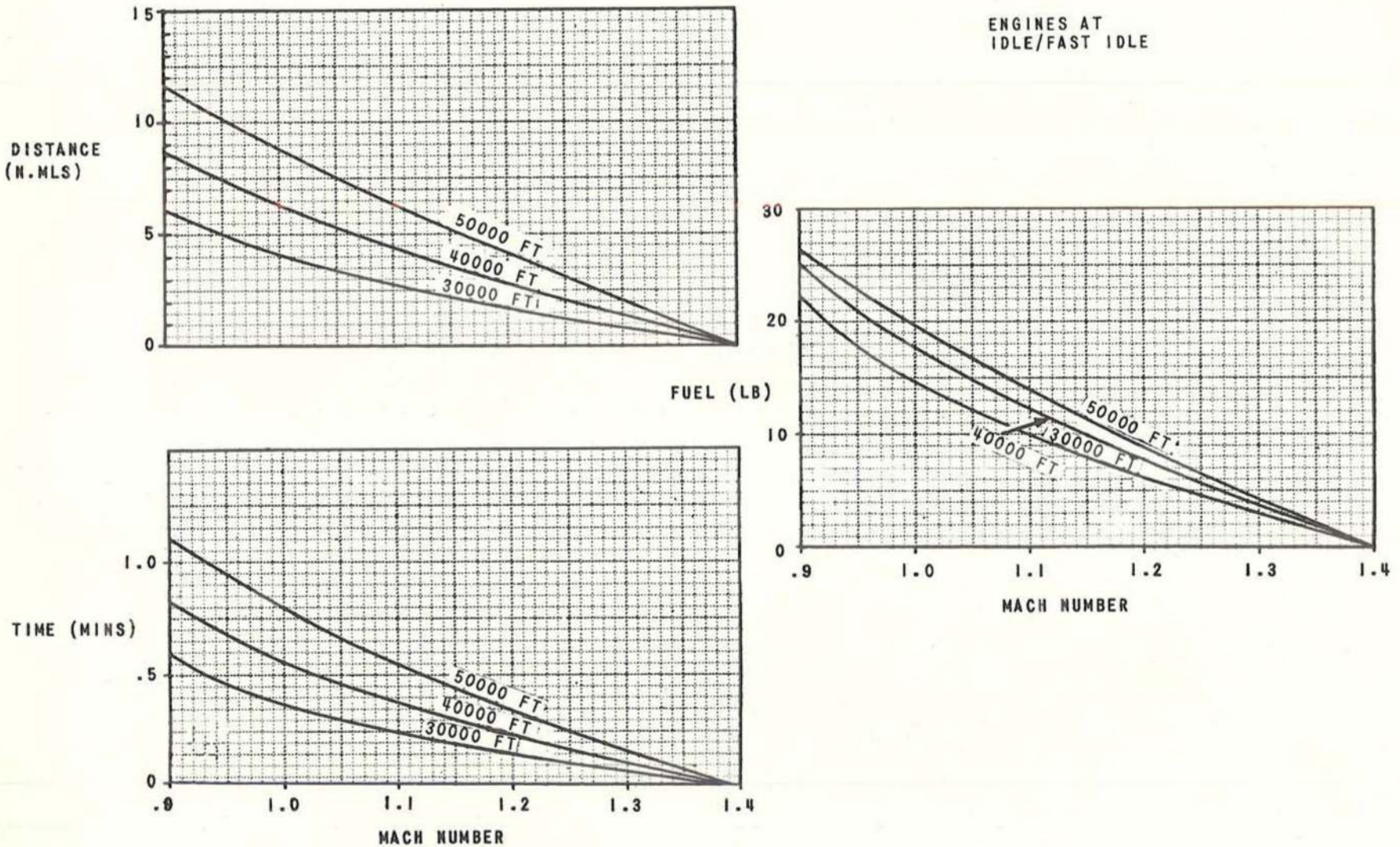


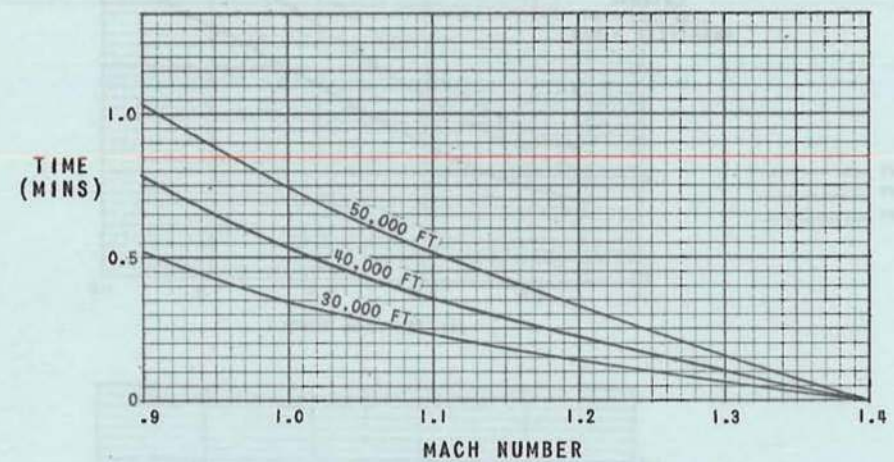
FIG. 5·16. IDLING DECELERATION IN LEVEL FLIGHT. AIRBRAKES IN. -56·5 °C 31,000 LB

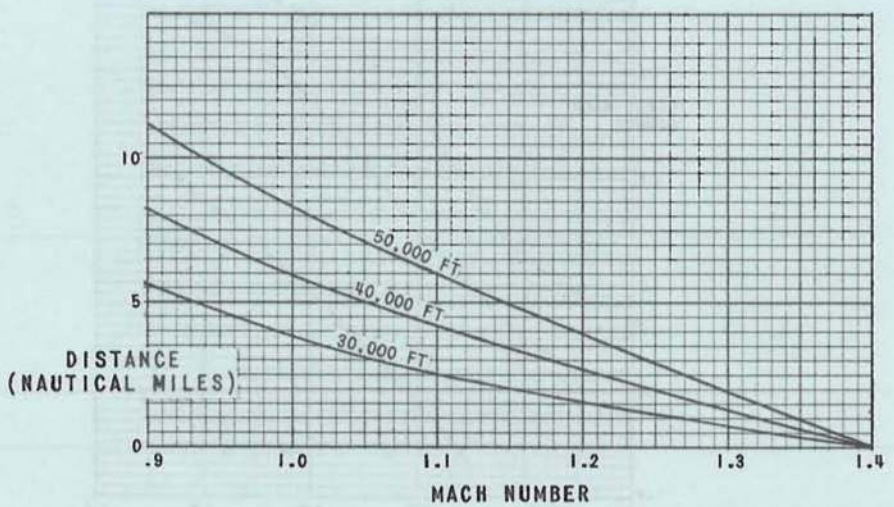


– 56·5°C

FIG. 5·17. IDLING DECELERATION IN LEVEL FLIGHT, AIRBRAKES OUT, 31,000 LB

LIGHTNING T MK. 4 ONLY





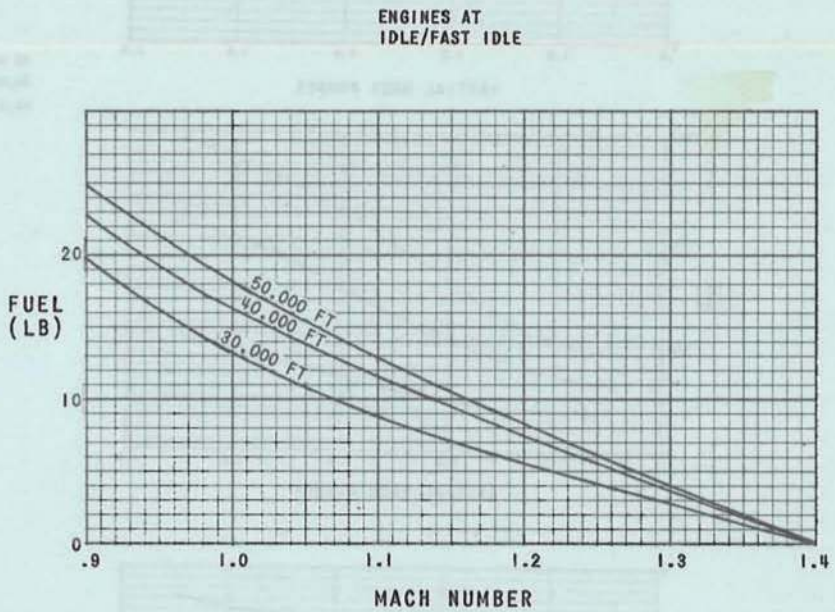
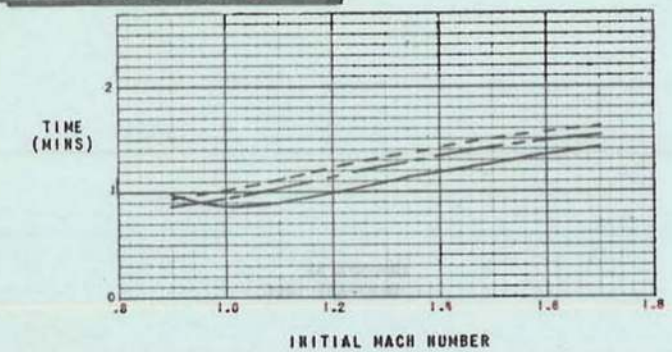
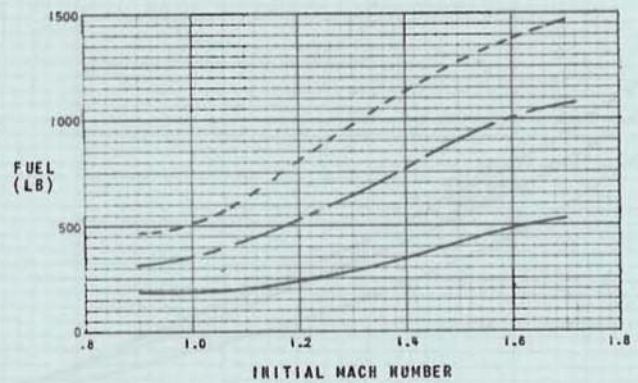
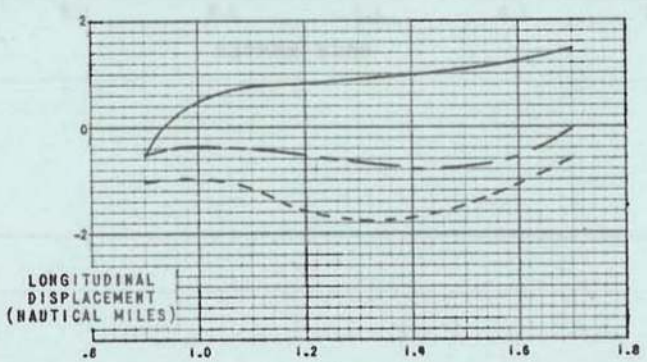


FIG. 5·17T. IDLING DECELERATION IN LEVEL FLIGHT -AIRBRAKES OUT- 31,000LB., -56·5°C

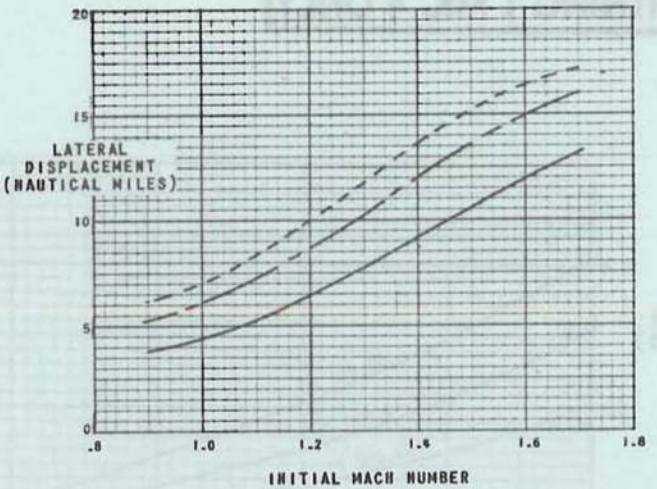
LIGHTNING T MK. 4 ONLY







30 000 FT
35,000 FT
40,000 FT



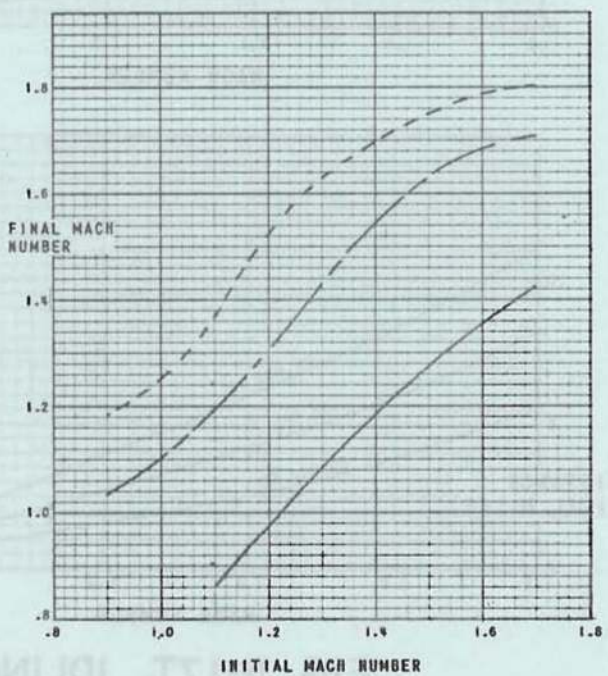


FIG. 5·18T. 180° ACCELERATED 2G TURN–FULL REHEAT., -56·5°C

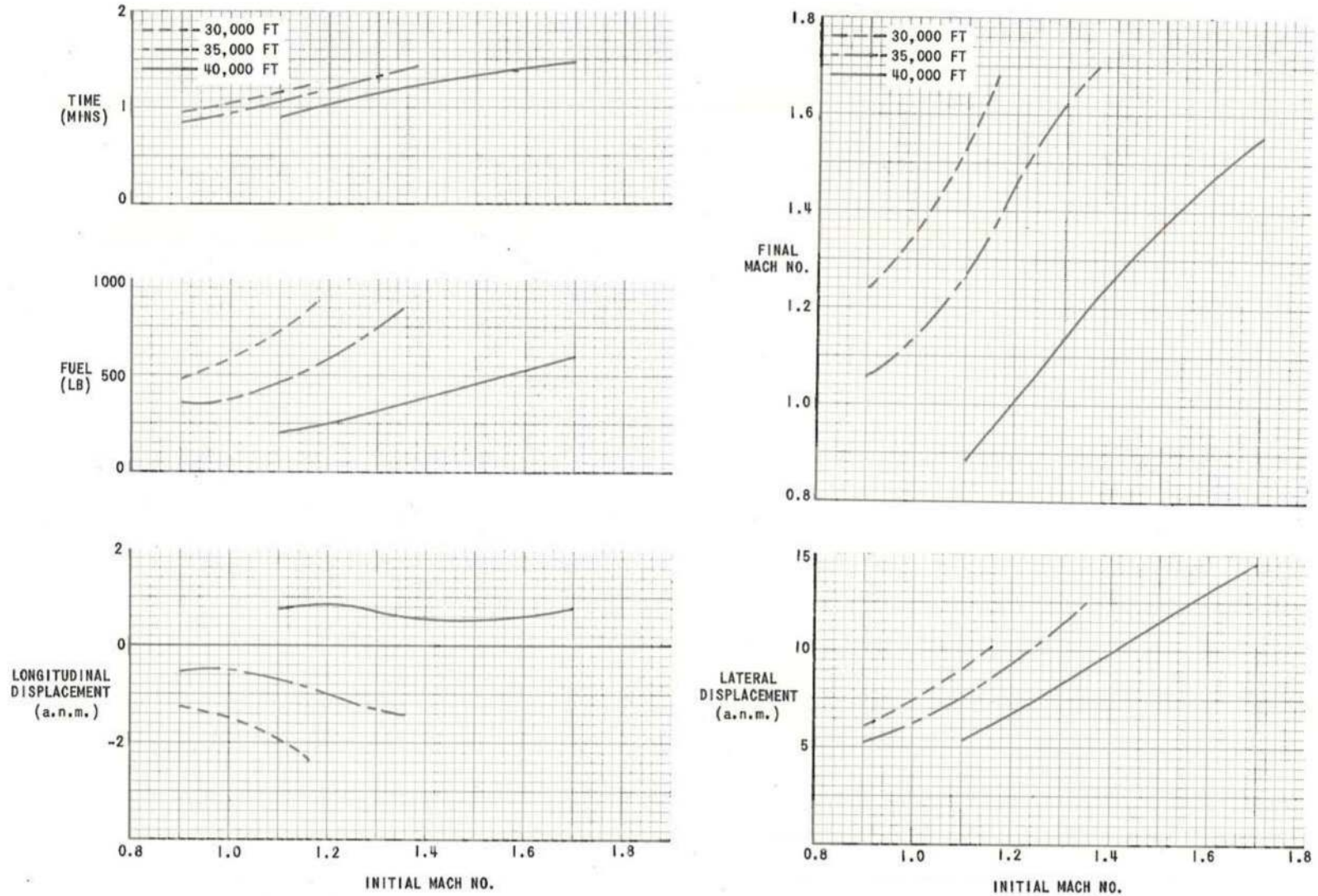


FIG.5.18. 180° ACCELERATED 2 G TURN. FULL REHEAT. —56.5°C

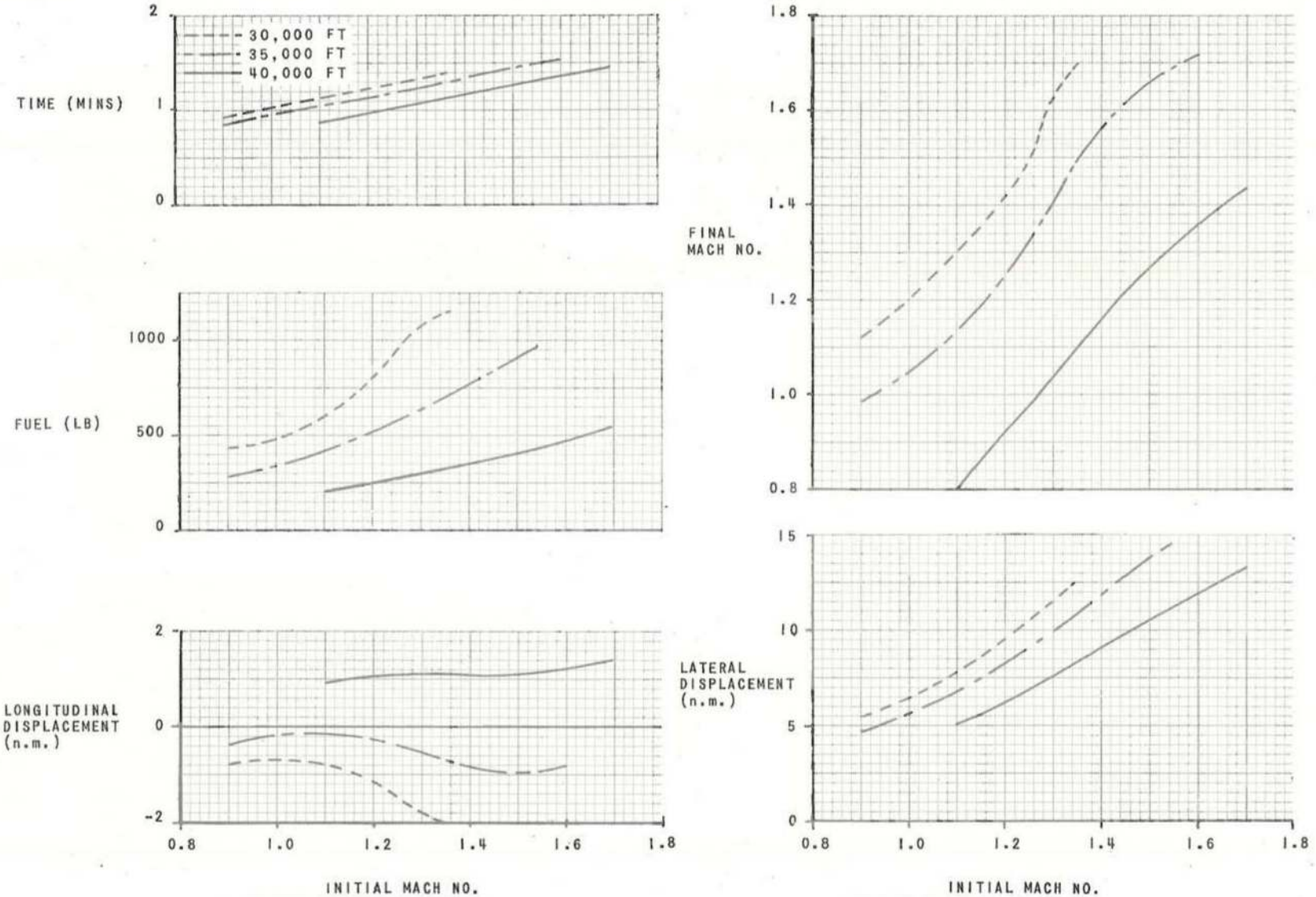


FIG.5.19. 180° ACCELERATED 2 G TURN. FULL REHEAT —56.5°C

LIGHTNING T MK. 4 ONLY

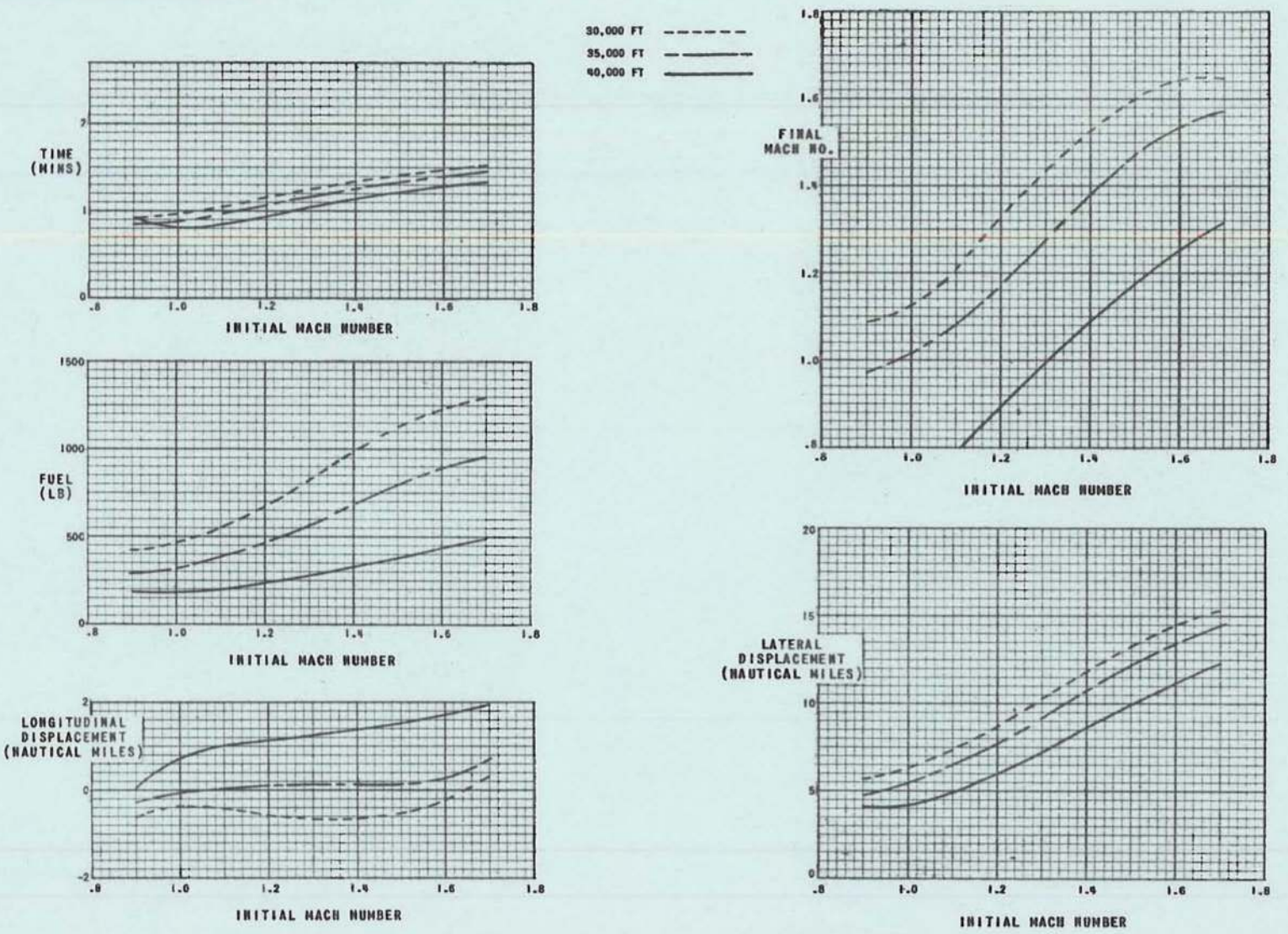


FIG. 5·19T. 180° ACCELERATED 2G TURN – FULL REHEAT., −56·5°C

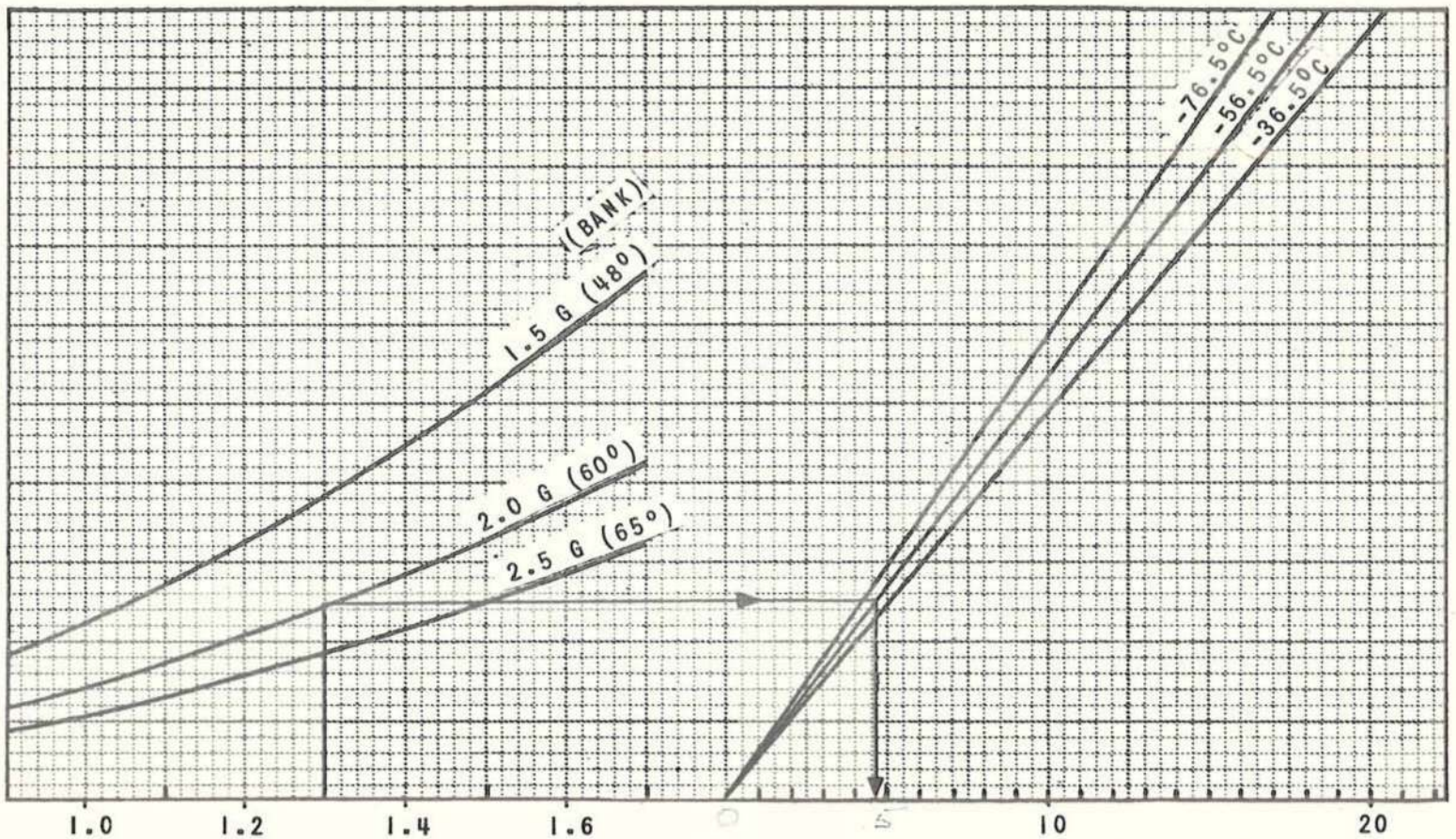


FIG. 5·20. STEADY LEVEL TURN RADIUS

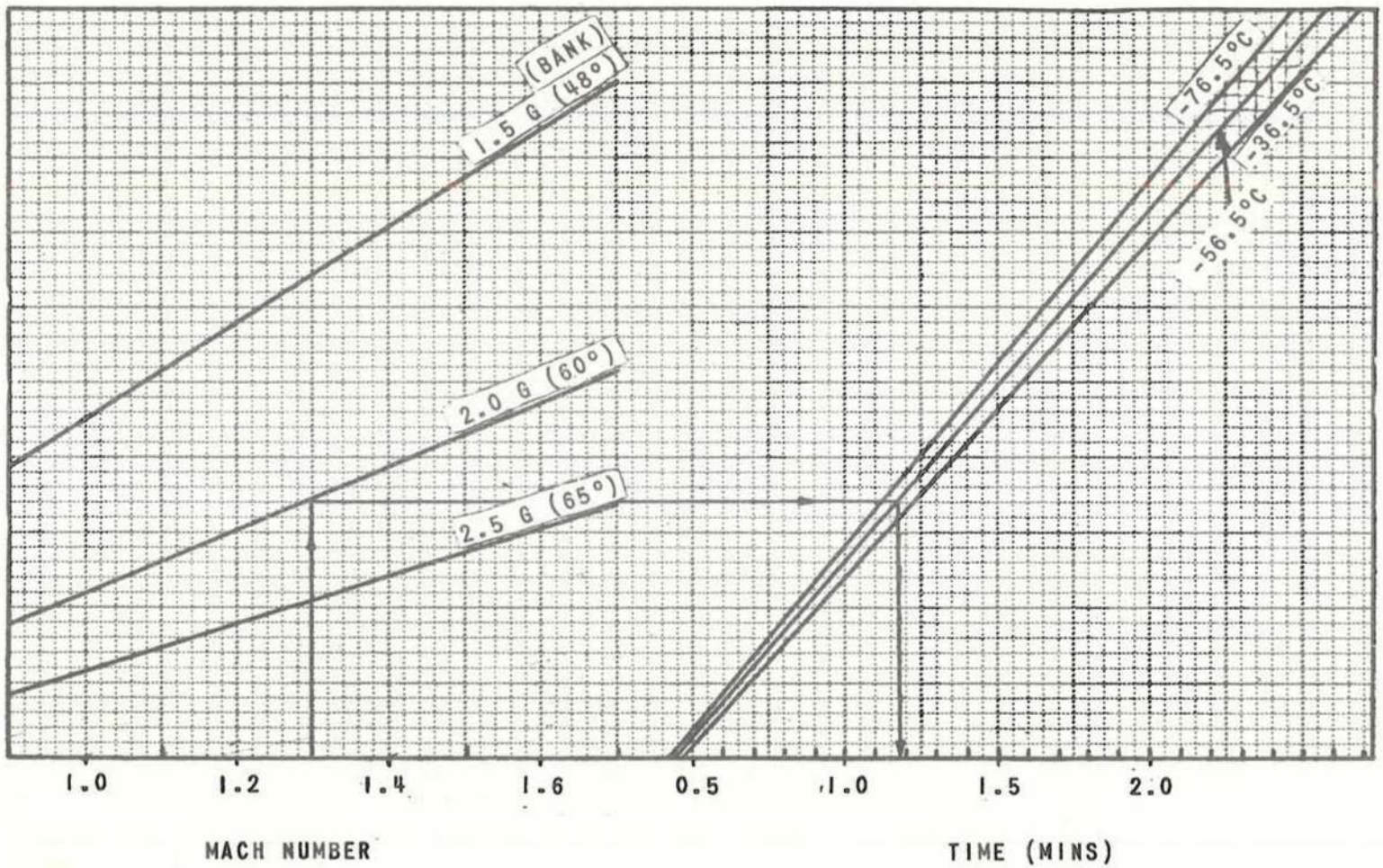


FIG.5·21. STEADY LEVEL TURN TIME FOR 180°

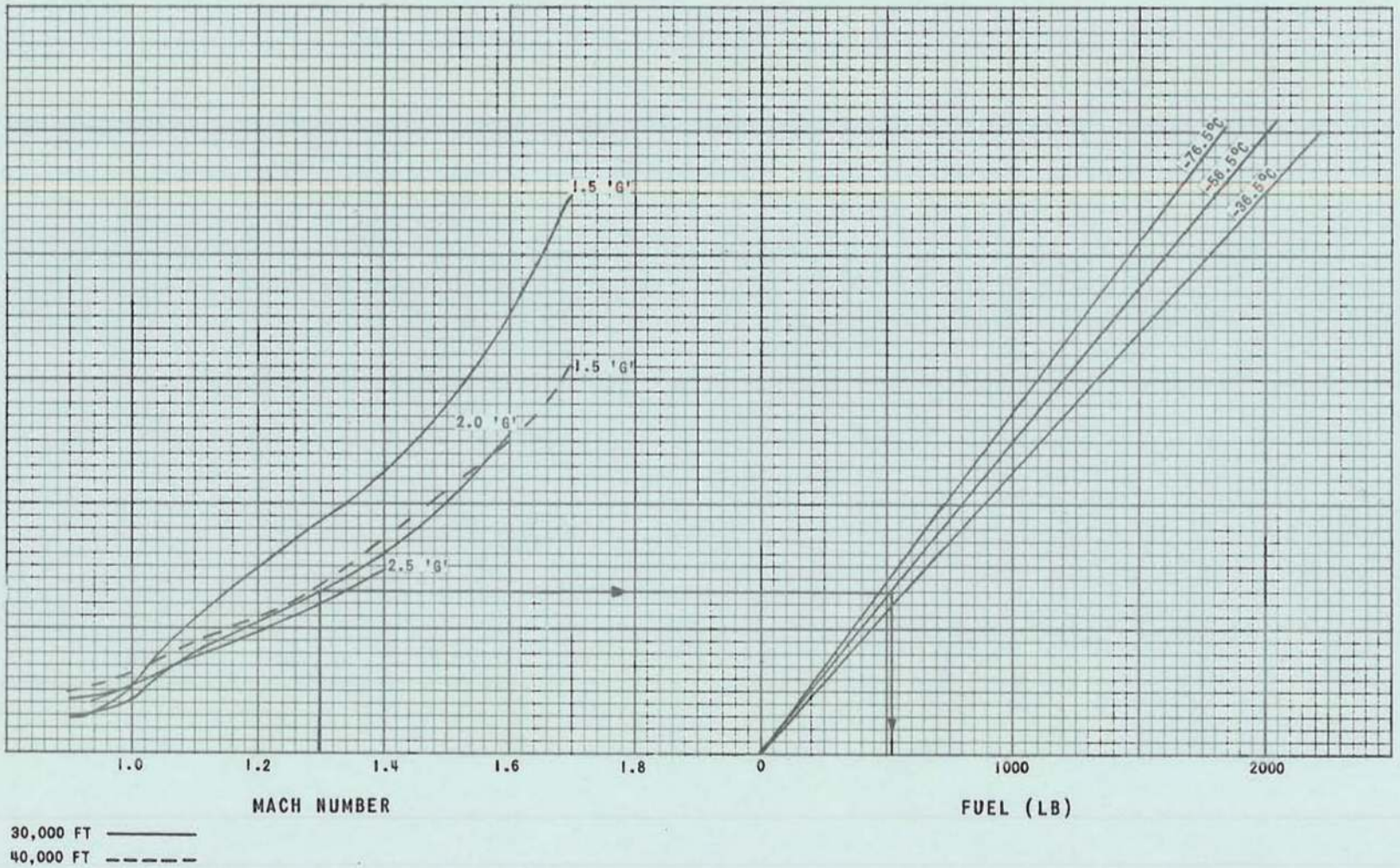


FIG. 5·22T. STEADY LEVEL TURN- FUEL USED FOR 180° — 30,000LB

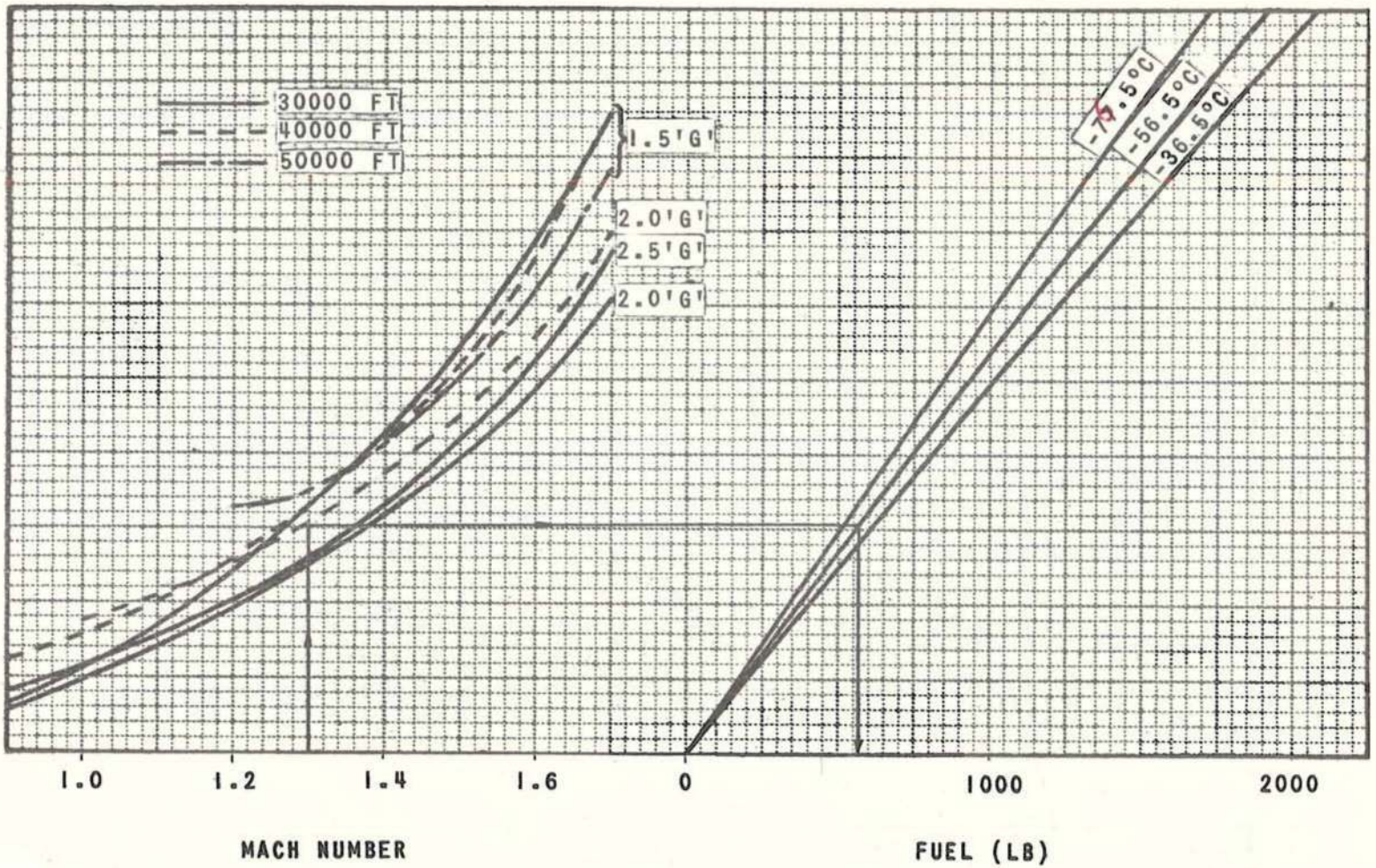


FIG. 5·22. STEADY LEVEL TURN. FUEL USED FOR 180°

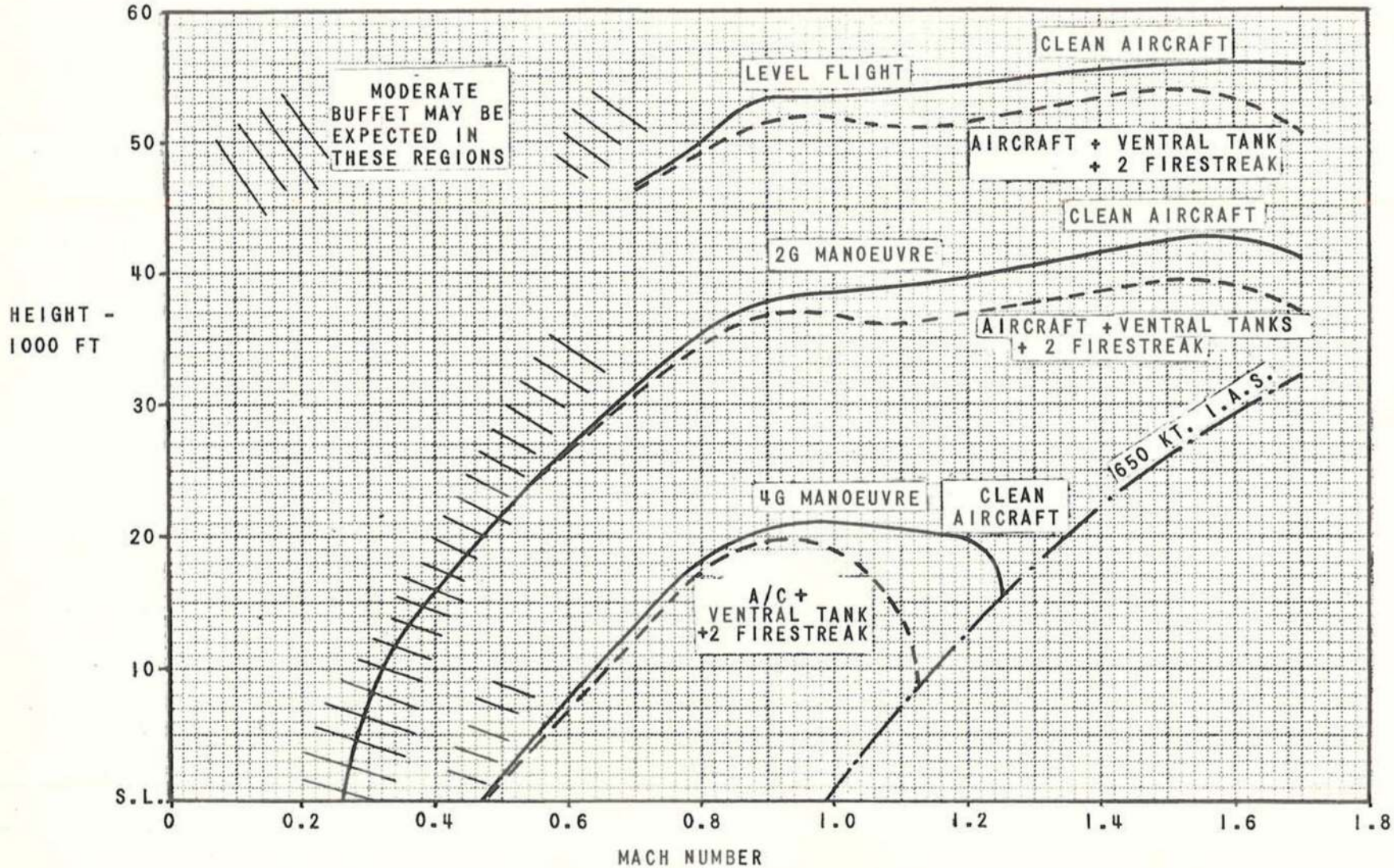


FIG. 5·23. THRUST BOUNDARIES AT FULL REHEAT. MAX. R.P.M. 30,000 LB. I.S.A.

LIGHTNING T MK. 4 ONLY

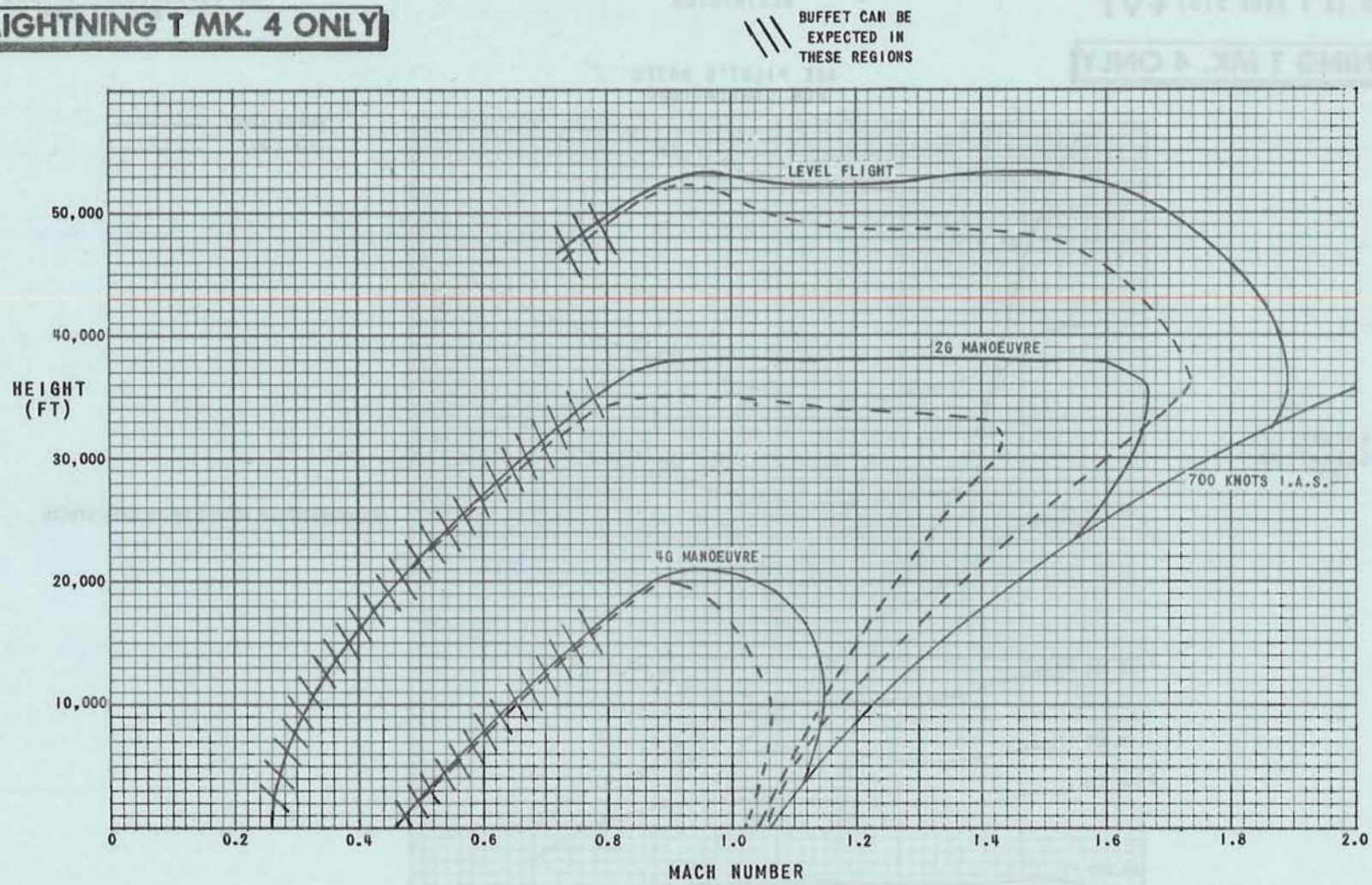


FIG. 5·23T. THRUST BOUNDARIES AT FULL REHEAT - MAX. R.P.M.
INTERNATIONAL STANDARD ATMOSPHERE - 30,000LB

LIGHTNING T MK. 4 ONLY

SEE PILOT'S NOTES
FOR LIMITATIONS

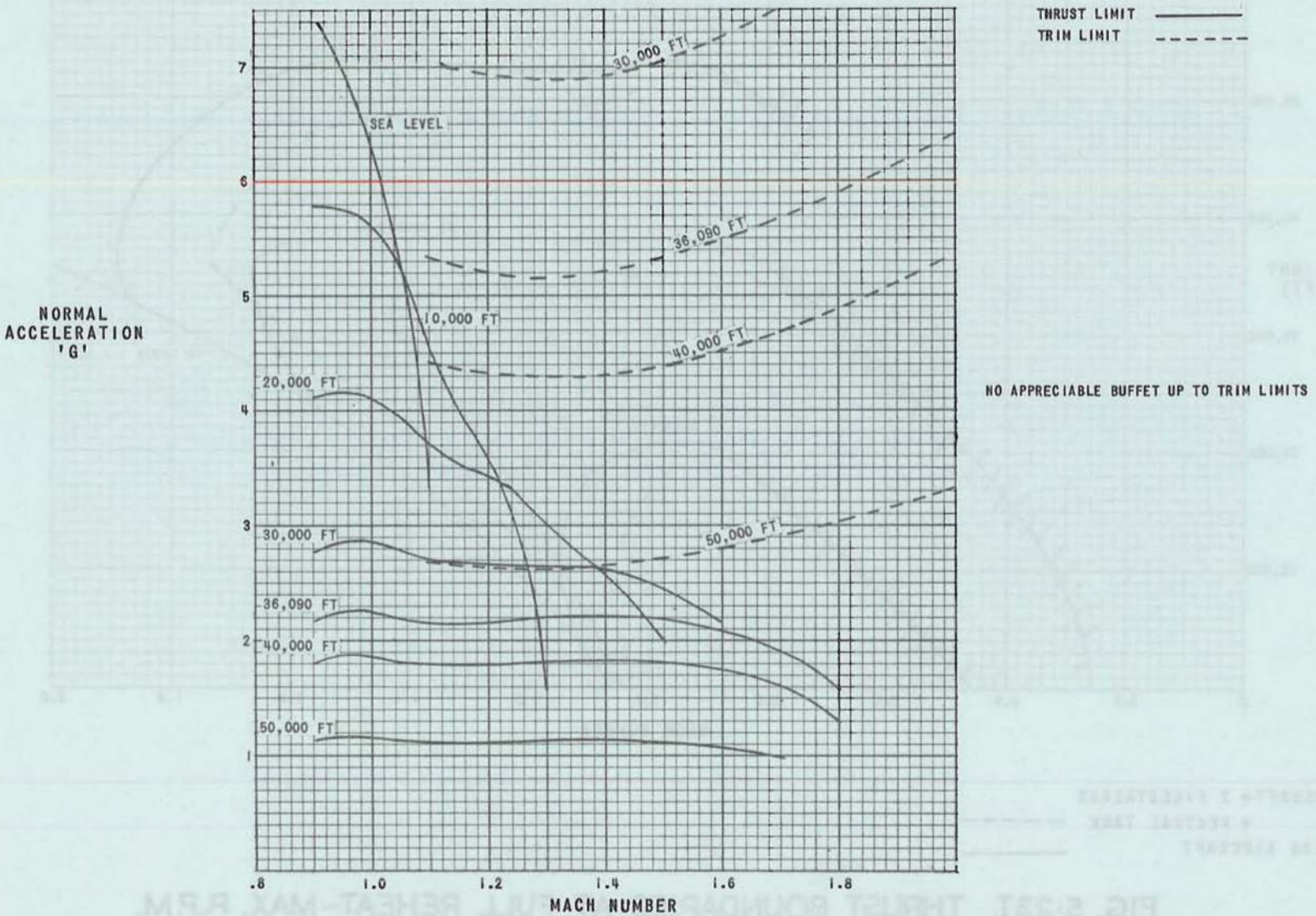


FIG. 5·24T. MANOEUVRE BOUNDARIES AT FULL REHEAT-MAX R.P.M.-~~ISOTHERMAL~~
INTERNATIONAL STANDARD ATMOSPHERE. -30,000LB

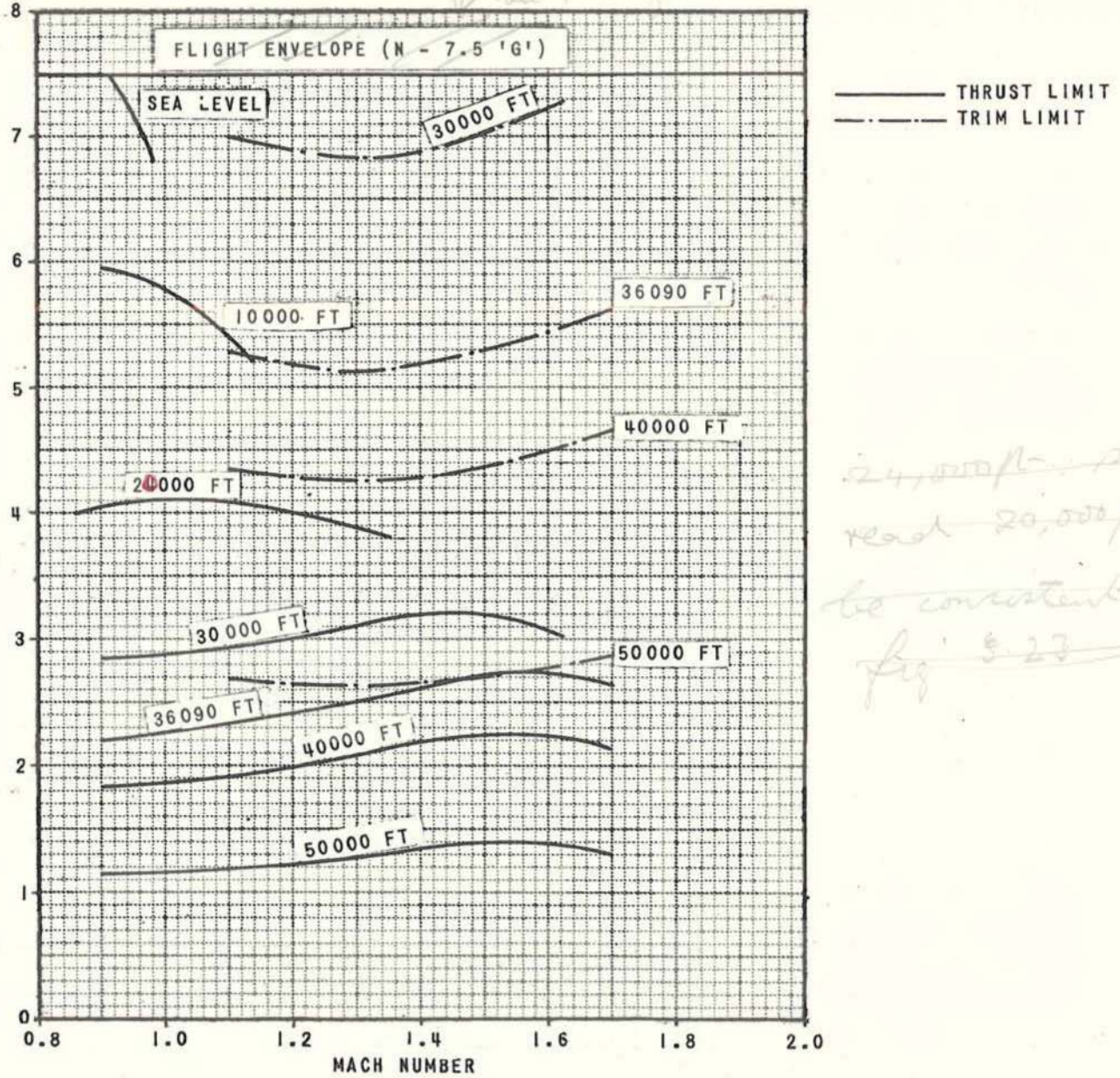


FIG. 5·24. MANOEUVRE BOUNDARIES AT FULL REHEAT MAX. R.P.M. I.S.A.

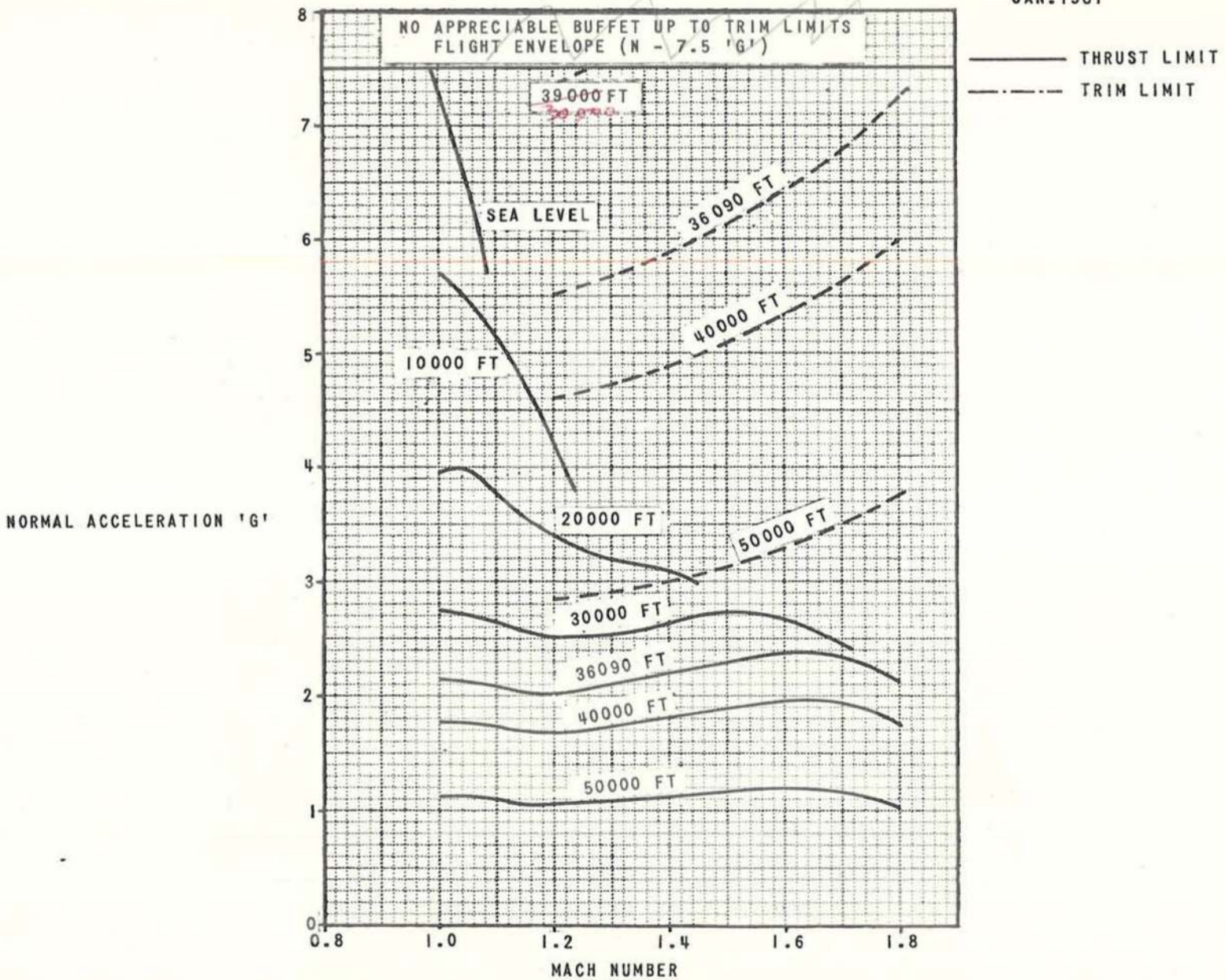
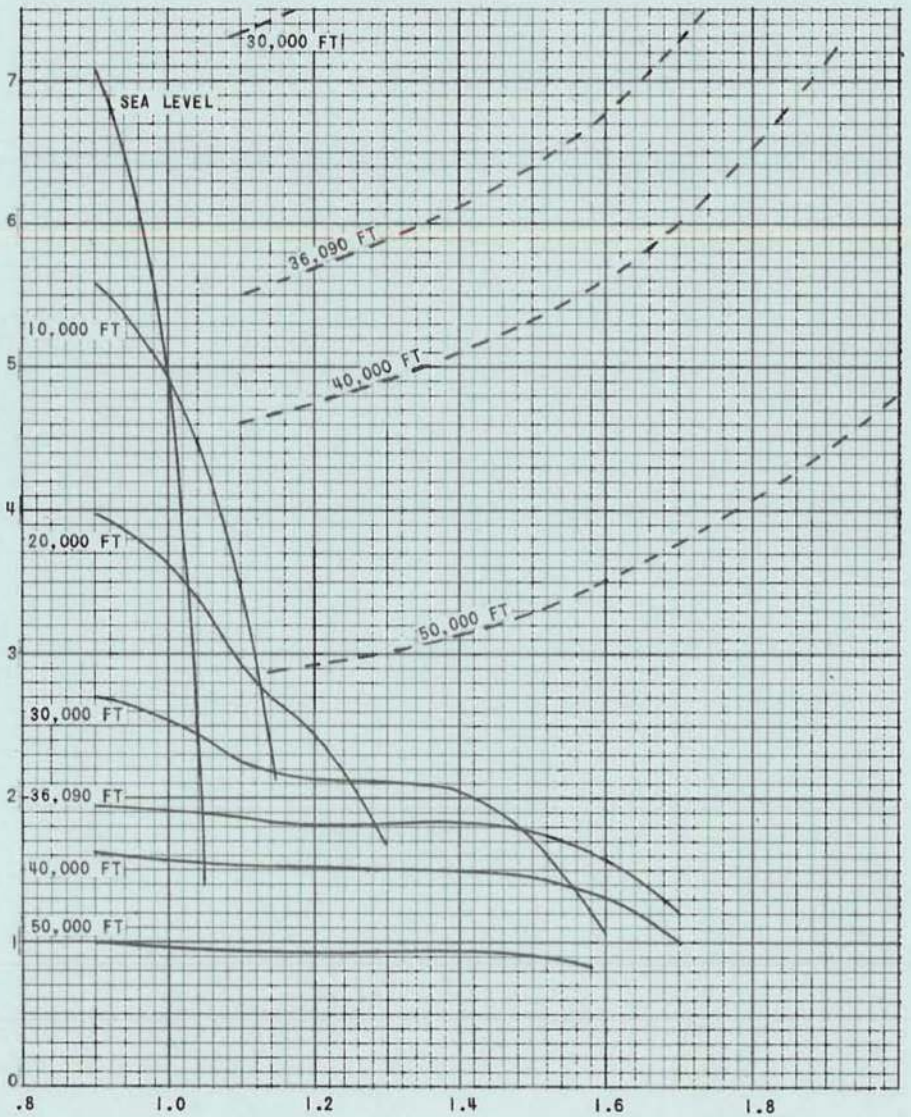


FIG. 5·25. MANOEUVRE BOUNDARIES AT FULL REHEAT, MAX. R.P.M.
I.S.A., 30,000 LB

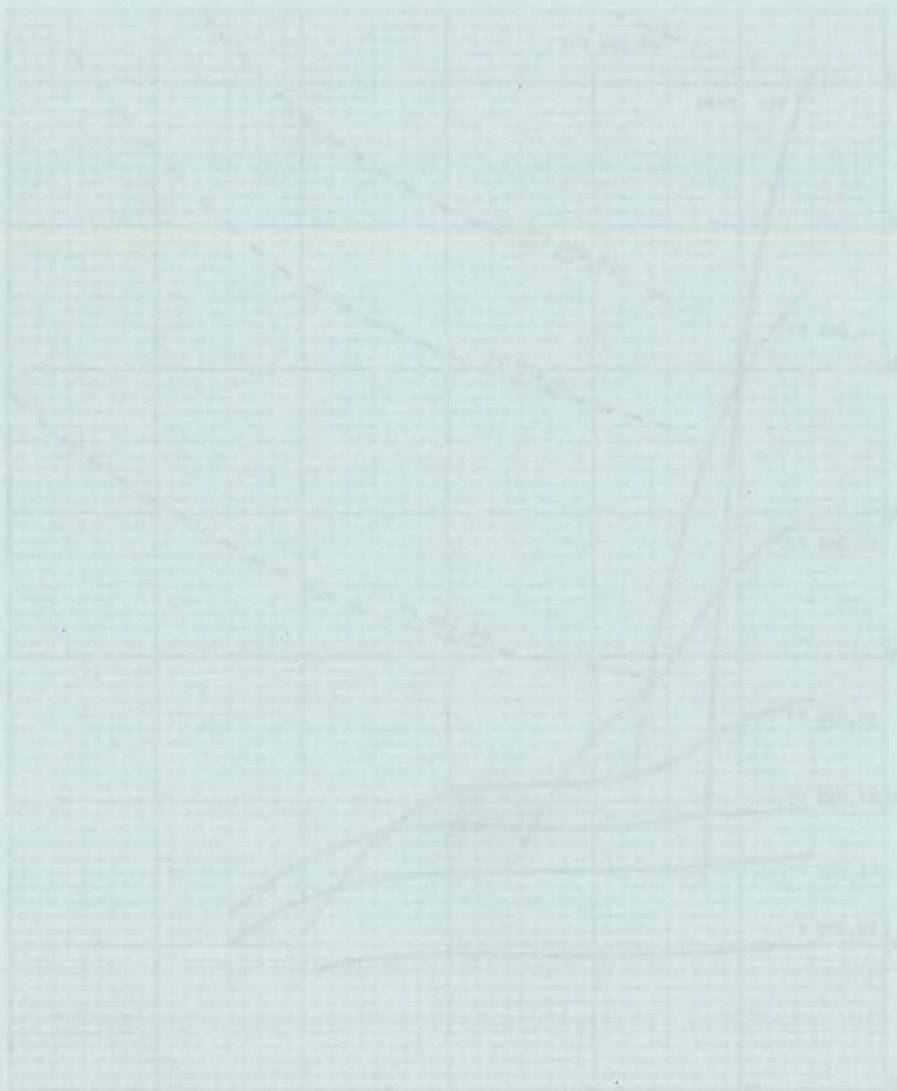
LIGHTNING T MK. 4 ONLY

SEE PILOT'S NOTES FOR LIMITATIONS



NO APPRECIABLE BUFFET UP TO TRIM LIMITS

FIG. 5 25T. MANOEUVRE BOUNDARIES AT FULL REHEAT-MAX. R.P.M.—I.S.A.—30,000 LB



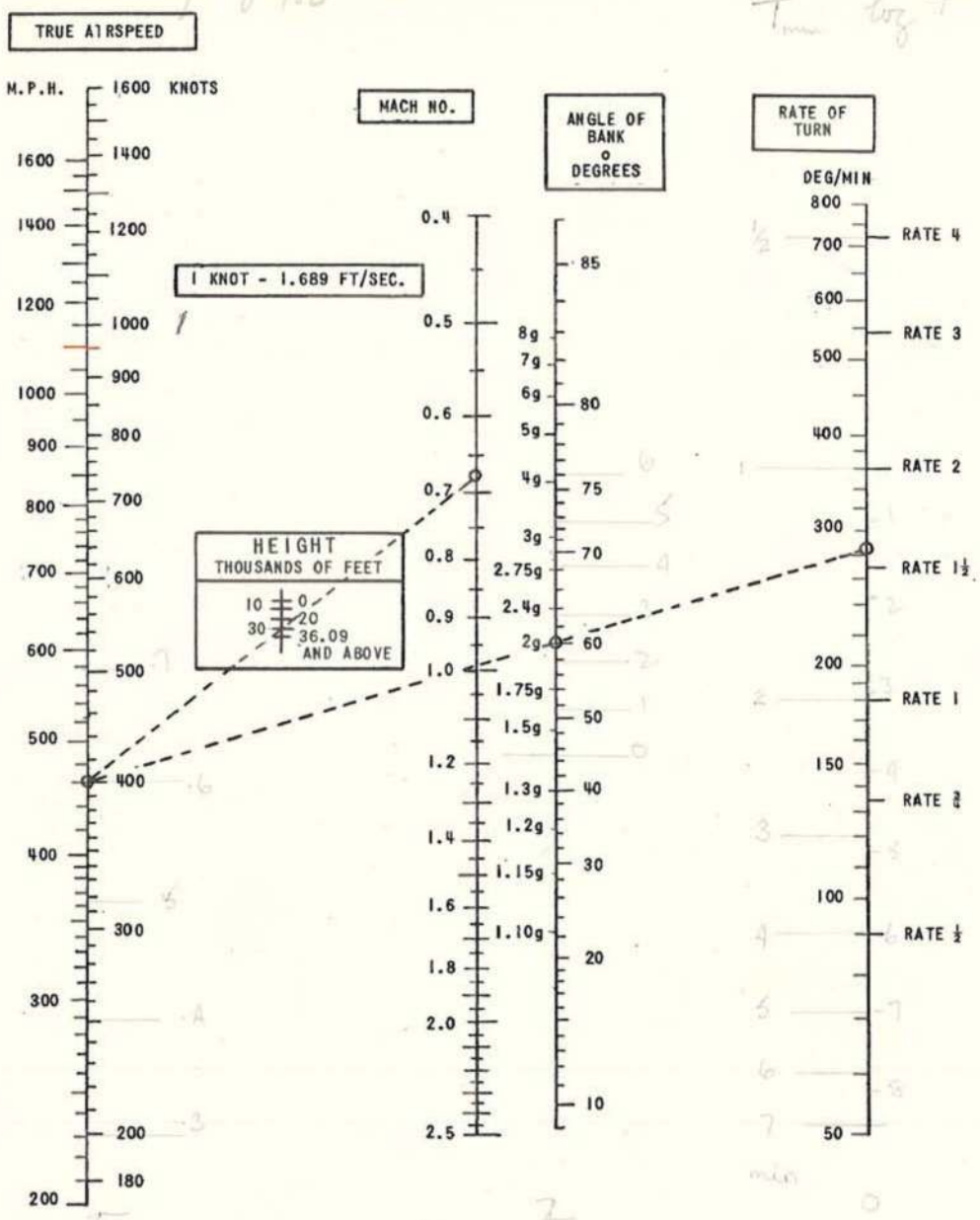


FIG. 5·26. NOMOGRAM OF TURNING PERFORMANCE