

PART 3. CLIMB

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

Two configurations: with ventral tank
with ventral tank and 2 Firestreaks

LIST OF FIGURES

Without reheat

- 3.1 Ground level acceleration to 450 knots IAS
- 3.2 Time in troposphere
- 3.3 Fuel in troposphere
- 3.4 Distance in troposphere
- 3.5 Time in Isothermal atmosphere
- 3.6 Fuel in Isothermal atmosphere
- 3.7 Distance in Isothermal atmosphere

With reheat

- 3.8 Ground level acceleration to 450 knots IAS
Subsonic climb at 450KT/0.9M
- 3.9 Time in troposphere
- 3.10 Fuel in troposphere
- 3.11 Distance in troposphere
- 3.12 Time in Isothermal atmosphere
- 3.13A Fuel in Isothermal atmosphere (with tank)
- 3.13B Fuel in Isothermal atmosphere (tank + 2 Firestreaks)
- 3.14 Distance in Isothermal atmosphere

Supersonic climbs in Isothermal atmosphere

3.15 & 3.15T	1.3M	time
3.16 & 3.16T	1.3M	fuel
3.17 & 3.17T	1.3M	distance
3.18 & 3.18T	1.6M	time
3.19 & 3.19T	1.6M	fuel
3.20 & 3.20T	1.6M	distance

◀ Climbs at constant altitude (roller blind)

3.21	$\theta = 15^\circ$ - time and distance from 36,000 ft
3.22	$\theta = 15^\circ$ - fuel and Mach number from 36,000 ft
3.23	$\theta = 15^\circ$ - time, distance, fuel and Mach number from 50,000 ft
3.24	$\theta = 25^\circ$ - time and distance from 36,000 ft
3.25	$\theta = 25^\circ$ - fuel and Mach number from 36,000 ft
3.26	$\theta = 25^\circ$ - time, distance, fuel and Mach number from 50,000 ft ▶

1. Presentation

Because of the amount of fuel used the climb phase may be of considerable importance in planning. The time, distance and fuel vary widely with atmospheric temperature, and data are given over a temperature range of ICAO $\pm 20^\circ\text{C}$.

In order that any atmosphere likely to be met in practice is covered, (tropopause between 25,000 ft,

and 39,000 ft) the climb has been divided into two parts, tropospheric and stratospheric. The first applies to atmospheres up to 39,000 ft with a standard lapse-rate of 2°C per 1000 ft, the second covers isothermal atmospheres from 25,000 ft to 44,000 ft. The total time, distance and fuel is found by the addition of the two parts.

Most of the figures are presented as carpet graphs (refer to Introduction).

Numerical examples

- (1) Climb from SL to 36,000 ft in ICAO atmosphere at 450 knots/0.9M, with ventral tank, without reheat.

Acceleration to 450 knots (*fig.3.1*) takes

◀ 1 min, 740 lb fuel and 2.9 anm ▶

Climb to 36,000 ft (*fig.3.2, 3.3, 3.4 - for A/C + tank*) takes

3.1 min, 760 lb fuel and 25.5 anm

Hence, total is

◀ 4.1 min, 1500 lb fuel and 28.4 anm ▶

- (2) Climb from SL to 40,000 ft pressure altitude at 450 knots/0.9M with ventral tank + 2 Firestreaks, without reheat. Tropopause reported at -50°C at 30,000 ft.

This is ICAO -5°C in troposphere.

Acceleration to 450 knots (*fig.3.1*) takes

◀ 0.9 min, 735 lb fuel and 2.7 anm ▶

Climb to 30,000 ft (*fig.3.2, 3.3, 3.4 - for A/C + tank + 2 Firestreaks*) takes

2.2 min, 650 lb fuel and 19 anm

Climb from 30,000 ft to 40,000 ft at -50°C (*fig. 3.5, 3.6, 3.7 - for A/C + tank + 2 Firestreaks*) takes

(2.9-0.5) = 2.4 min, (420-100) = 320 lb fuel and (24.8-4.4) = 20.4 anm

Hence, total is

◀ 5.5 min, 1705 lb fuel and 42.1 anm ▶

- (3) Take-off and climb from 6,000 ft to 44,000 ft with ventral tank and 2 Firestreaks, with reheat. Tropopause reported at -55°C at 32,000 ft. This is ICAO -7°C in troposphere.

Acceleration to 450 knots (*fig.3.8*) takes

◀ 0.8 min, 950 lb fuel and 2.3 anm ▶

Climb from 6,000 ft to 32,000 ft (*fig.3.9, 3.10, 3.11 - for A/C + tank + 2 Firestreaks*) takes

(1.4-0.2) = 1.2 min, (930-220) = 710 lb fuel and (11.1-1.6) = 9.5 anm

Climb from 32,000 ft to 44,000 ft at -55°C (*fig. 3.12, 3.13, 3.14 - for A/C + tank + 2 Firestreaks*) takes

(2.2-0.5) = 1.7 min, (660-190) = 470 lb fuel and (18.4-3.6) = 14.8 anm

Hence, total is

◀ 3.7 min, 2130 lb fuel and 26.6 anm ▶

- (4) Ground level temperature may not correspond to the troposphere temperatures as defined by the tropopause. In this case the ground level performance would be altered slightly. Thus, if in example 3 the measured ground level temperature were 10°C , then the acceleration to 450 knots (*fig.3.8*) would take

◀ 0.8 min, 980 lb fuel and 2.5 anm ▶

The two climb phases would not be altered significantly. Hence, the total is

◀ 3.7 min, 2160 lb fuel and 26.8 anm ▶

- (5) Climb at $\theta = 15^{\circ}$ from 36,000 ft to 55,000 ft, initial Mach number 1.7

Fig.3.21 gives:-

time taken to climb is 1.18 min

distance covered on climb is 17 anm

Fig.3.22 gives:-

fuel used during climb is 460 lb and final Mach number is 1.4 ▶

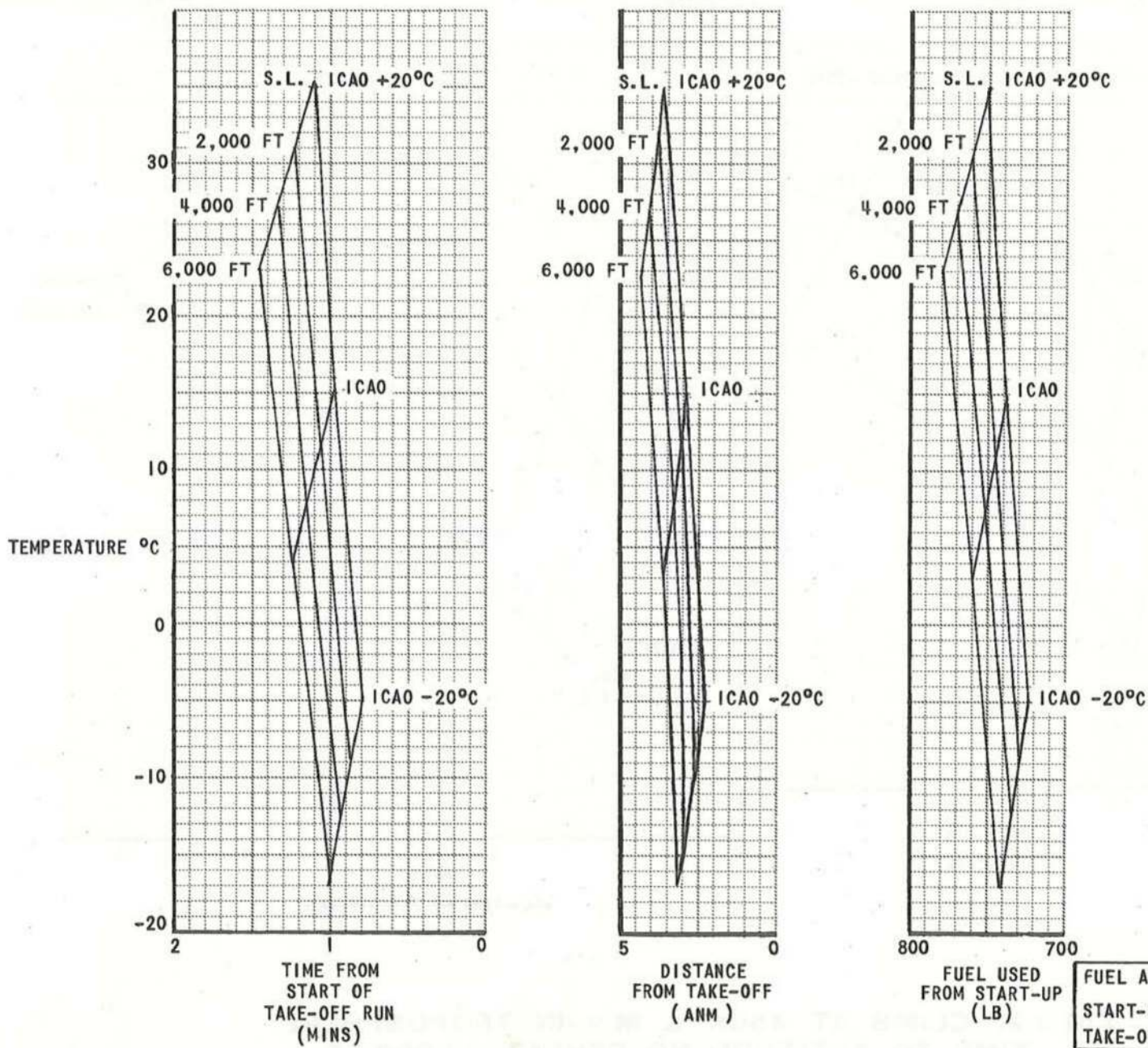
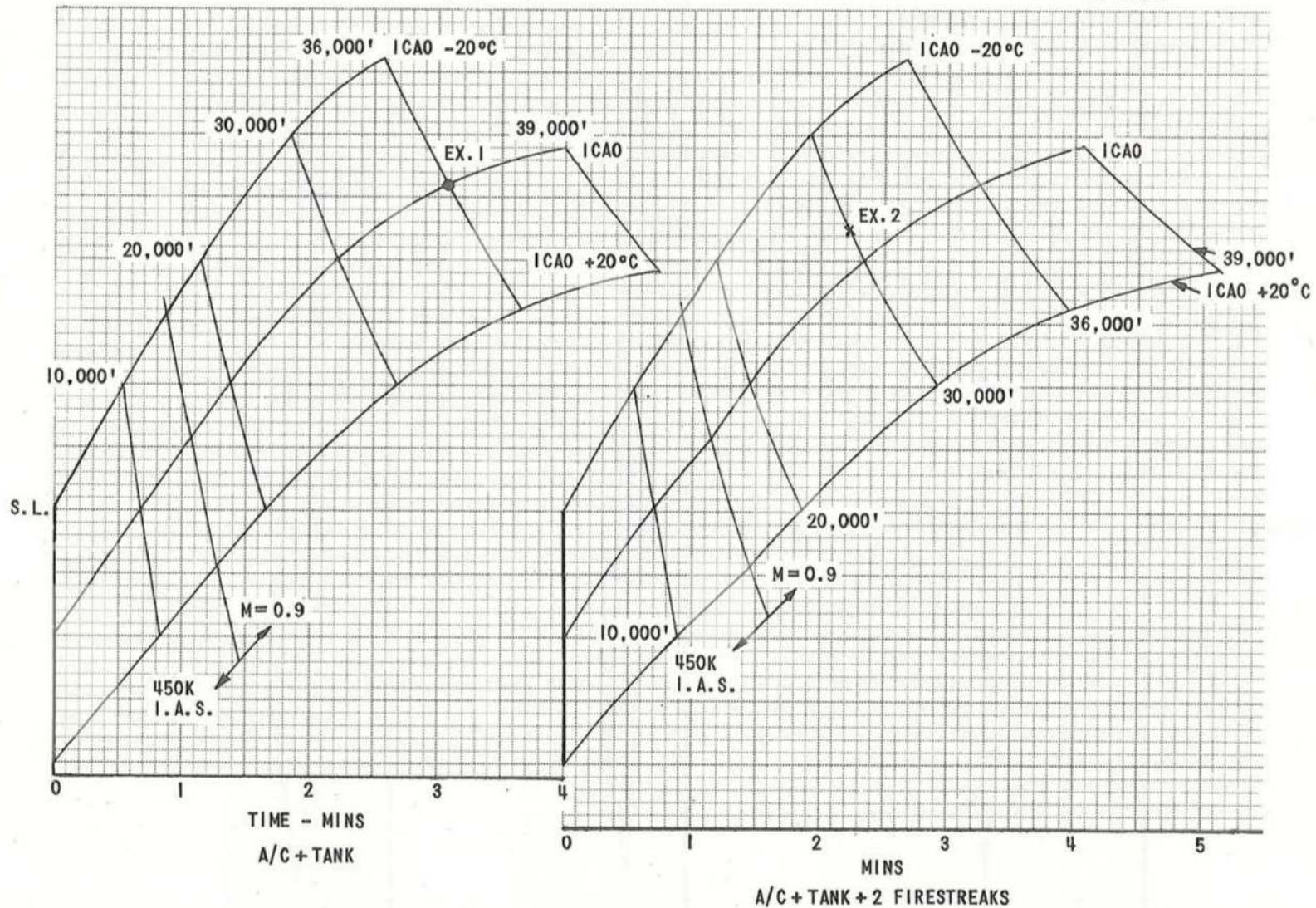


FIG.3.1. GROUND LEVEL ACCELERATION TO 450K I.A.S. - NO REHEAT



**FIG.3.2. CLIMB AT 450K & M.9 IN TROPOSPHERE
- TIME TO ALTITUDE NO REHEAT 33,000 LB**

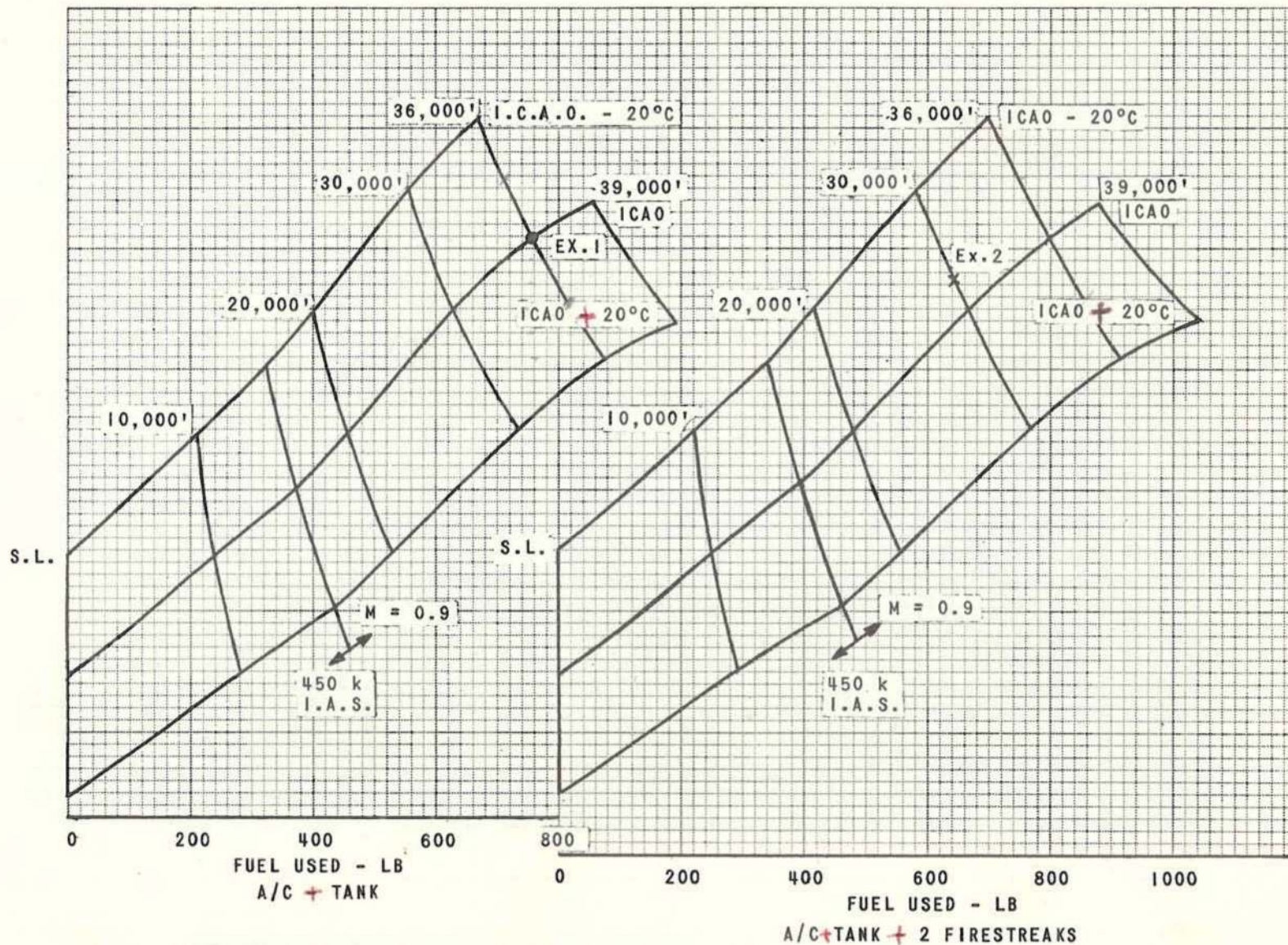


FIG. 3-3. CLIMB AT 450K & M.9 IN TROPOSPHERE. FUEL TO ALTITUDE. NO REHEAT. 33000 LB

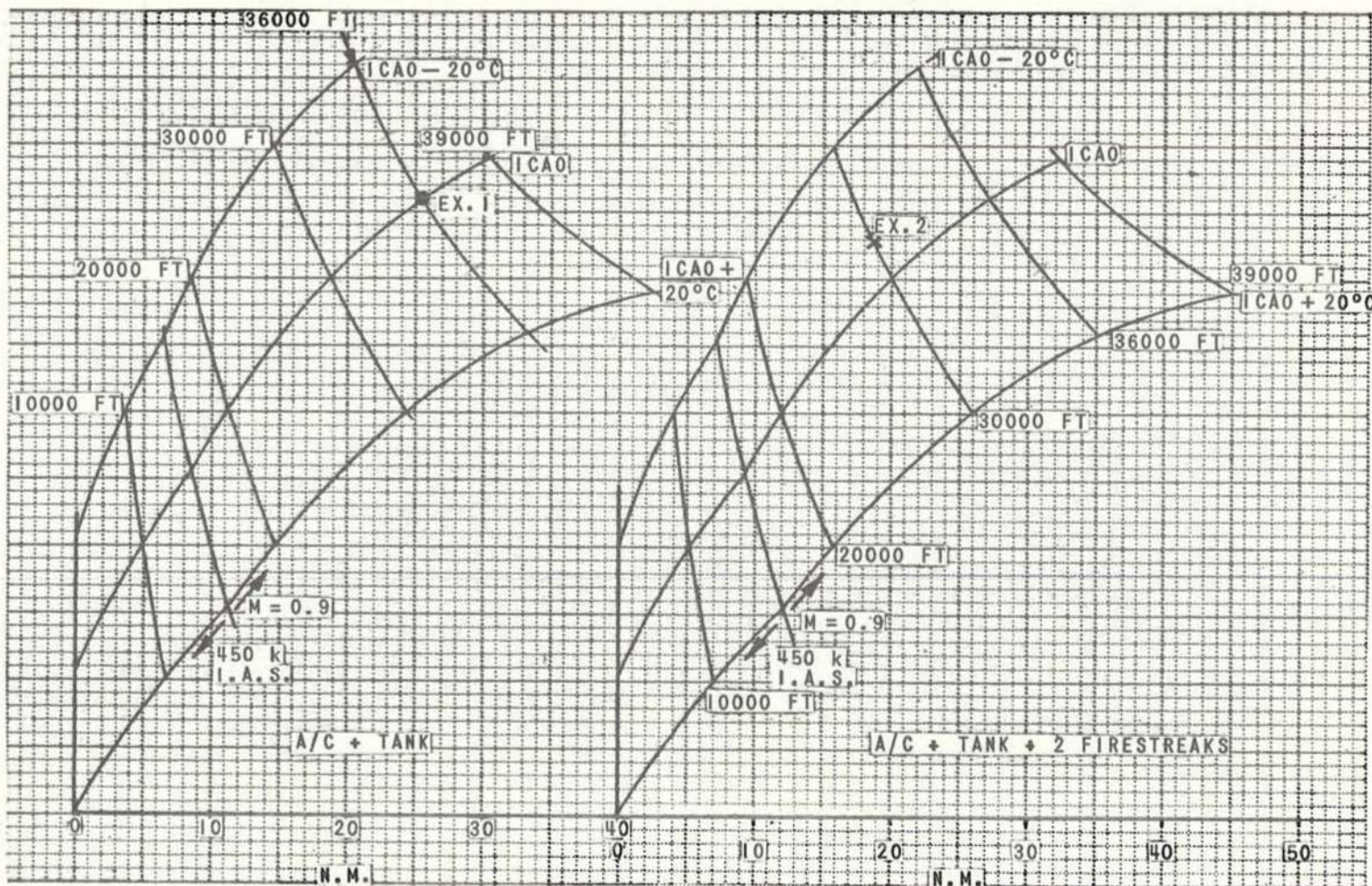


FIG. 3-4. CLIMB AT 450K & M-9 IN TROPOSPHERE
DISTANCE TO ALTITUDE—NO REHEAT—33,000 LB

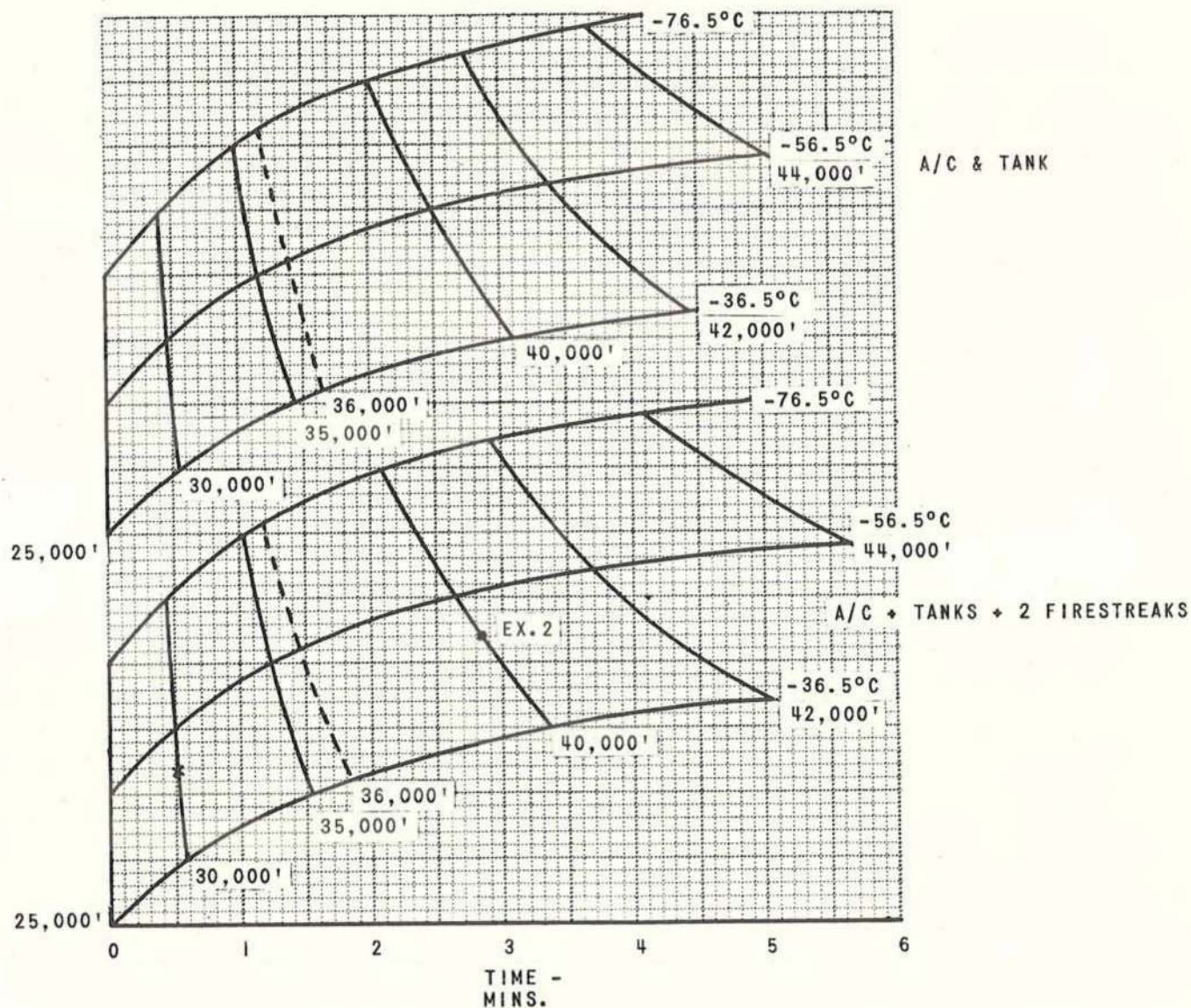


FIG. 3-5. CLIMB AT M-9 IN ISOTHERMAL ATMOSPHERE—TIME TO HEIGHT NO REHEAT. 33000 LB

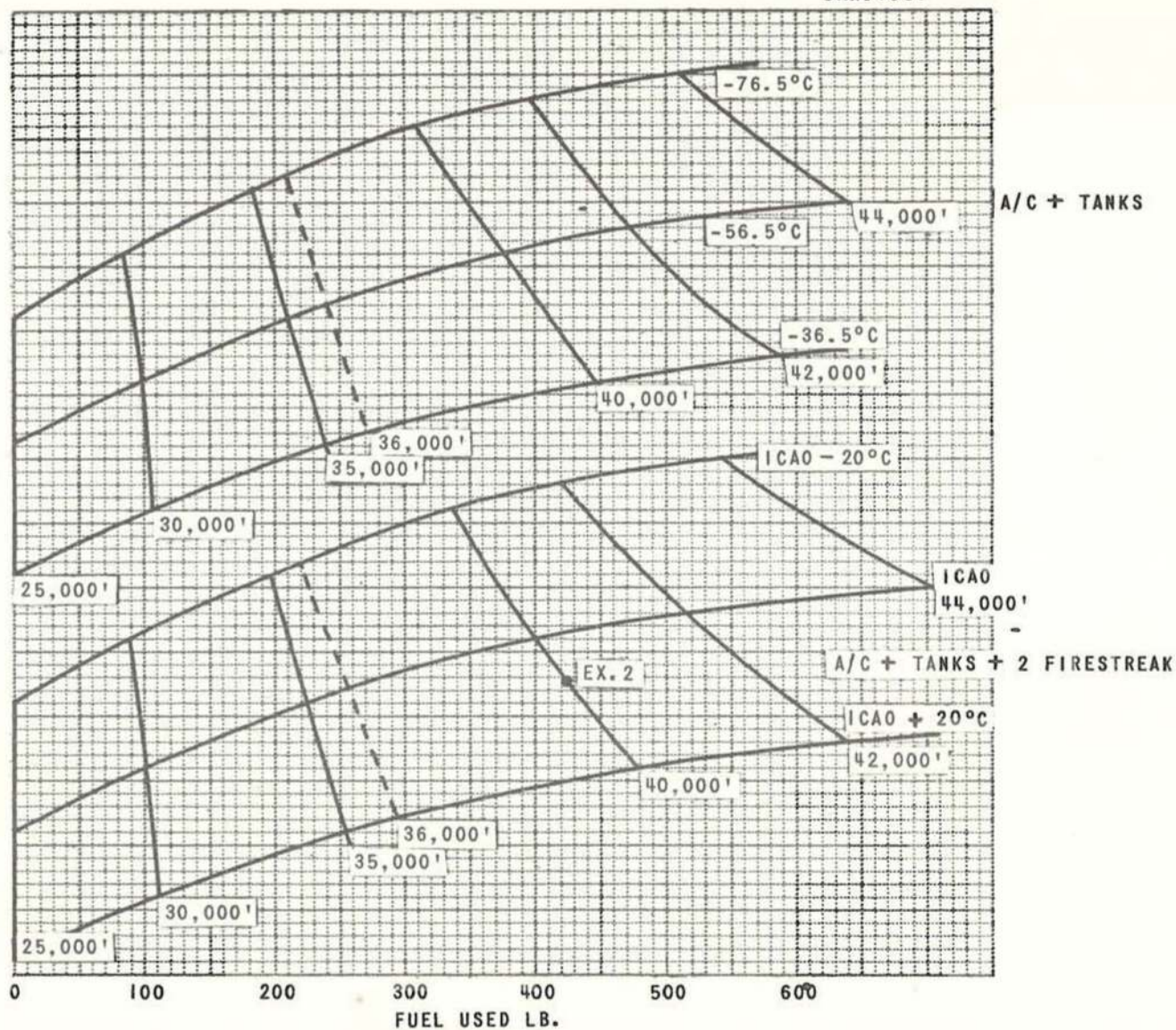


FIG. 3-6. CLIMB AT M-9 IN ISOTHERMAL ATMOSPHERE — FUEL USED TO HEIGHT NO REHEAT 33000 LB

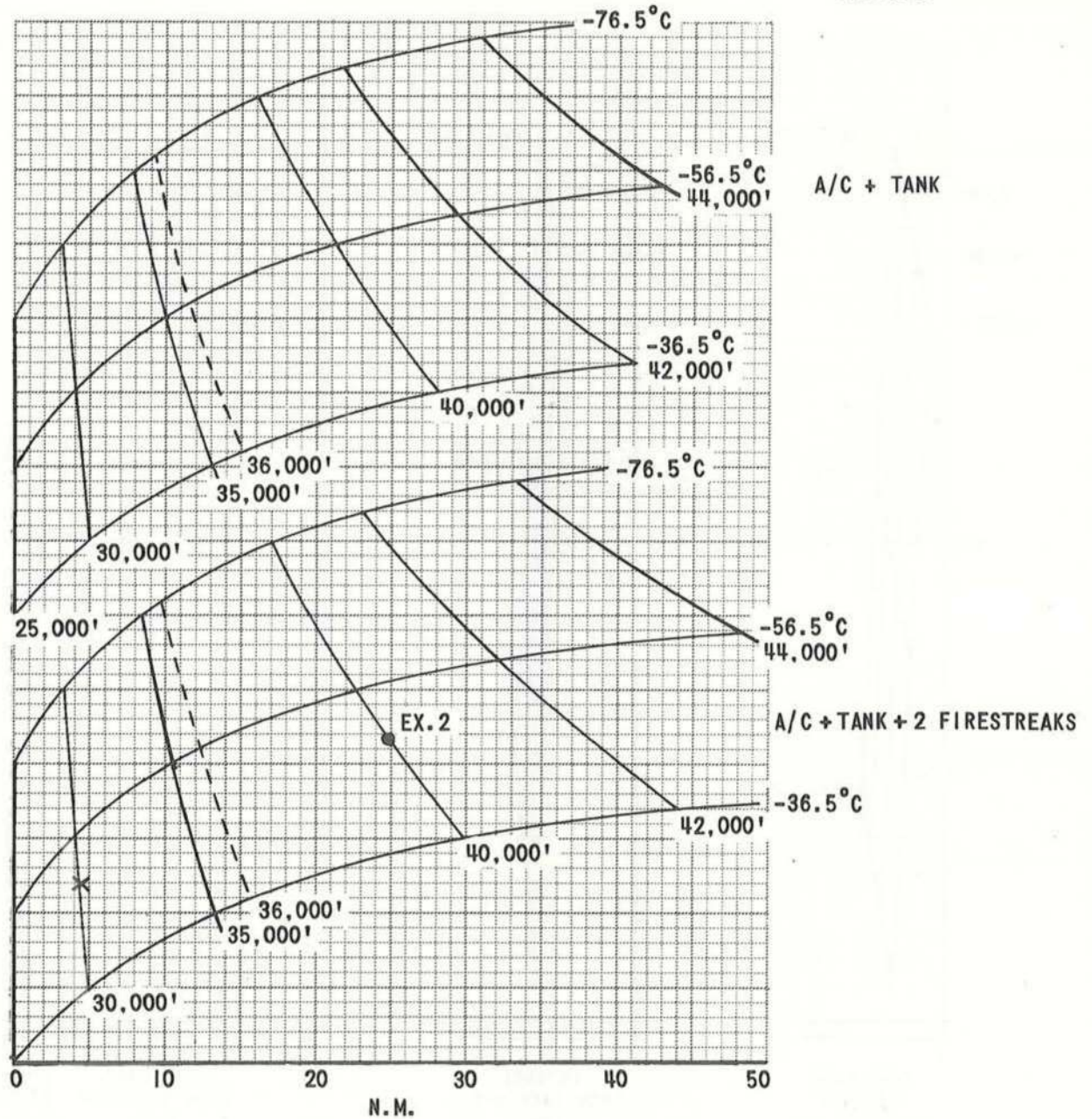


FIG.3.7. CLIMB AT M.9 IN ISOTHERMAL ATMOSPHERE
 - DISTANCE TO HEIGHT NO REHEAT 33,000 LB

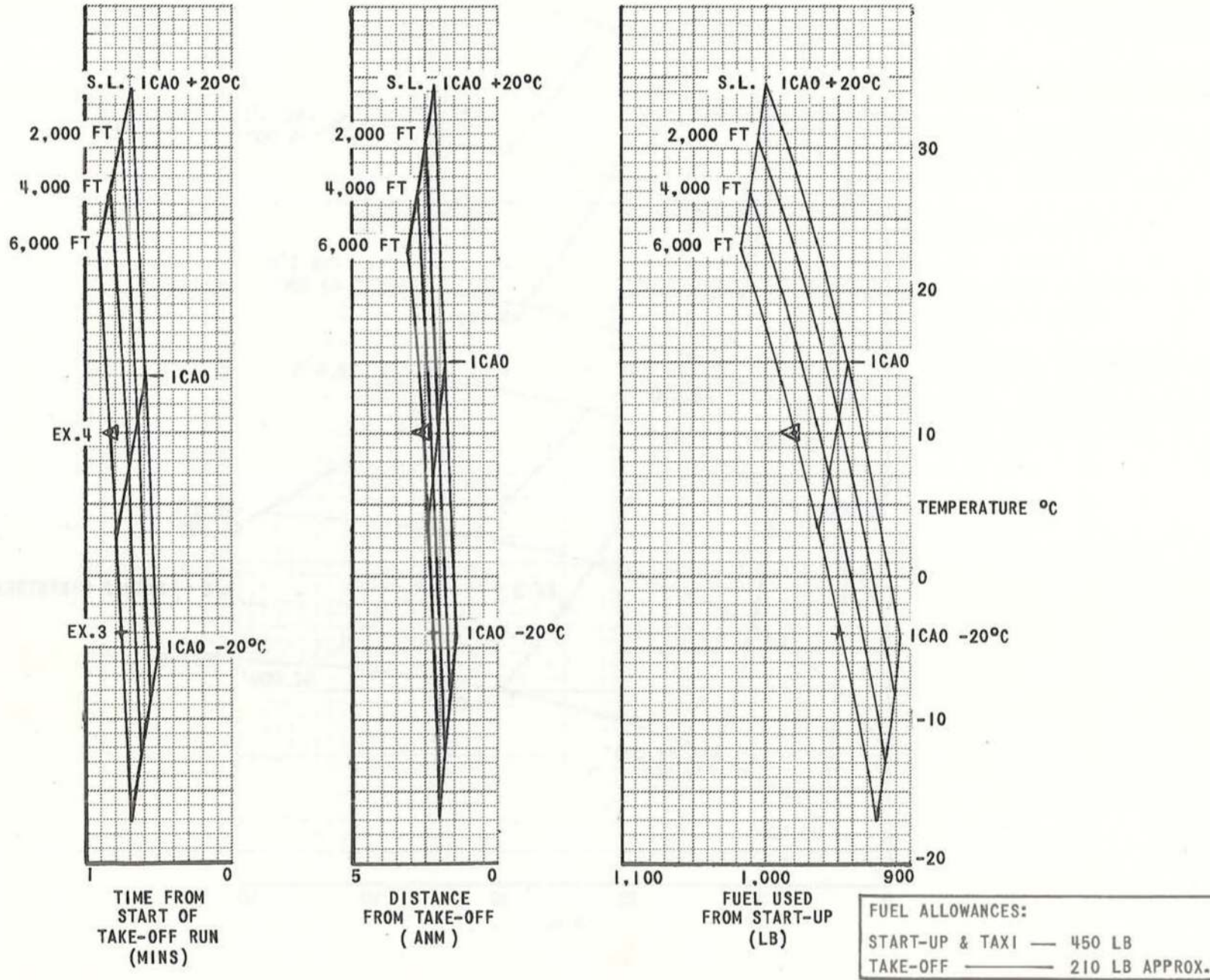


FIG.3.8. GROUND LEVEL ACCELERATION TO 450K I.A.S. - REHEAT

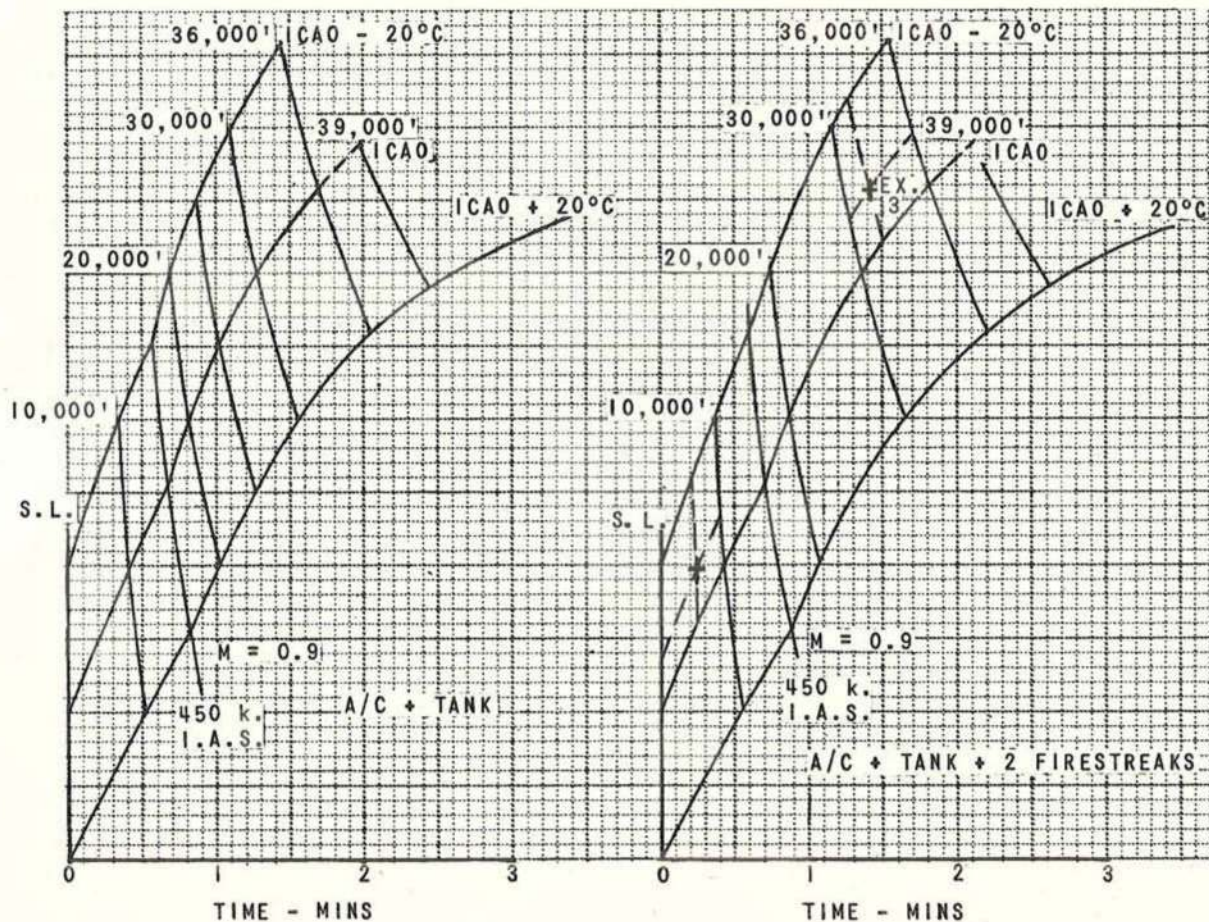


FIG. 3-9. CLIMB AT 450K & M-9 IN TROPOSPHERE
 TIME TO ALTITUDE—REHEAT 33,000 LB.

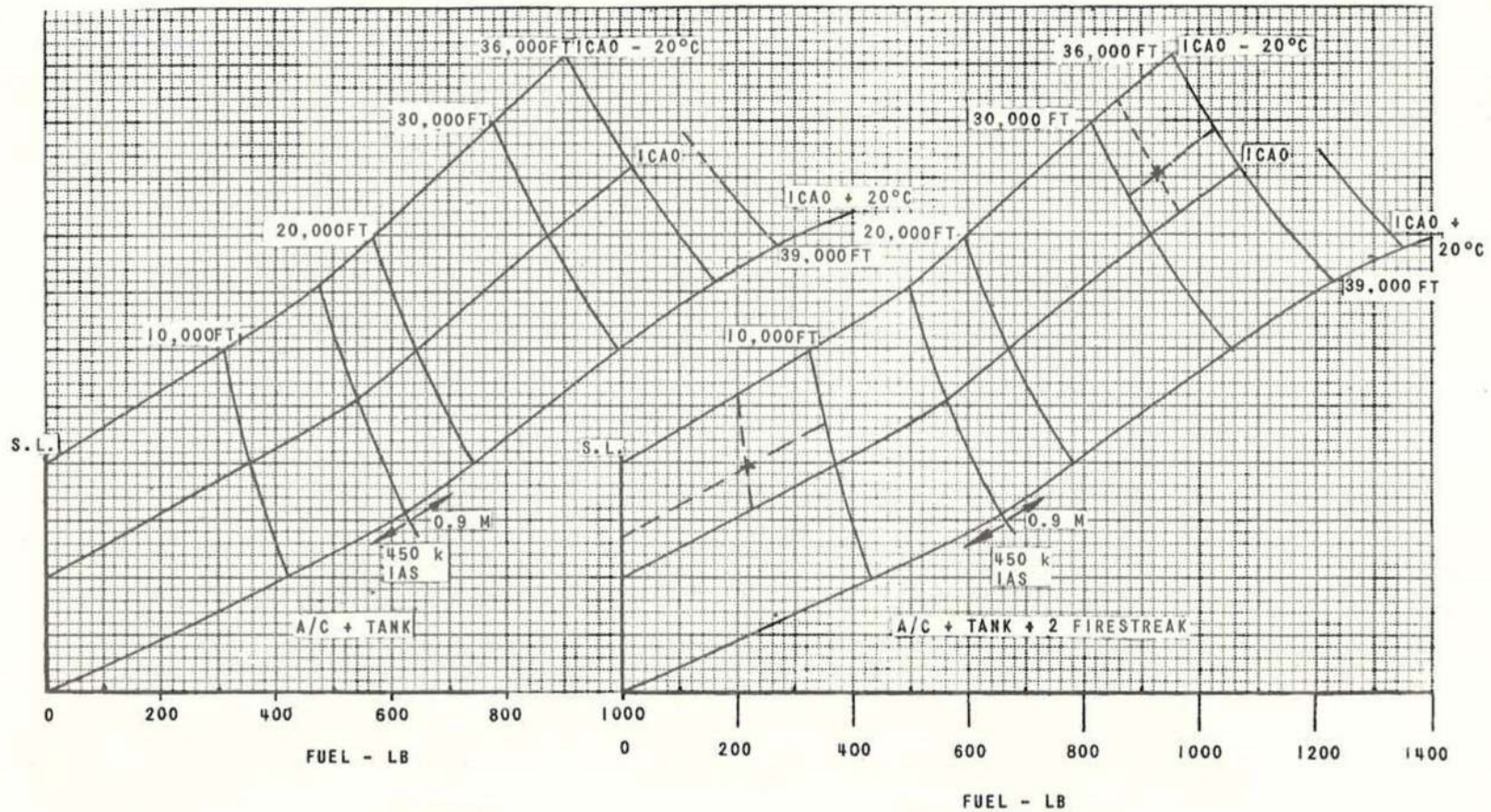


FIG. 3-10. CLIMB AT 450K & M.9 IN TROPOSPHERE
 FUEL USED TO ALTITUDE - REHEAT 33,000 LB.

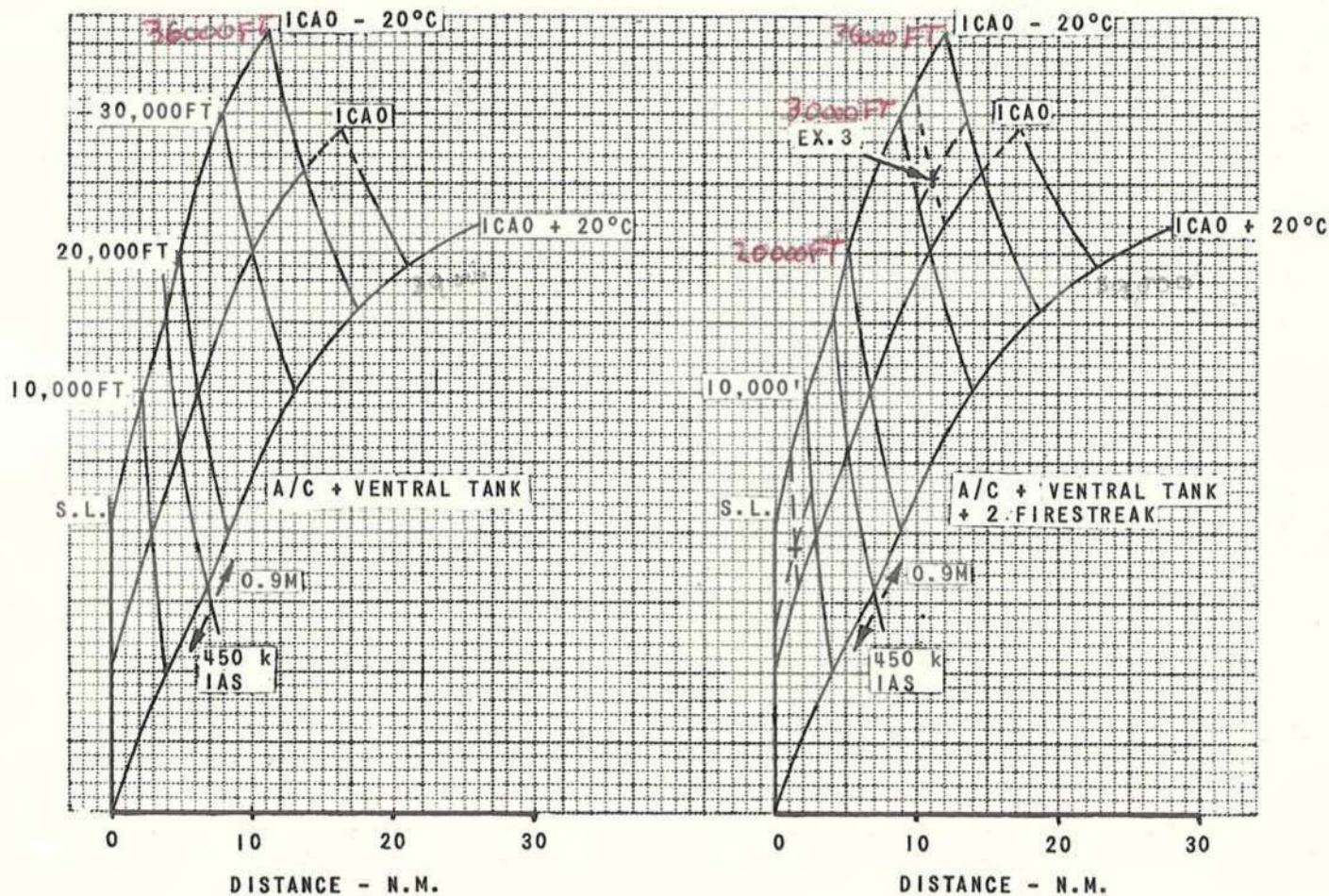


FIG. 3-11. CLIMB AT 450K & M9 IN TROPOSPHERE.
DISTANCE TO ALTITUDE. REHEAT. 33,000 LB.

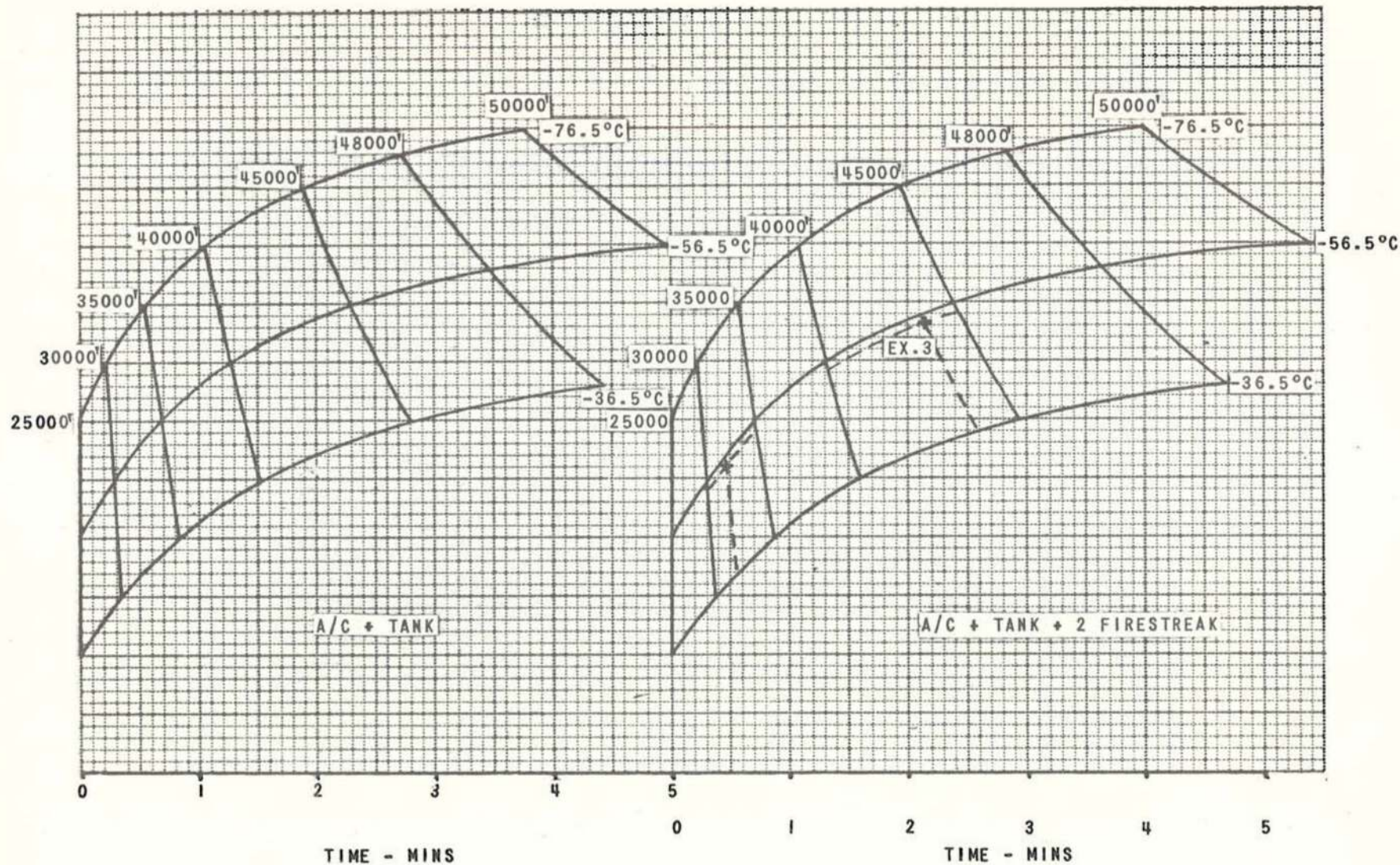


FIG. 3-12. CLIMB AT M·9 IN ISOTHERMAL ATMOSPHERE — TIME TO ALTITUDE REHEAT 33,000 LB.

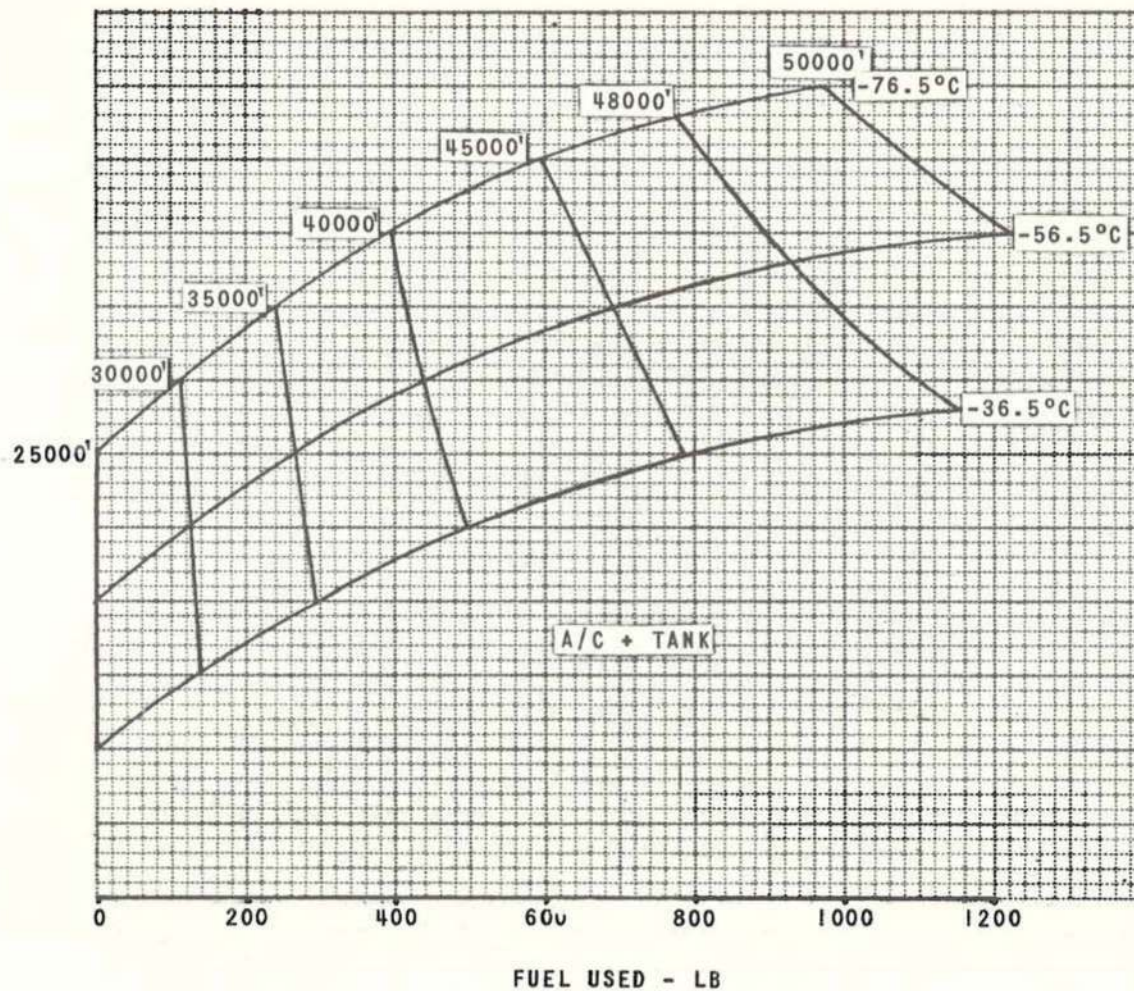


FIG. 3-13.(A) CLIMB AT M·9 IN ISOTHERMAL ATMOSPHERE - FUEL TO ALTITUDE REHEAT 33,000 LB.

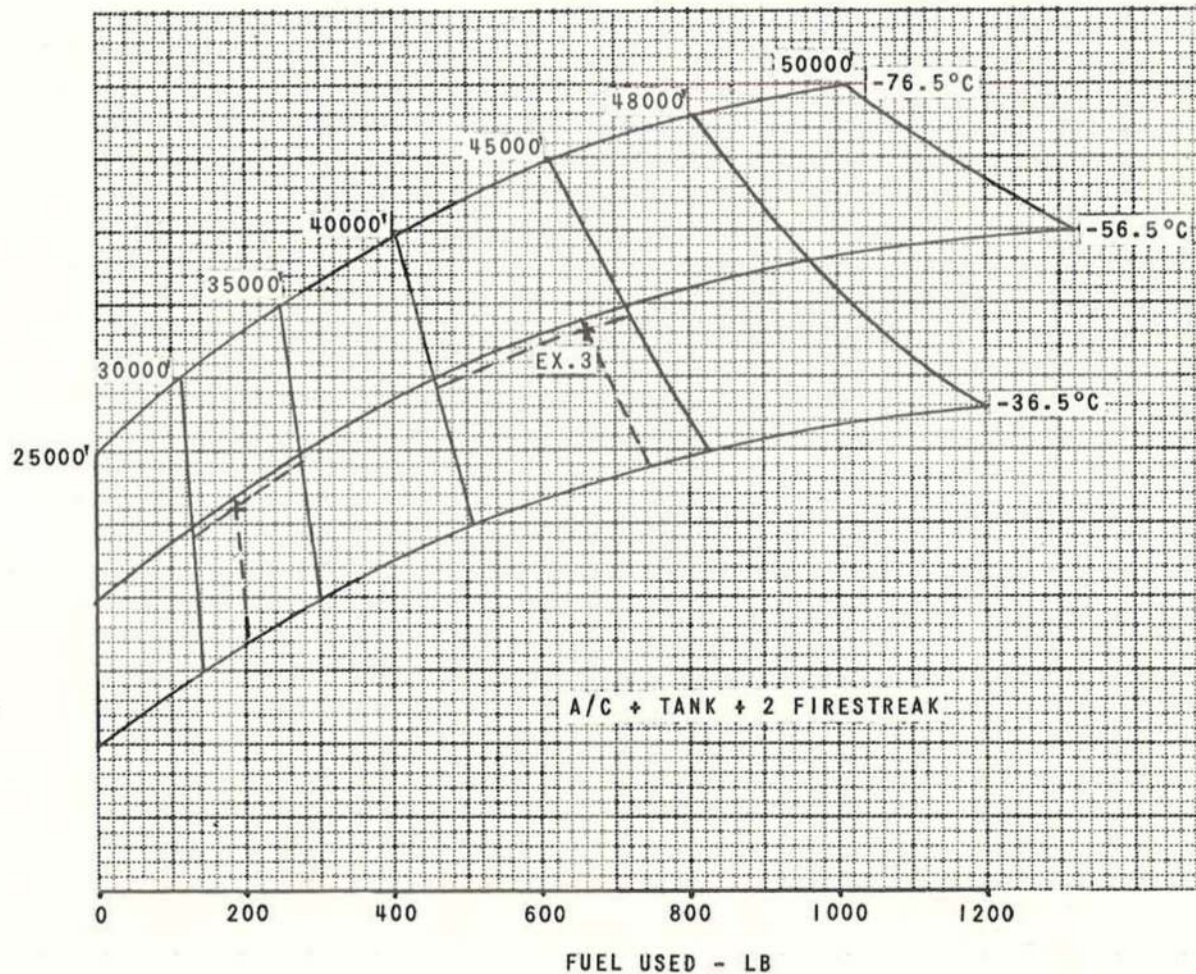


FIG. 3.13 (B). CLIMB AT M-9 IN ISOTHERMAL ATMOSPHERE — FUEL TO ALTITUDE REHEAT-33,000 LB

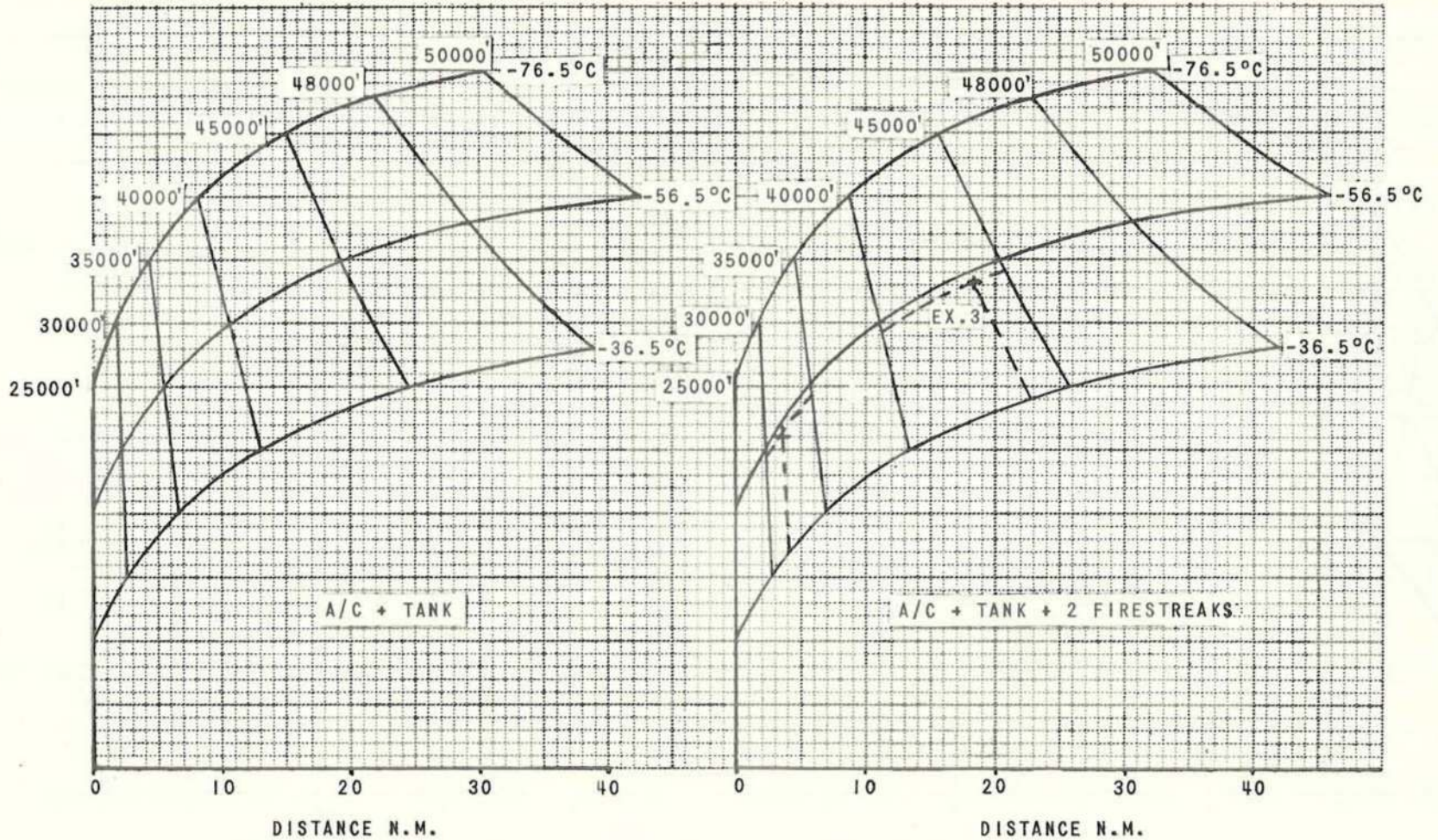


FIG. 3-14. CLIMB AT M-9 IN ISOTHERMAL ATMOSPHERE — DISTANCE TO ALTITUDE REHEAT 33,000 LB.

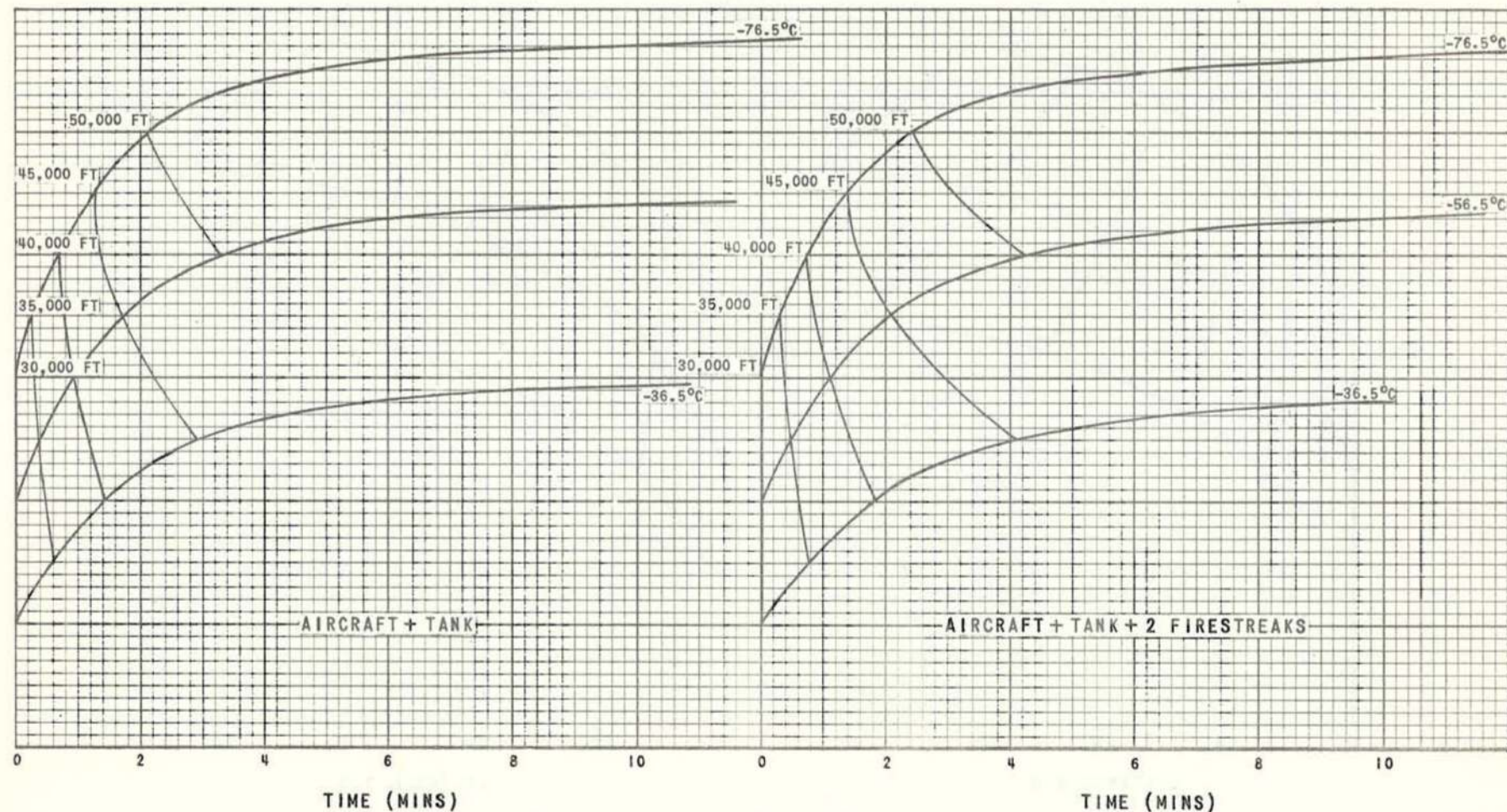
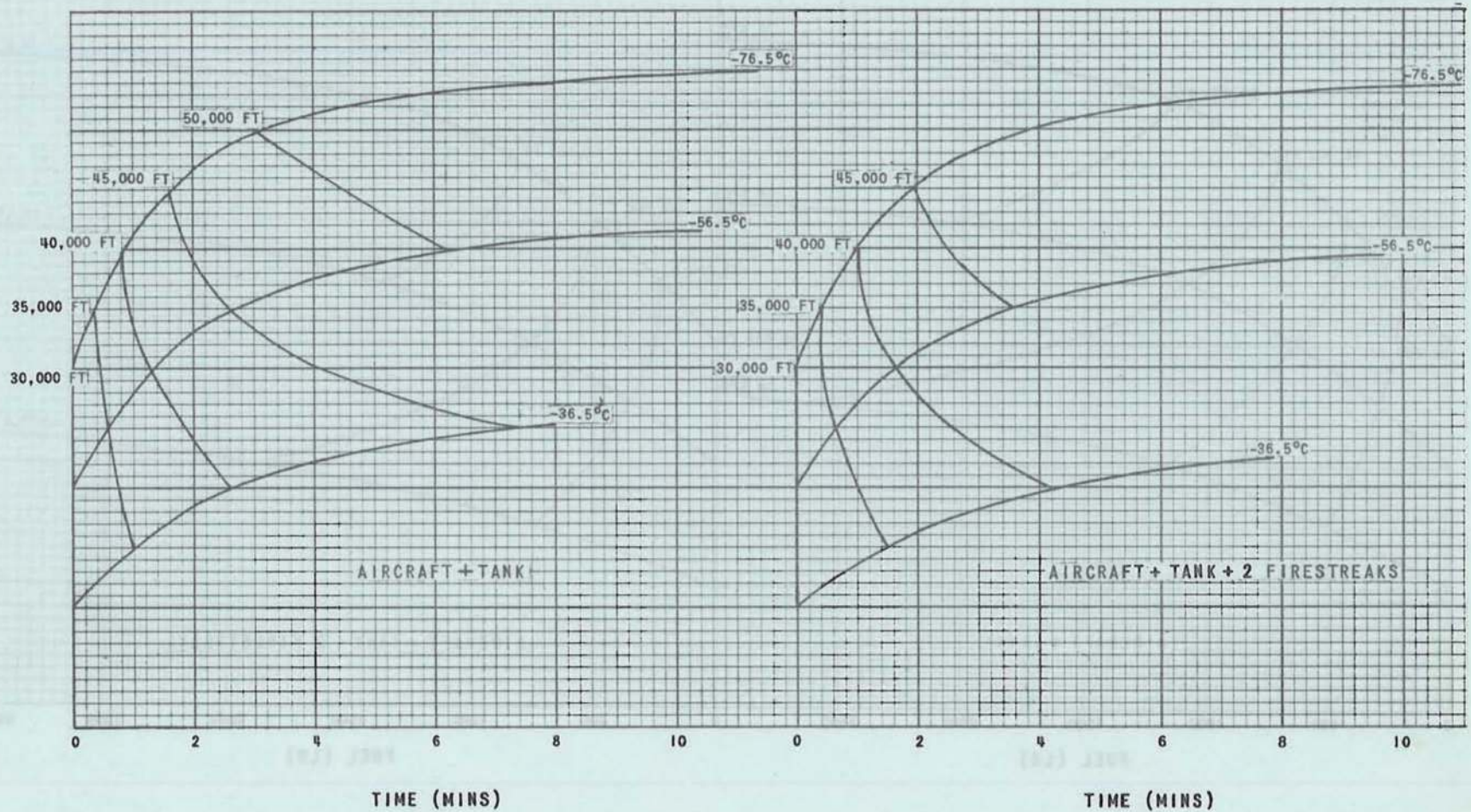


FIG. 3-15: CLIMB AT M1.3 ISOTHERMAL ATMOSPHERE
-TIME TO ALTITUDE-REHEAT-31,000LB

LIGHTNING T MK. 4 ONLY

LIGHTNING T MK. 4 ONLY



**FIG. 3-15T. CLIMB AT M1-3-ISOTHERMAL ATMOSPHERE—TIME TO ALTITUDE
—REHEAT—31,000LB**

LIGHTNING T MK. 4 ONLY

LIGHTNING T MK 4 ONLY

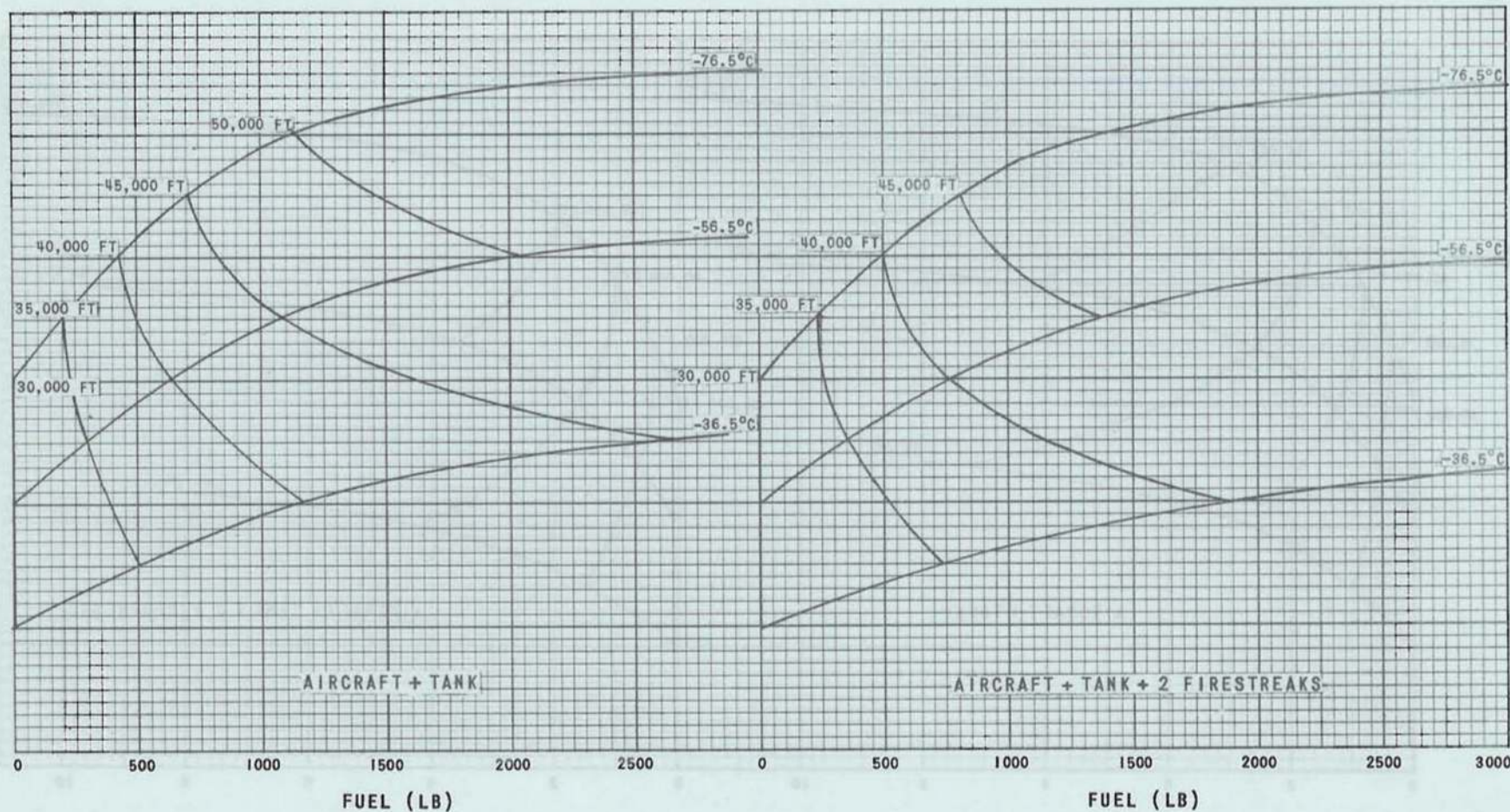


FIG. 3-1 6T. CLIMB AT MI-3-ISOTHERMAL ATMOSPHERE-FUEL TO ALTITUDE
-REHEAT - 31,000LB

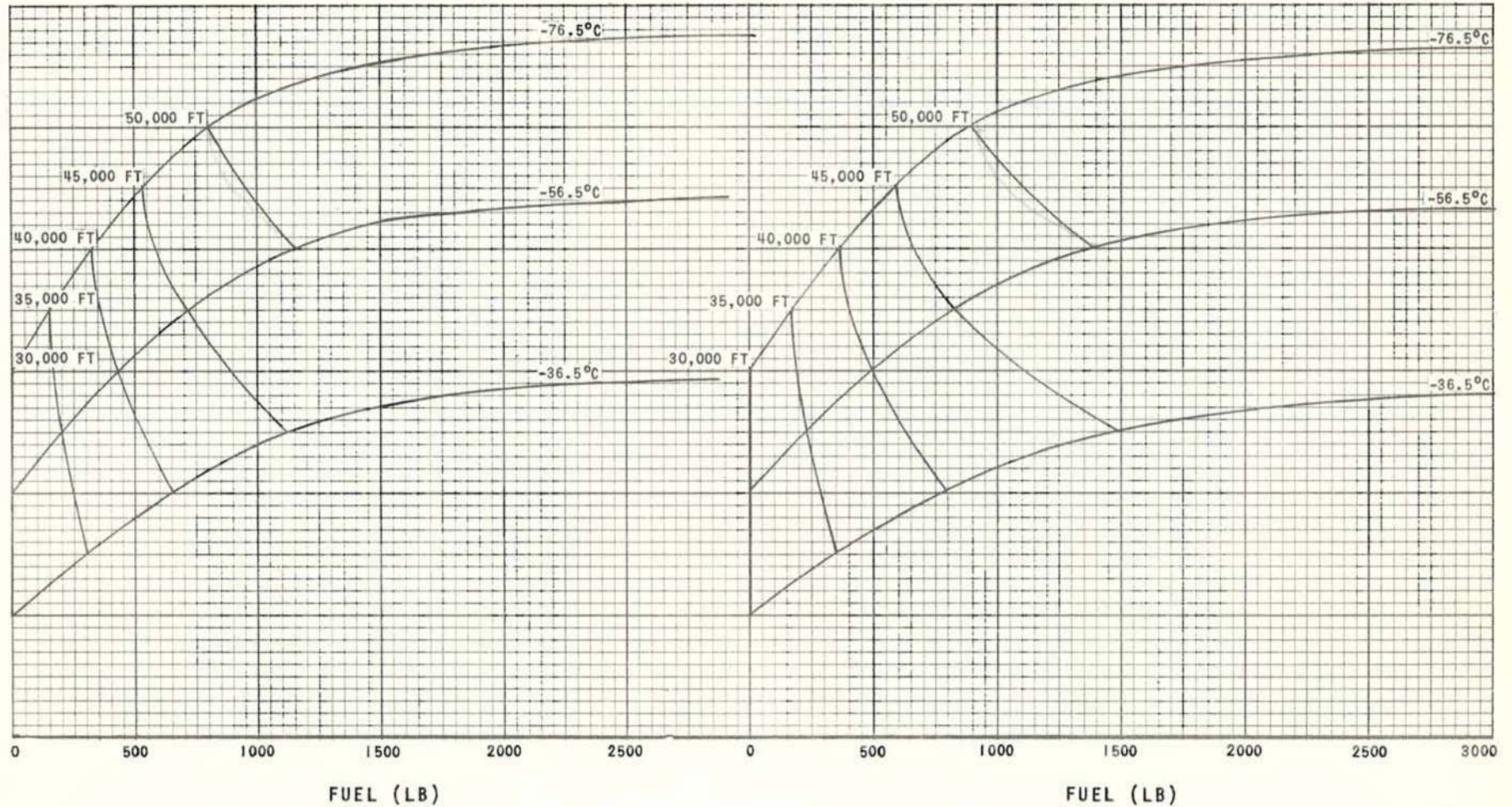


FIG. 3-16. CLIMB AT M1.3 ISOTHERMAL ATMOSPHERE
- FUEL TO ALTITUDE-REHEAT-31,000LB

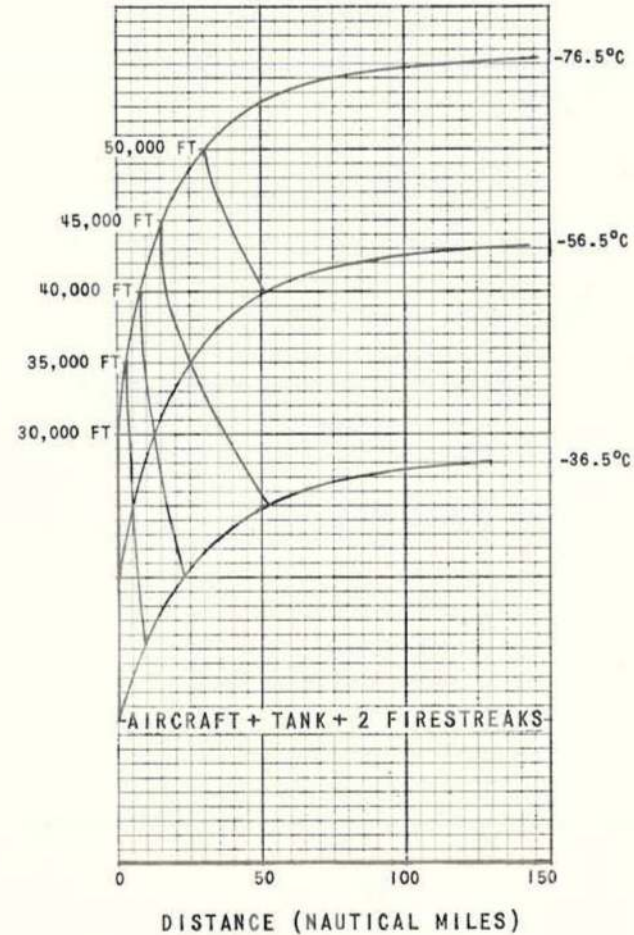
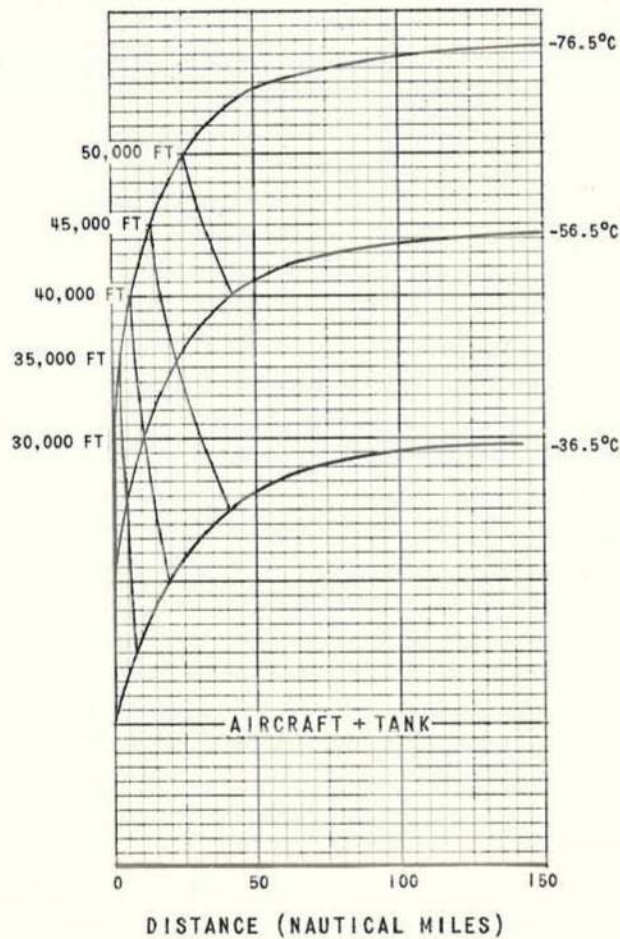


FIG. 3-17. CLIMB AT M1-3 ISOTHERMAL ATMOSPHERE
-DISTANCE TO ALTITUDE-REHEAT- 31,000LB

LIGHTNING T MK. 4 ONLY

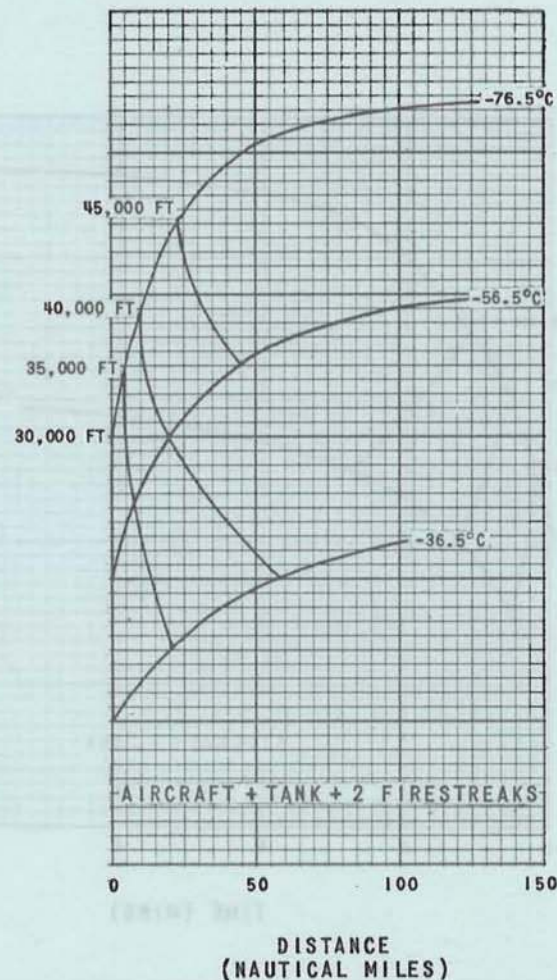
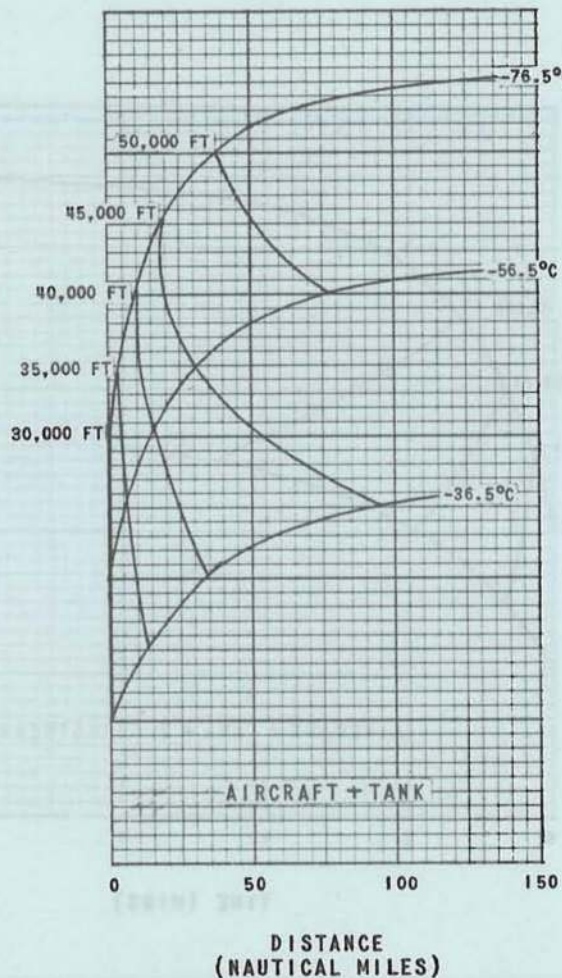


FIG.3-17T. CLIMB AT MI-3-ISOTHERMAL ATMOSPHERE-DISTANCE TO ALTITUDE
-REHEAT- 31,000LB

LIGHTNING T MK. 4 ONLY

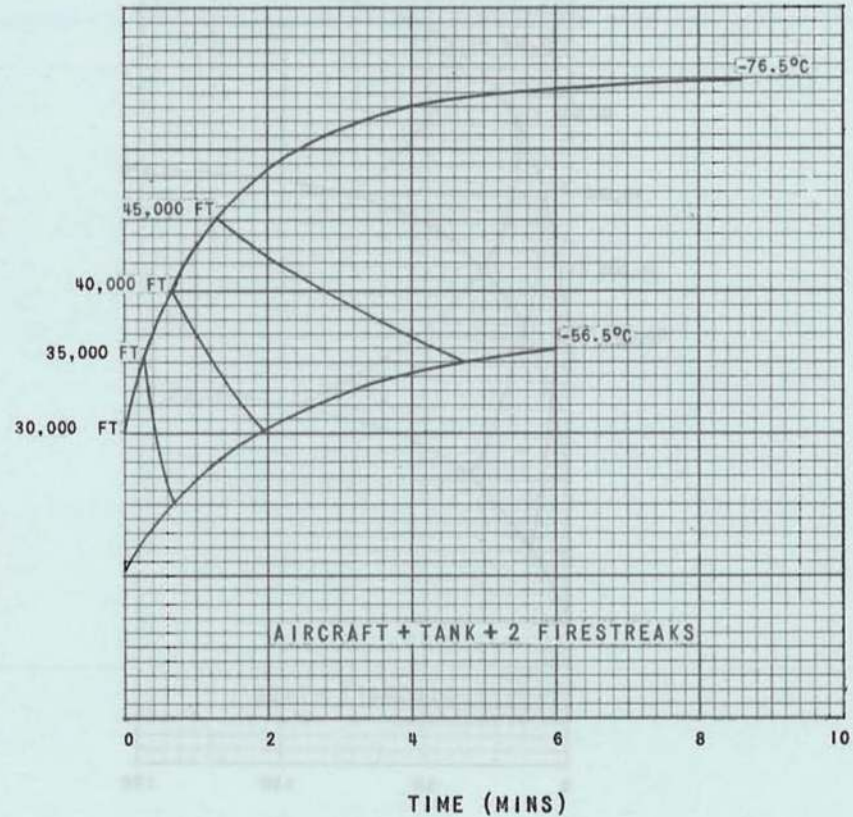
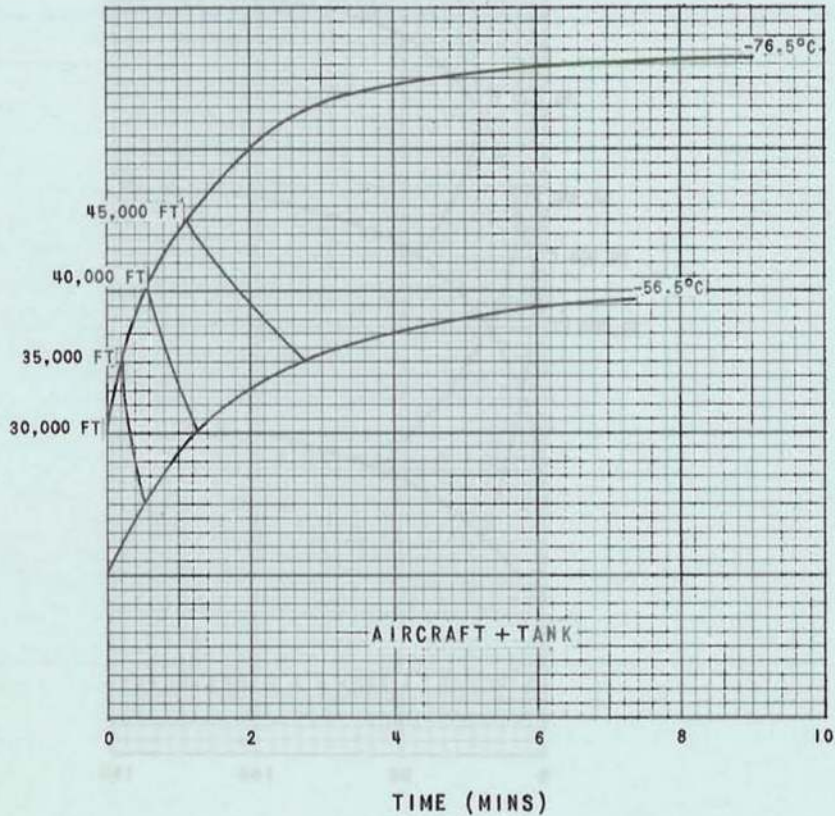


FIG. 3-18T. CLIMB AT MI-6-ISOTHERMAL ATMOSPHERE-TIME TO ALTITUDE
-REHEAT-31,000LB

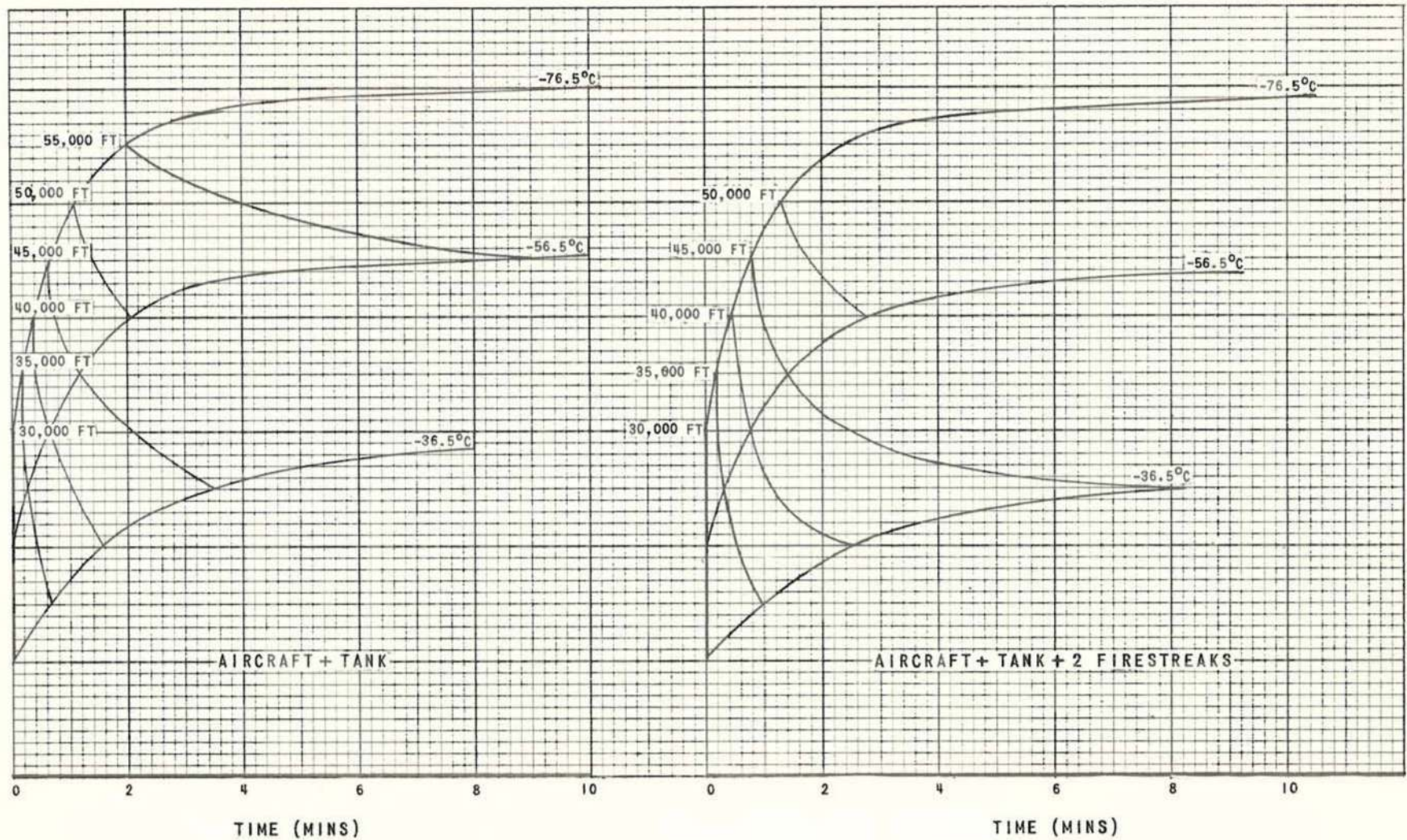


FIG. 3-18. CLIMB AT MI-6-ISOTHERMAL ATMOSPHERE-TIME TO ALTITUDE-REHEAT-31,000LB

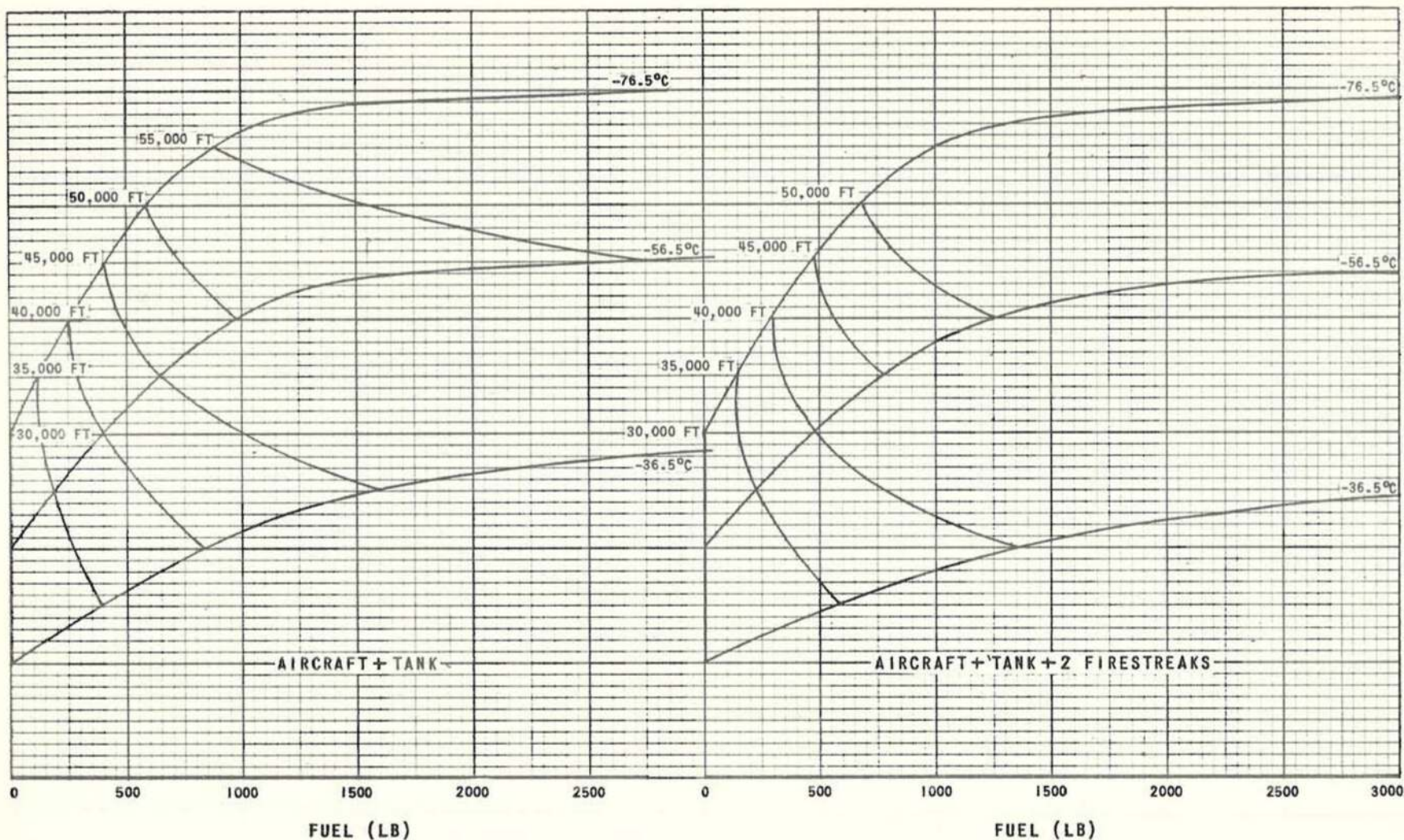


FIG. 3-19. CLIMB AT M1.6 ISOTHERMAL ATMOSPHERE
-FUEL TO ALTITUDE-REHEAT - 31,000LB

LIGHTNING T MK. 4 ONLY

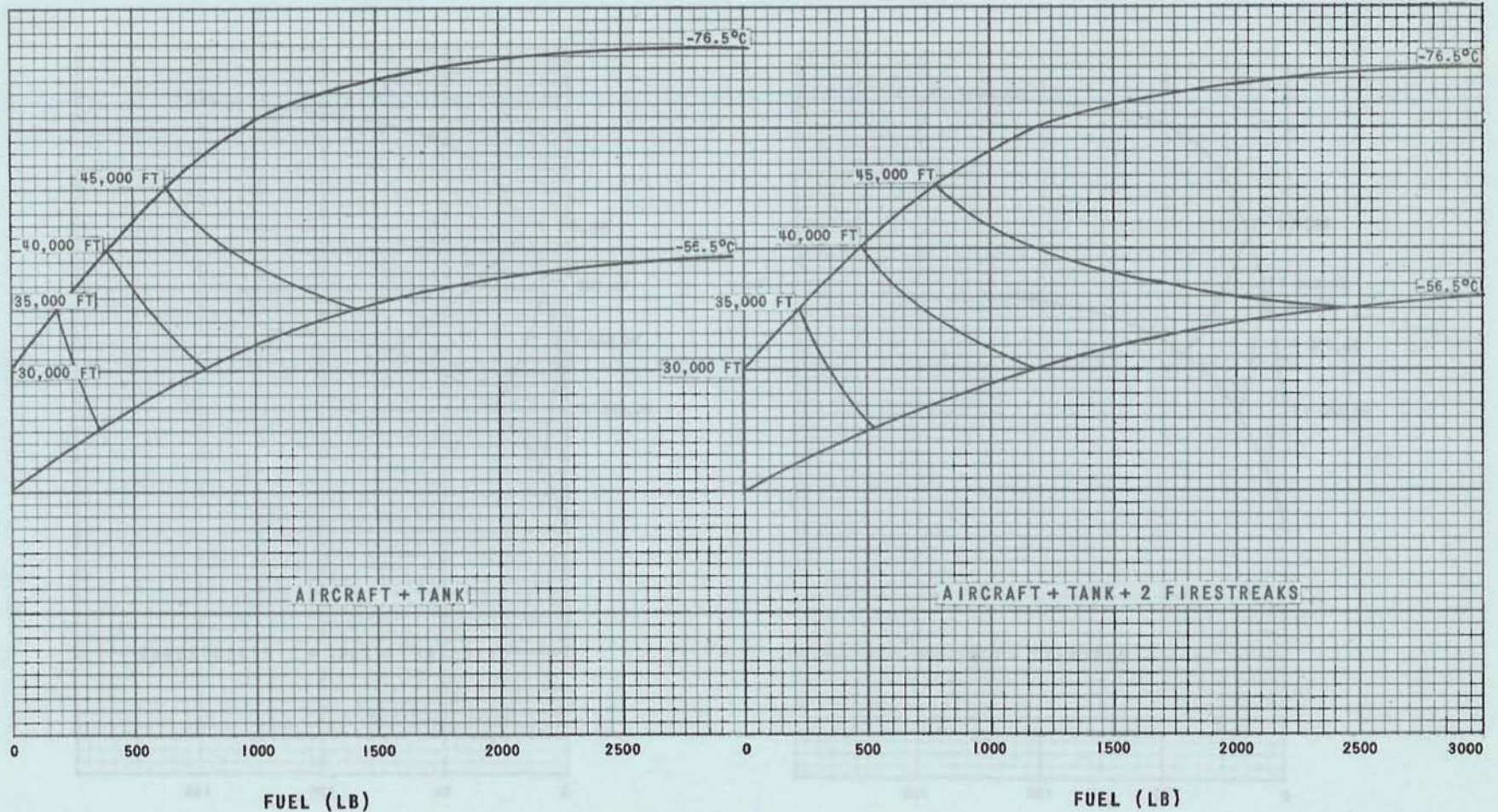


FIG. 3-19T. CLIMB AT MI-6-ISOTHERMAL ATMOSPHERE-FUEL TO ALTITUDE
-REHEAT - 31,000LB

LIGHTNING T MK. 4 ONLY

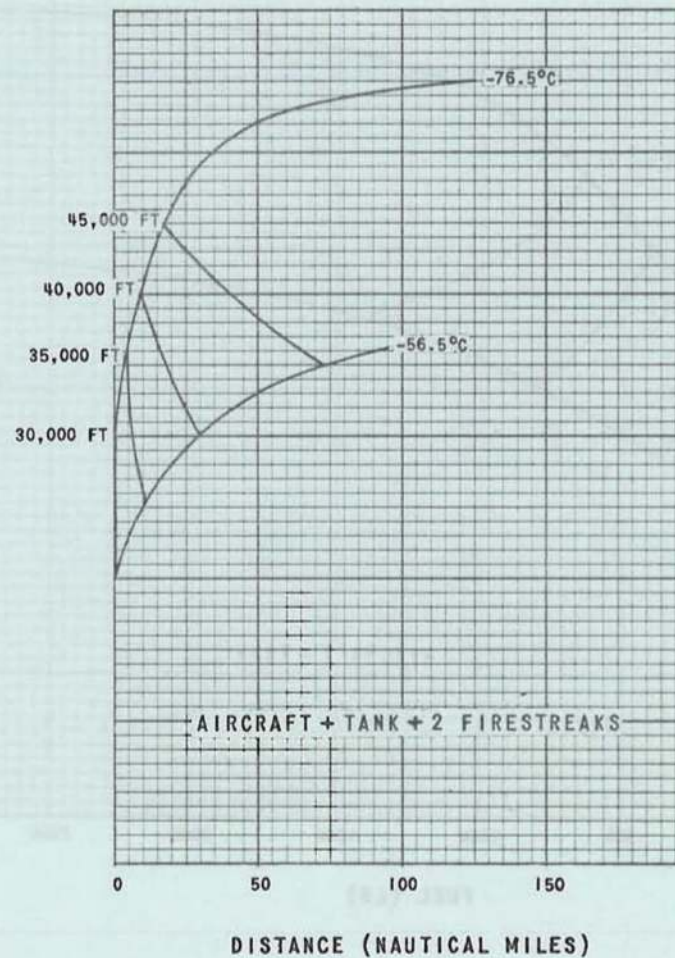
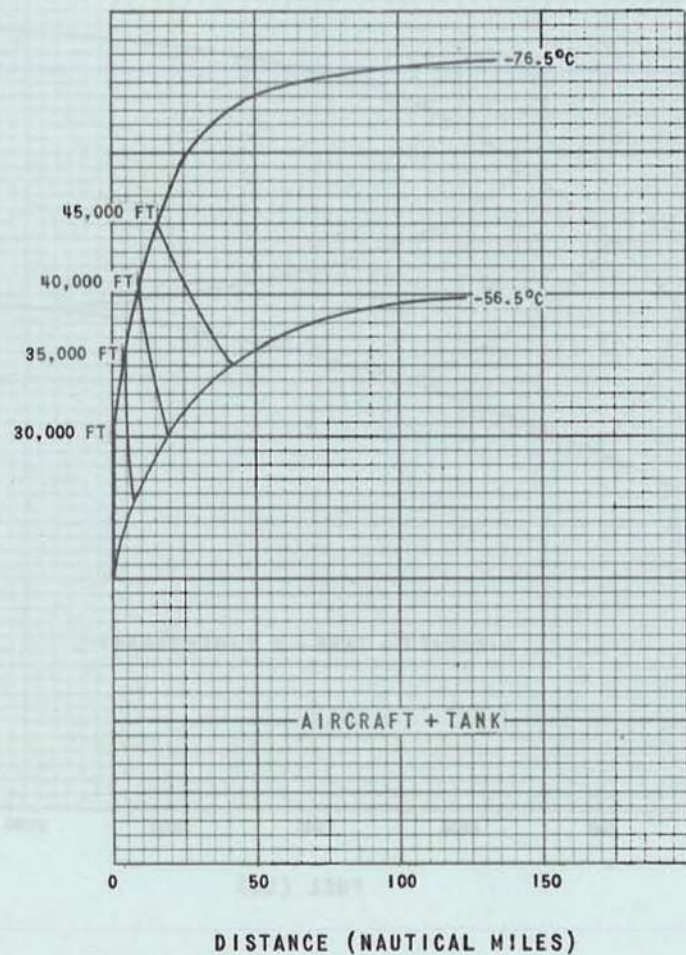


FIG. 3-20T. CLIMB AT MI-6-ISOTHERMAL ATMOSPHERE-DISTANCE TO ALTITUDE
-REHEAT-31,000LB

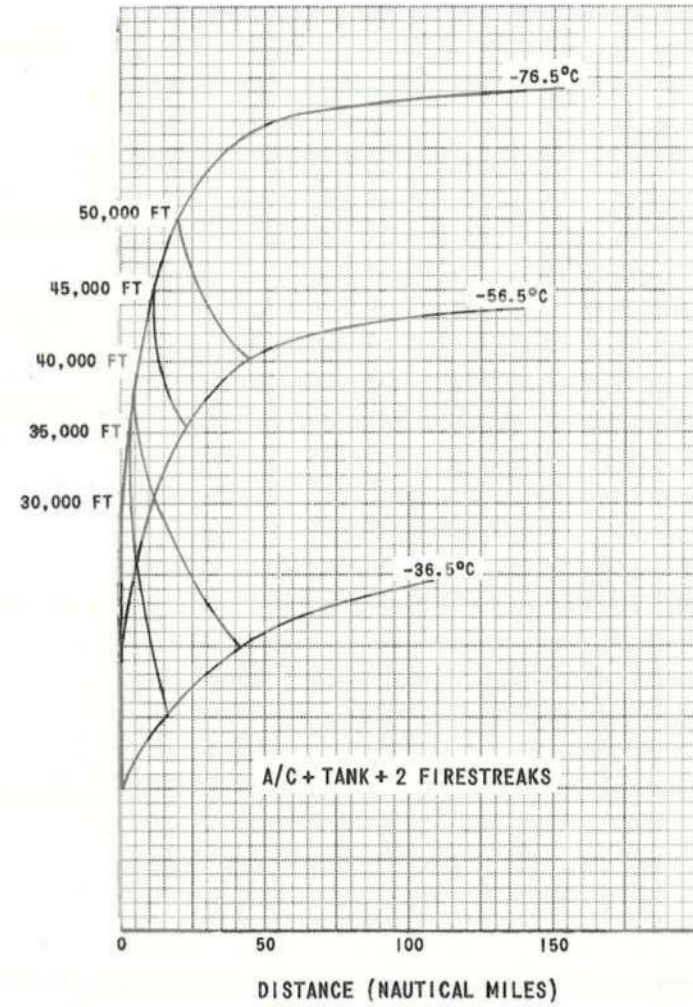
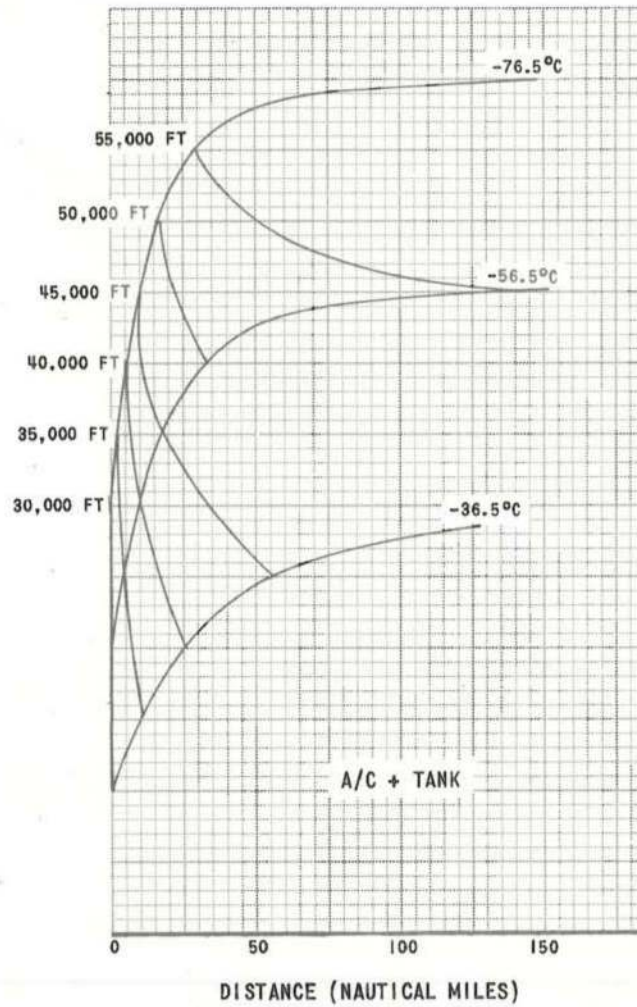


FIG.3.20. CLIMB AT M1.6 ISOTHERMAL ATMOSPHERE
- DISTANCE TO ALTITUDE - REHEAT 31,000 LB

————— INITIAL 1.7M
- - - - - INITIAL 1.5M
- · - · - INITIAL 1.3M

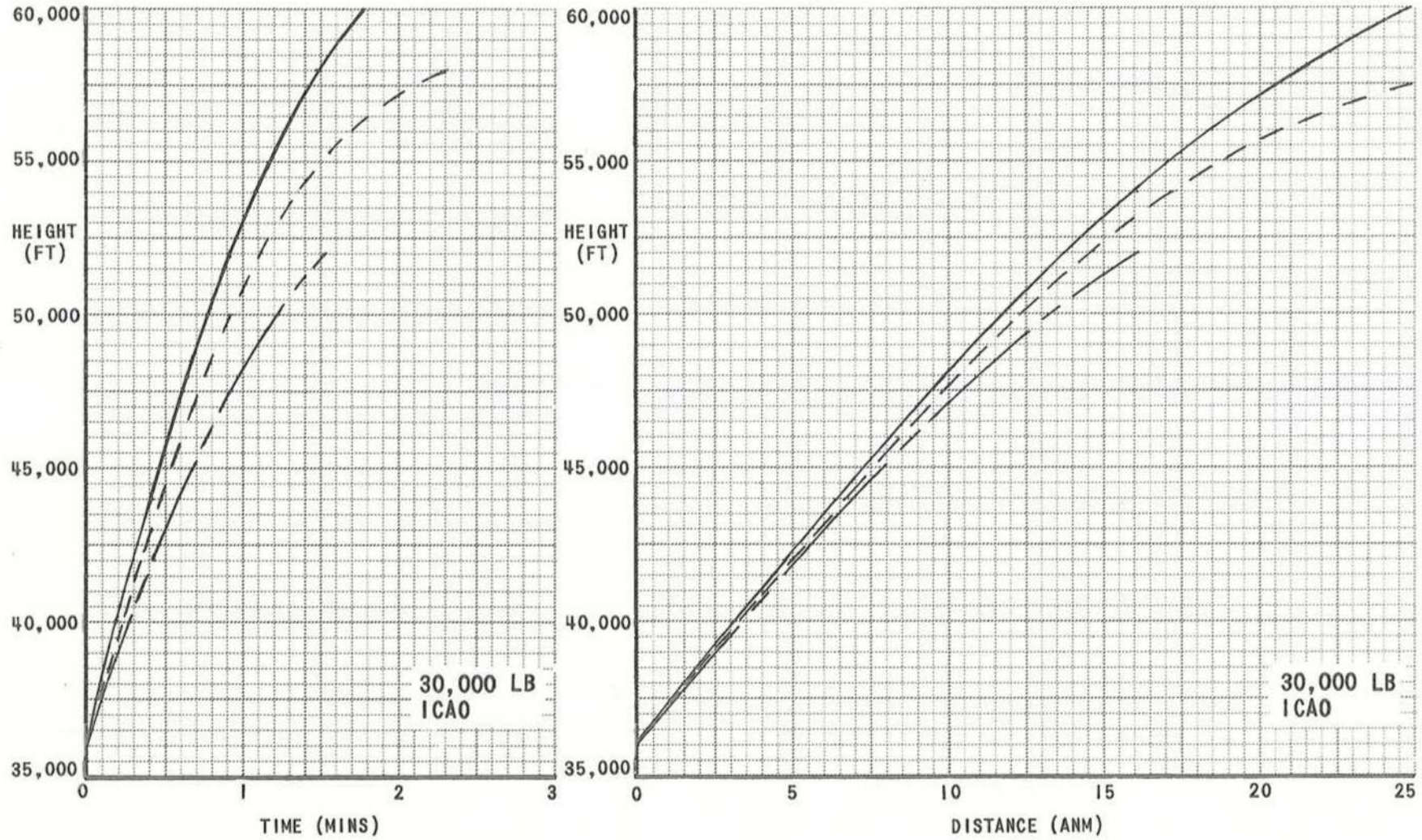


FIG.3.21. CLIMB AT CONSTANT A/C ATTITUDE $\theta = 15^\circ$ TIME AND DISTANCE

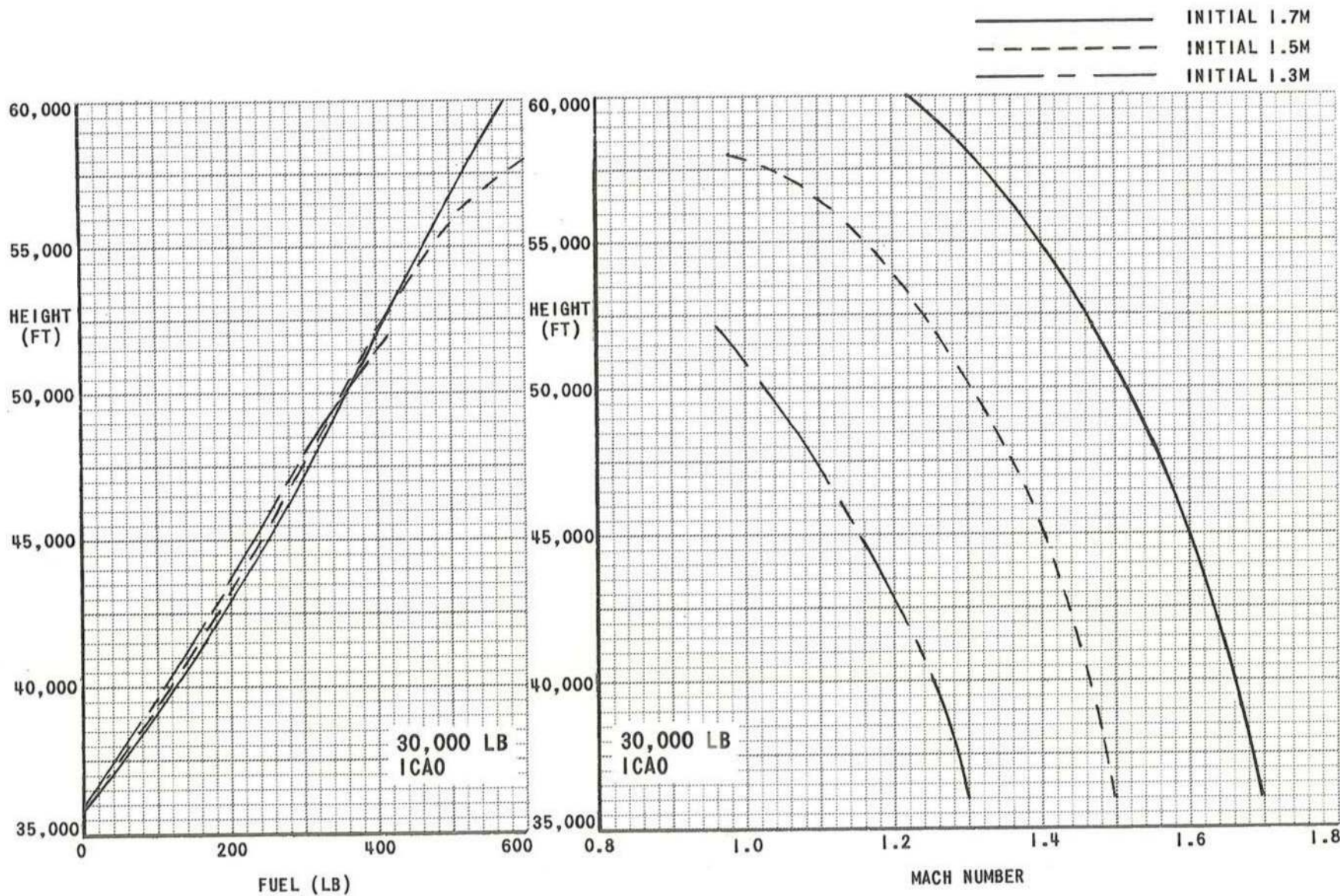
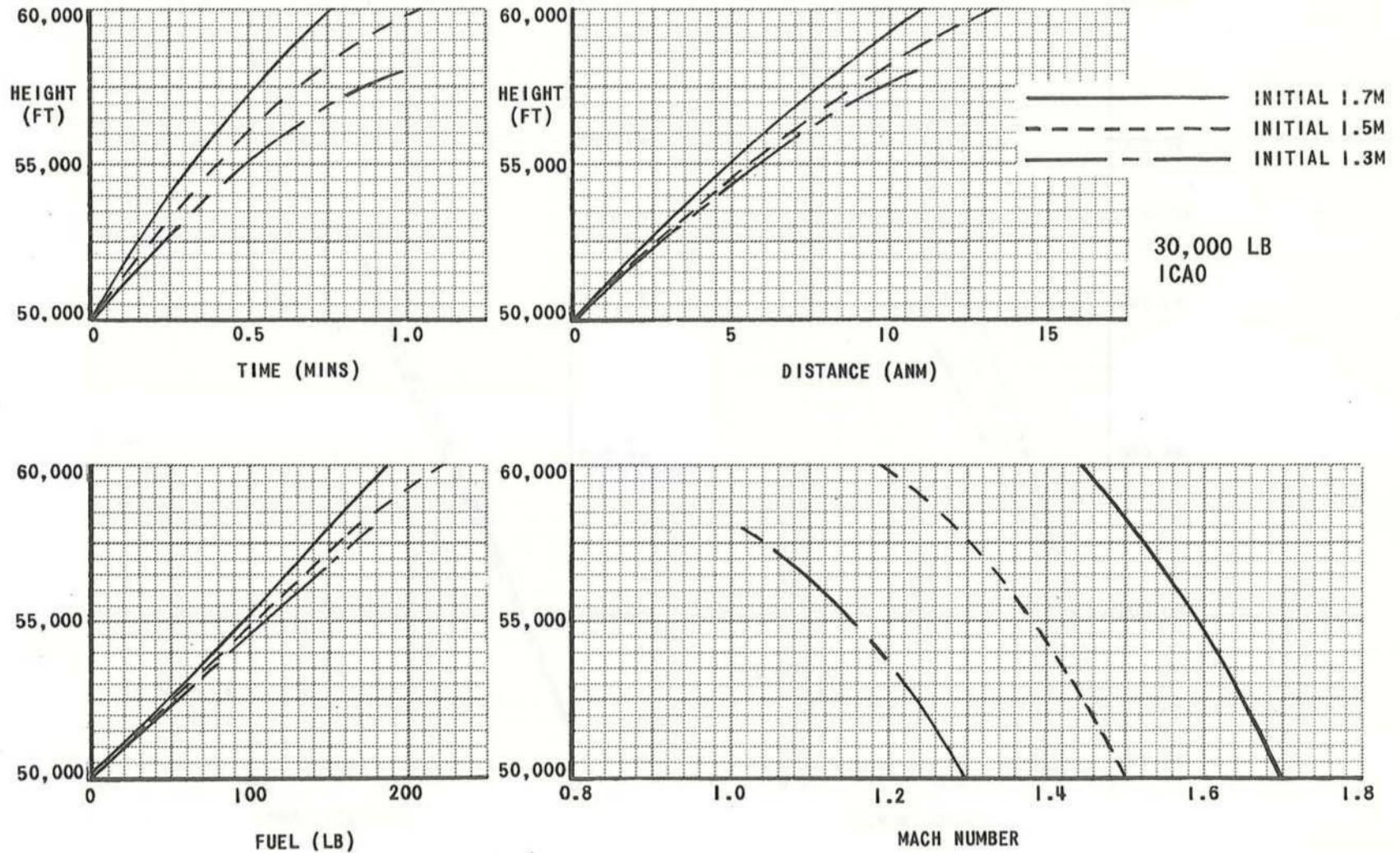


FIG.3.22. CLIMB AT CONSTANT A/C ATTITUDE $\theta = 15^\circ$ FUEL AND MACH NO.



**FIG.3.23. CLIMB AT CONSTANT A/C ATTITUDE
 $\theta = 15^\circ$ TIME, DISTANCE, FUEL & MACH NO.**

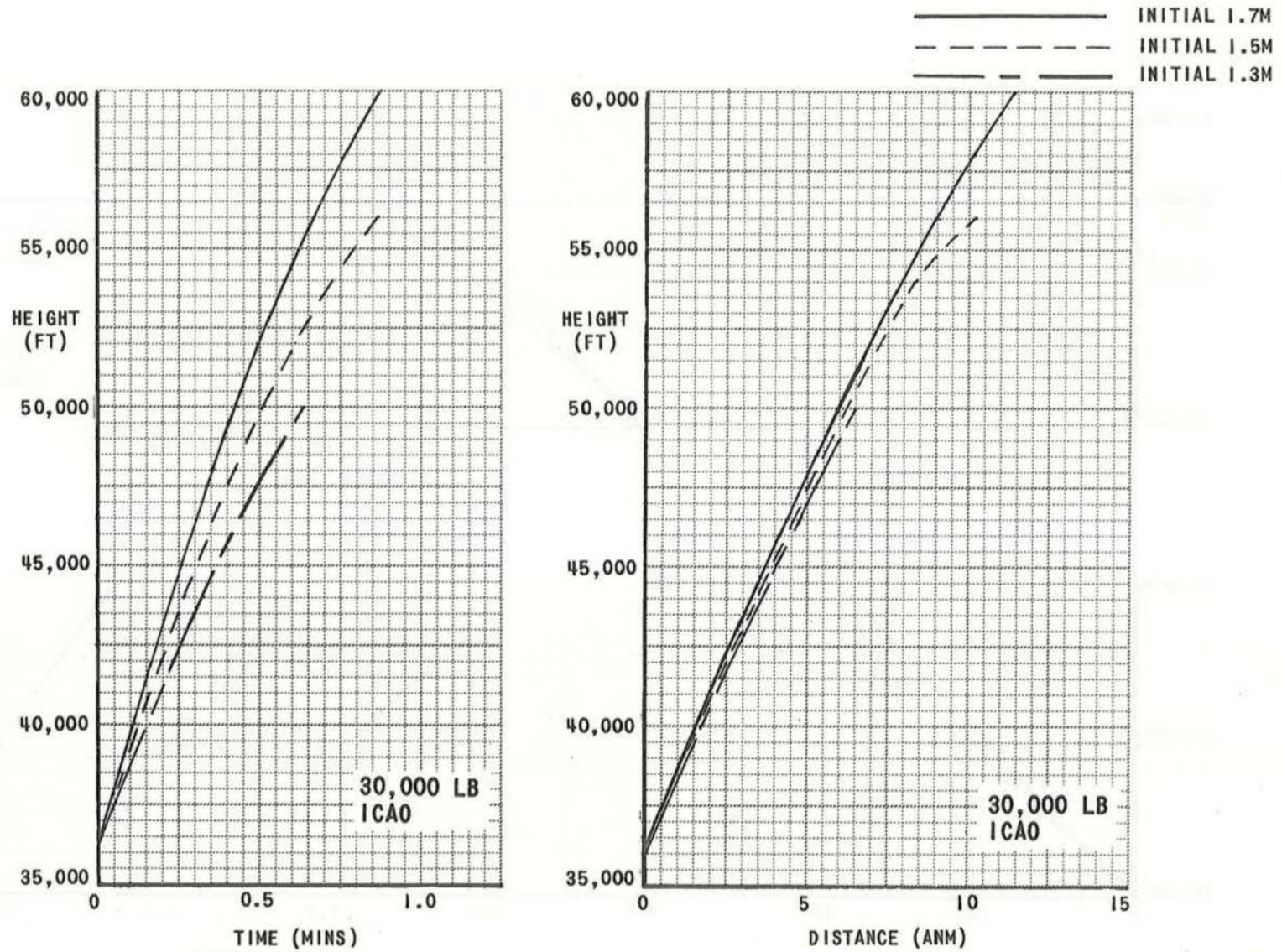


FIG.3.24. CLIMB AT CONSTANT A/C ATTITUDE $\theta = 25^\circ$ TIME AND DISTANCE

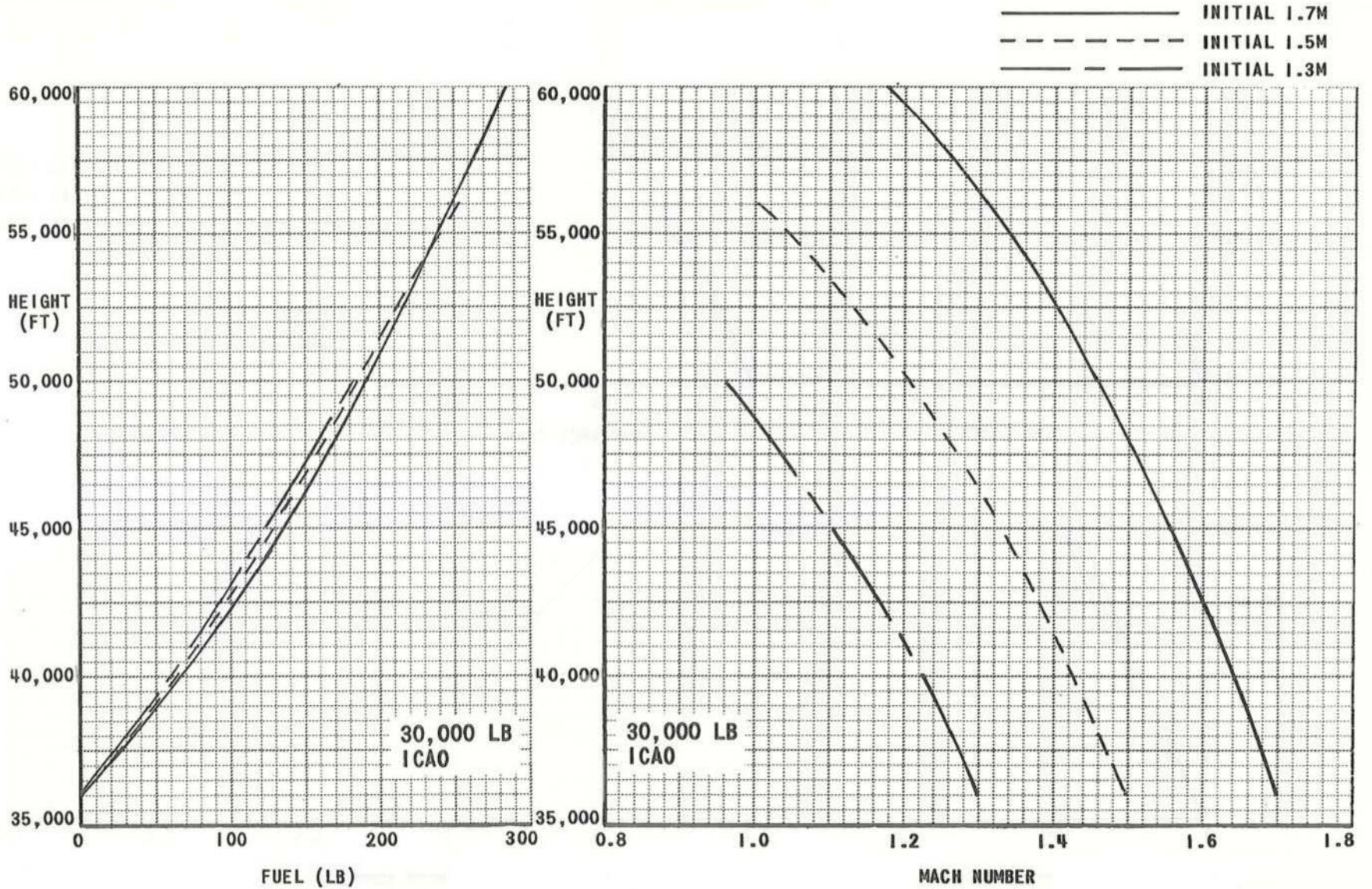


FIG.3.25. CLIMB AT CONSTANT A/C ATTITUDE $\theta = 25^\circ$ FUEL AND MACH NO.

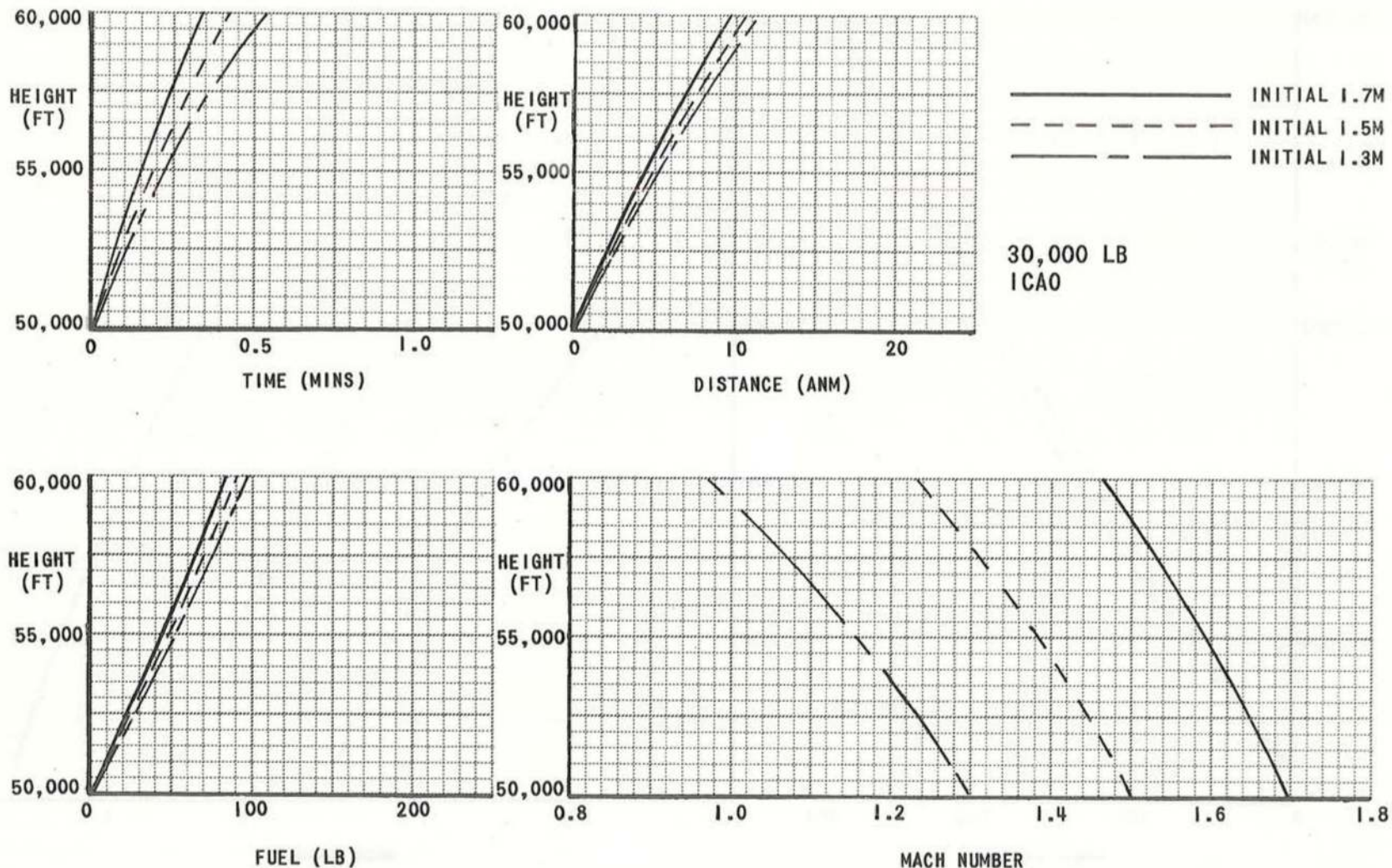


FIG.3.26. CLIMB AT CONSTANT A/C ATTITUDE
 $\theta = 25^\circ$ TIME, DISTANCE, FUEL & MACH NO.

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