

# Warpstock Wonderplane

## Performance Information

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Warpstock

Wapstock Europe 2011  
Haarlem - The Netherlands

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and is designed for double-sided printing on A4-size paper.  
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# Abbreviations

<b>ASD</b>	Accelerate-Stop Distance
<b>ASDA</b>	Accelerate-Stop Distance Available
<b>CAS</b>	Calibrated Airspeed
<b>EAS</b>	Equivalent Airspeed
<b>FAA</b>	Federal Aviation Administration
<b>FAR</b>	Federal Aviation Regulations
<b>FL</b>	Flight level
<b>ICAO</b>	International Civil Aviation Organization
<b>ISA</b>	International Standard Atmosphere
<b>JAA</b>	Joint Aviation Authorities
<b>JAR</b>	Joint Aviation Requirements
<b>LD</b>	Landing Distance
<b>LDA</b>	Landing Distance Available
<b>MLW</b>	Maximum Landing Weight
<b>MMO</b>	Maximum Operating Mach number
<b>MRW</b>	Maximum Ramp Weight
<b>MTOW</b>	Maximum Take-off Weight
<b>MZFW</b>	Maximum Zero-Fuel Weight
<b>OAT</b>	Outside Air Temperature (Ambient temperature)
<b>OEW</b>	Operating Empty Weight
<b>ROC</b>	Rate of Climb
<b>ROD</b>	Rate of Descent
<b>RVSM</b>	Reduced Vertical Separation Minimum
<b>S/L</b>	Sea Level
<b>TAS</b>	True Airspeed
<b>TOD</b>	Take-off Distance
<b>TODA</b>	Take-off Distance Available
<b>TOR</b>	Take-off Run
<b>TORA</b>	Take-off Run Available
<b>VMO</b>	Maximum Operating Speed
<b>WAT</b>	Weight, Altitude, Temperature



# Chapter 1

## Aircraft Characteristics

The Warpstock Wonderplane is a modern medium-range airliner powered by two turbofan engines. A three-view drawing is shown in figure 1.1.

The main characteristics are as follows:

### Powerplant

Engine type	OS/2 Warp
Number of engines	2
Maximum take-off thrust, each	16 000 lb

### Weights

Operational empty weight (typical)	26 500 kg	58 422 lb
Maximum structural payload (typical)	11 100 kg	24 471 lb
Maximum zero-fuel weight	37 600 kg	82 893 lb
Maximum landing weight	40 000 kg	88 184 lb
Maximum take-off weight	46 000 kg	101 411 lb
Maximum ramp weight	46 250 kg	101 962 lb

### Fuel capacity

By volume	13 365 liter	3 531 USg
By weight (at 0.810 kg/liter, 6.76 lb/USg)	10 731 kg	23 658 lb

### Operating limitations

Maximum operating altitude	35 000 ft
Maximum operating speed $V_{MO}$	320 kts CAS
Maximum operating Mach number $M_{MO}$	0.80

### Note:

Everything up to this point is prepared manually in advance of the automatic process. From the next chapter onwards, all pages are generated automatically. This includes the fragments of  $\LaTeX$  code that form the chapters and all performance graphs.

To be supplied later.

Figure 1.1: Three-view drawing of Warpstock Wonderplane.

# Chapter 2

## Stall speed

### Introduction

This is a call to the  $\LaTeX$  macro `\Intro`. This can optionally be defined in the preamble of the file to provide any text needed to serve as an introduction to this chapter.

The interesting thing is that while the text is defined in the first (manually prepared) part of the file, it actually appears much later in the automatically-generated part.

### Assumptions

The stall speed is based on the minimum speed reached during the stall manoeuvre.

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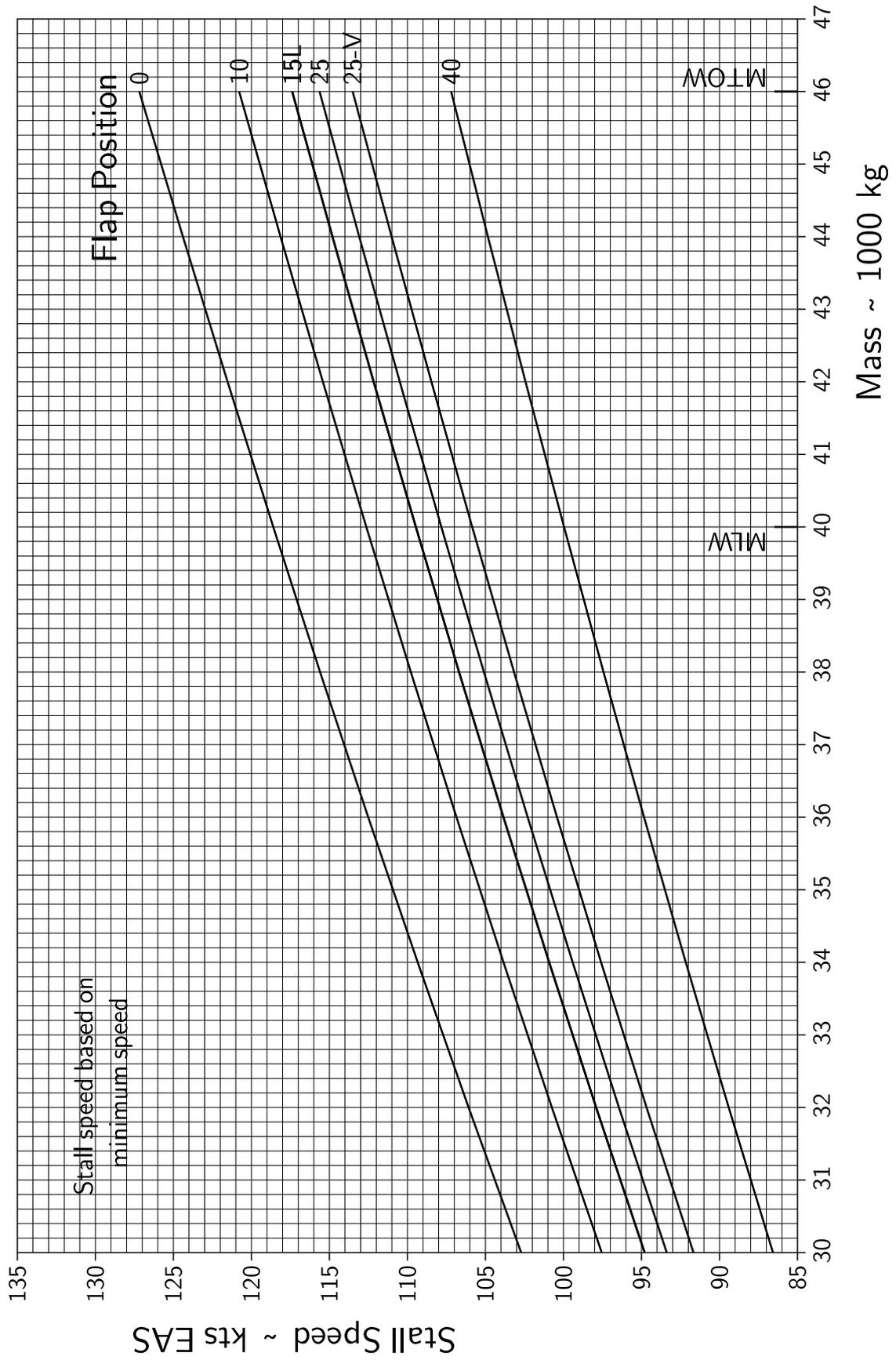


Figure 2.1: Stall speed for all flap positions.

# Chapter 3

## Take-off

### Introduction

This is a call to the `\Intro` macro. This can optionally be defined in the preamble of the file to provide any text needed to serve as an introduction to this chapter.

The interesting thing is that while the text is defined in the first (manually prepared) part of the file, it actually appears much later in the automatically-generated part.

### Assumptions

- Joint Aviation Requirements 25 (Transport Category), without Change 5.
- Balanced take-off field length.
- Smooth hard-surfaced runway, no slope, no wind.
- Anti-icing off.
- Net climb with critical engine inoperative and undercarriage retracted.
- Net climb gradient is gross gradient diminished by 0.8 %.

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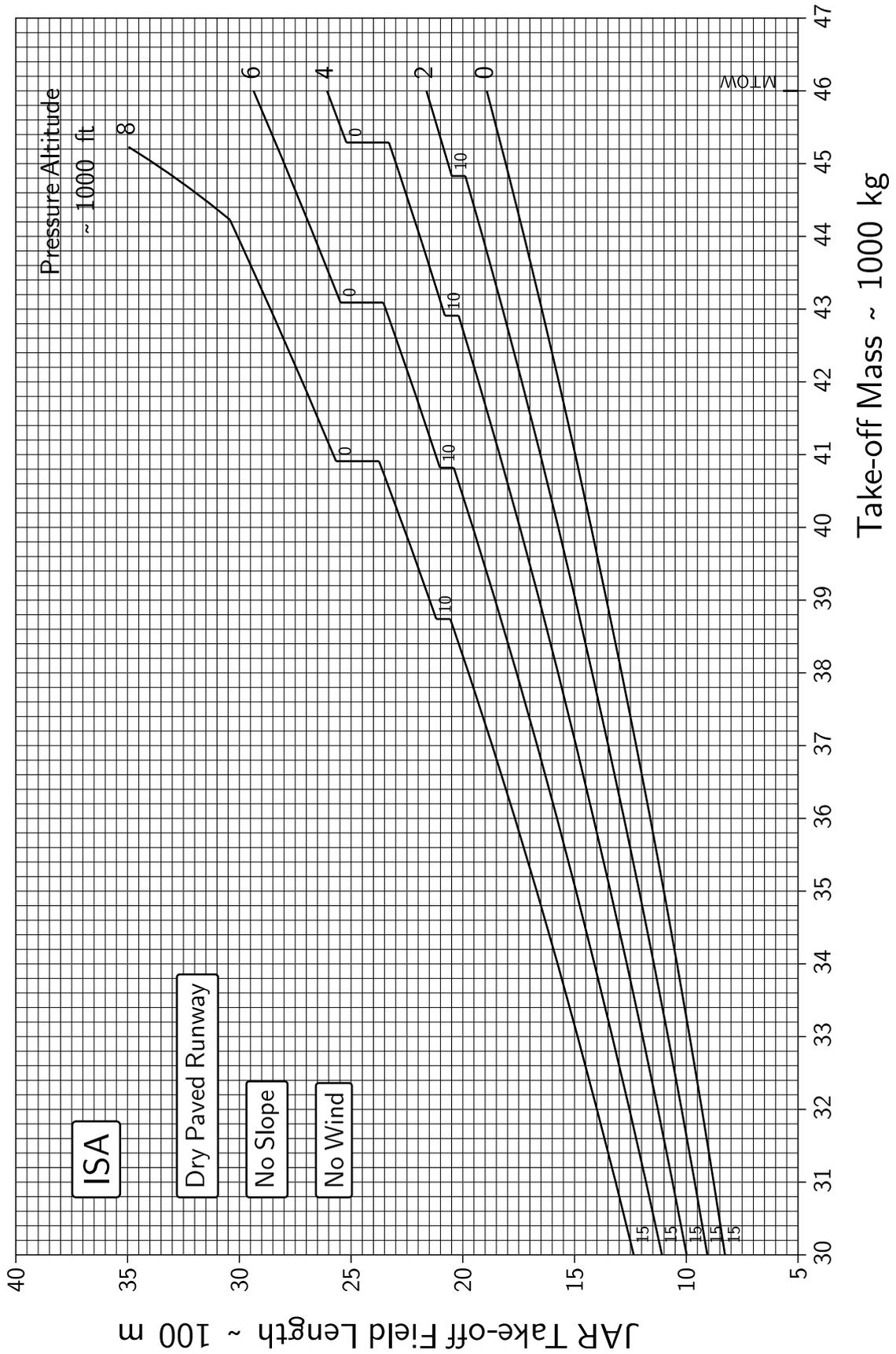


Figure 3.1: Take-off field length, dry runway, at ISA.

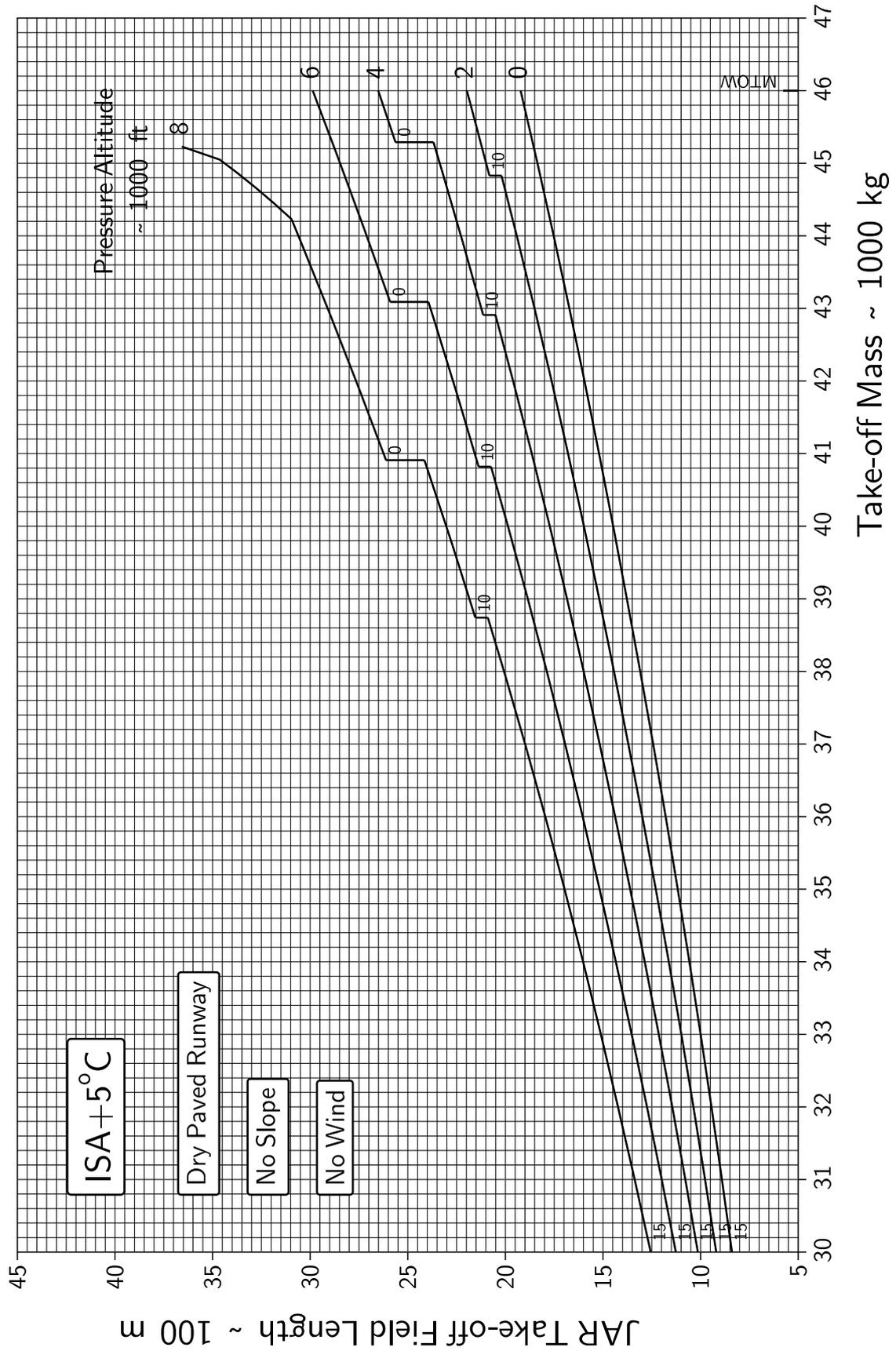


Figure 3.2: Take-off field length, dry runway, at ISA + 5°C.

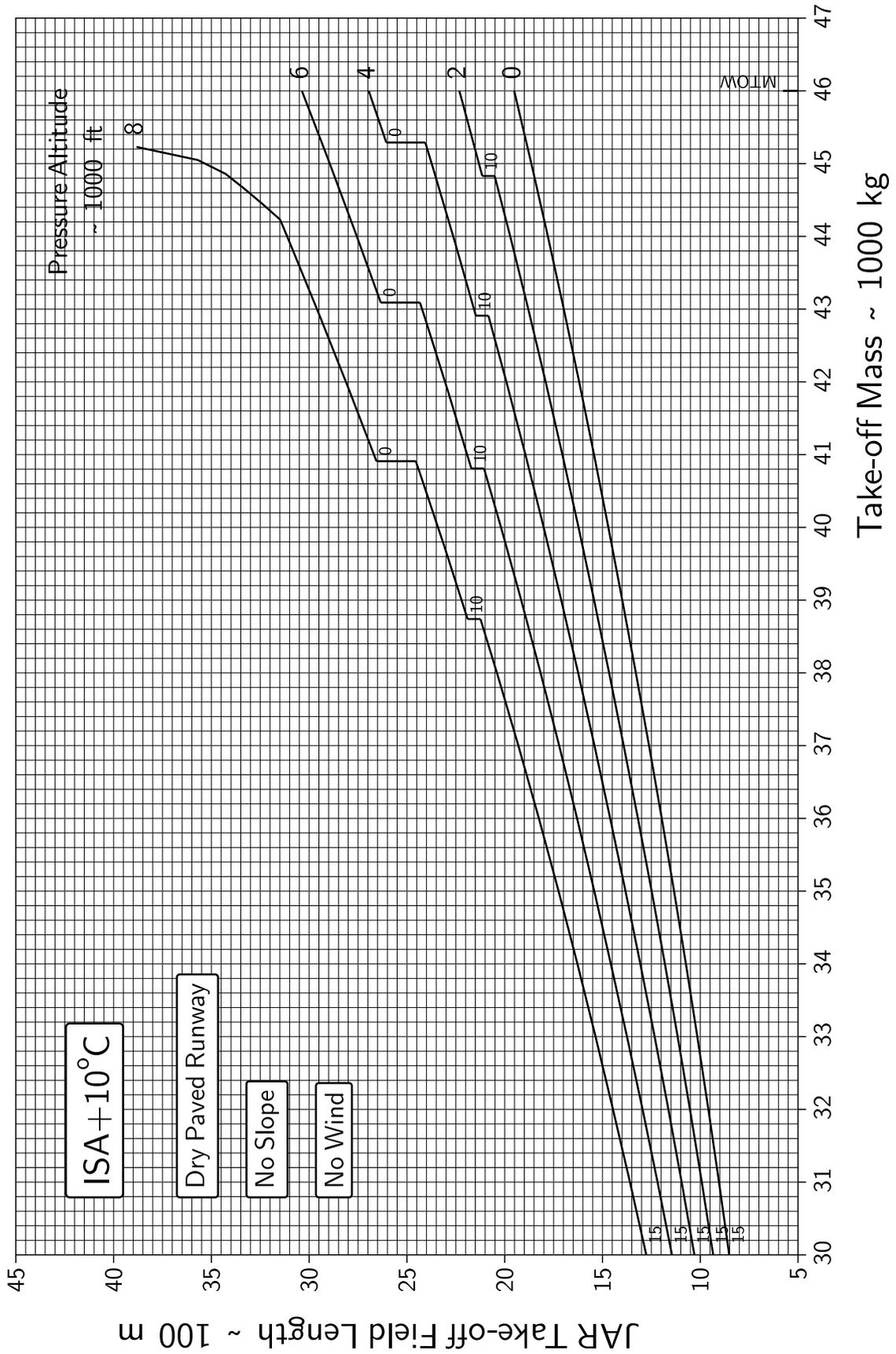


Figure 3.3: Take-off field length, dry runway, at ISA + 10°C.

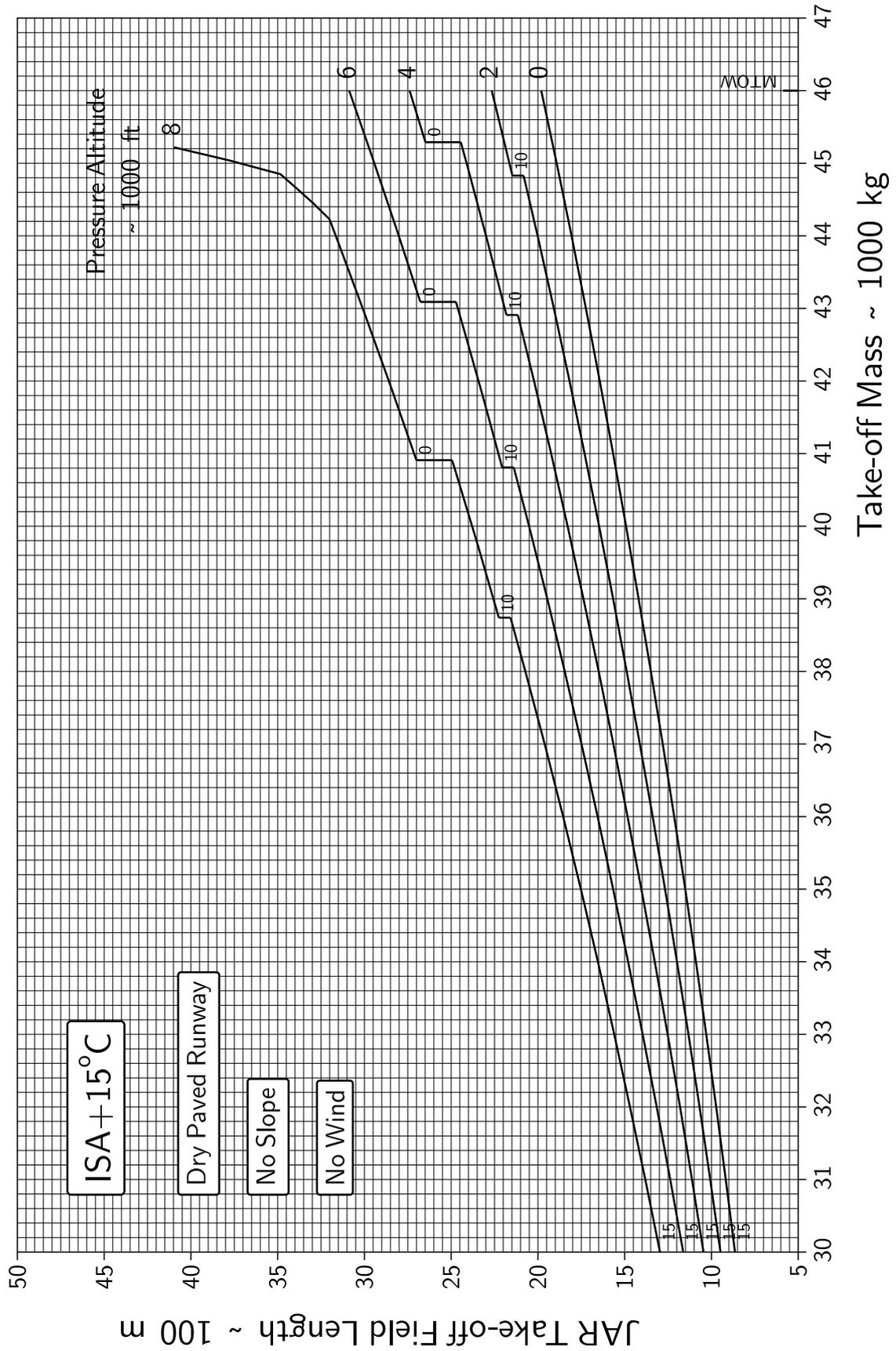


Figure 3.4: Take-off field length, dry runway, at ISA + 15°C.

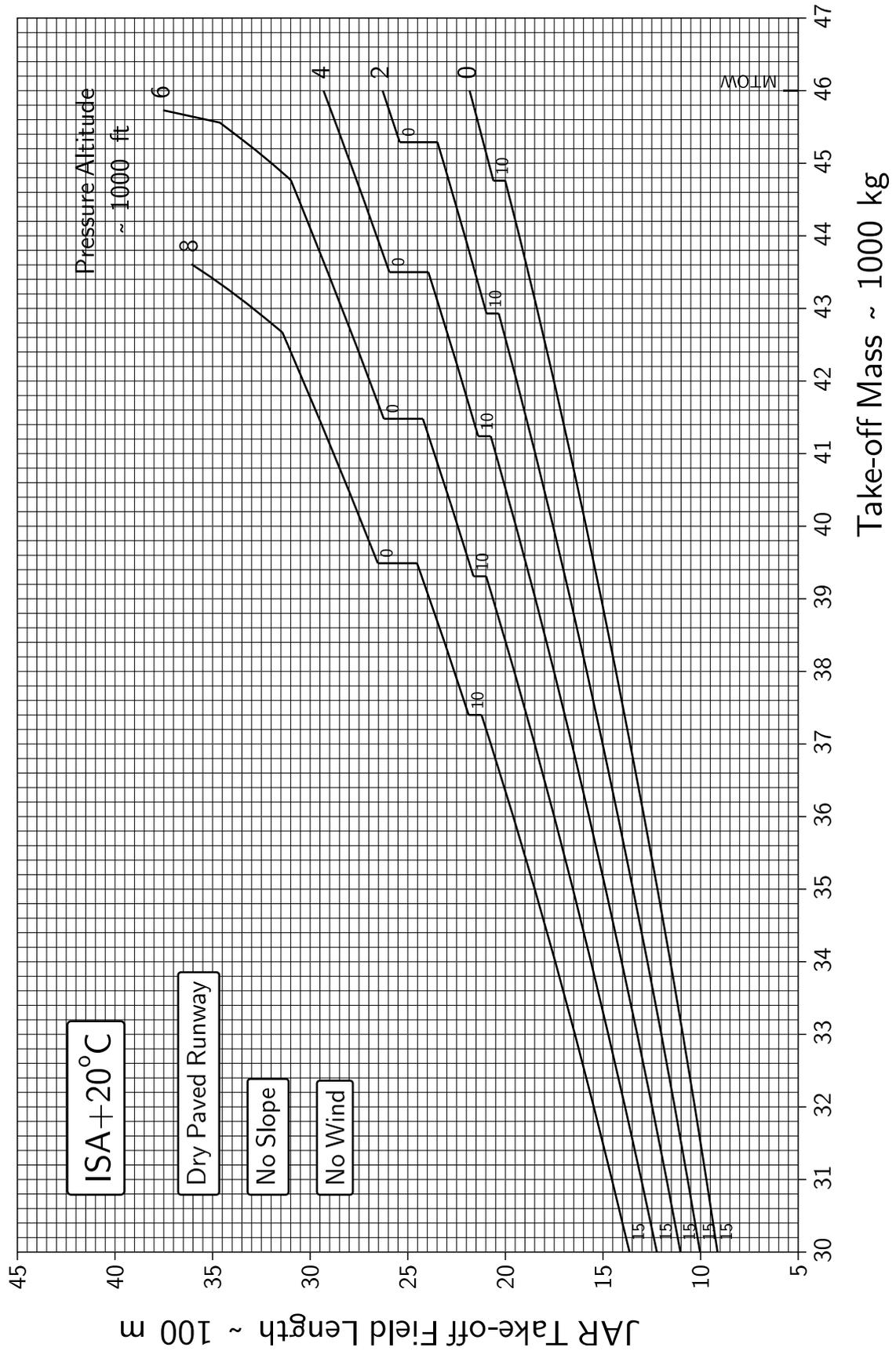
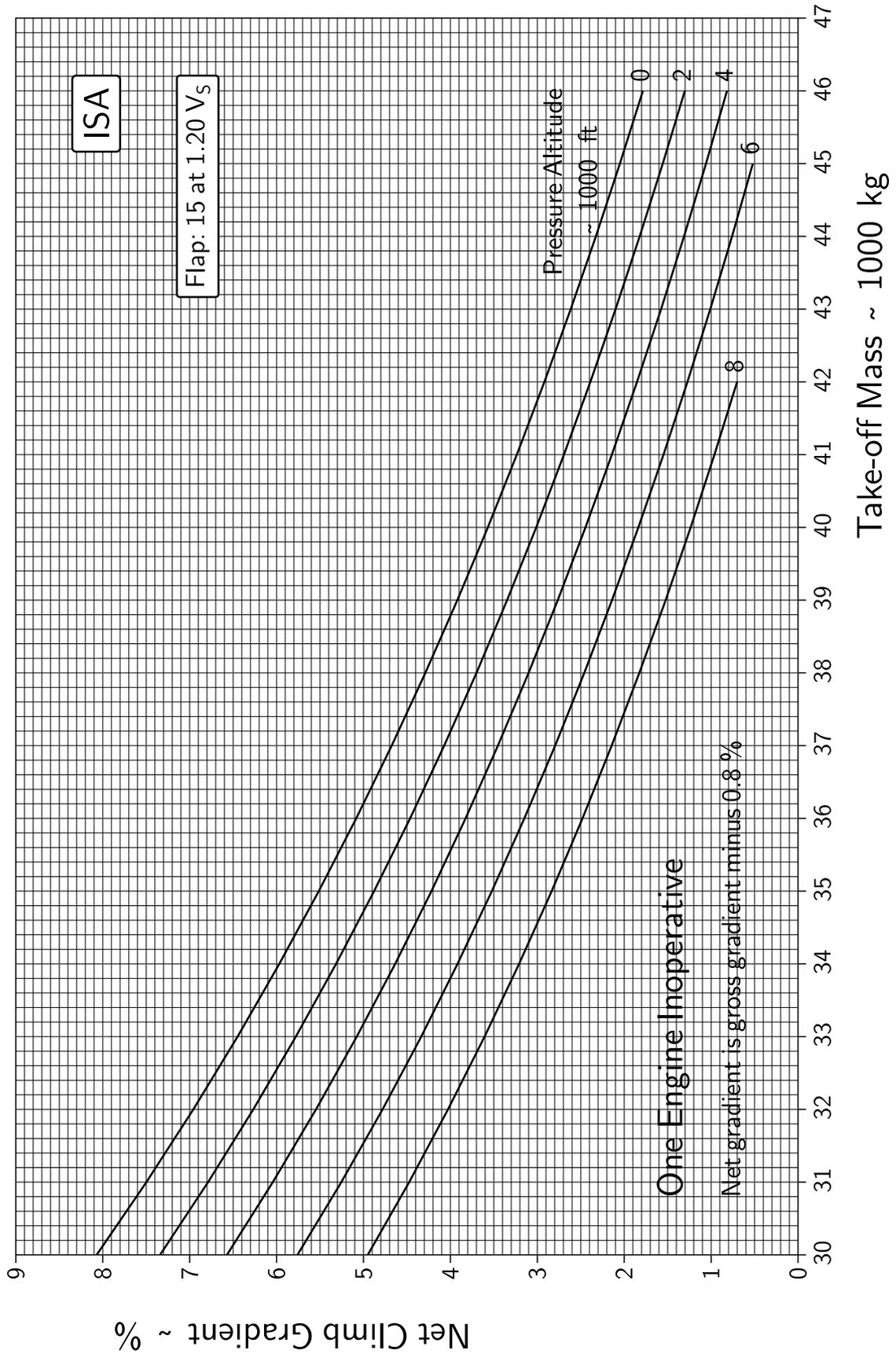


Figure 3.5: Take-off field length, dry runway, at ISA + 20°C.


 Figure 3.6: Net climb gradient with flap 15 and 1.20  $V_S$  at ISA.

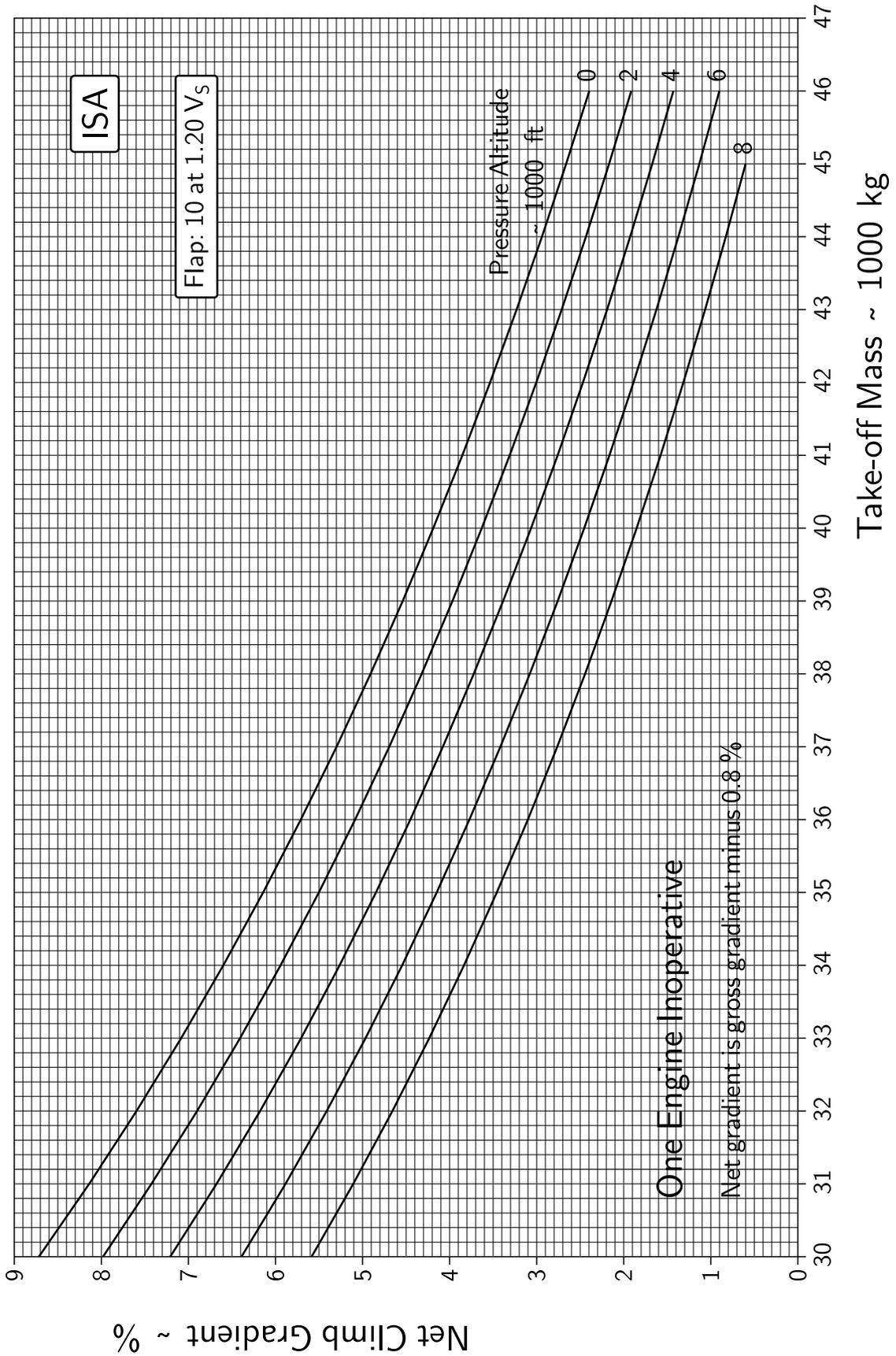
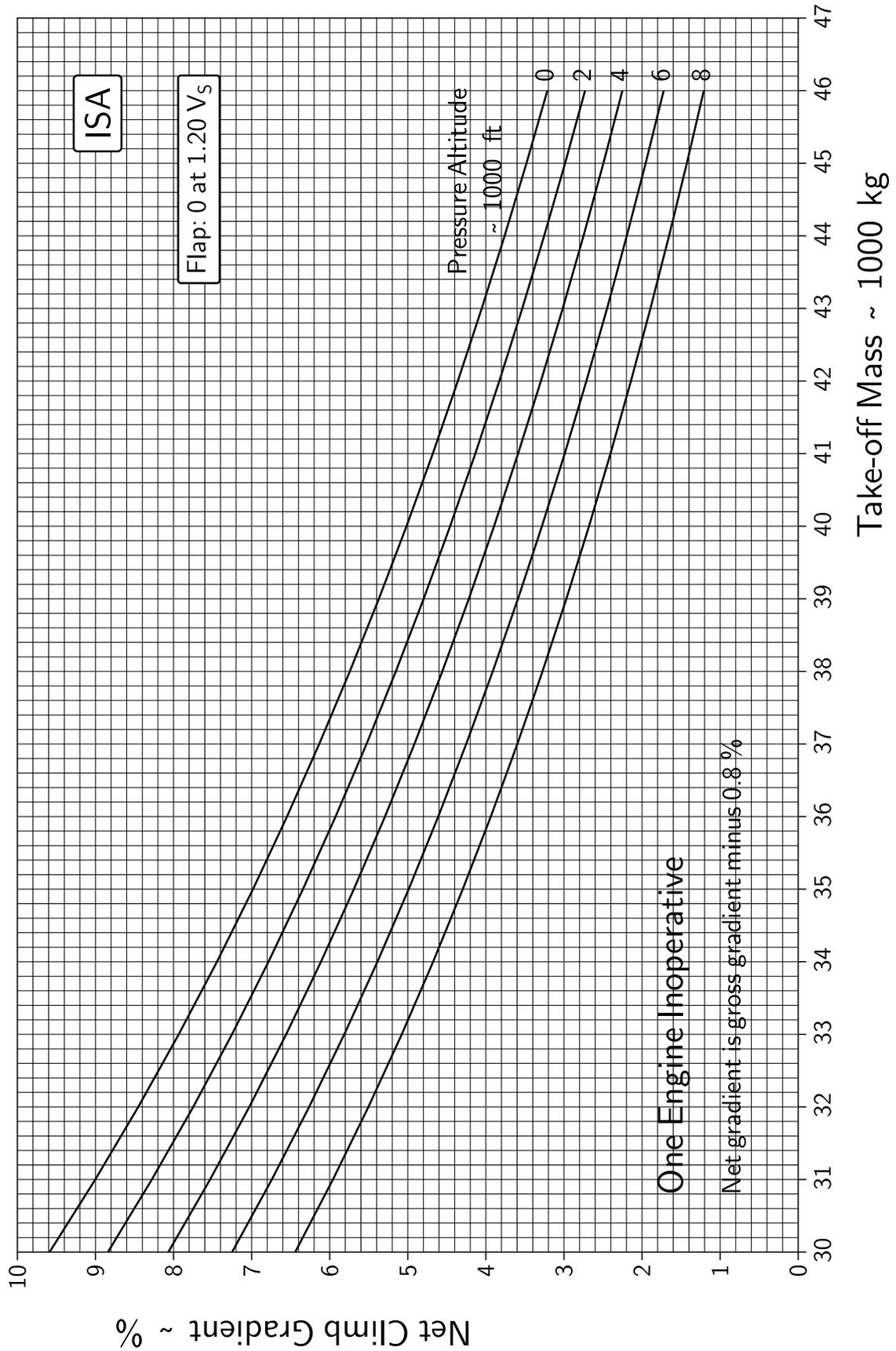


Figure 3.7: Net climb gradient with flap 10 and 1.20  $V_S$  at ISA.


 Figure 3.8: Net climb gradient with flap 0 and 1.20  $V_S$  at ISA.

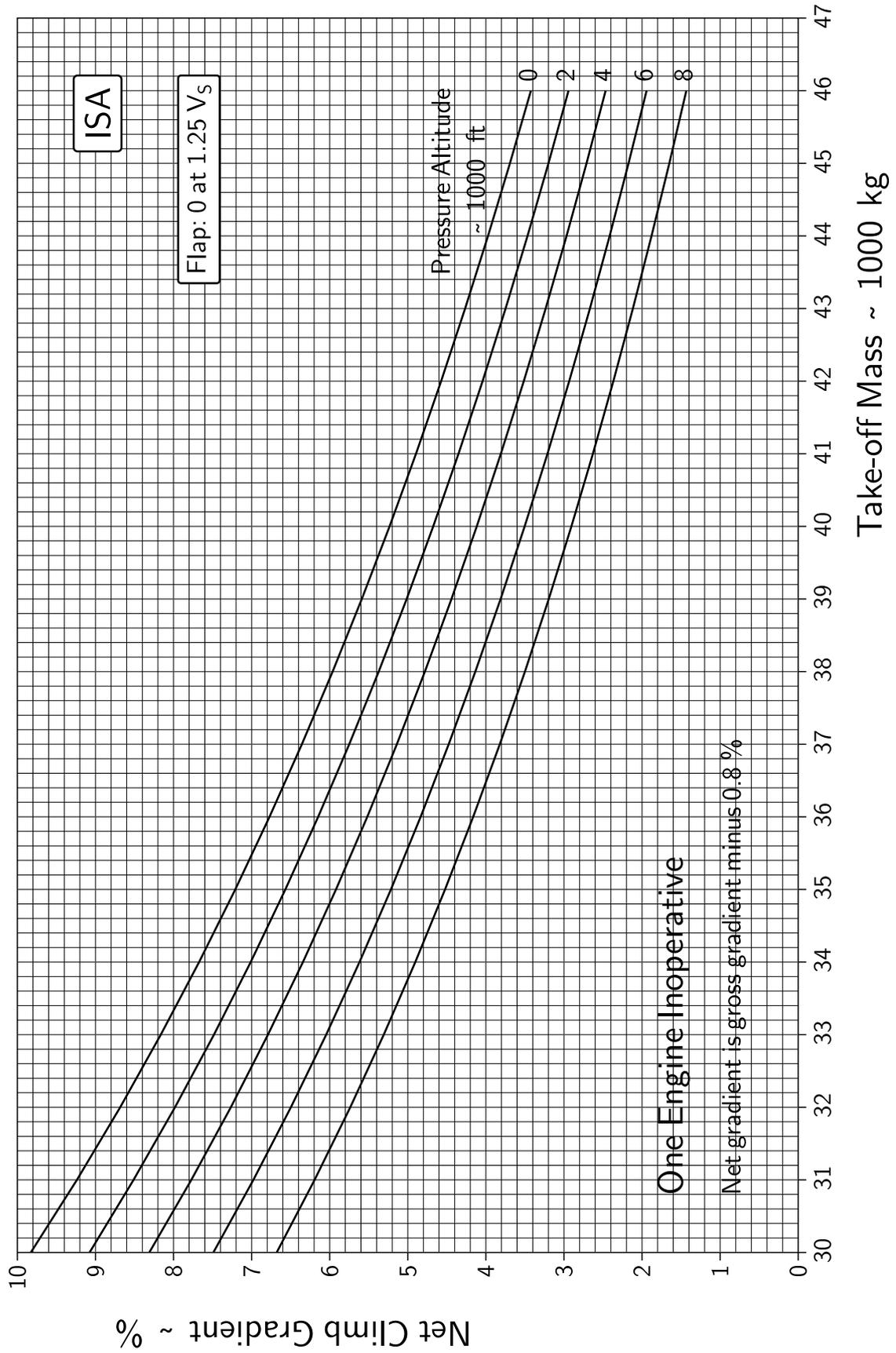


Figure 3.9: Net climb gradient with flap 0 and 1.25  $V_S$  at ISA.

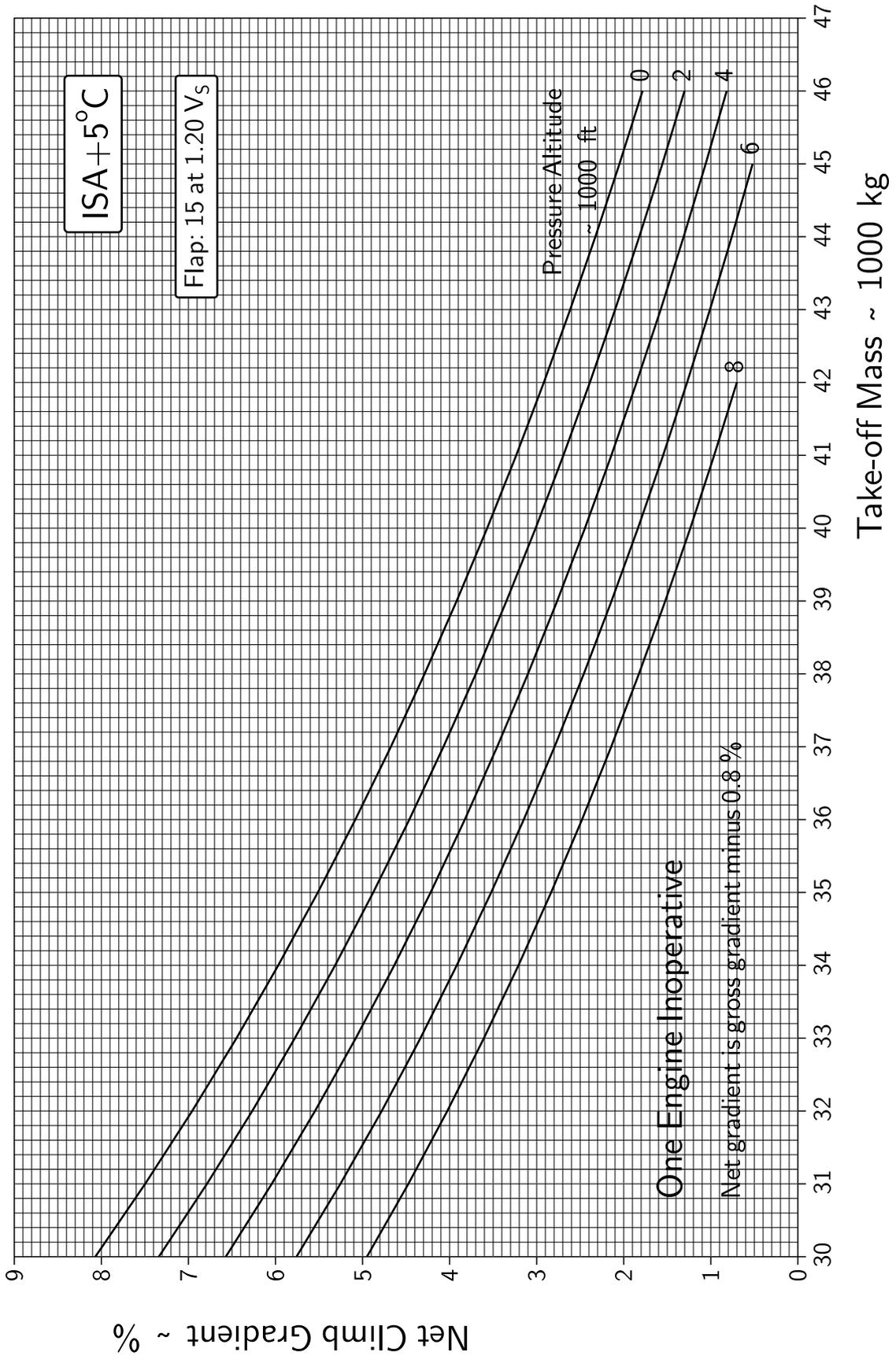


Figure 3.10: Net climb gradient with flap 15 and 1.20 Vs at ISA + 5°C.

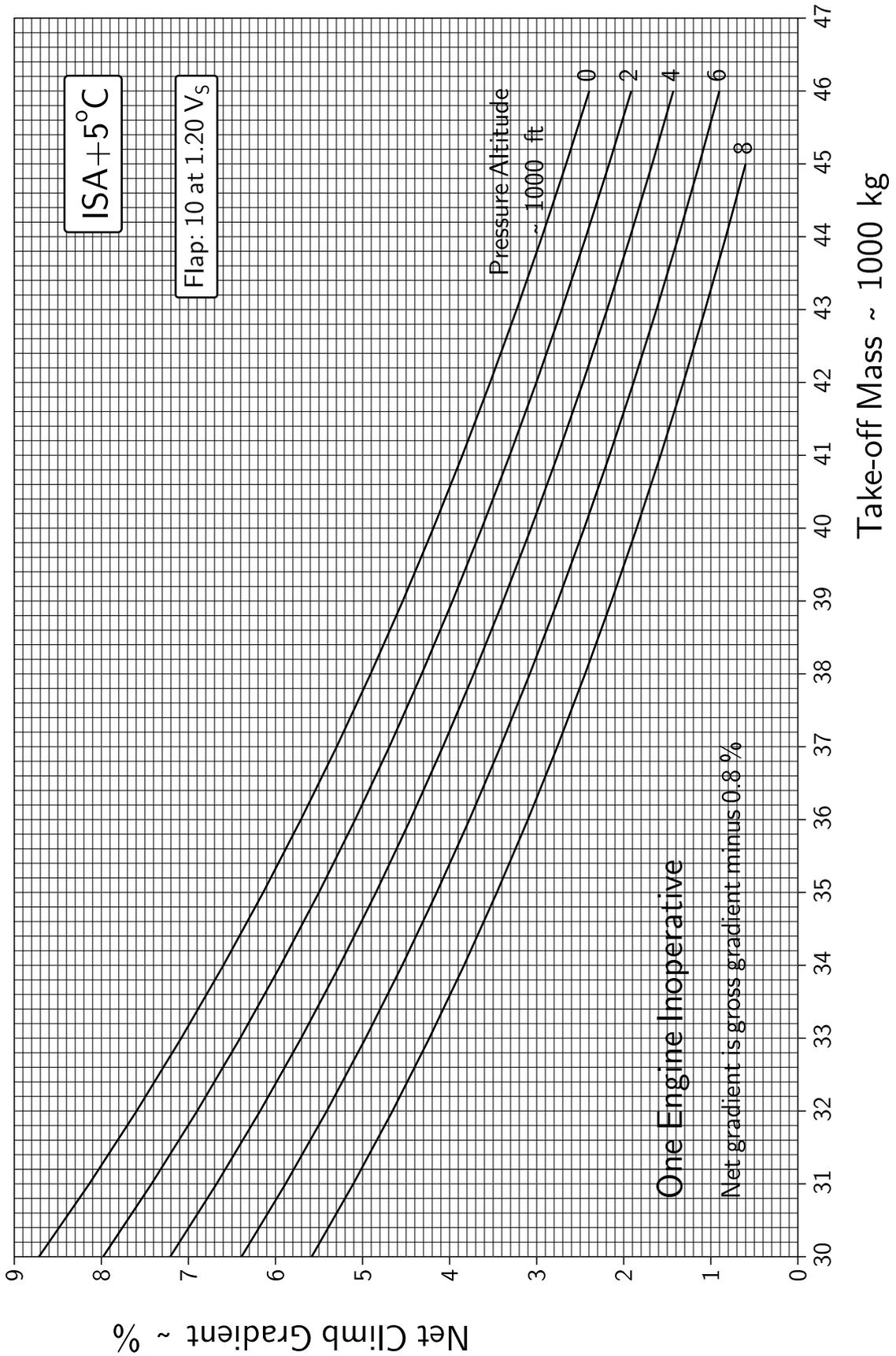
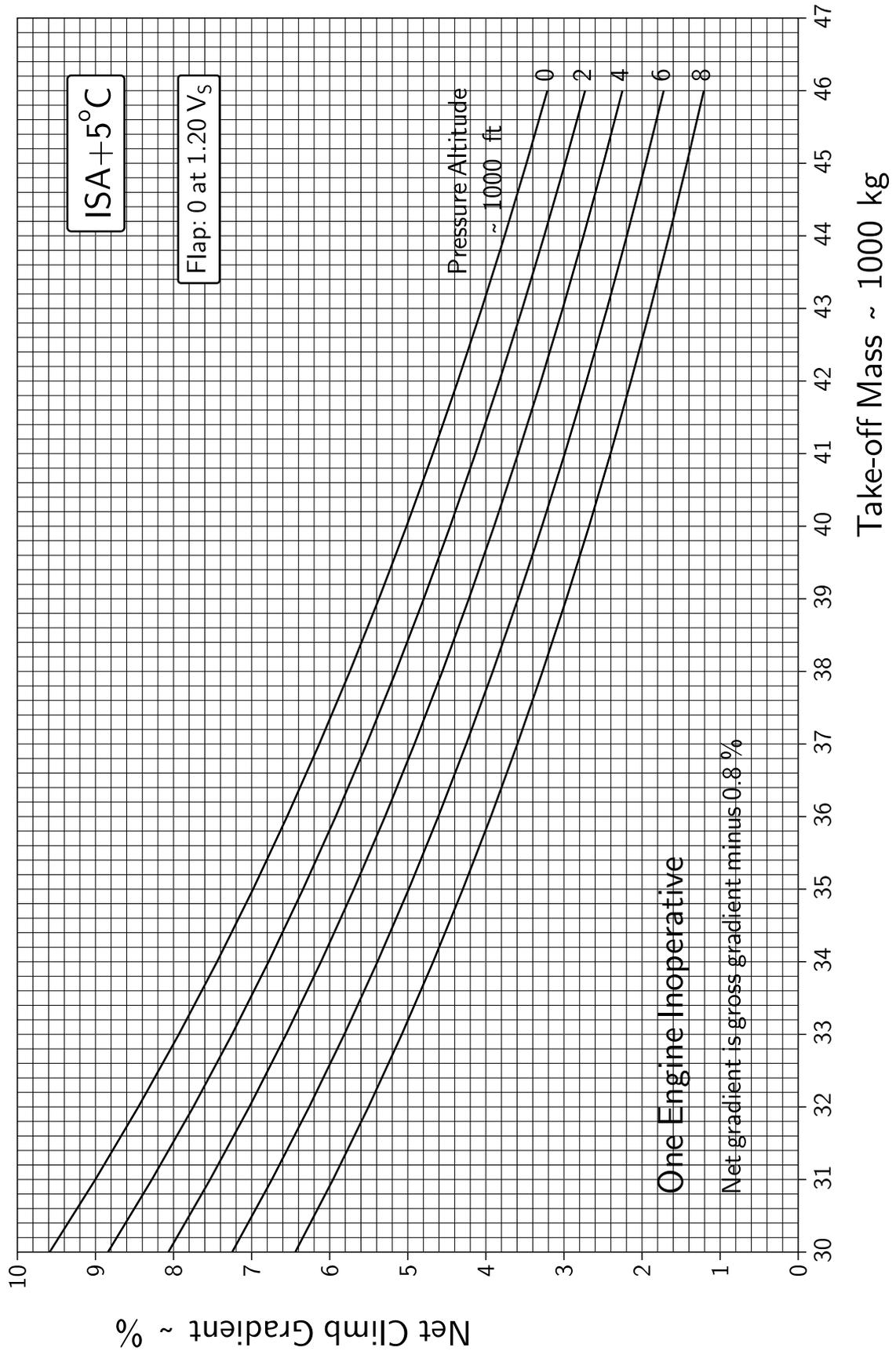


Figure 3.11: Net climb gradient with flap 10 and 1.20  $V_S$  at ISA + 5°C.


 Figure 3.12: Net climb gradient with flap 0 and 1.20 V<sub>S</sub> at ISA + 5°C.

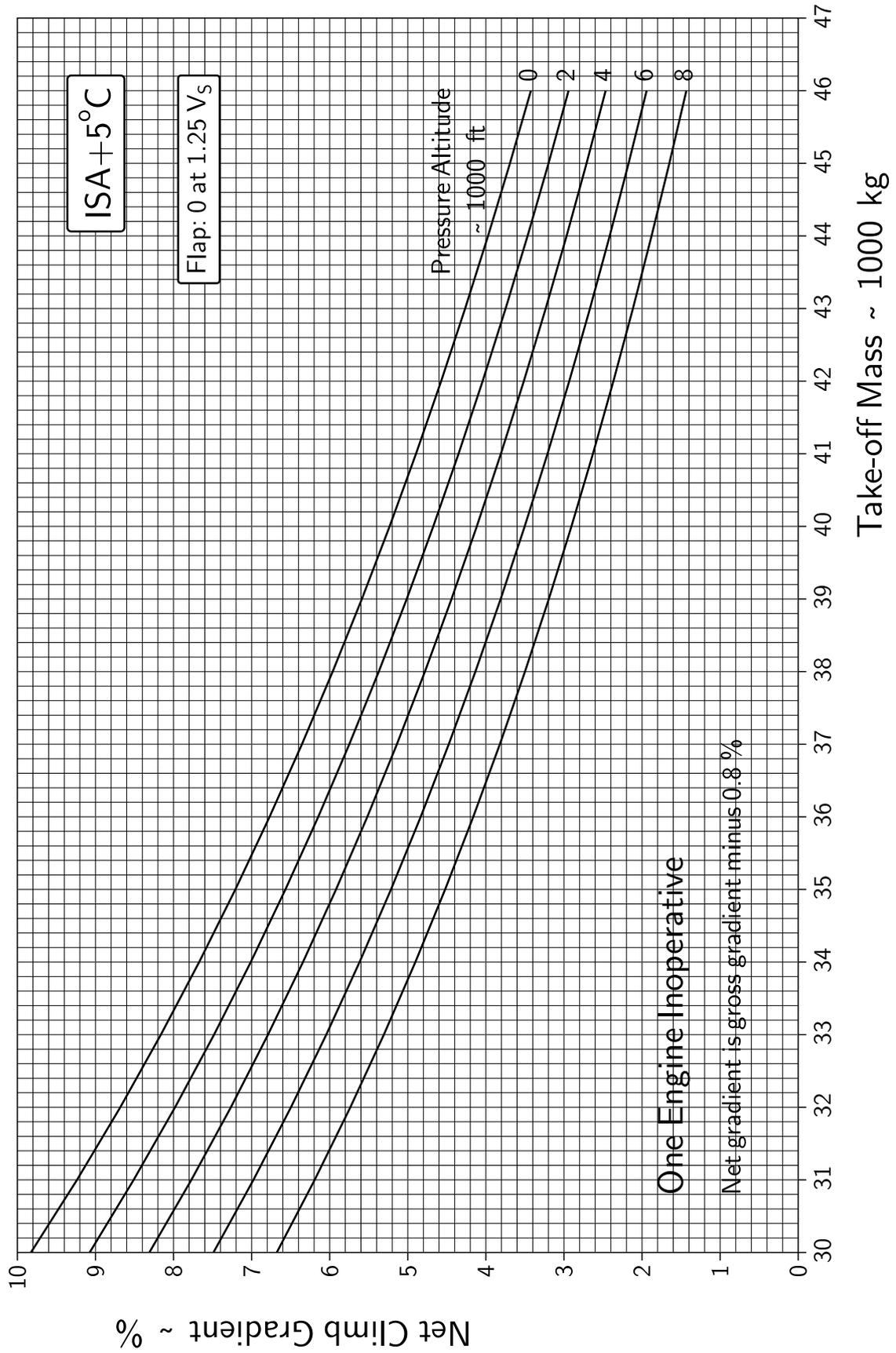


Figure 3.13: Net climb gradient with flap 0 and 1.25 V<sub>S</sub> at ISA + 5°C.

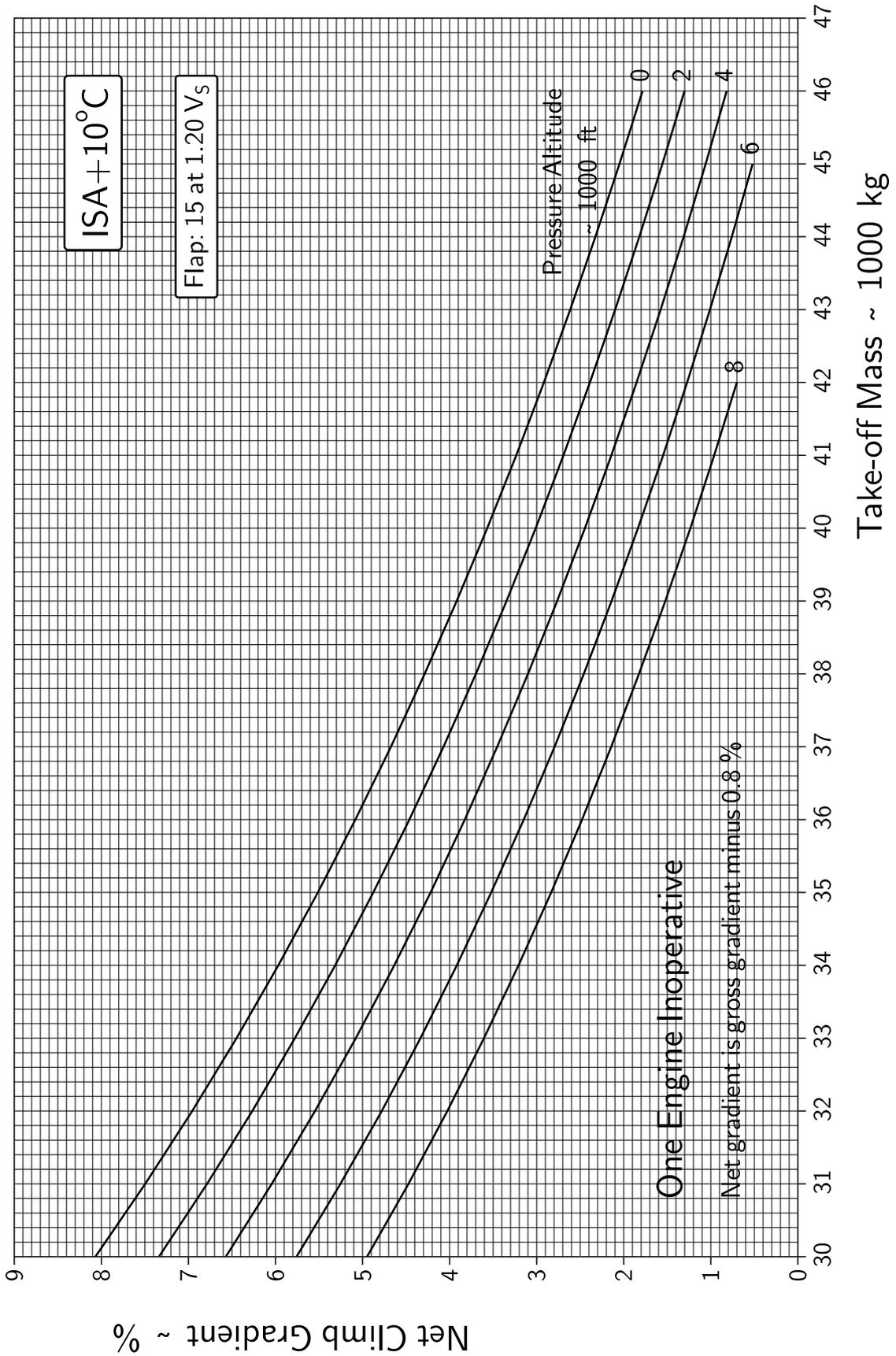


Figure 3.14: Net climb gradient with flap 15 and 1.20 Vs at ISA + 10°C.

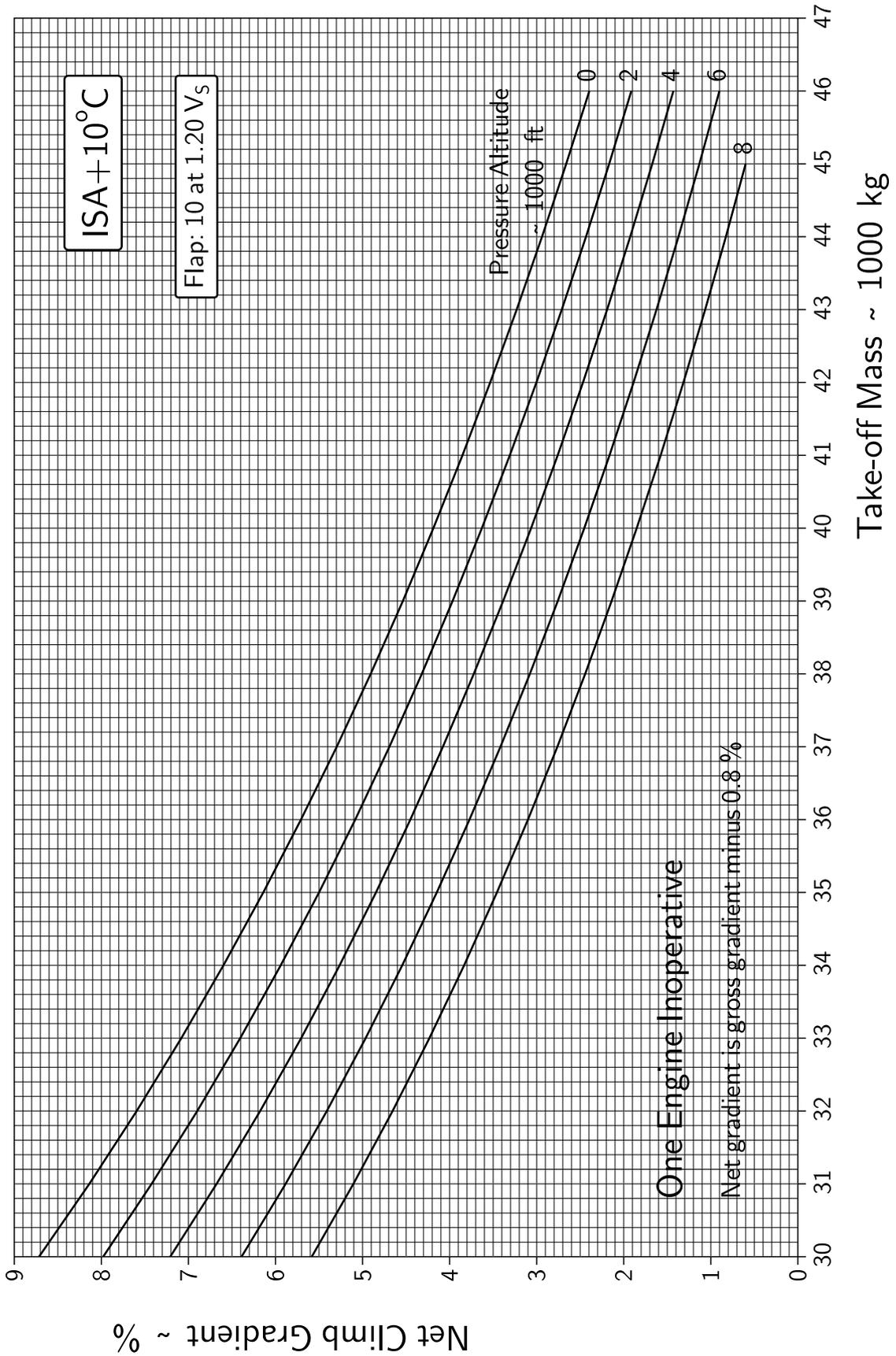
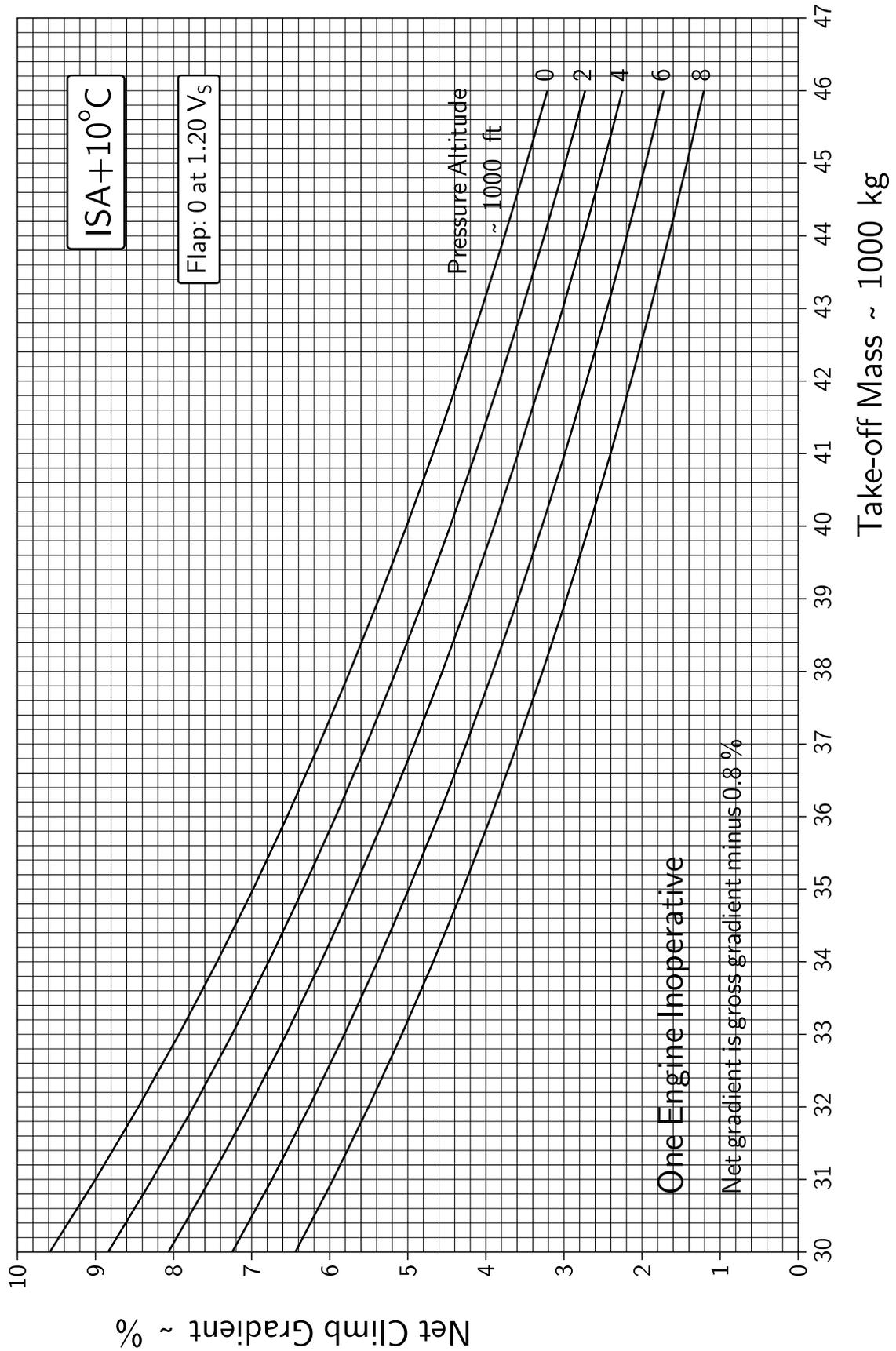


Figure 3.15: Net climb gradient with flap 10 and 1.20  $V_S$  at ISA + 10°C.


 Figure 3.16: Net climb gradient with flap 0 and 1.20  $V_S$  at ISA + 10°C.

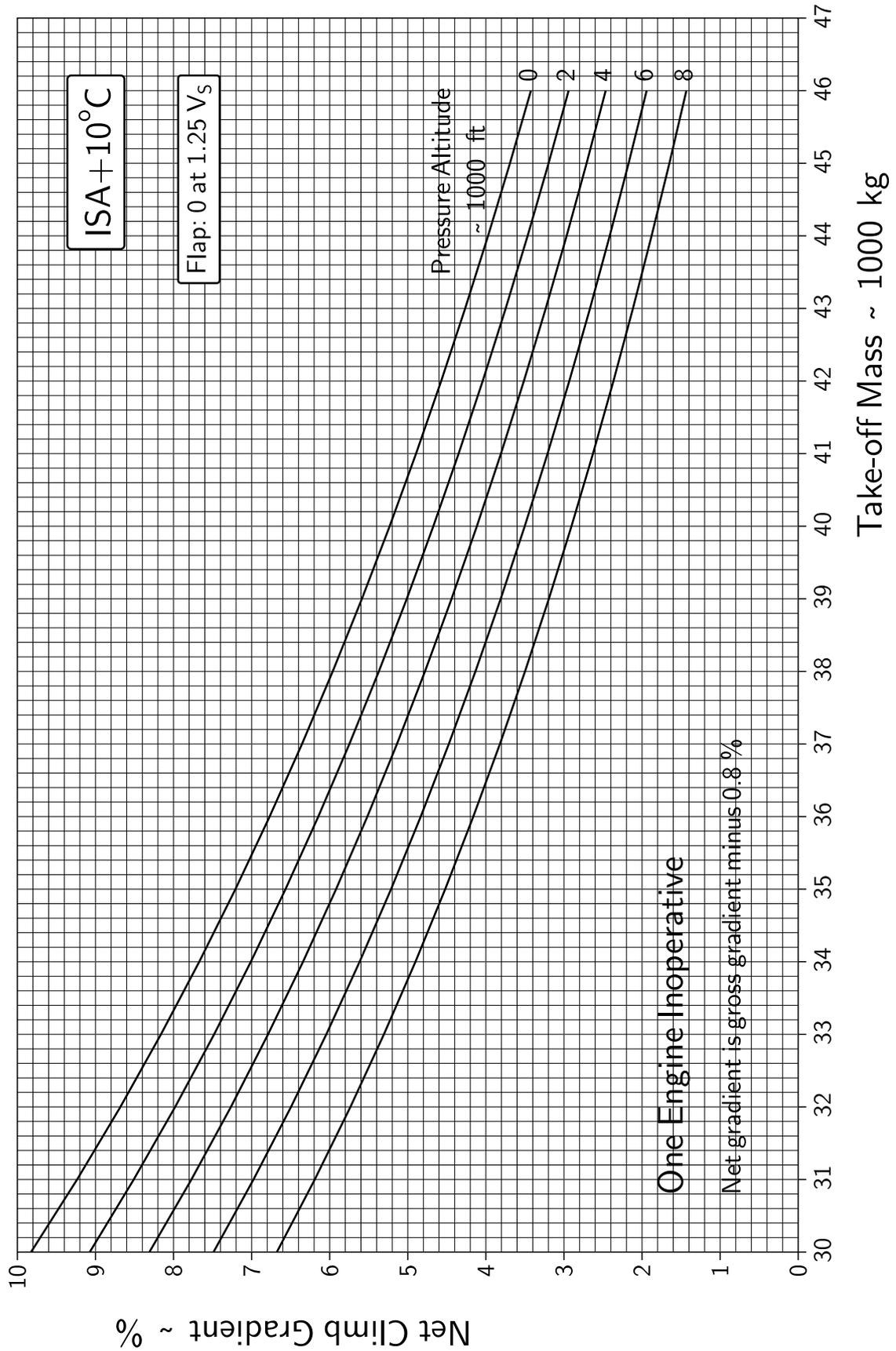


Figure 3.17: Net climb gradient with flap 0 and 1.25 Vs at ISA + 10°C.

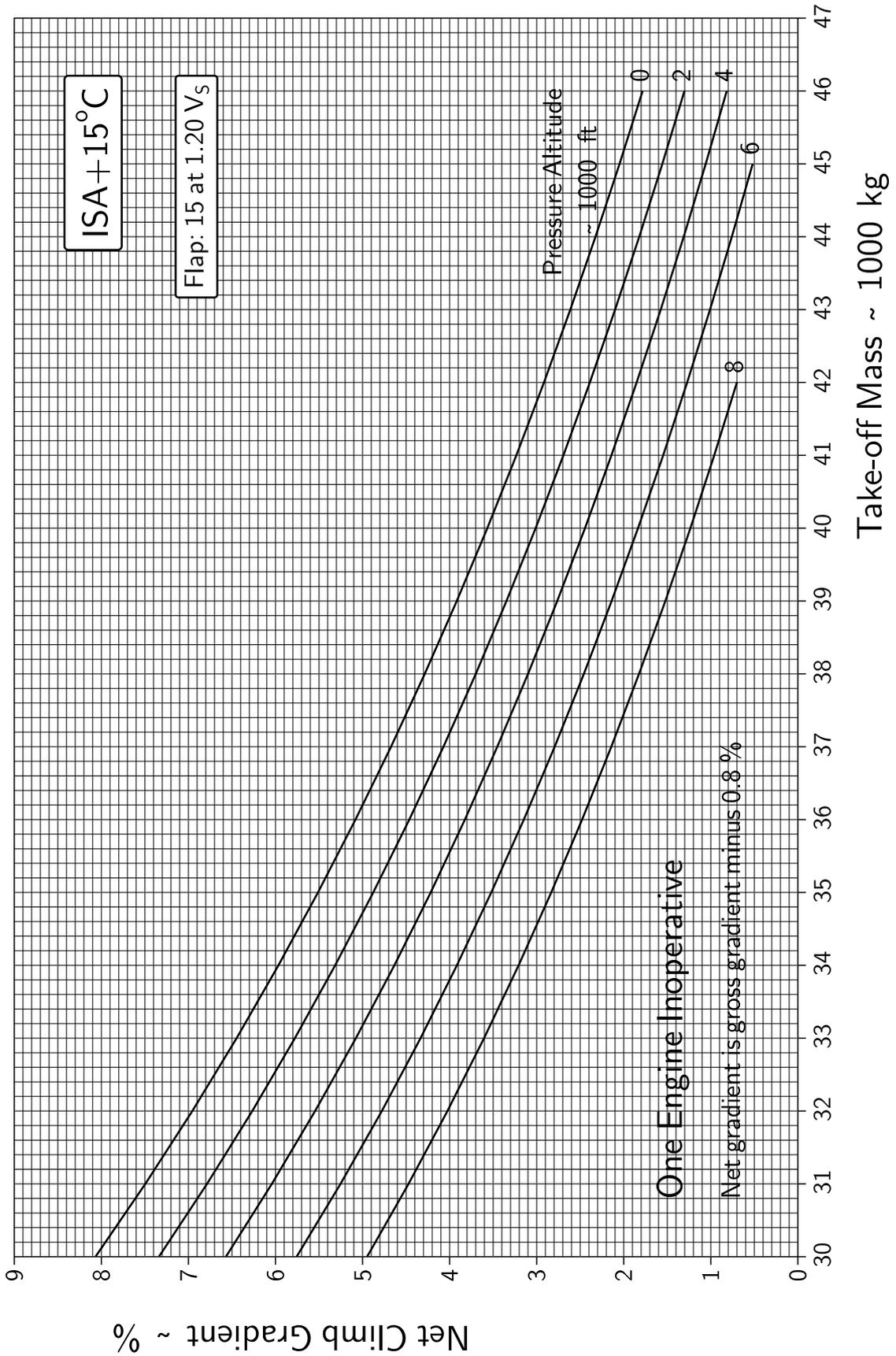


Figure 3.18: Net climb gradient with flap 15 and 1.20  $V_S$  at ISA + 15°C.

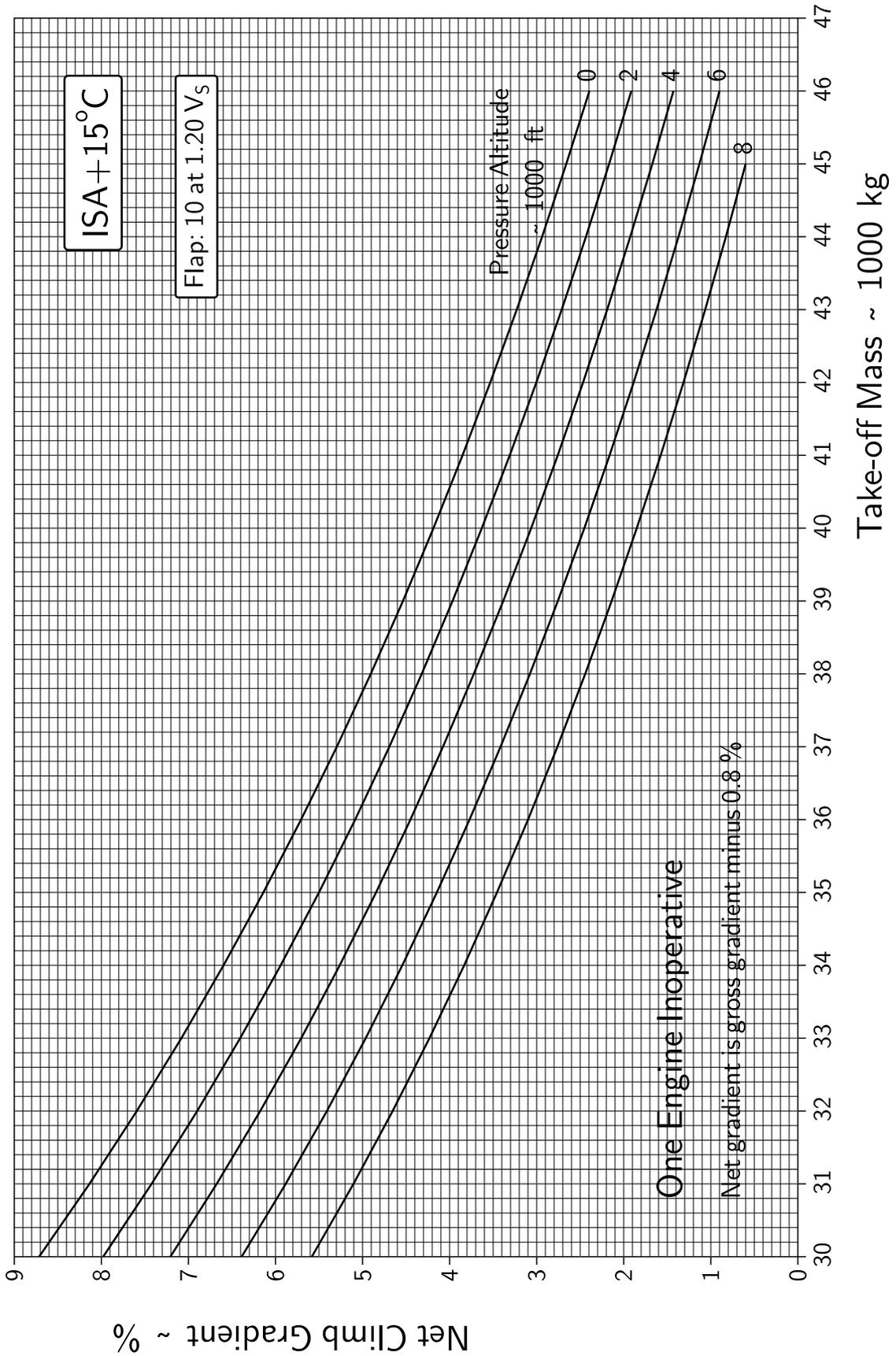
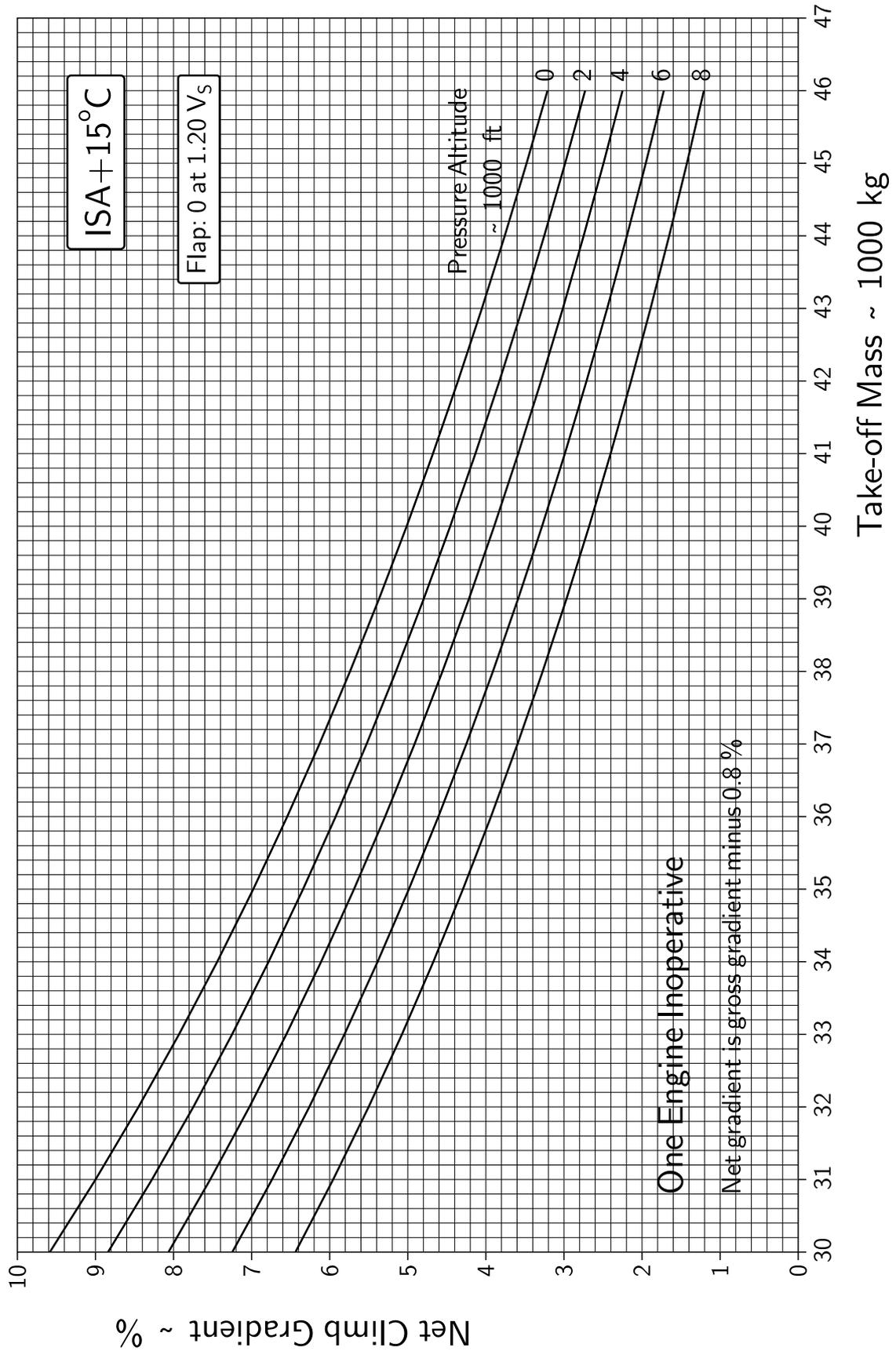


Figure 3.19: Net climb gradient with flap 10 and 1.20 V<sub>S</sub> at ISA + 15°C.


 Figure 3.20: Net climb gradient with flap 0 and 1.20  $V_S$  at ISA + 15°C.

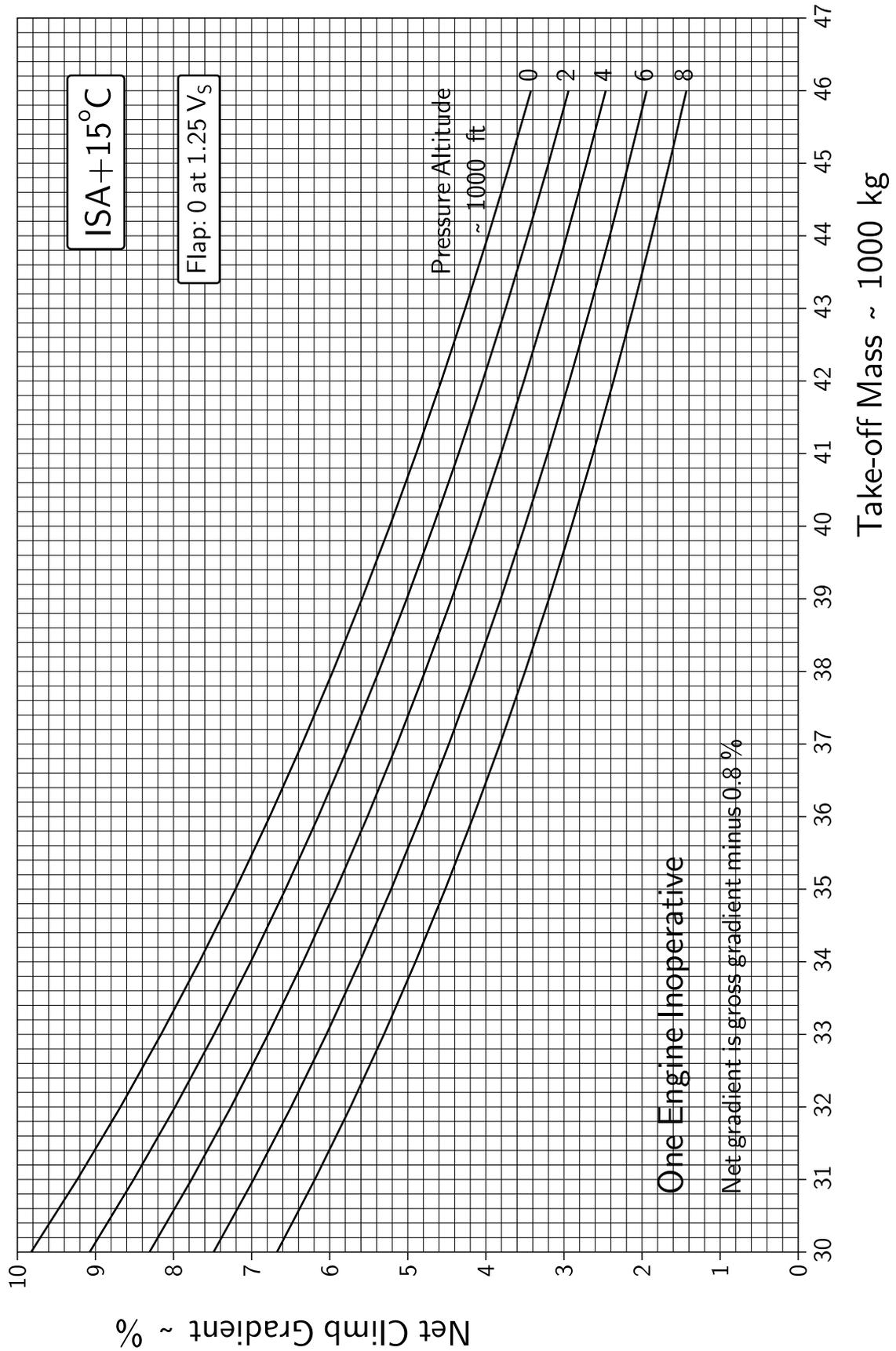
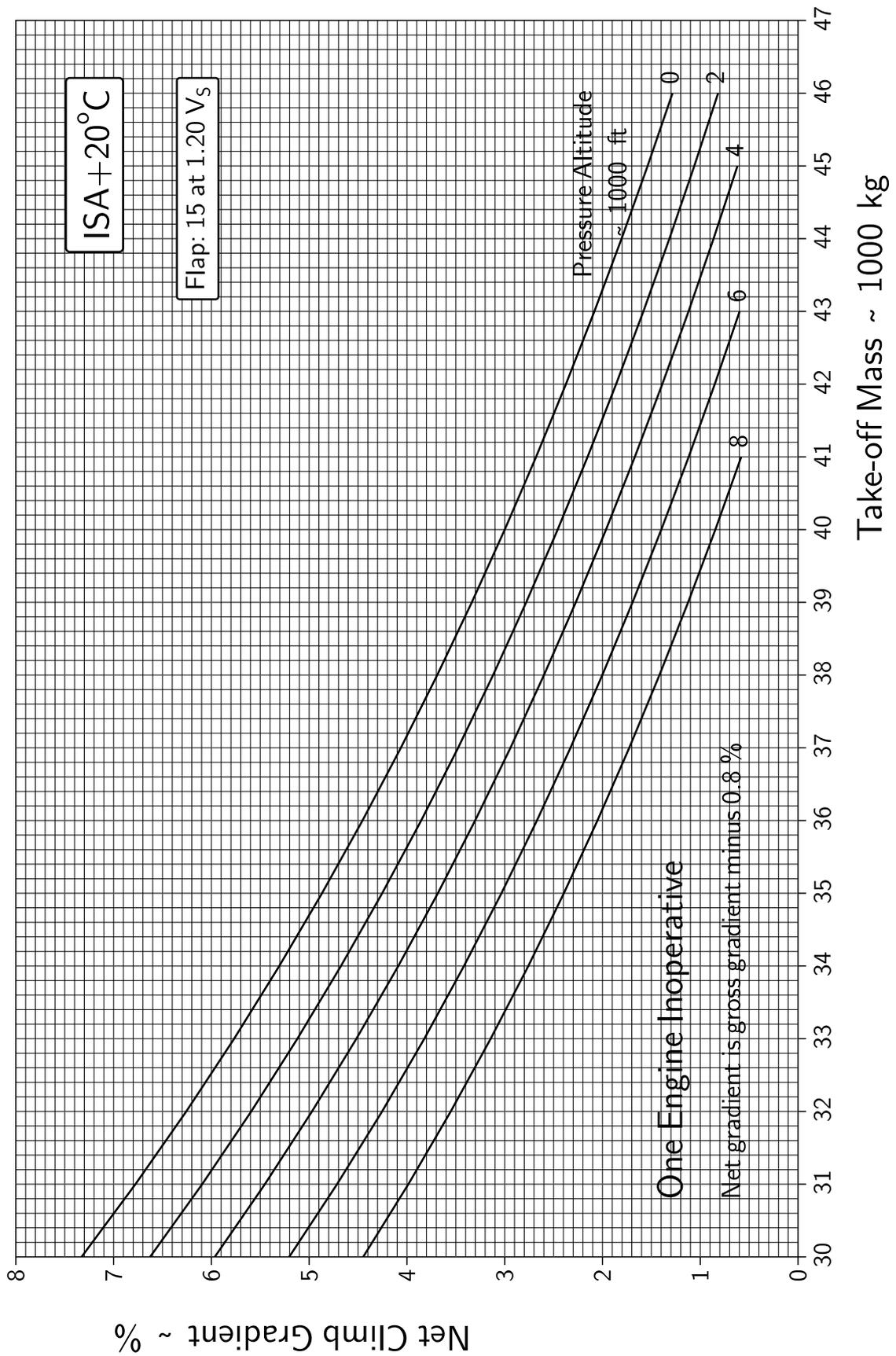


Figure 3.21: Net climb gradient with flap 0 and 1.25 Vs at ISA + 15°C.


 Figure 3.22: Net climb gradient with flap 15 and 1.20  $V_S$  at ISA + 20°C.

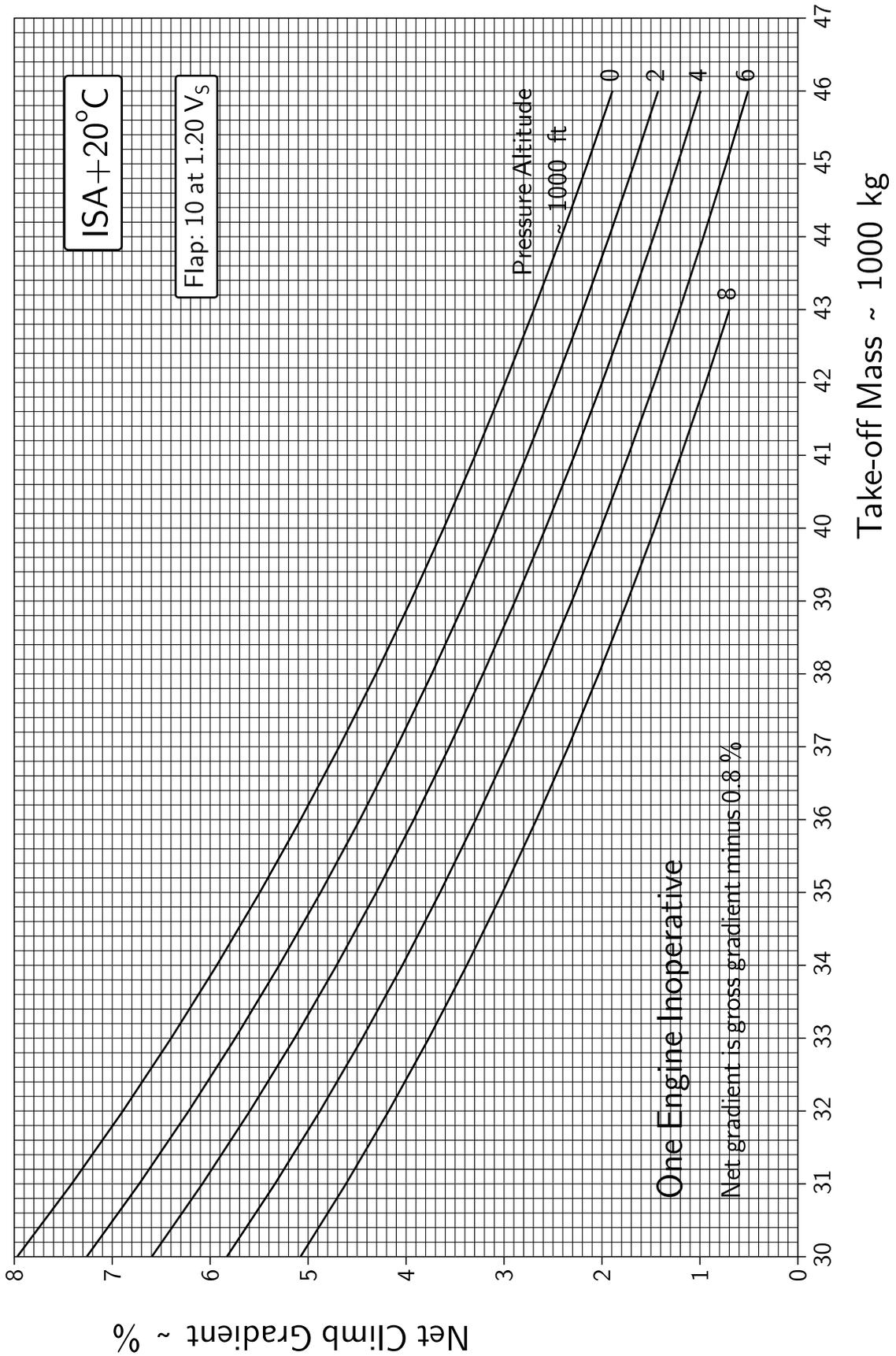
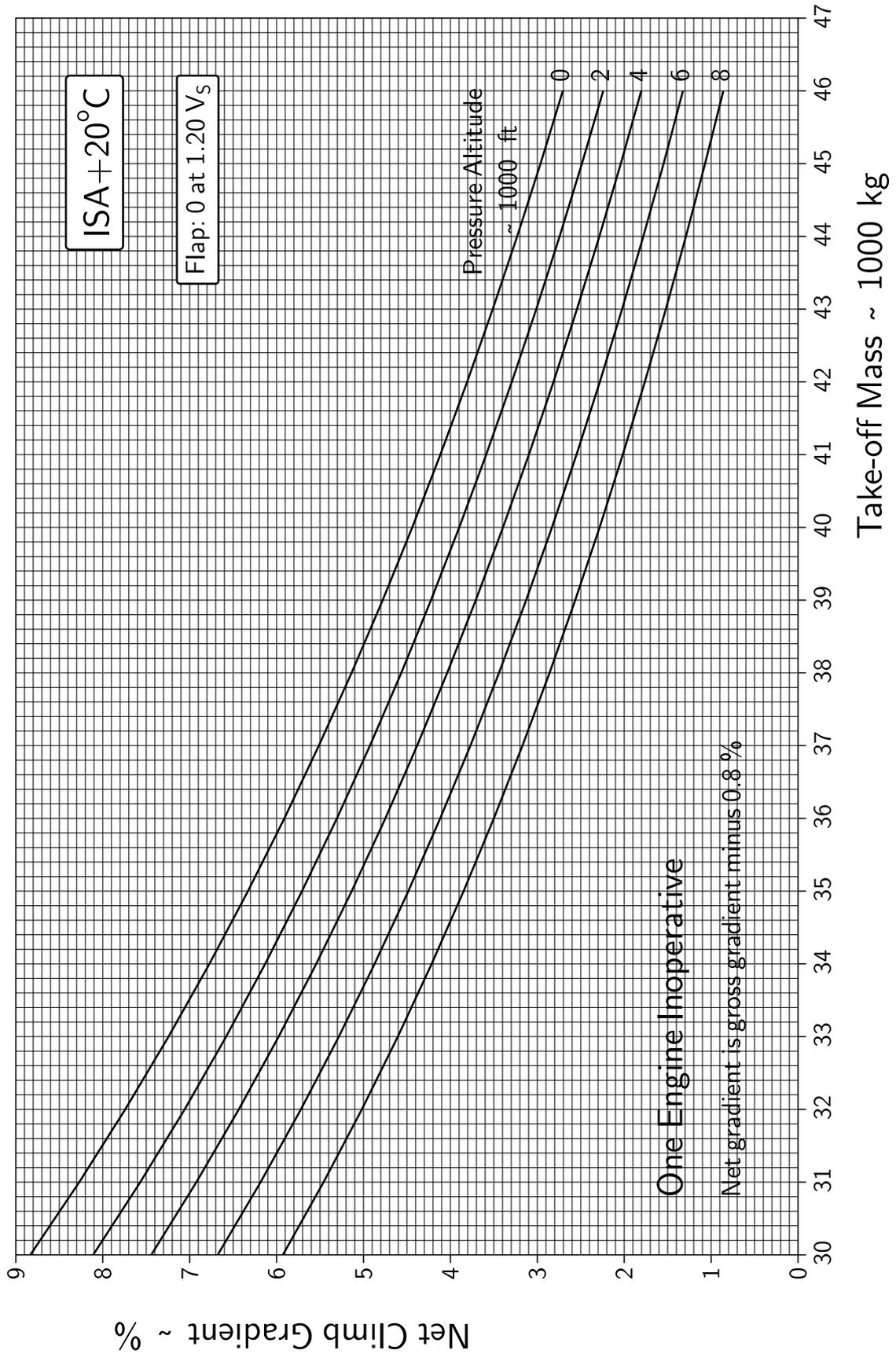


Figure 3.23: Net climb gradient with flap 10 and 1.20 V<sub>S</sub> at ISA + 20°C.


 Figure 3.24: Net climb gradient with flap 0 and 1.20  $V_S$  at ISA + 20°C.

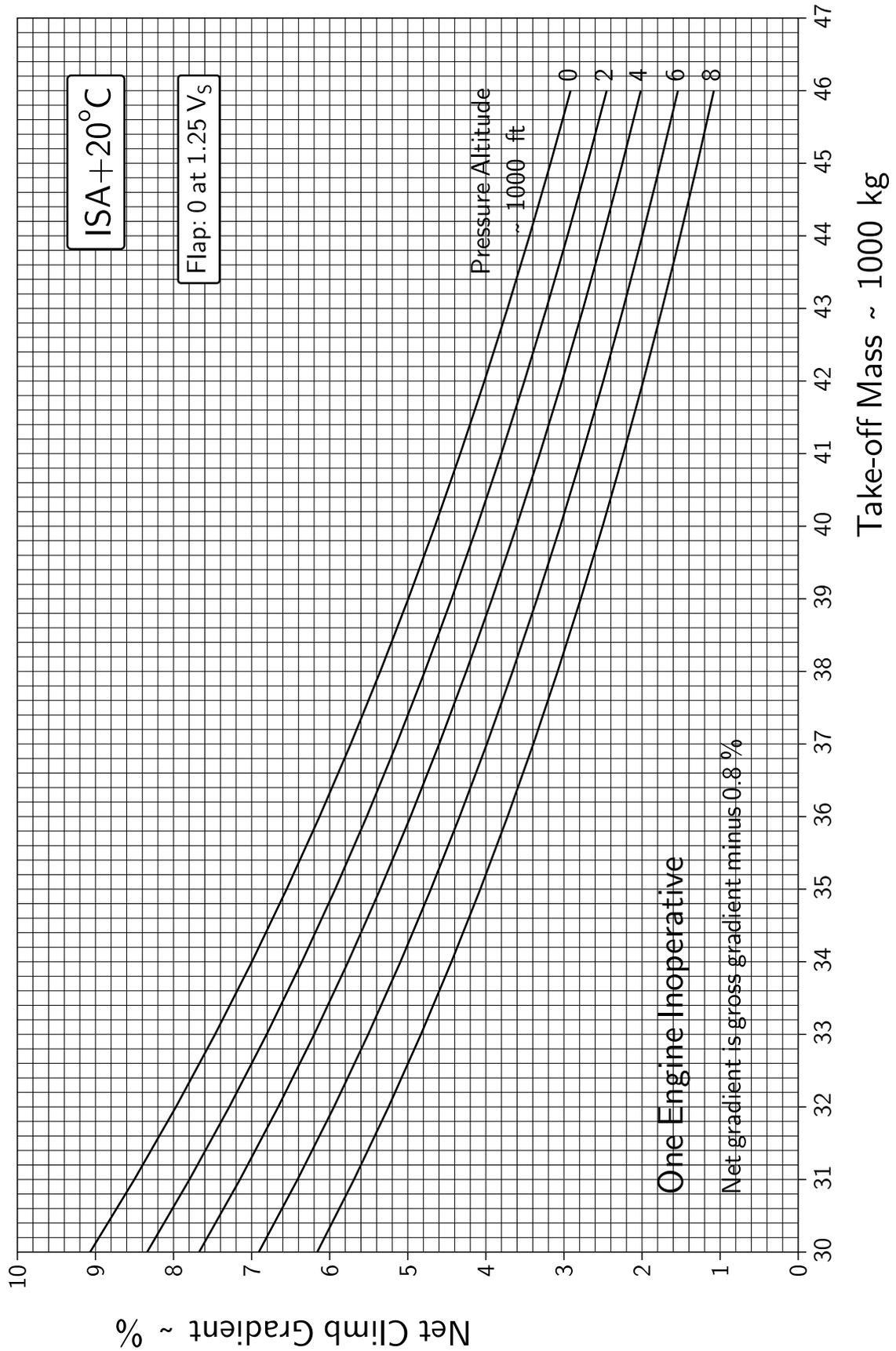


Figure 3.25: Net climb gradient with flap 0 and 1.25  $V_S$  at ISA + 20°C.



# Chapter 4

## Landing

### Introduction

This is a call to the `\Intro` macro. This can optionally be defined in the preamble of the file to provide any text needed to serve as an introduction to this chapter.

The interesting thing is that while the text is defined in the first (manually prepared) part of the file, it actually appears much later in the automatically-generated part.

### Assumptions

Joint Aviation Requirements 25 (Transport Category).

Landing field length factored by 1.667.

Smooth hard-surfaced runway, no slope, no wind.

Anti-icing off.

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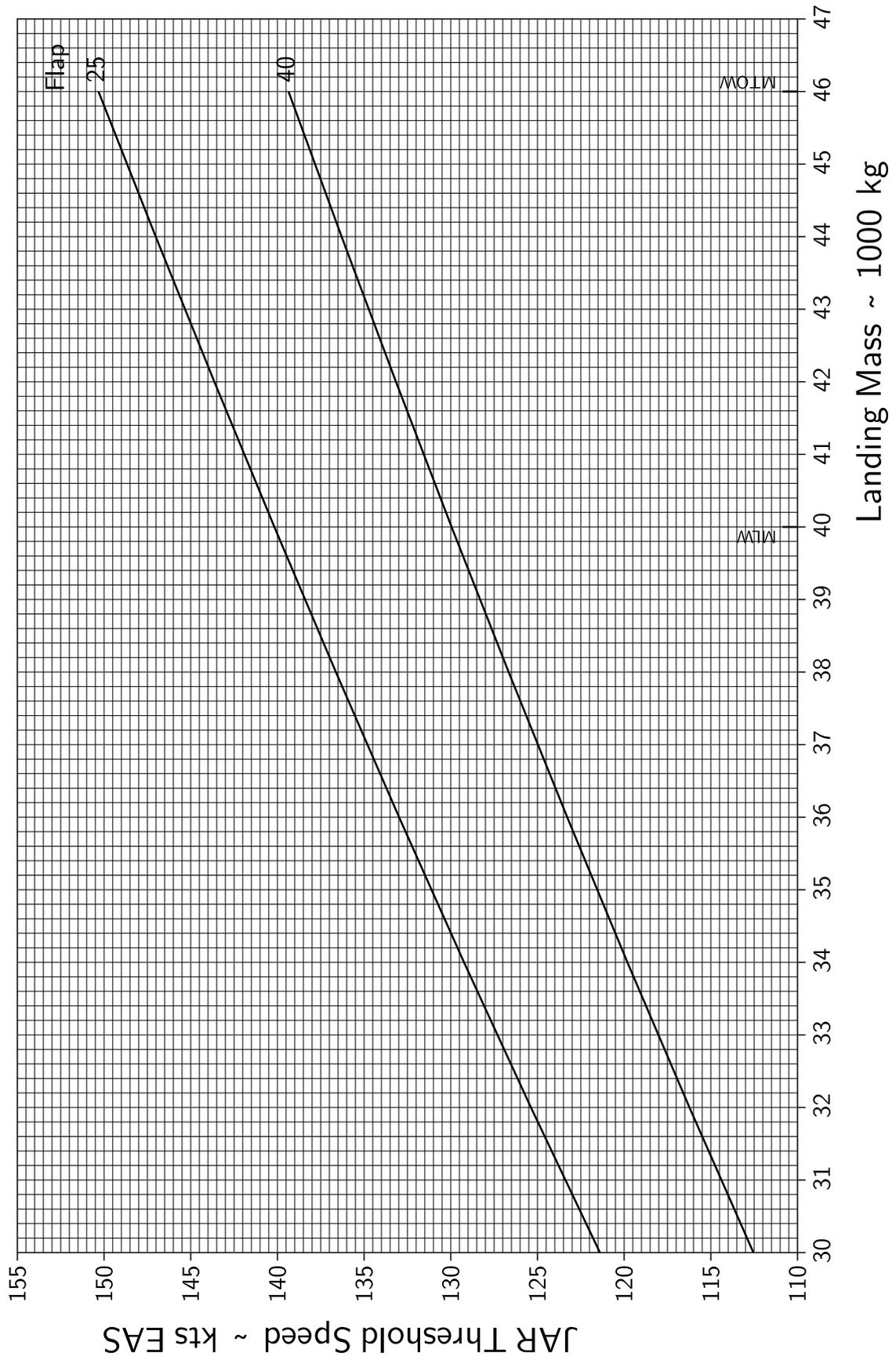


Figure 4.1: Threshold speed.

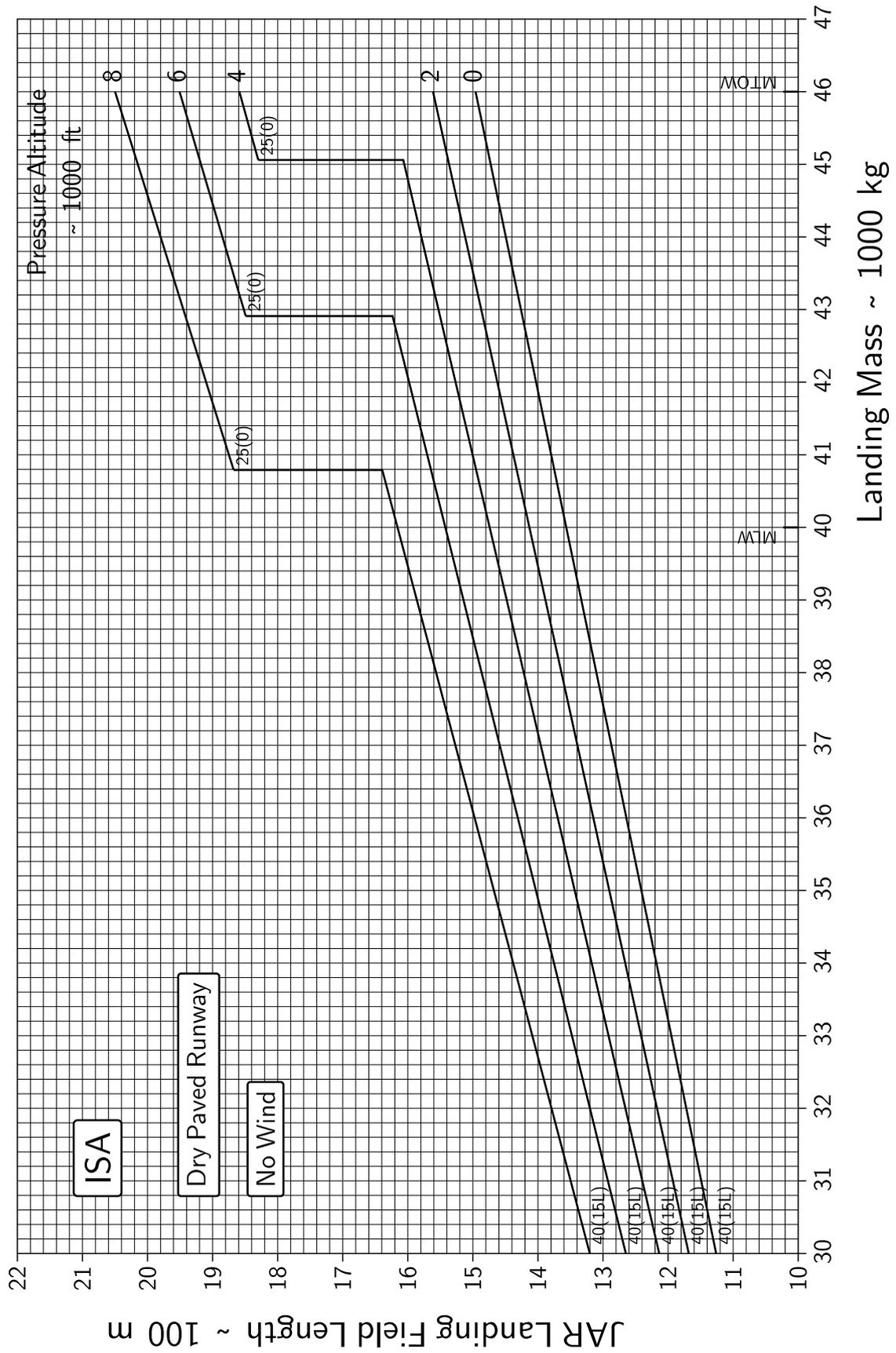


Figure 4.2: Landing field length, dry runway, at ISA.

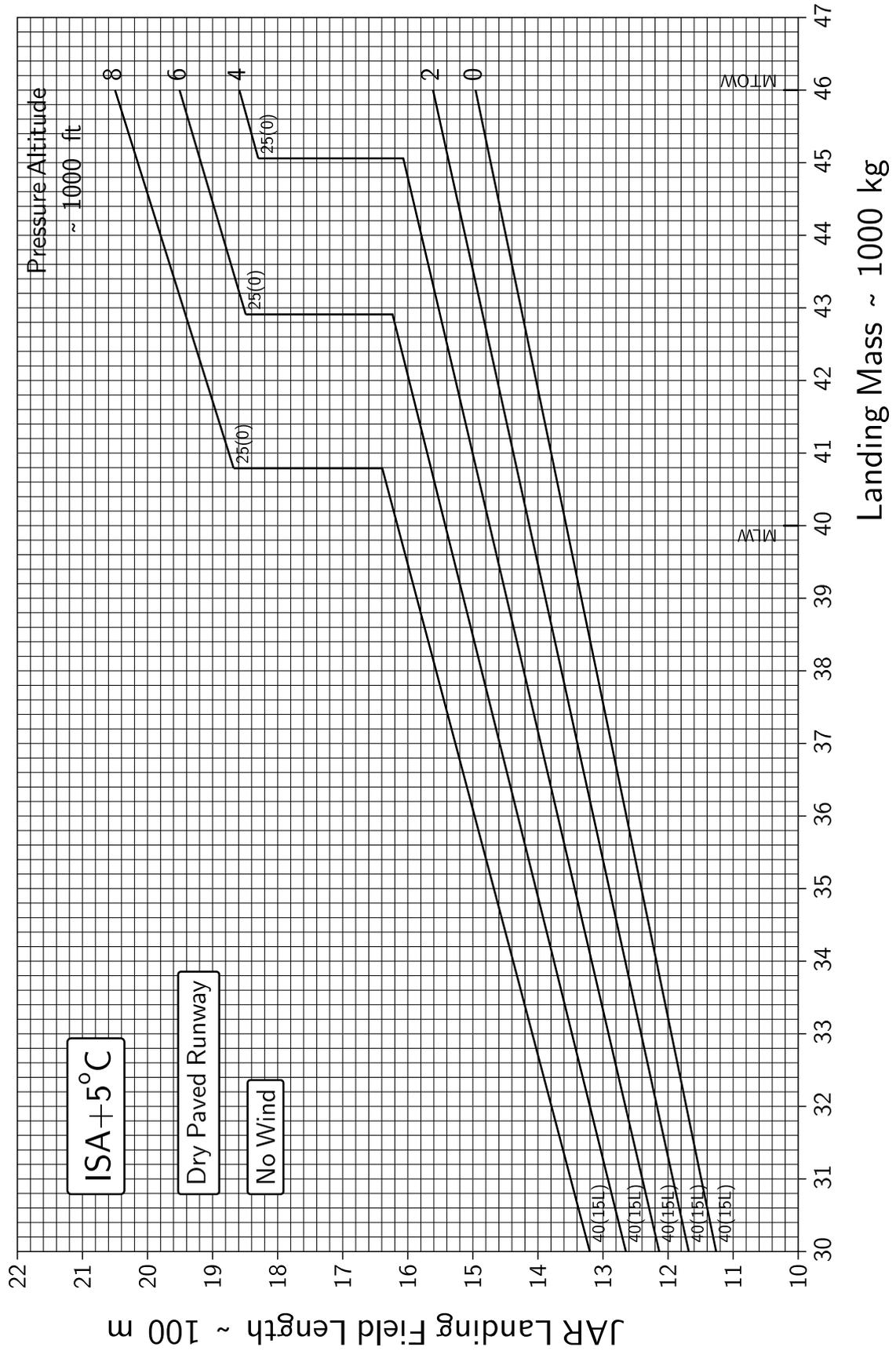


Figure 4.3: Landing field length, dry runway, at ISA + 5°C.

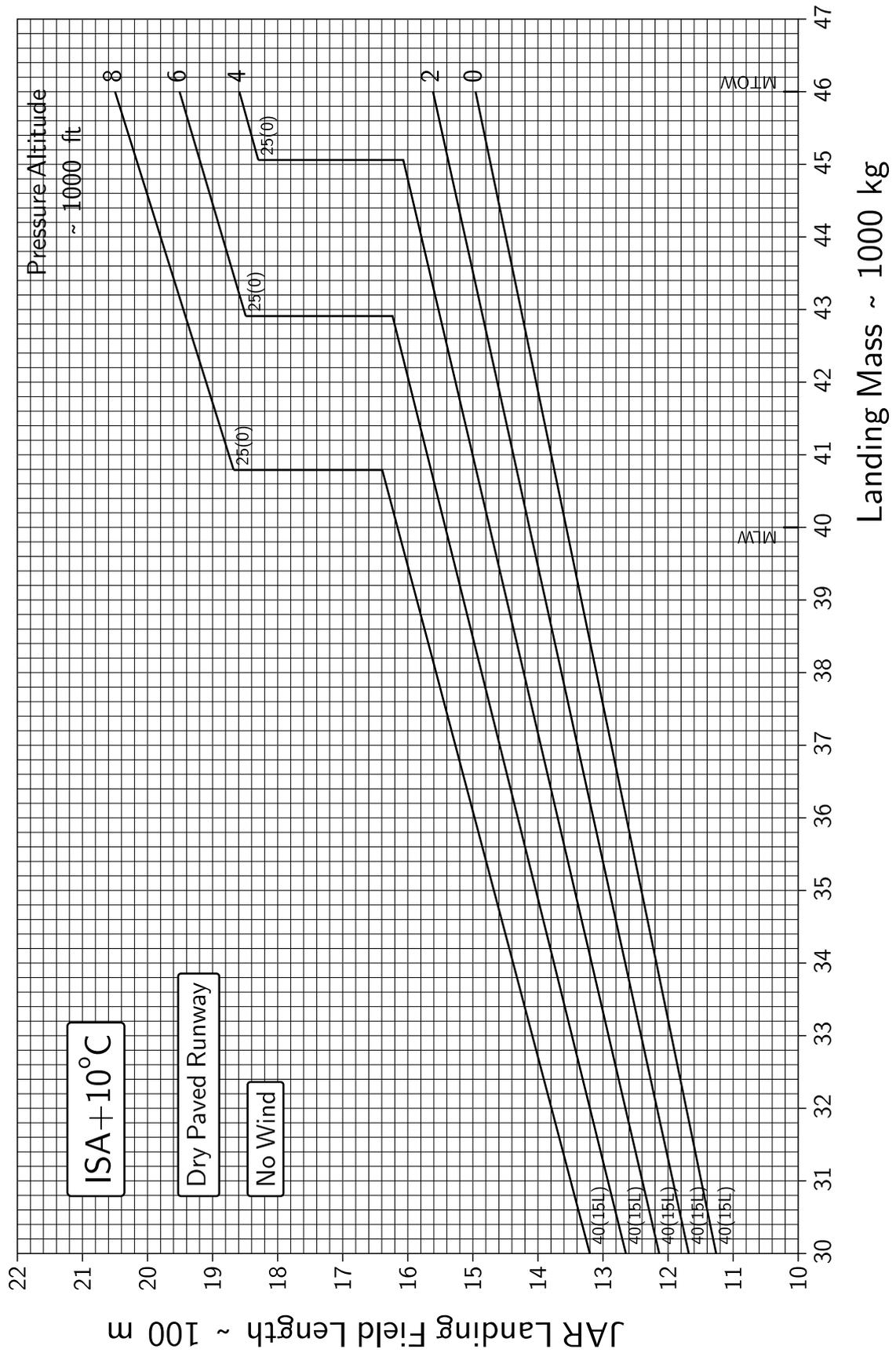


Figure 4.4: Landing field length, dry runway, at ISA + 10°C.

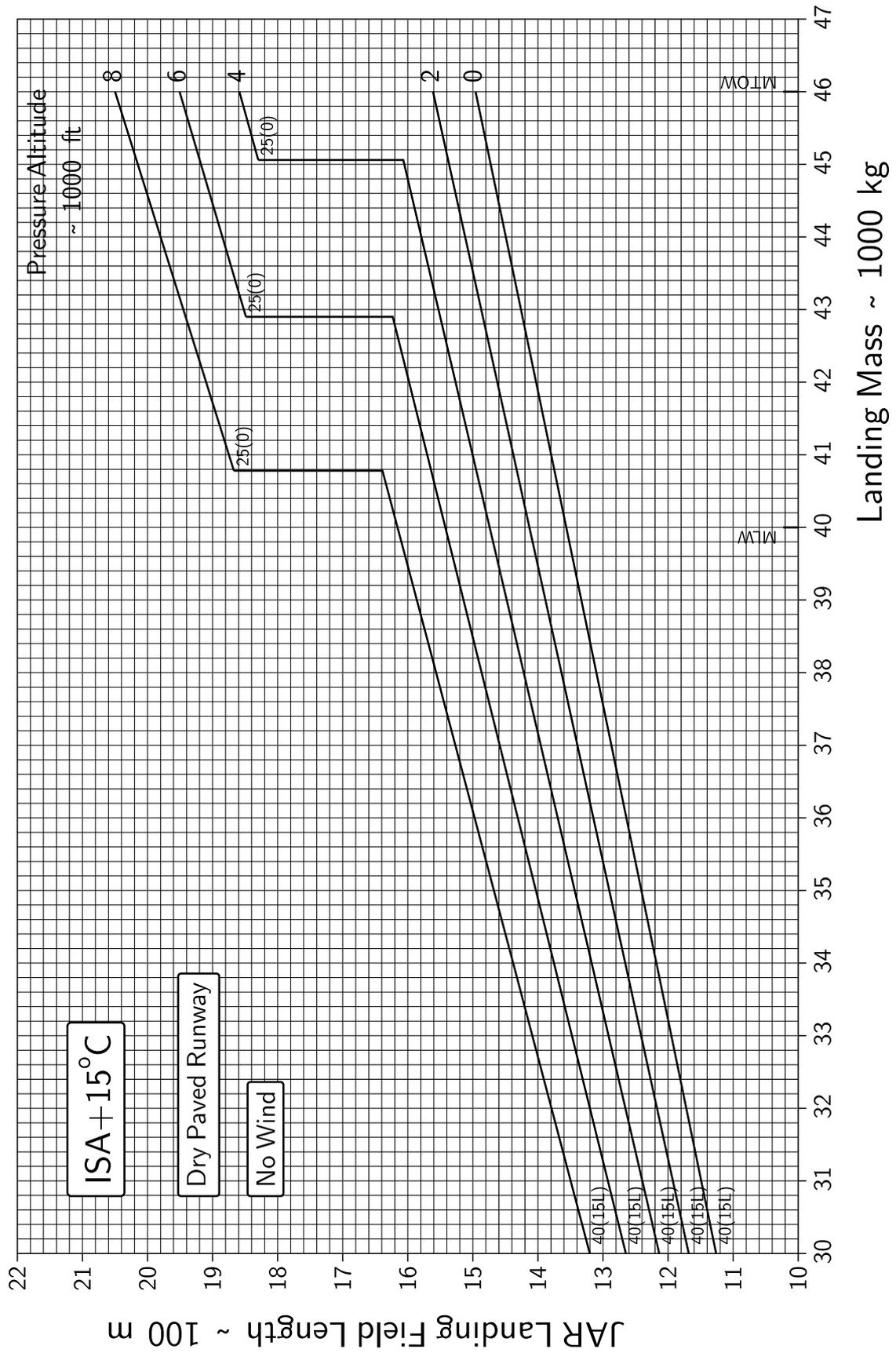


Figure 4.5: Landing field length, dry runway, at ISA + 15°C.

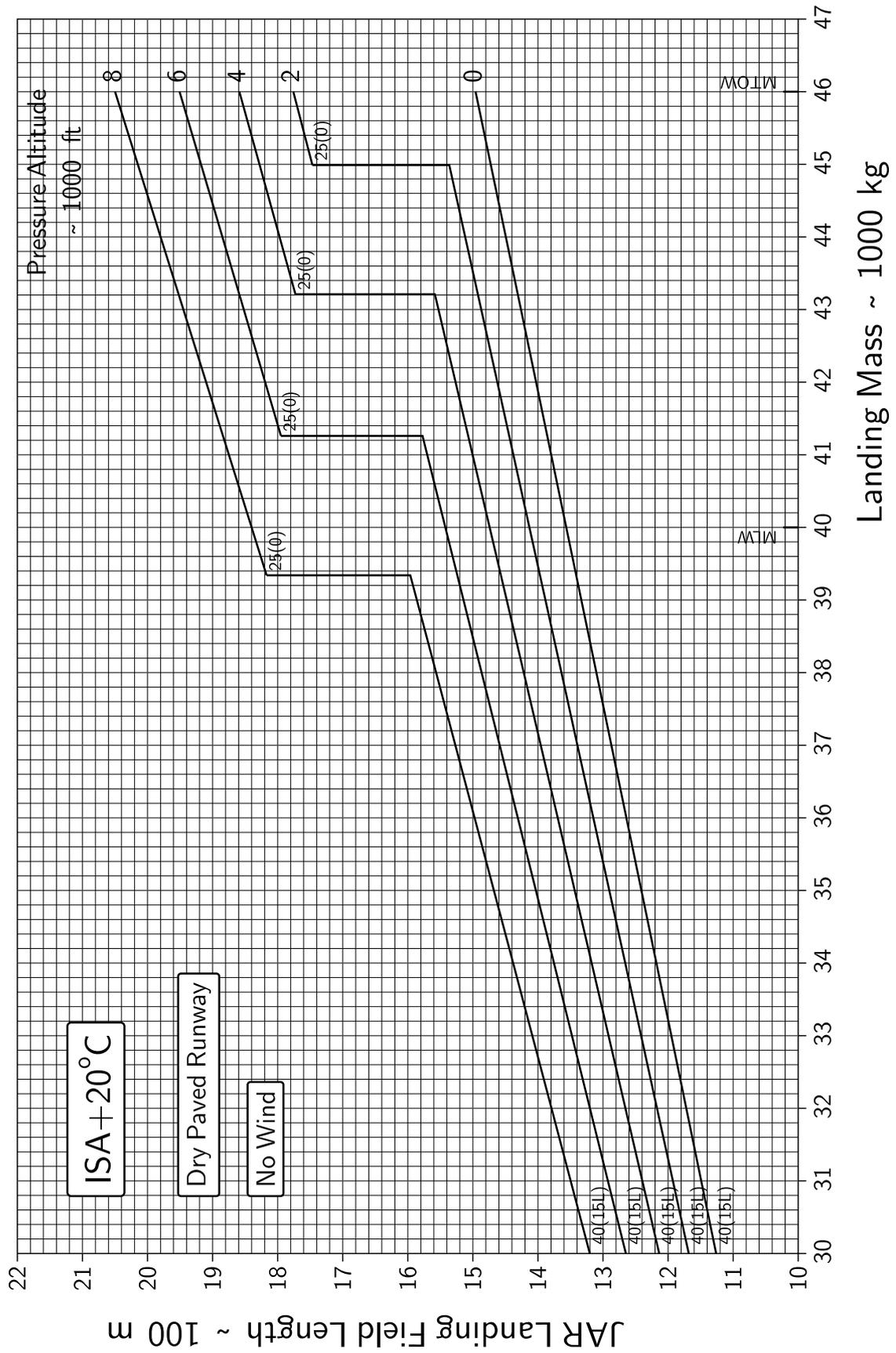


Figure 4.6: Landing field length, dry runway, at ISA + 20°C.



# Chapter 5

## Climb

### Assumptions

Engines at maximum climb rating.

Operational speed restriction of 250 kts CAS below 10 000 ft.

No wind.

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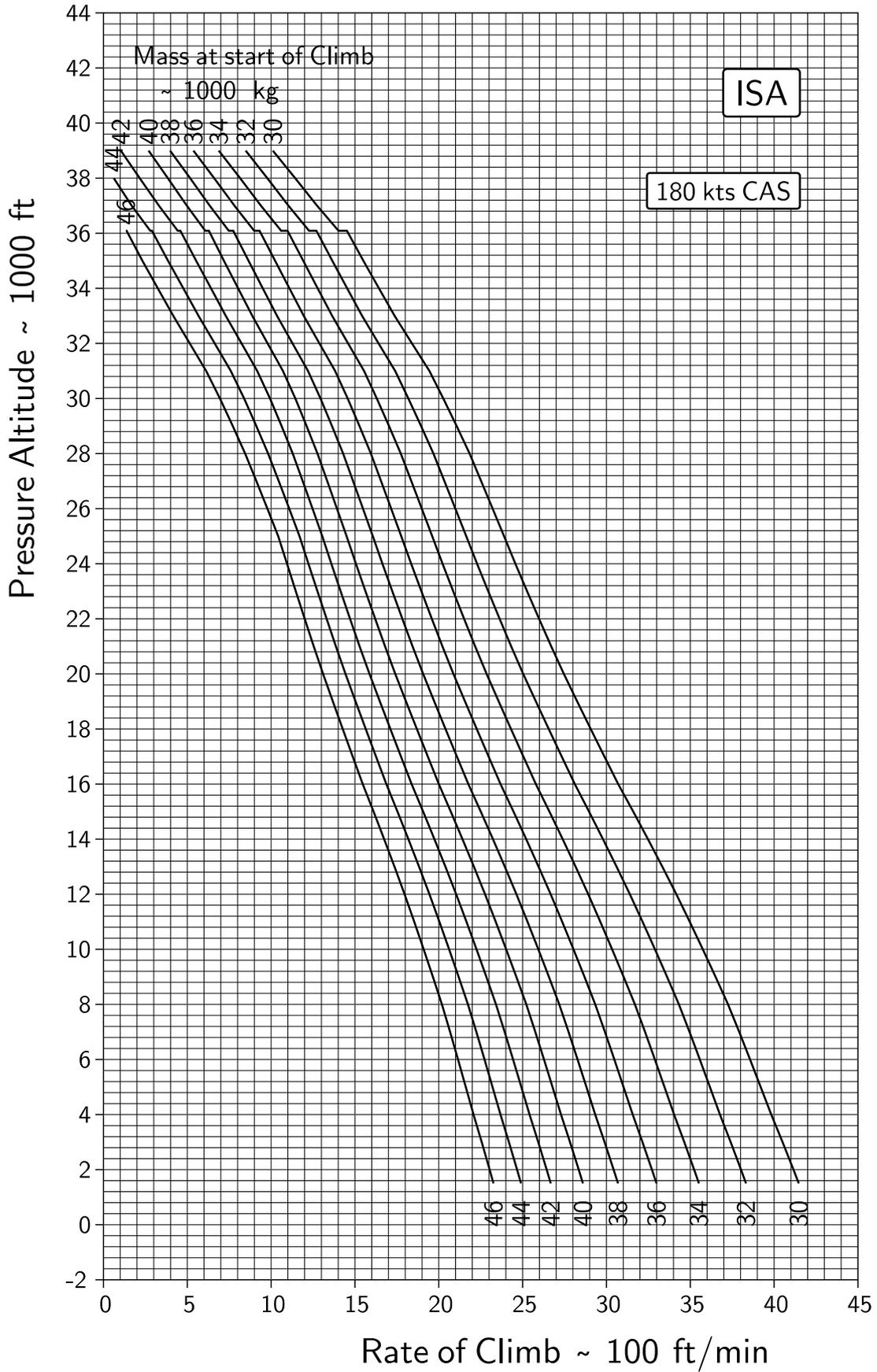


Figure 5.1: Rate of climb at 180 kts CAS / Mach 0.77 at ISA.

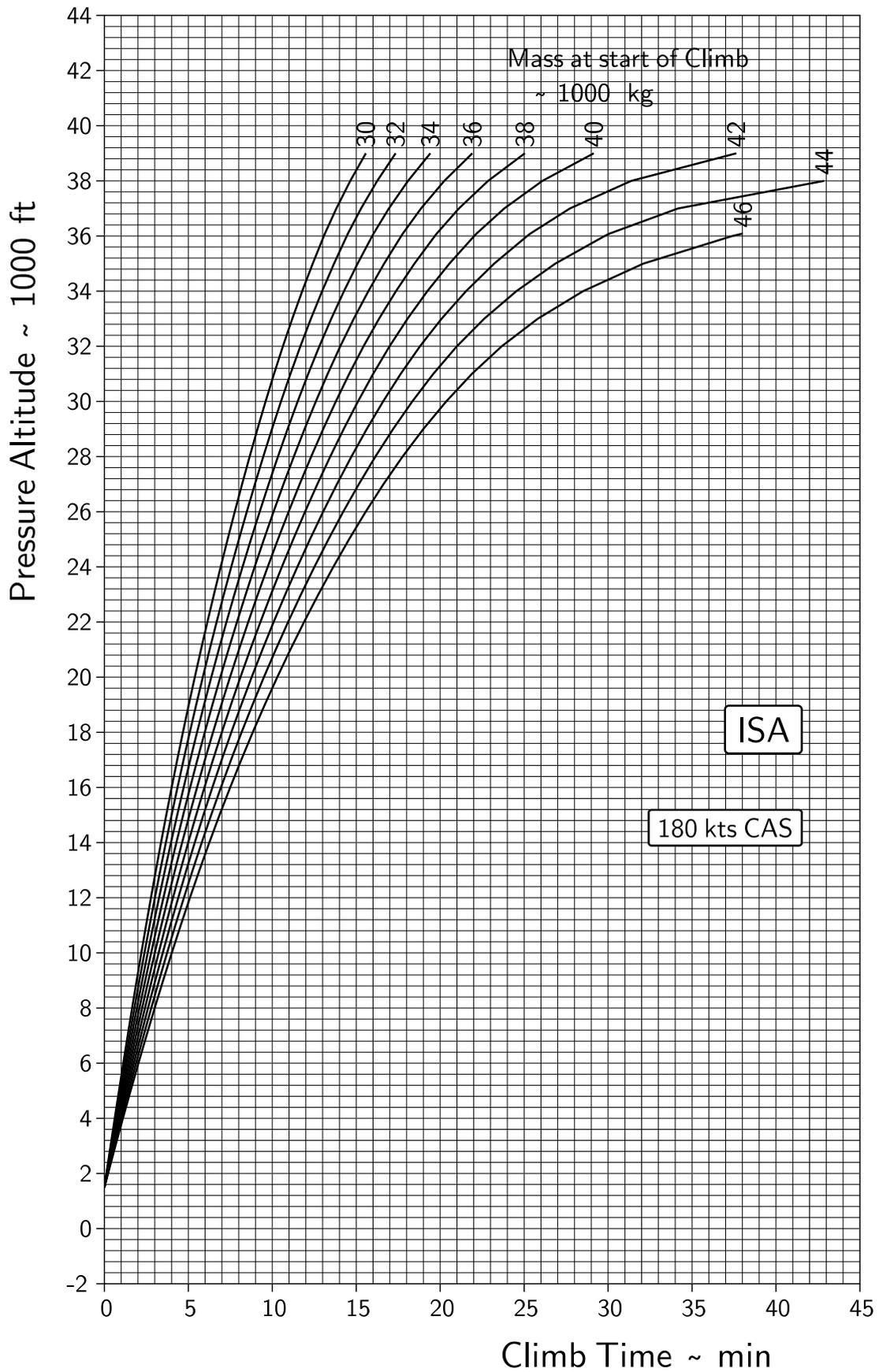


Figure 5.2: Climb time at 180 kts CAS / Mach 0.77 at ISA.

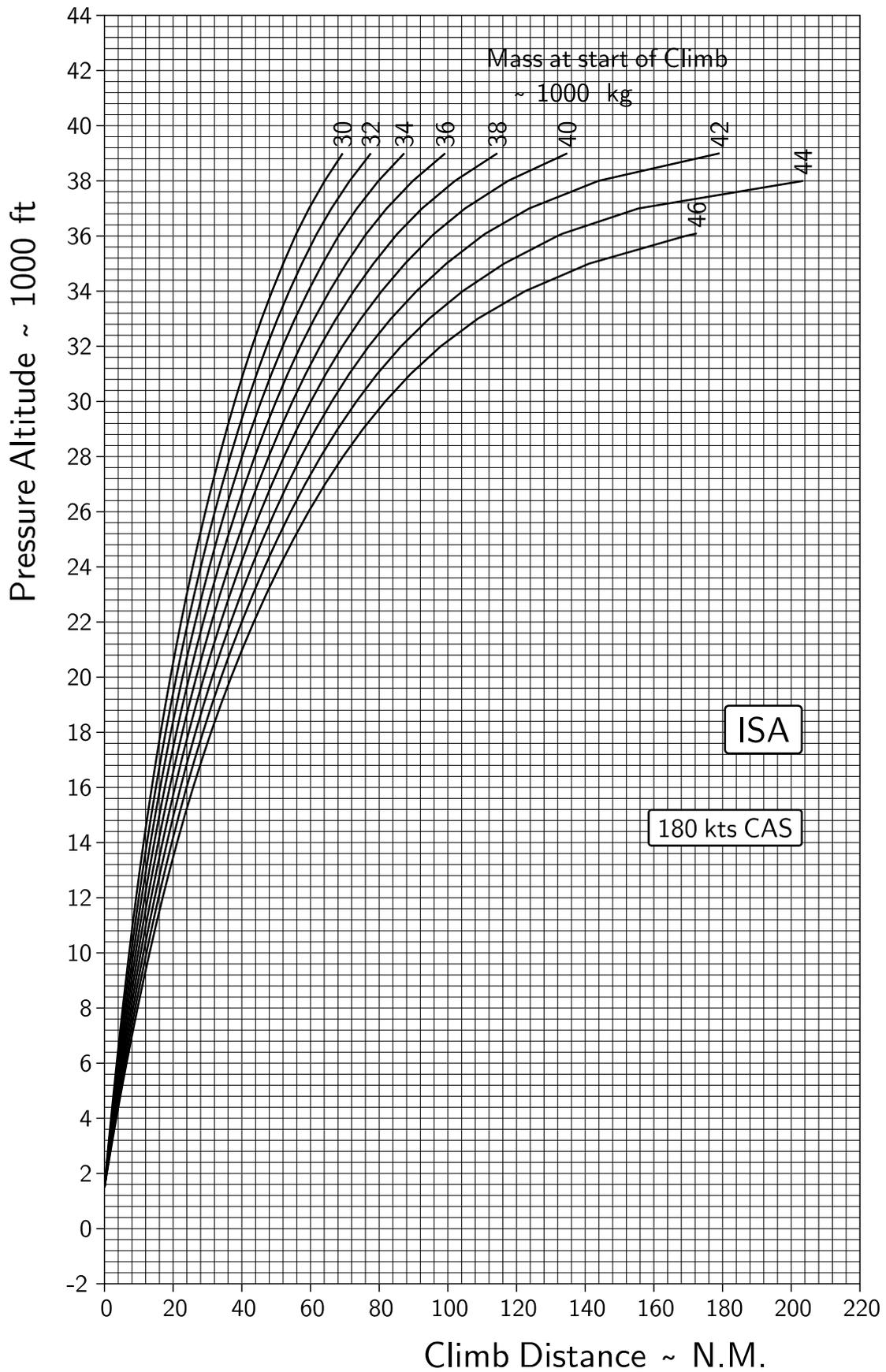


Figure 5.3: Climb distance at 180 kts CAS / Mach 0.77 at ISA.

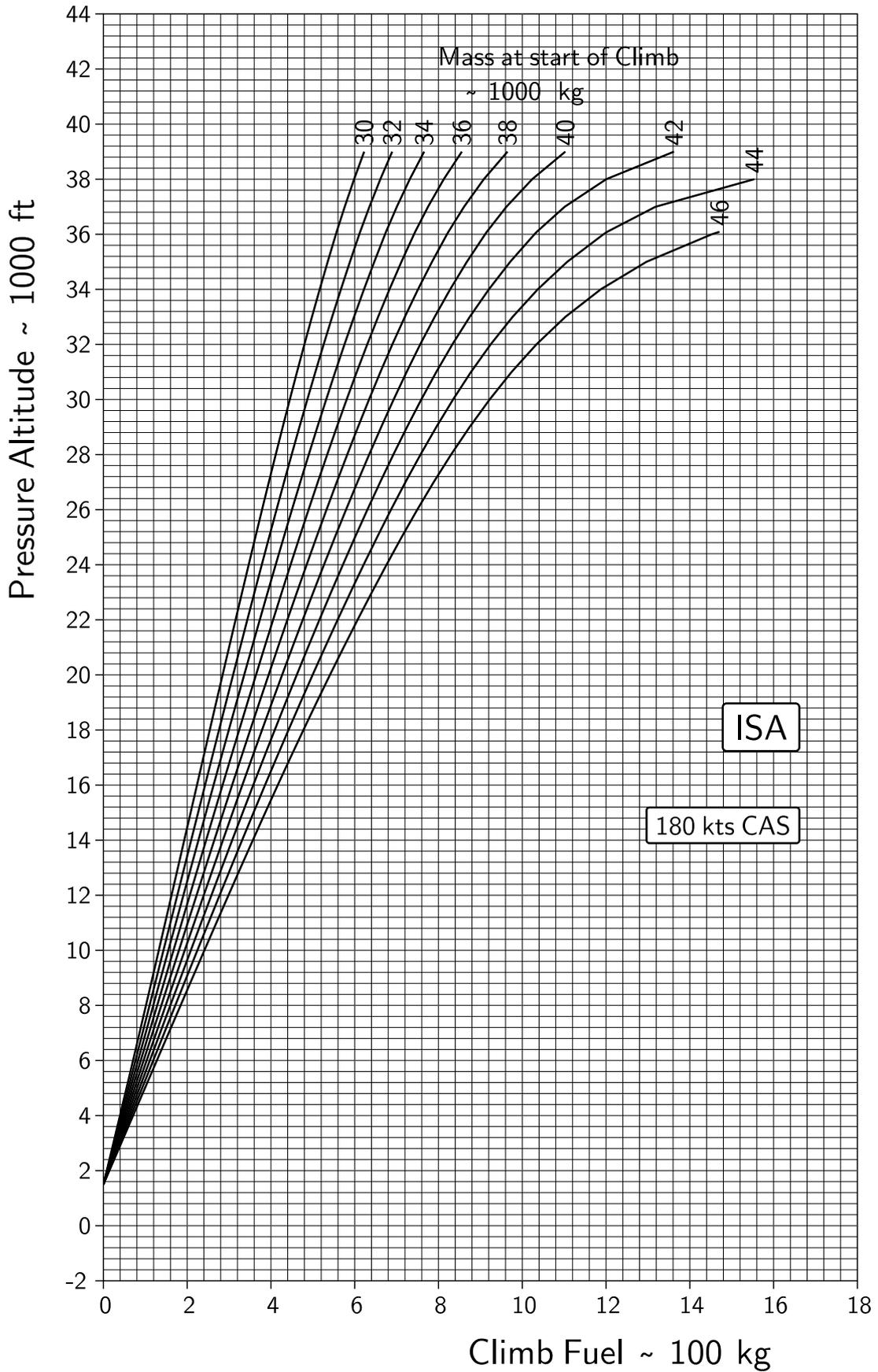


Figure 5.4: Climb fuel at 180 kts CAS / Mach 0.77 at ISA.

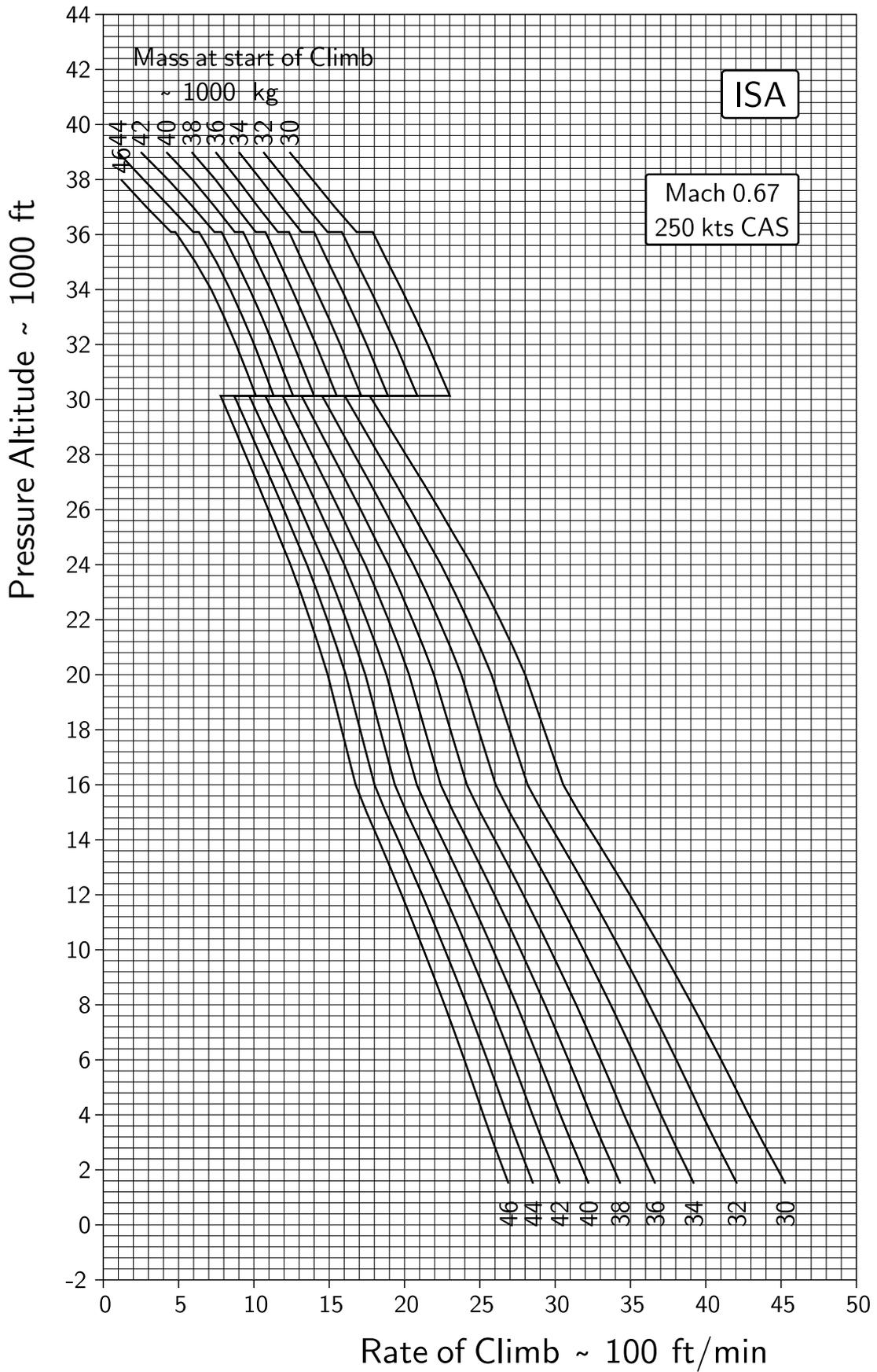


Figure 5.5: Rate of climb at 250 kts CAS / Mach 0.67 at ISA.

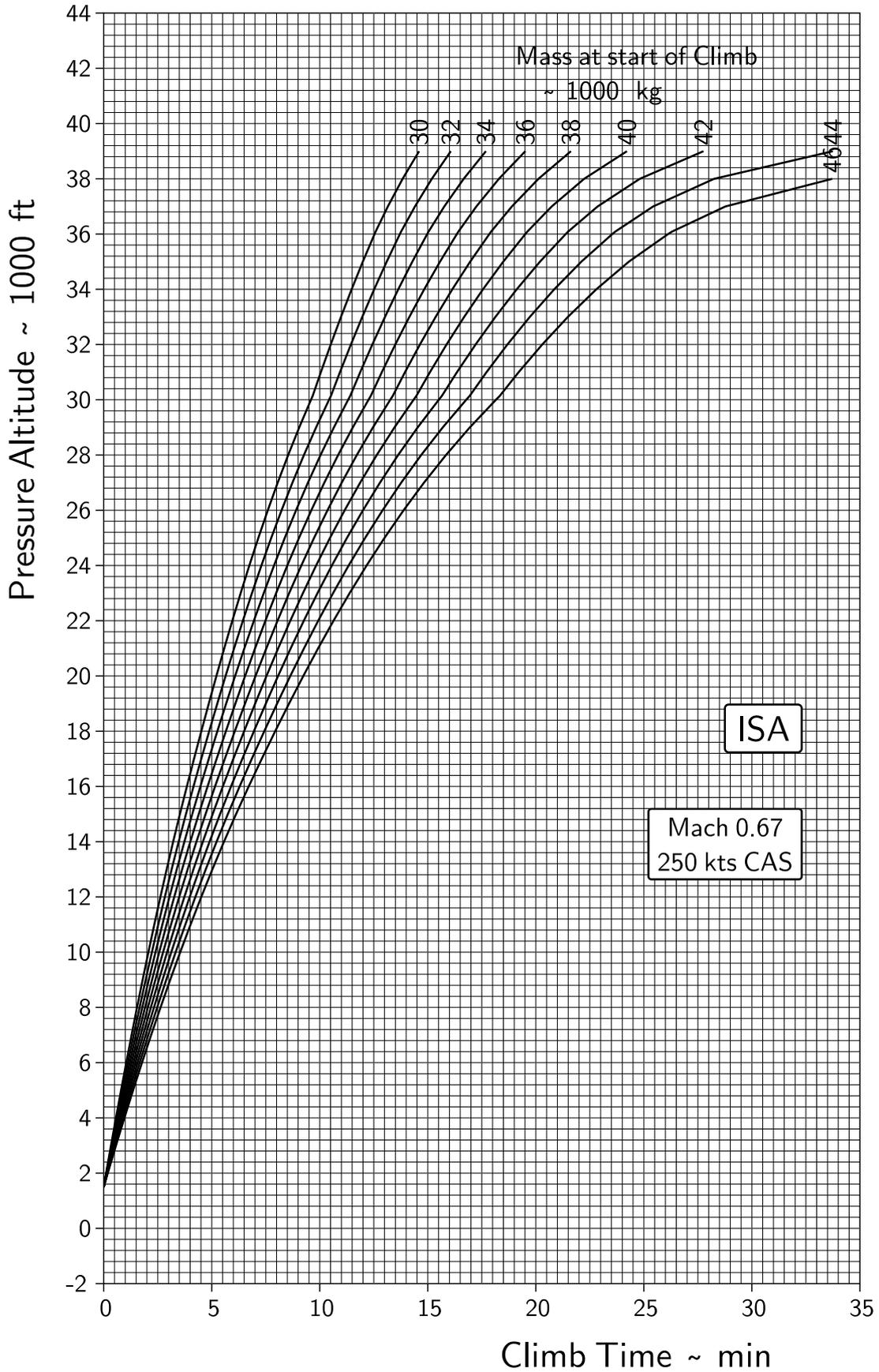


Figure 5.6: Climb time at 250 kts CAS / Mach 0.67 at ISA.

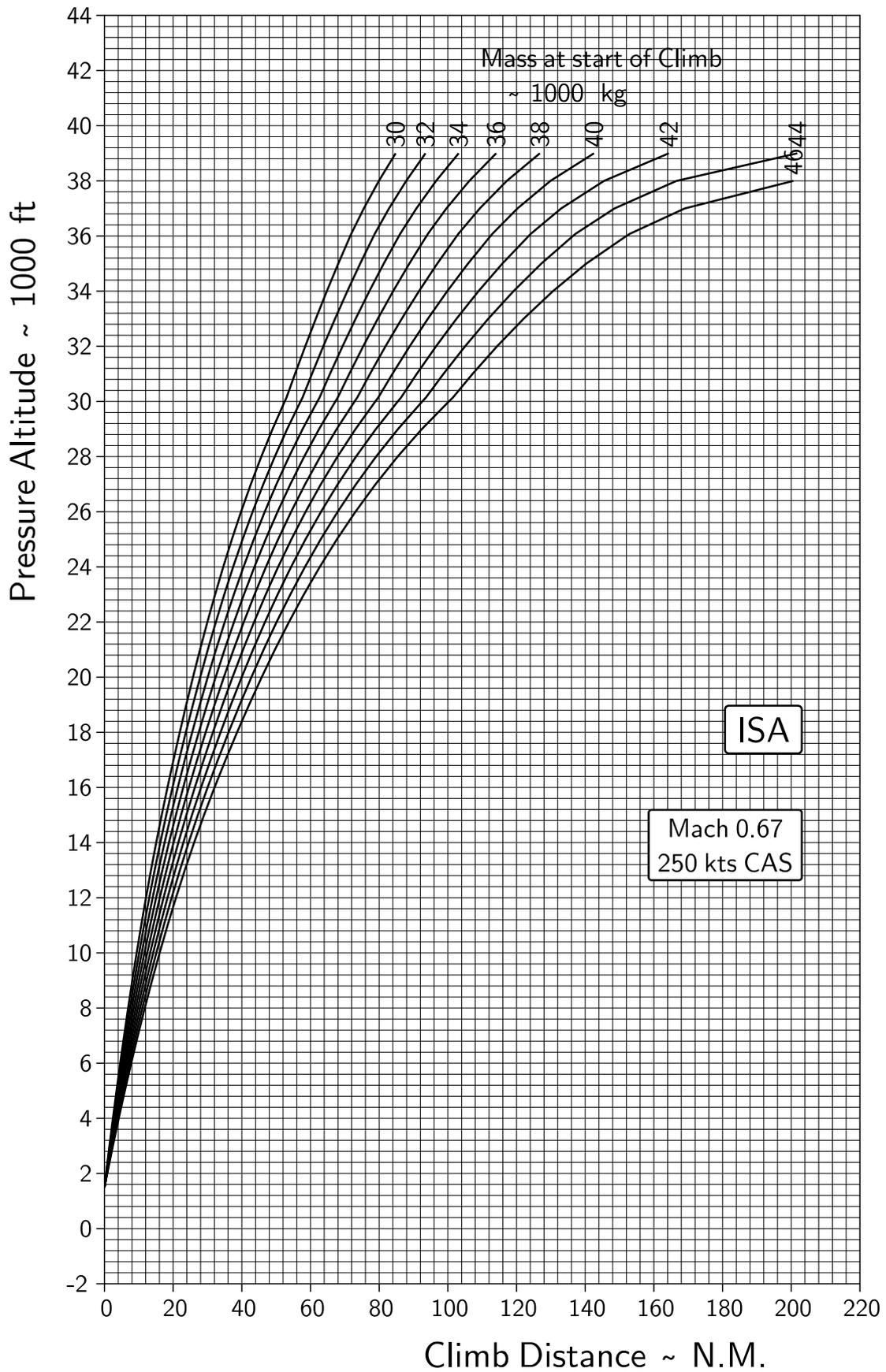


Figure 5.7: Climb distance at 250 kts CAS / Mach 0.67 at ISA.

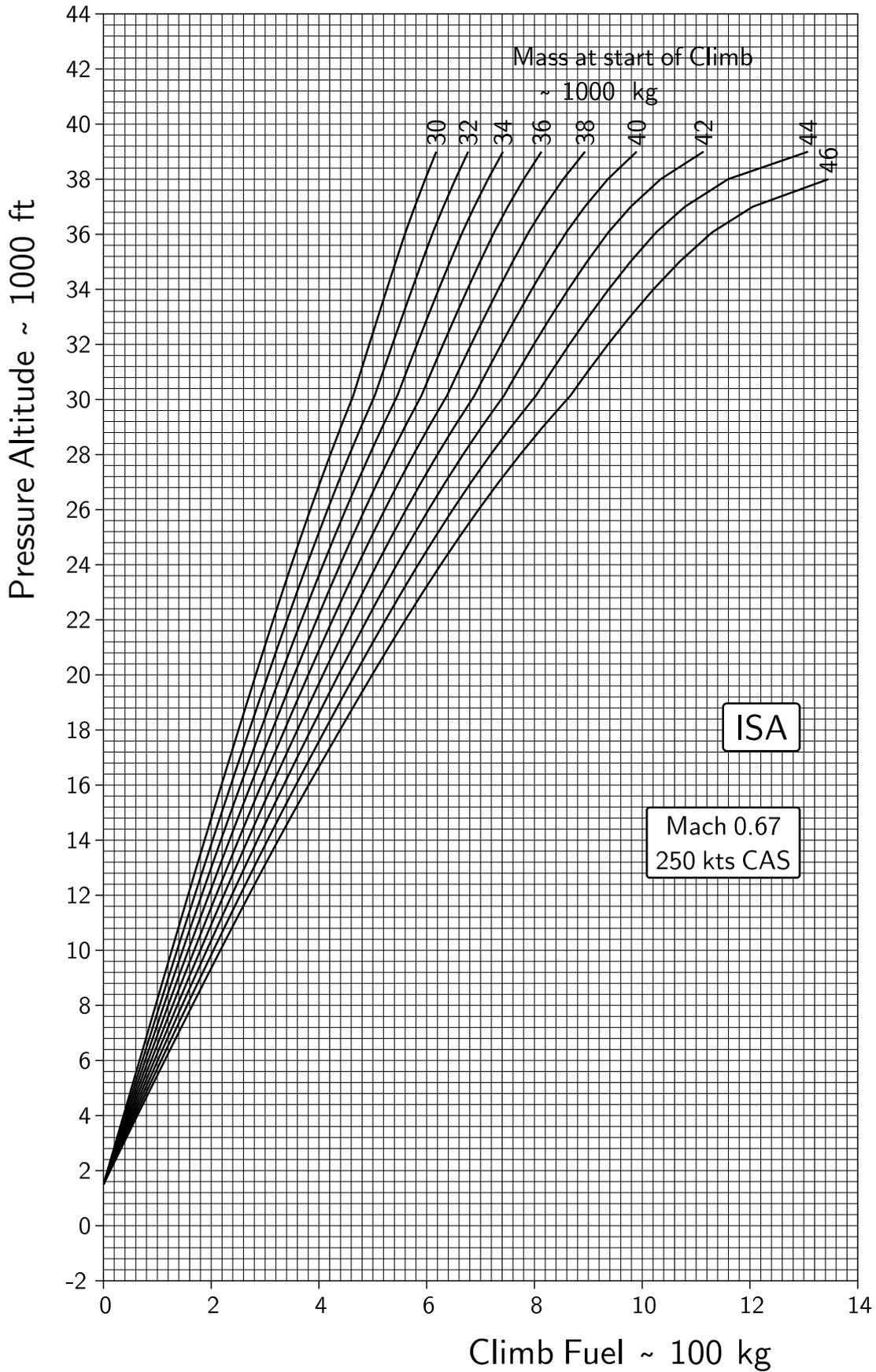


Figure 5.8: Climb fuel at 250 kts CAS / Mach 0.67 at ISA.

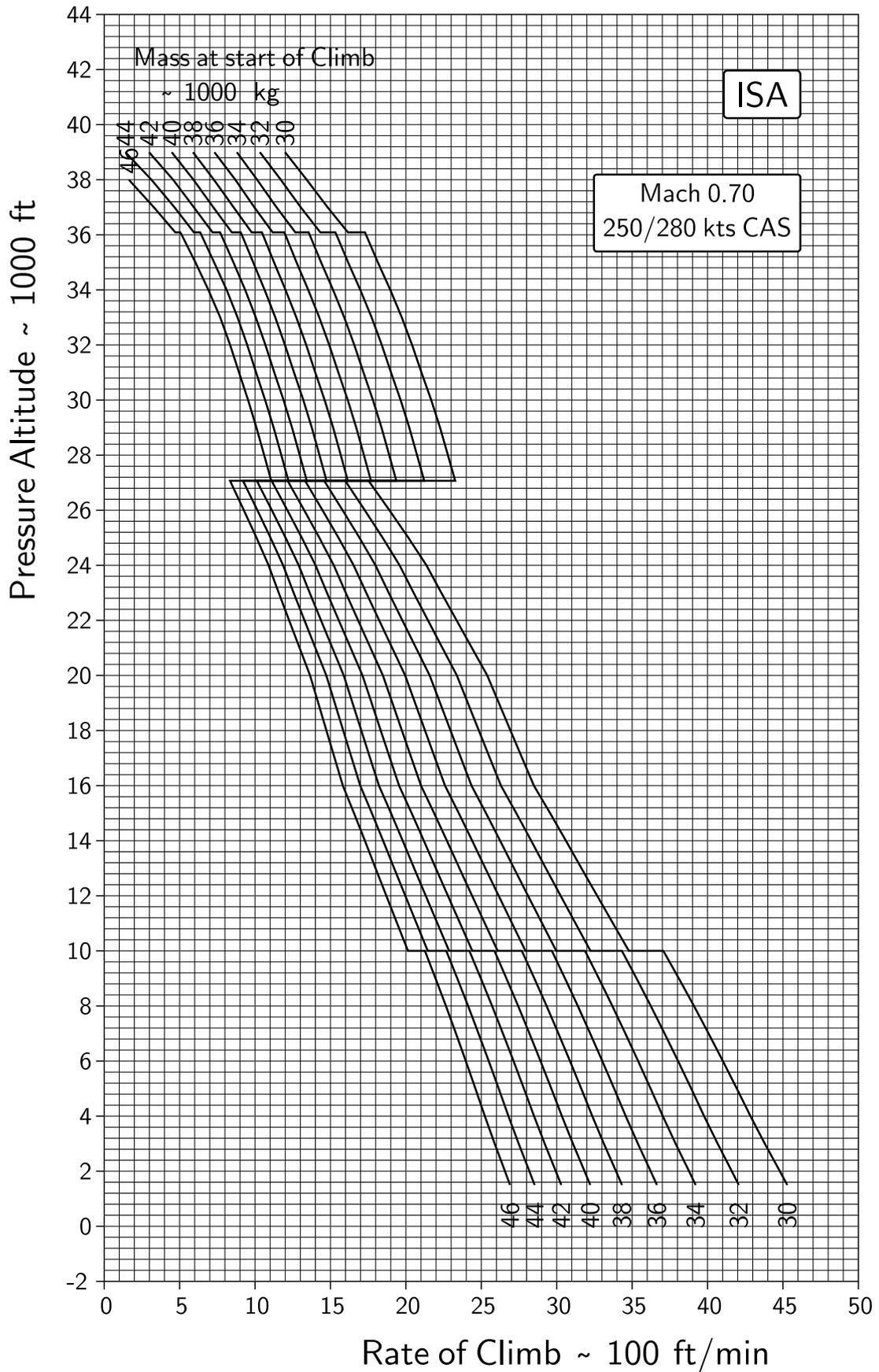


Figure 5.9: Rate of climb at 250/280 kts CAS / Mach 0.70 at ISA.

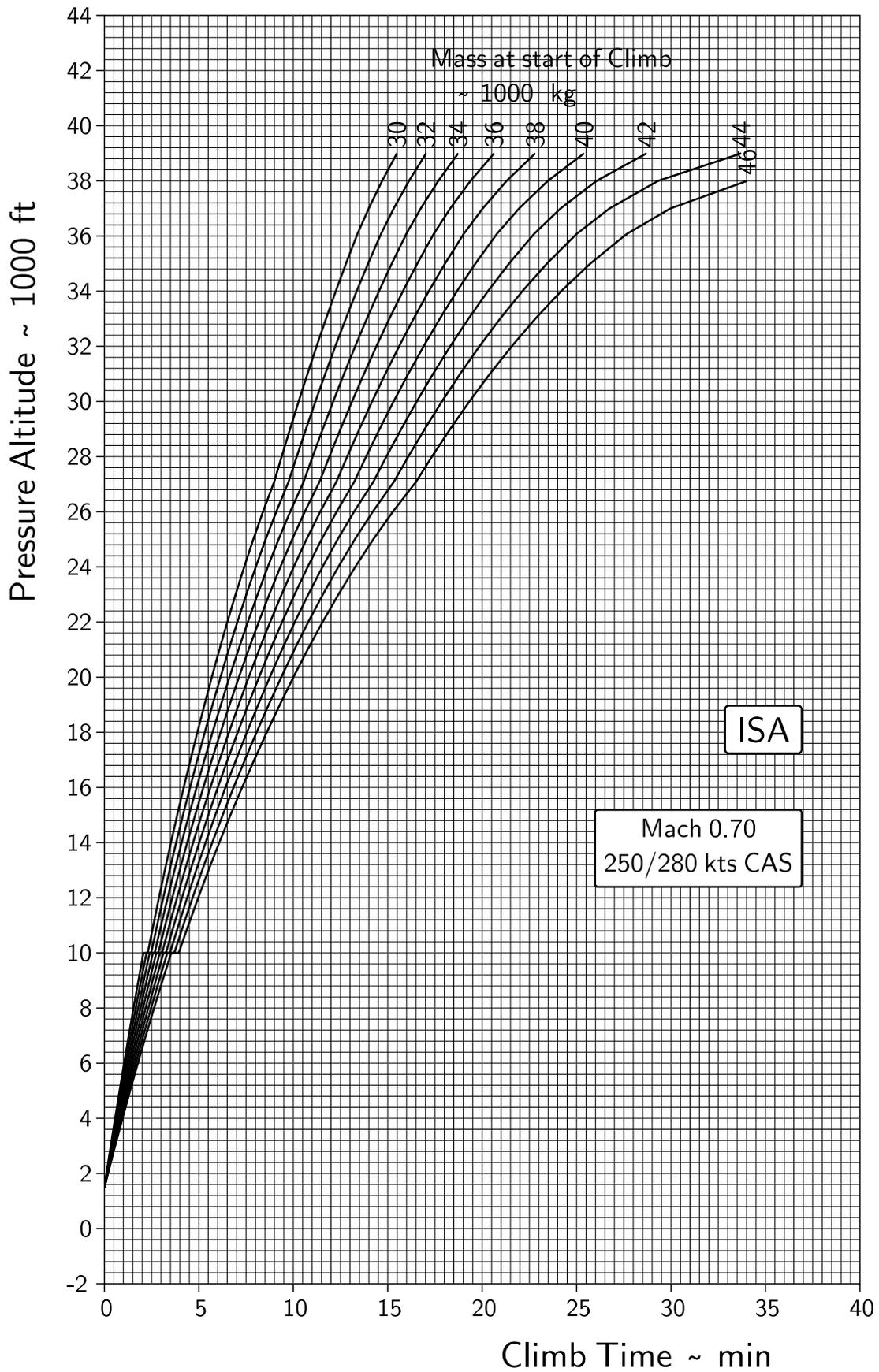


Figure 5.10: Climb time at 250/280 kts CAS / Mach 0.70 at ISA.

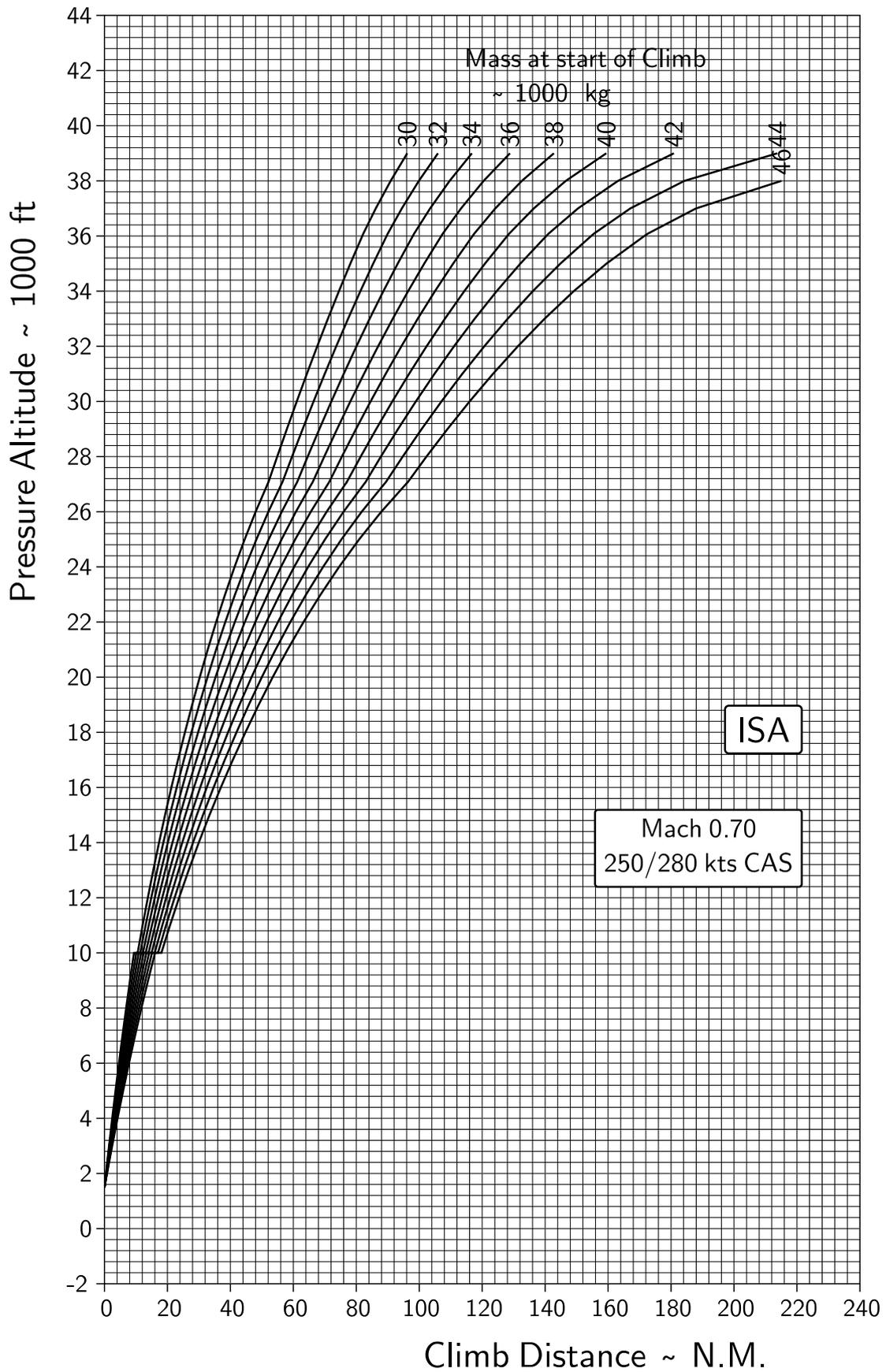


Figure 5.11: Climb distance at 250/280 kts CAS / Mach 0.70 at ISA.

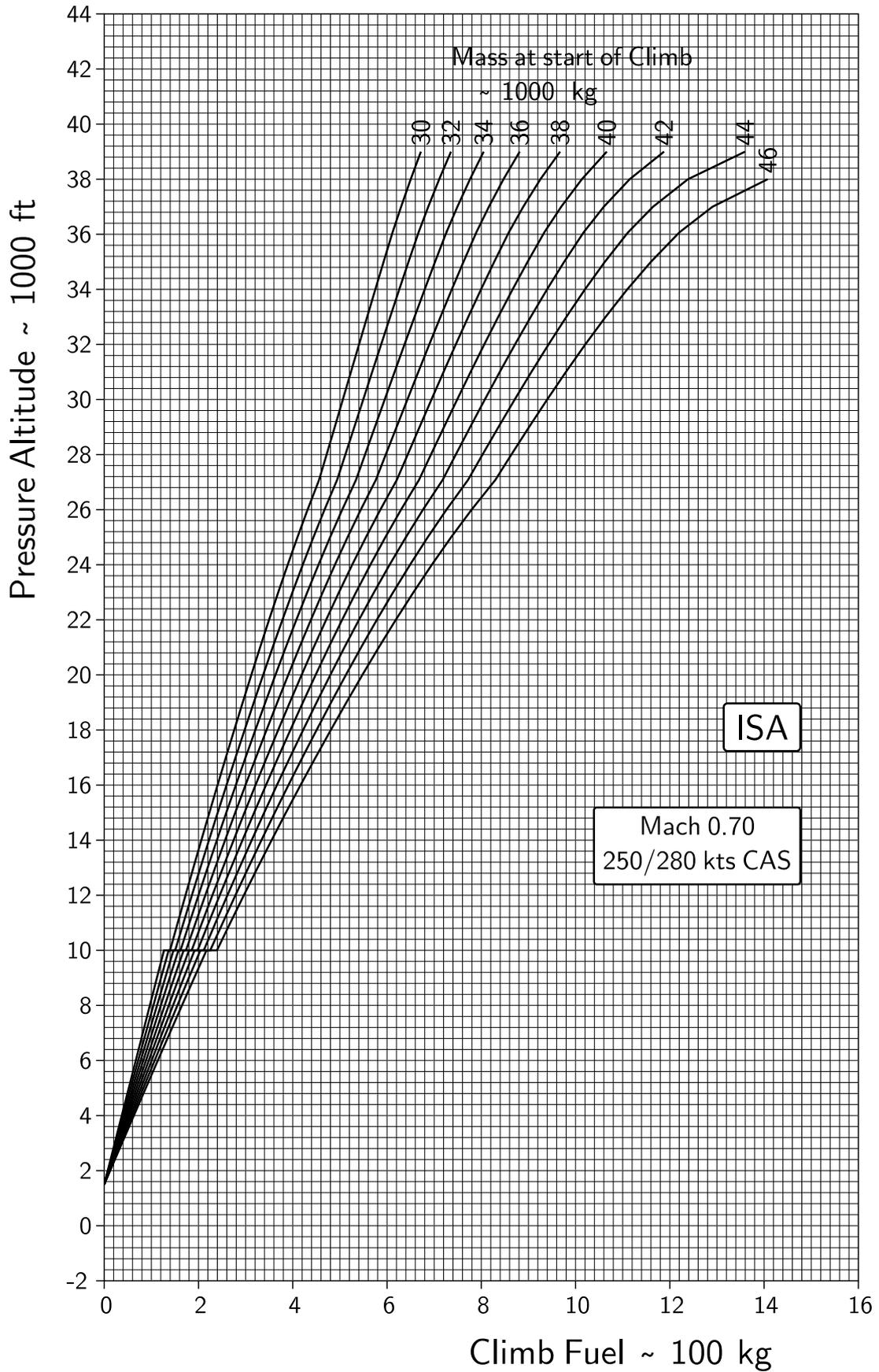


Figure 5.12: Climb fuel at 250/280 kts CAS / Mach 0.70 at ISA.

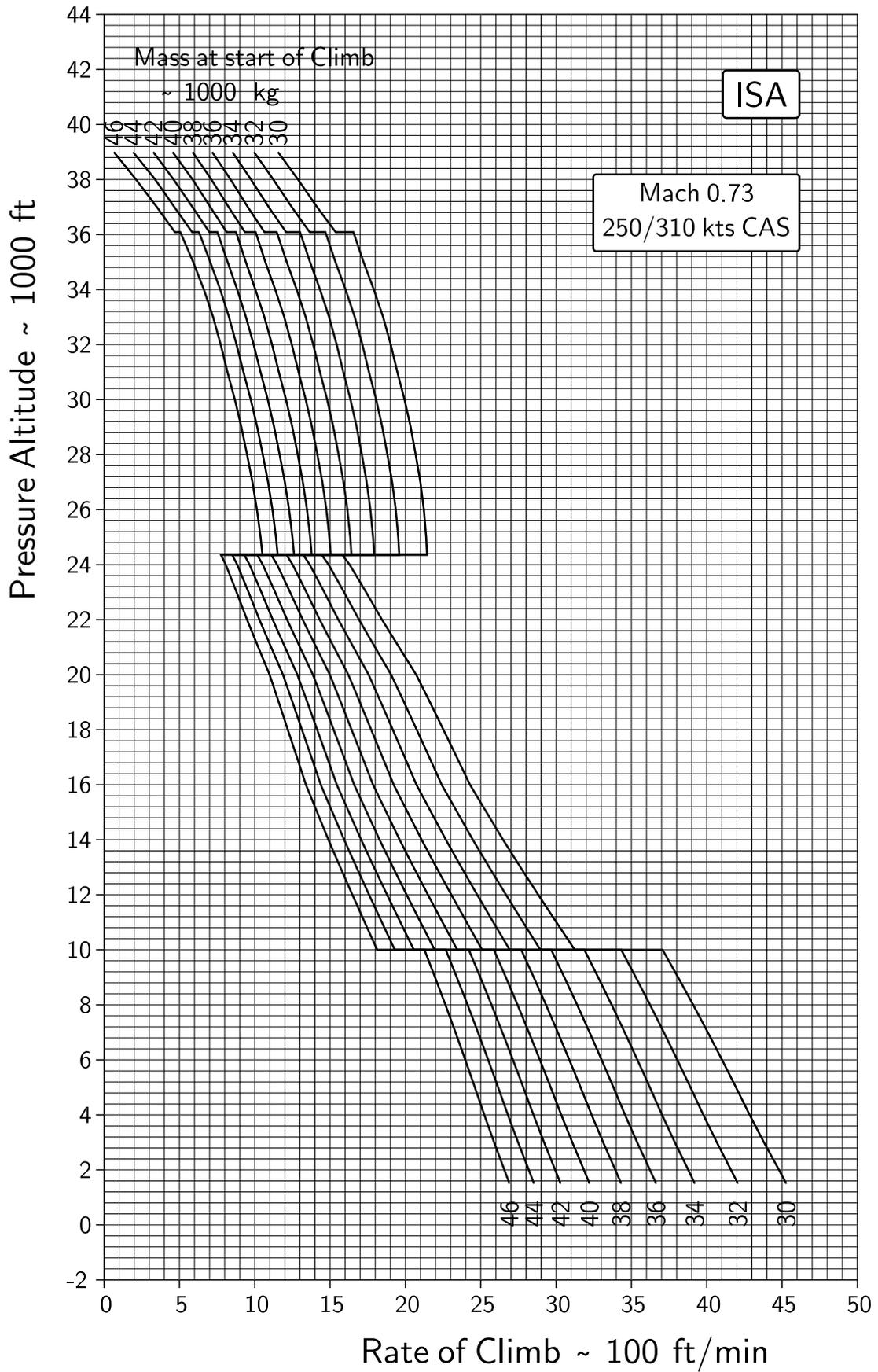


Figure 5.13: Rate of climb at 250/310 kts CAS / Mach 0.73 at ISA.

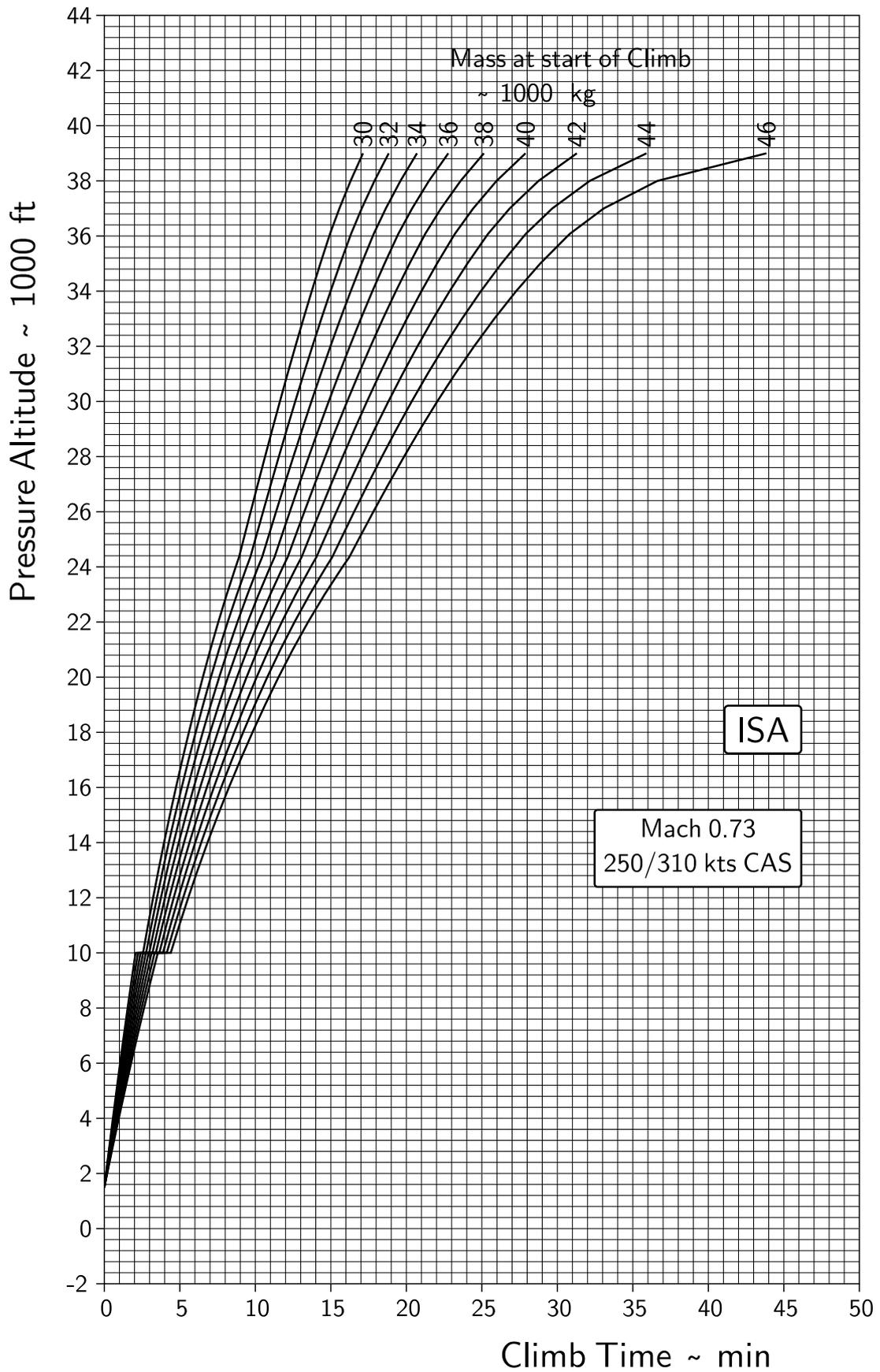


Figure 5.14: Climb time at 250/310 kts CAS / Mach 0.73 at ISA.

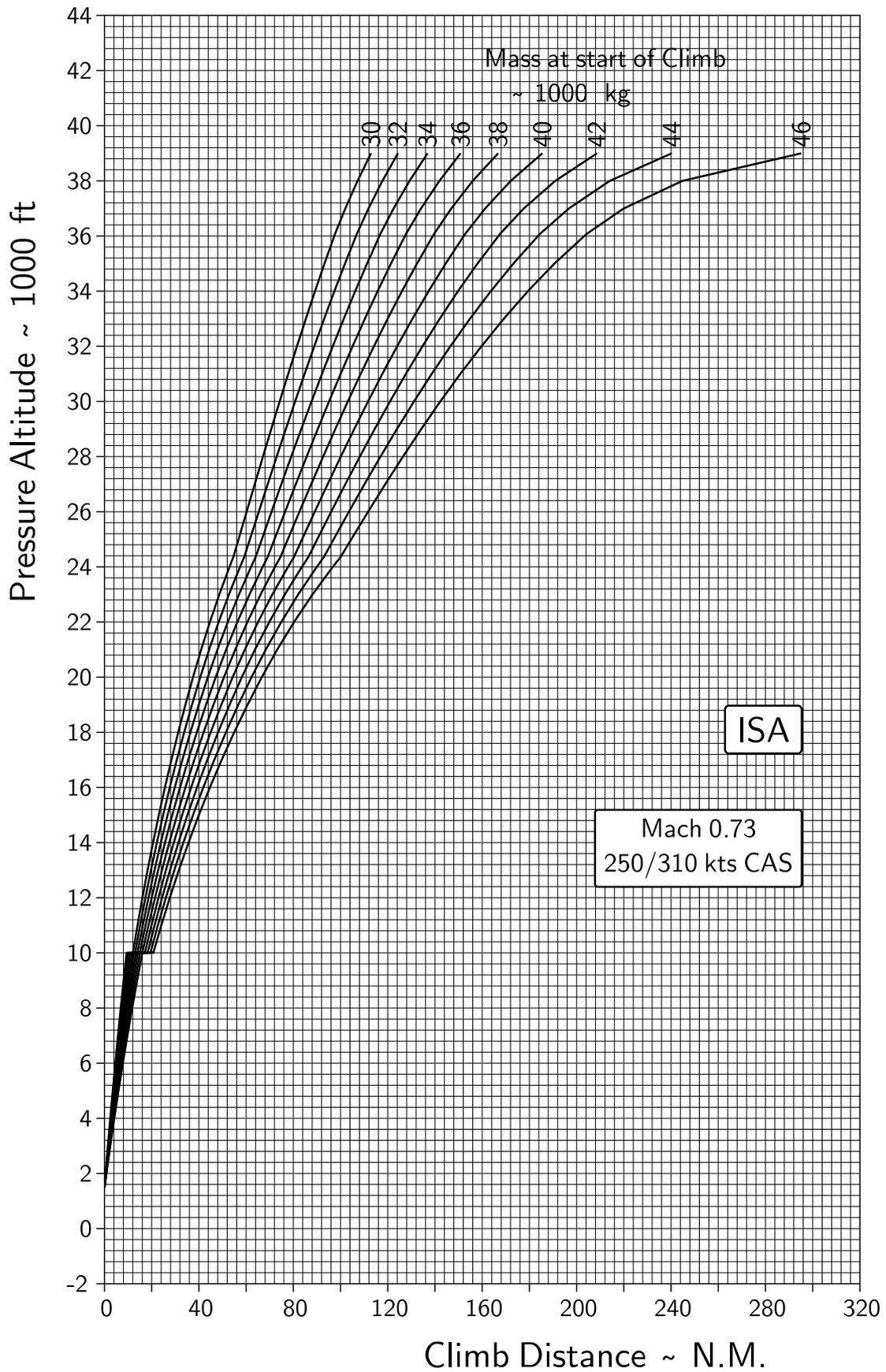


Figure 5.15: Climb distance at 250/310 kts CAS / Mach 0.73 at ISA.

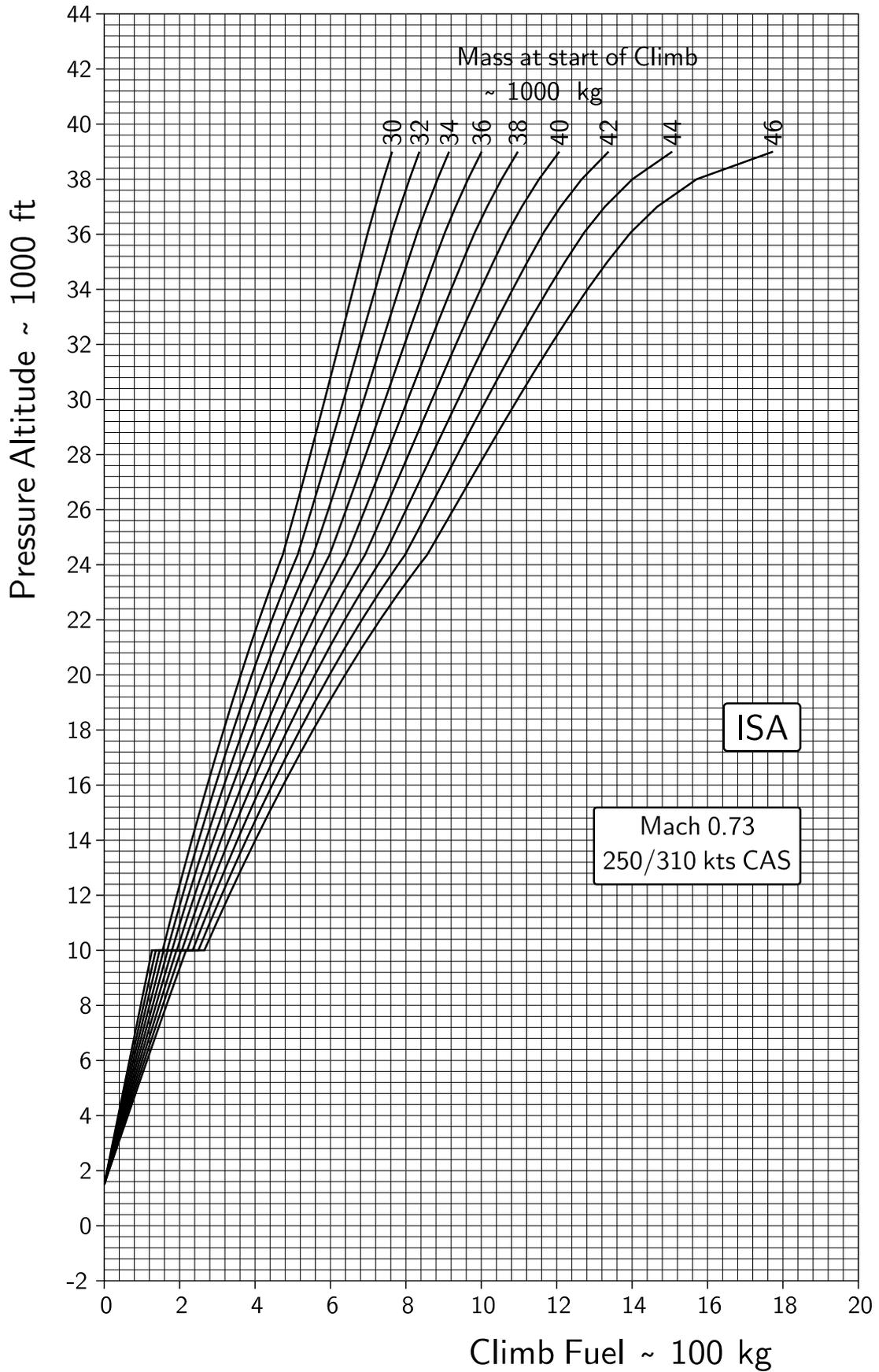


Figure 5.16: Climb fuel at 250/310 kts CAS / Mach 0.73 at ISA.



# Chapter 6

## Cruise

### Assumptions

Specific range in still air.

Long-range is defined as 99 % of best specific range.

Maximum speed in level flight determined by maximum cruise thrust or  $V_{mo}/M_{mo}$ .

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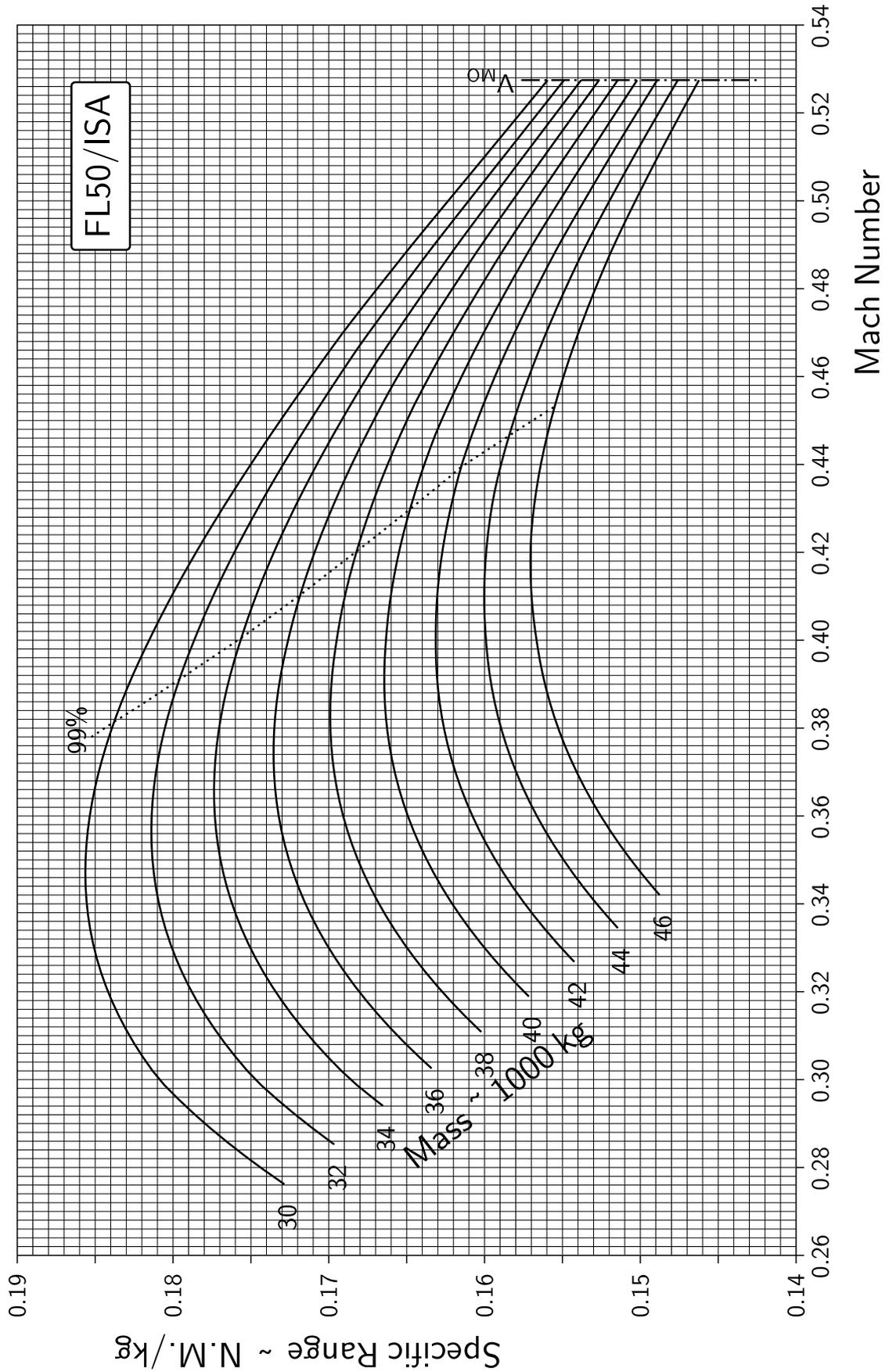


Figure 6.1: Specific range at FL50 / ISA.

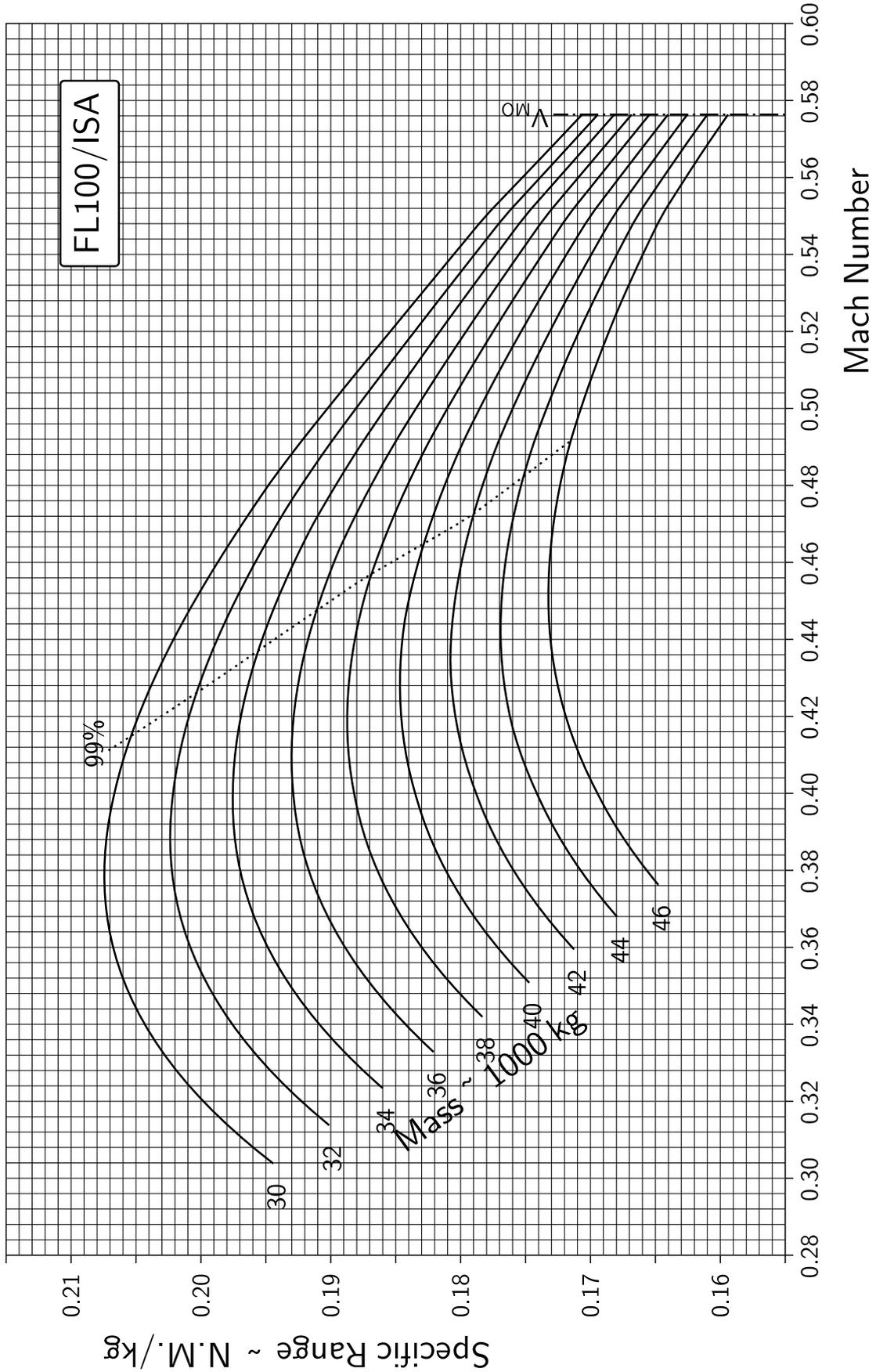


Figure 6.2: Specific range at FL100 / ISA.

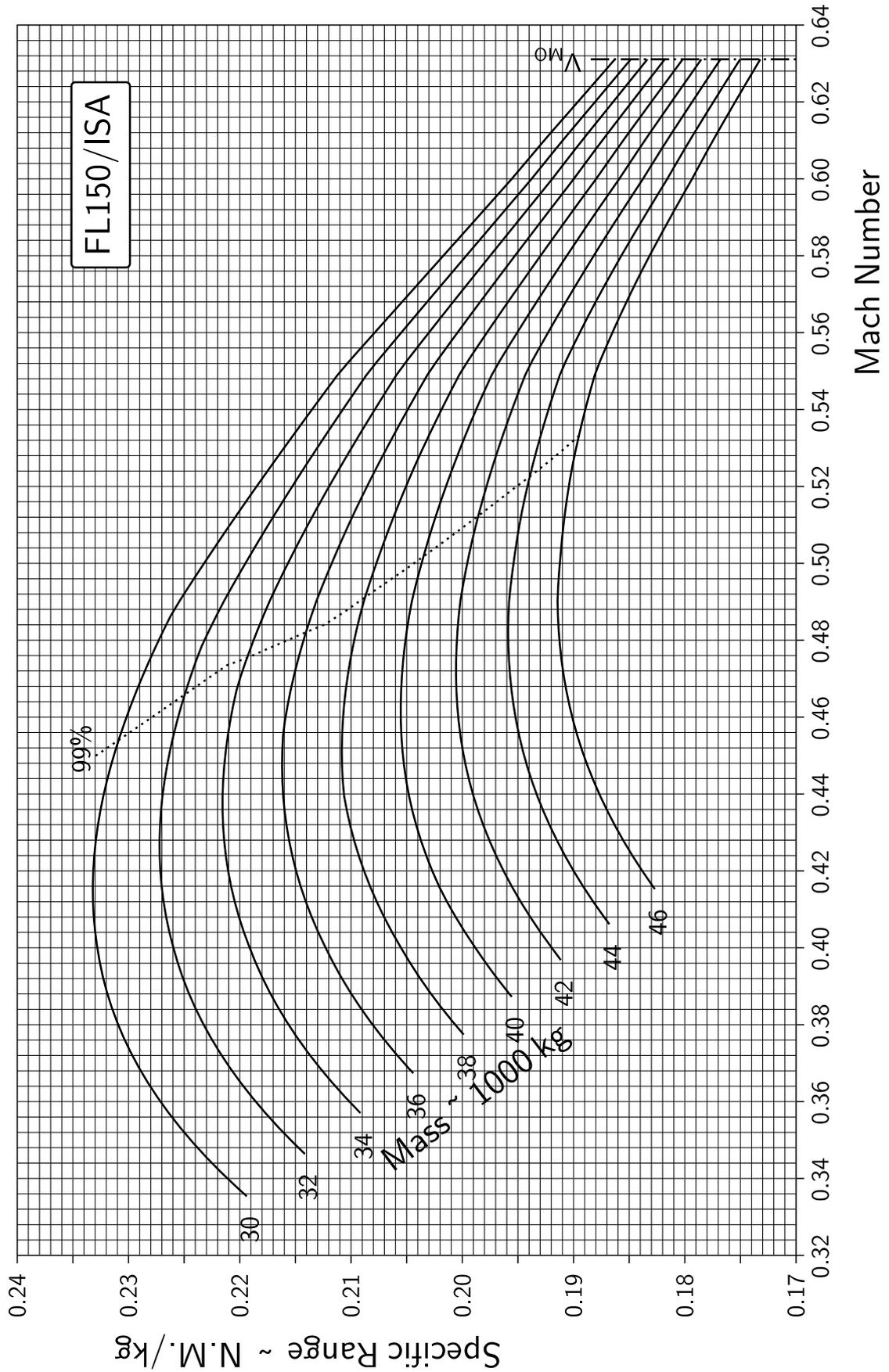


Figure 6.3: Specific range at FL150 / ISA.

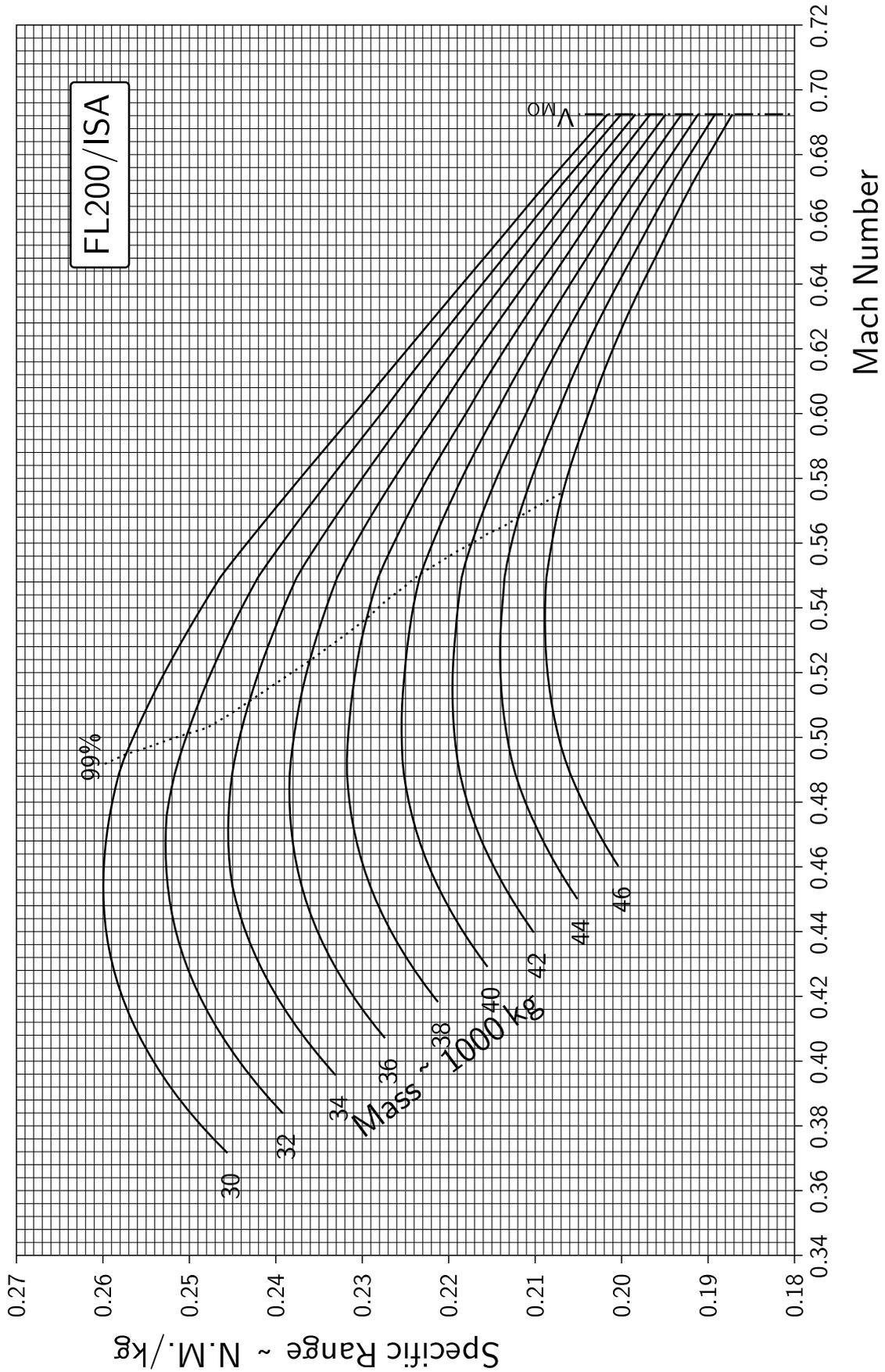


Figure 6.4: Specific range at FL200 / ISA.

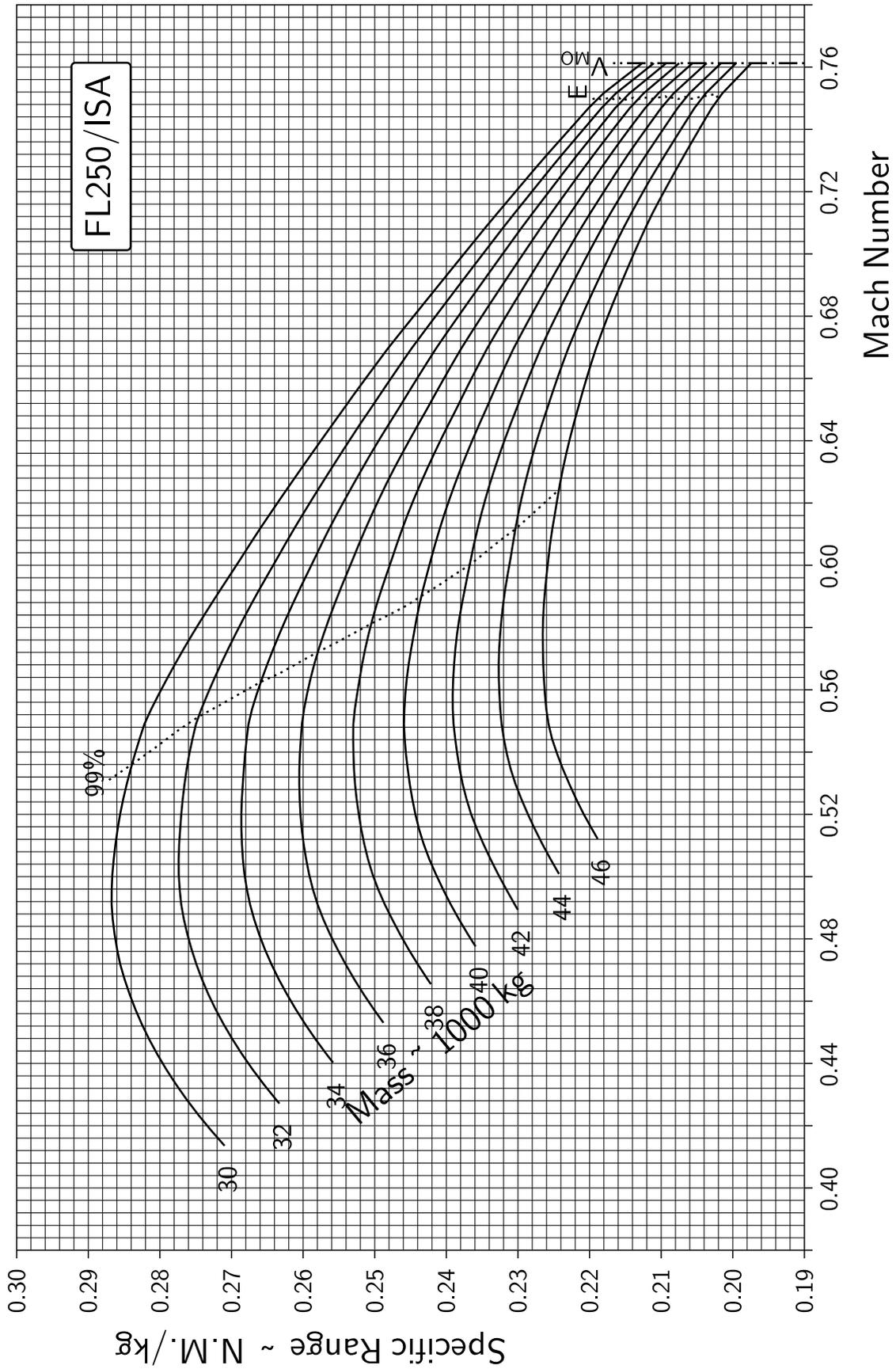


Figure 6.5: Specific range at FL250 / ISA.

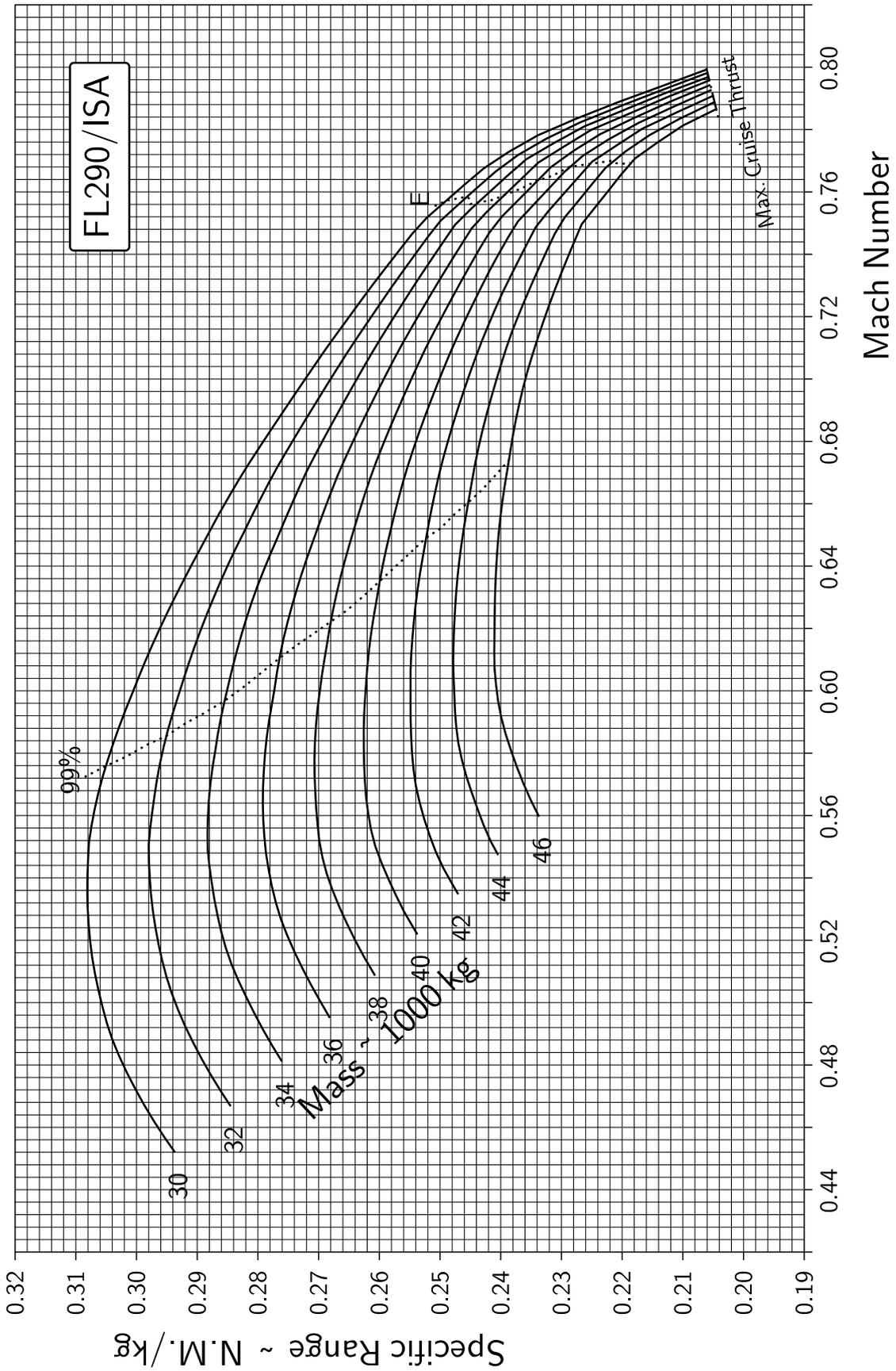


Figure 6.6: Specific range at FL290 / ISA.

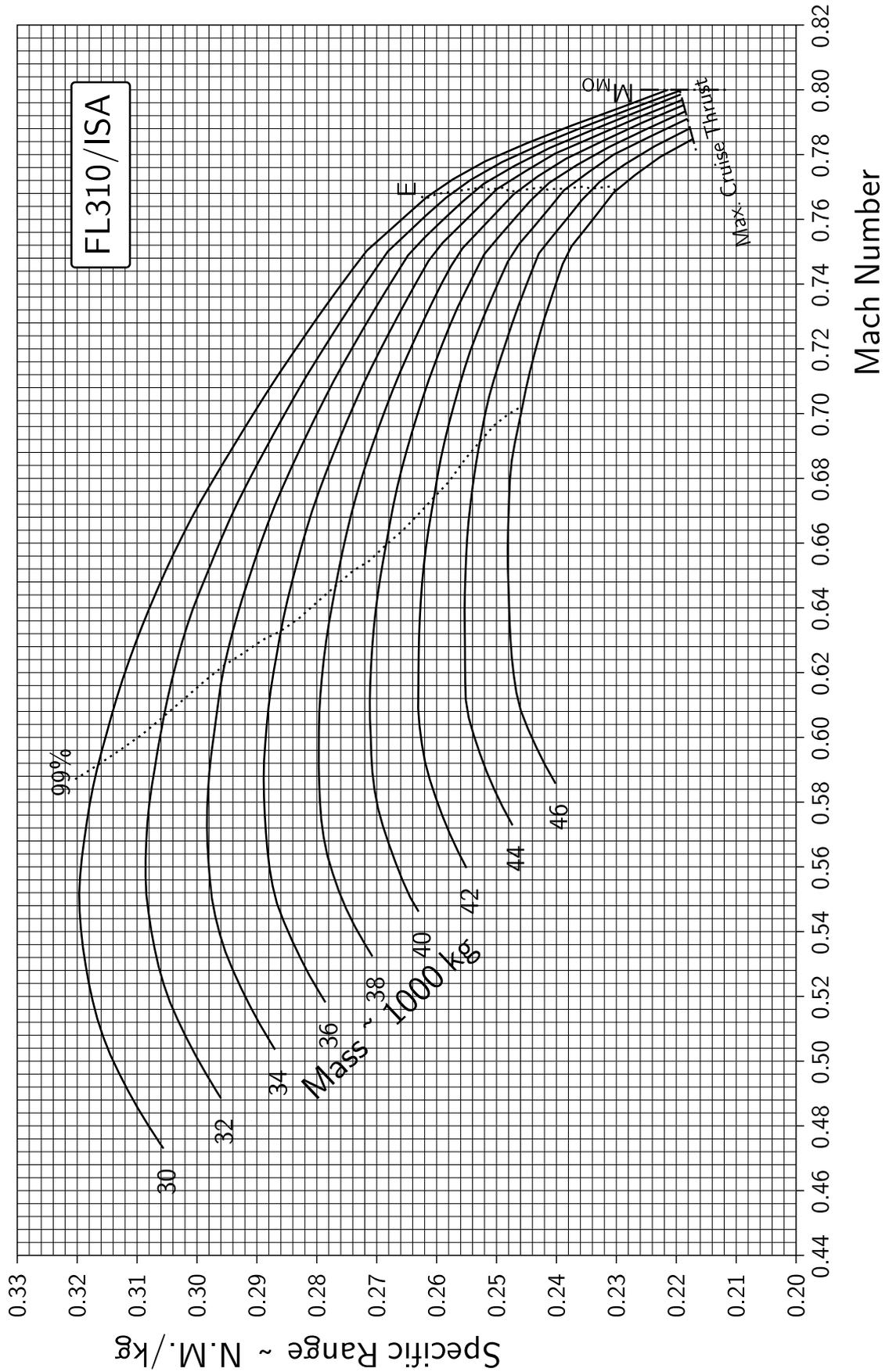


Figure 6.7: Specific range at FL310 / ISA.

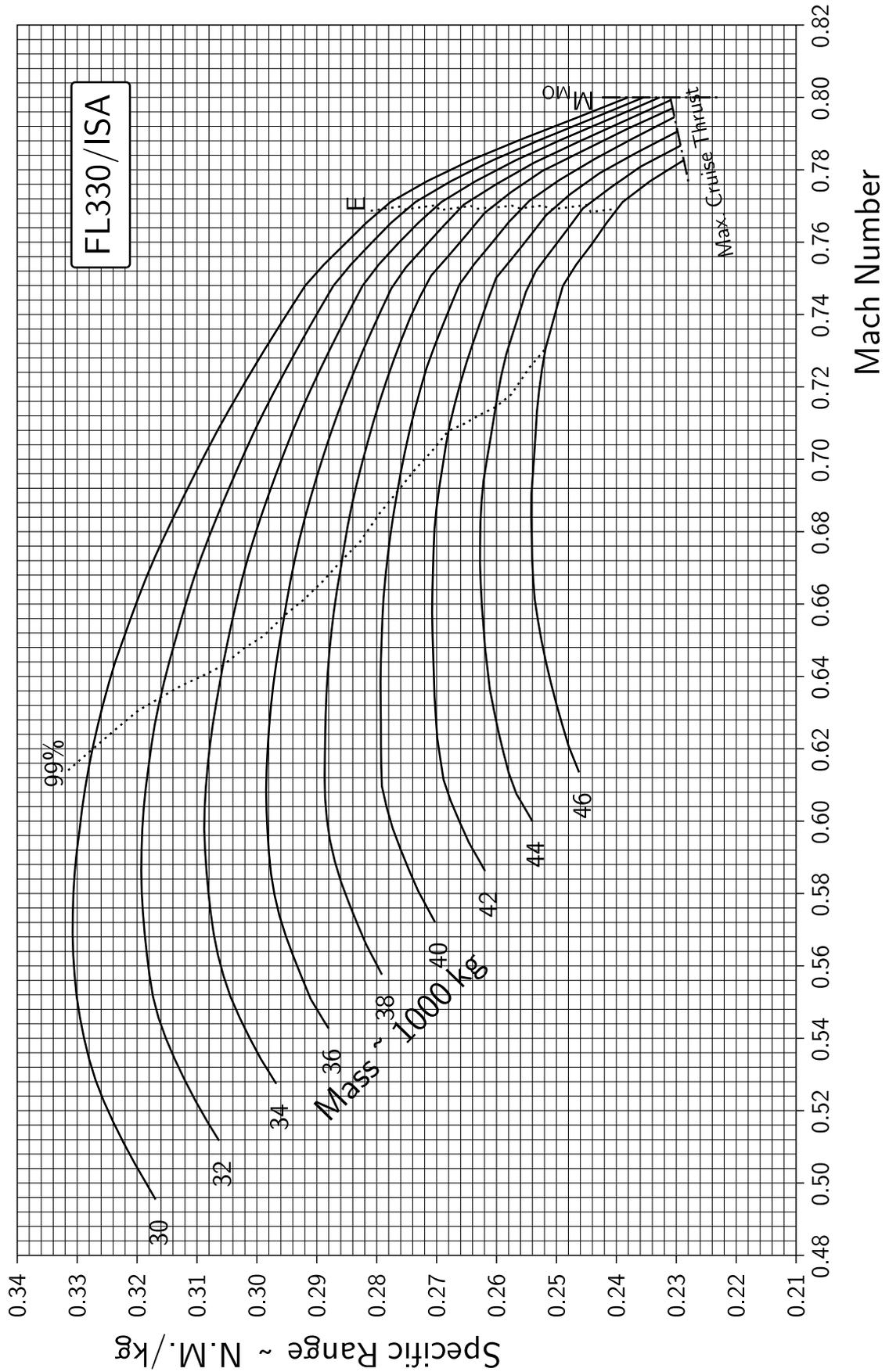


Figure 6.8: Specific range at FL330 / ISA.

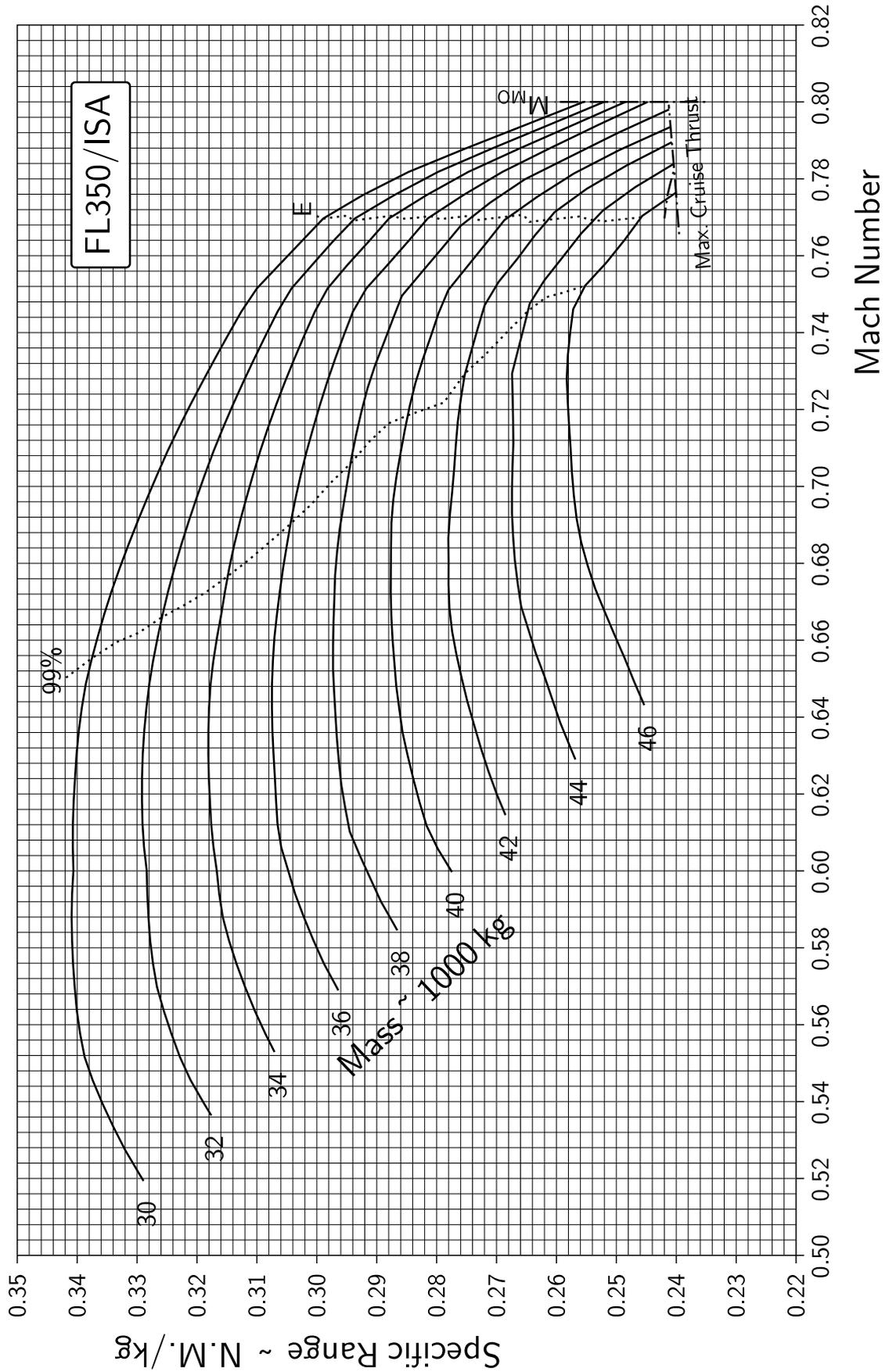


Figure 6.9: Specific range at FL350 / ISA.

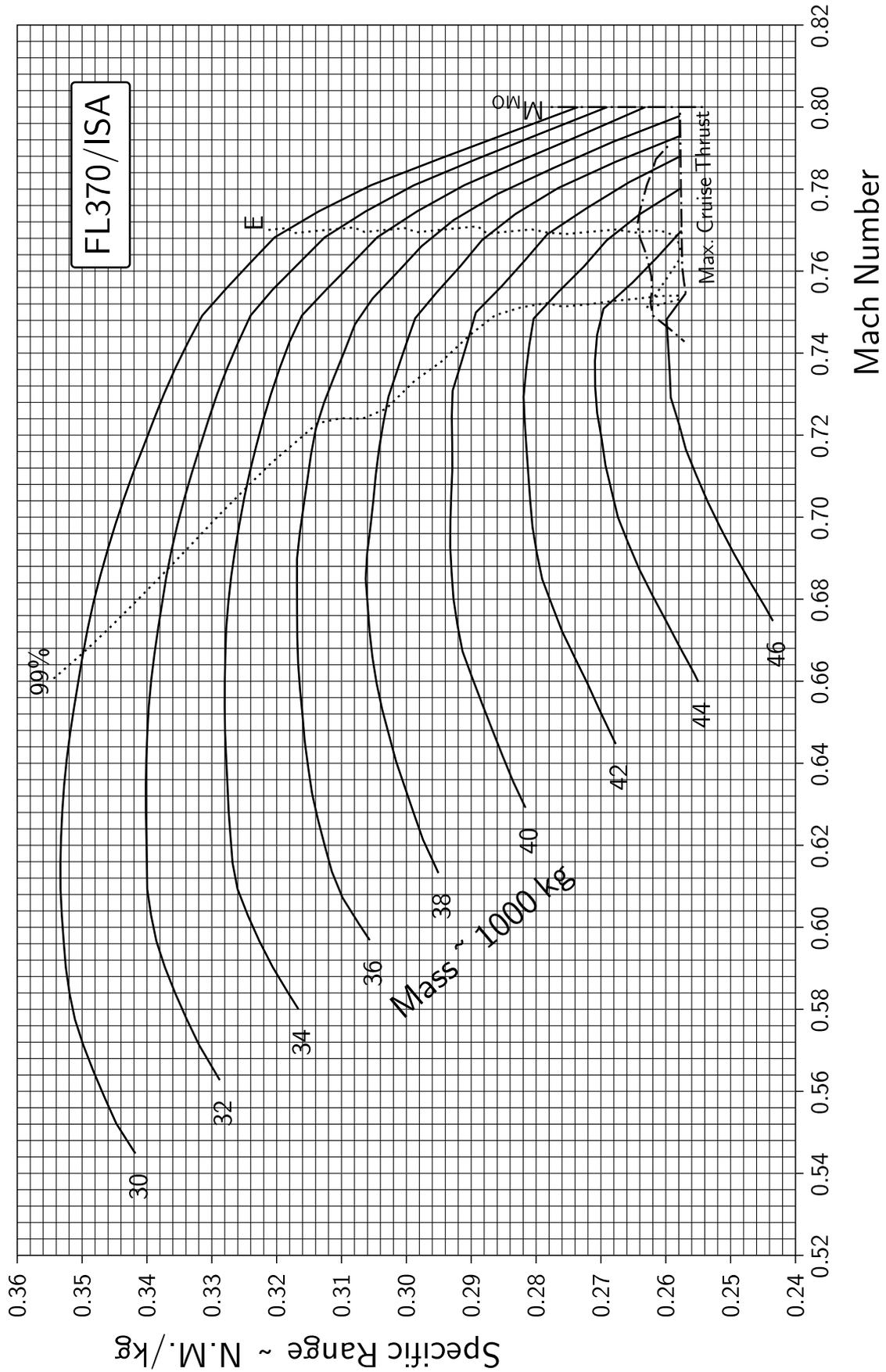


Figure 6.10: Specific range at FL370 / ISA.

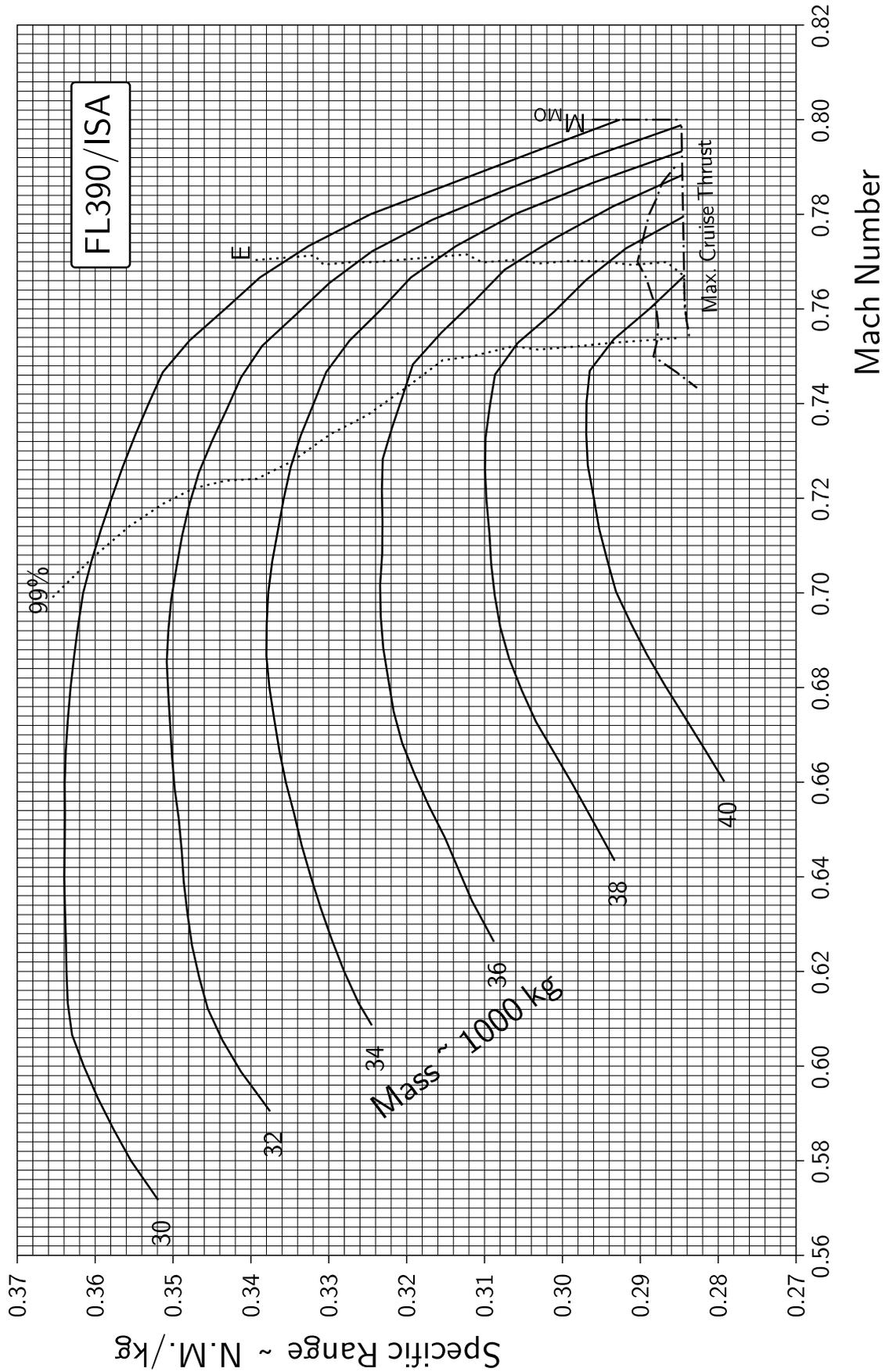


Figure 6.11: Specific range at FL390 / ISA.

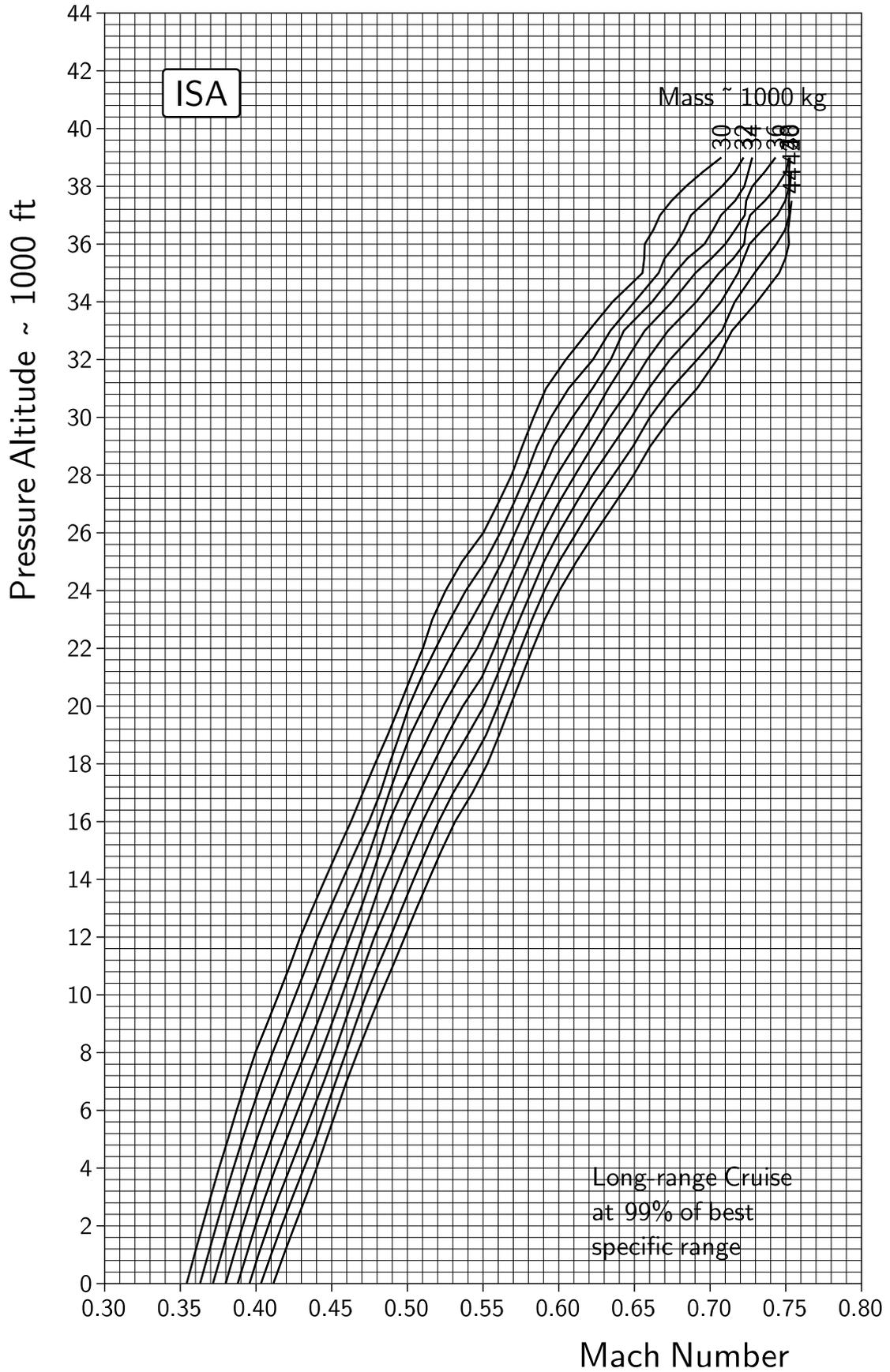


Figure 6.12: Long-range Mach Number at ISA.

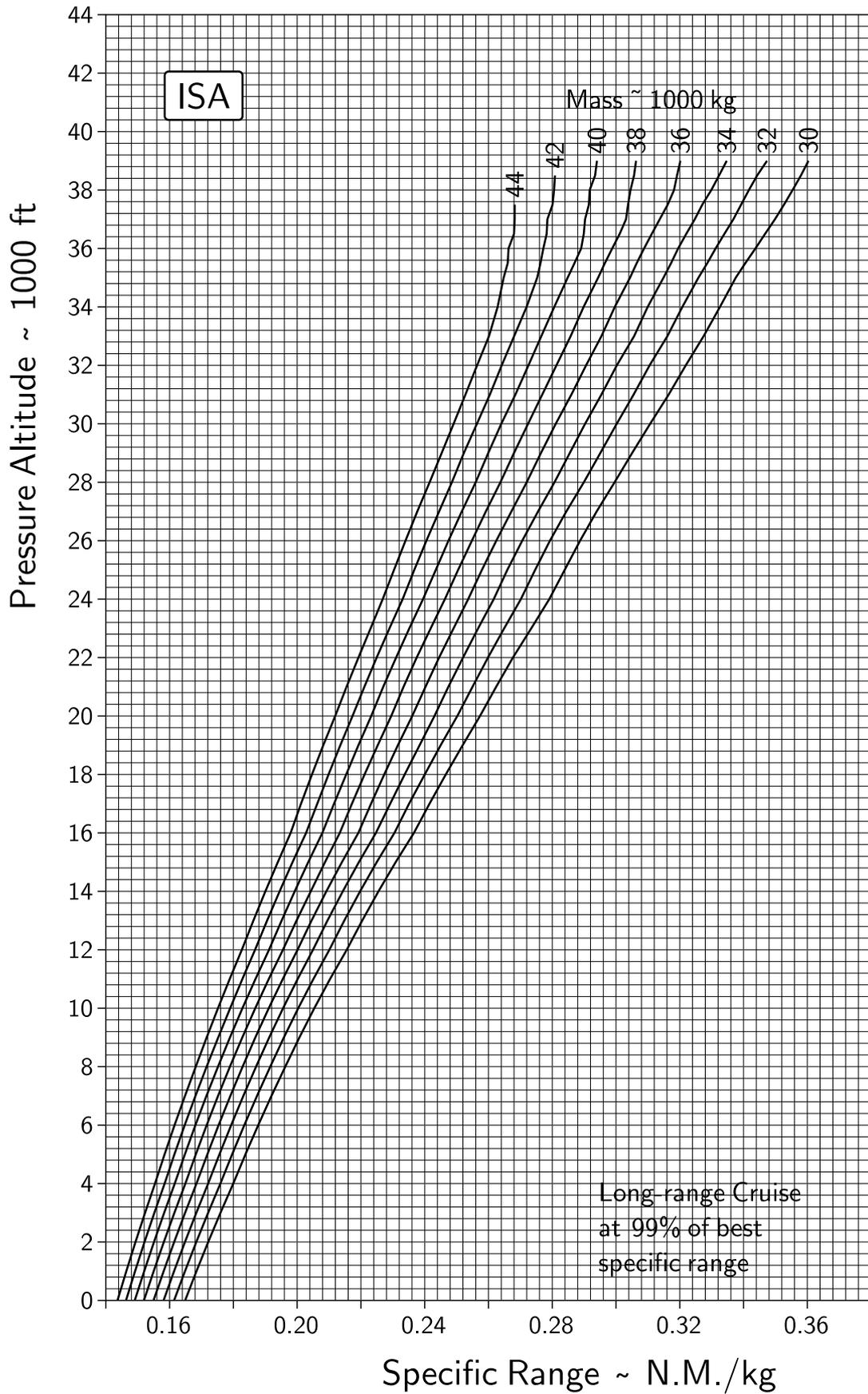


Figure 6.13: Long-range specific range at ISA.

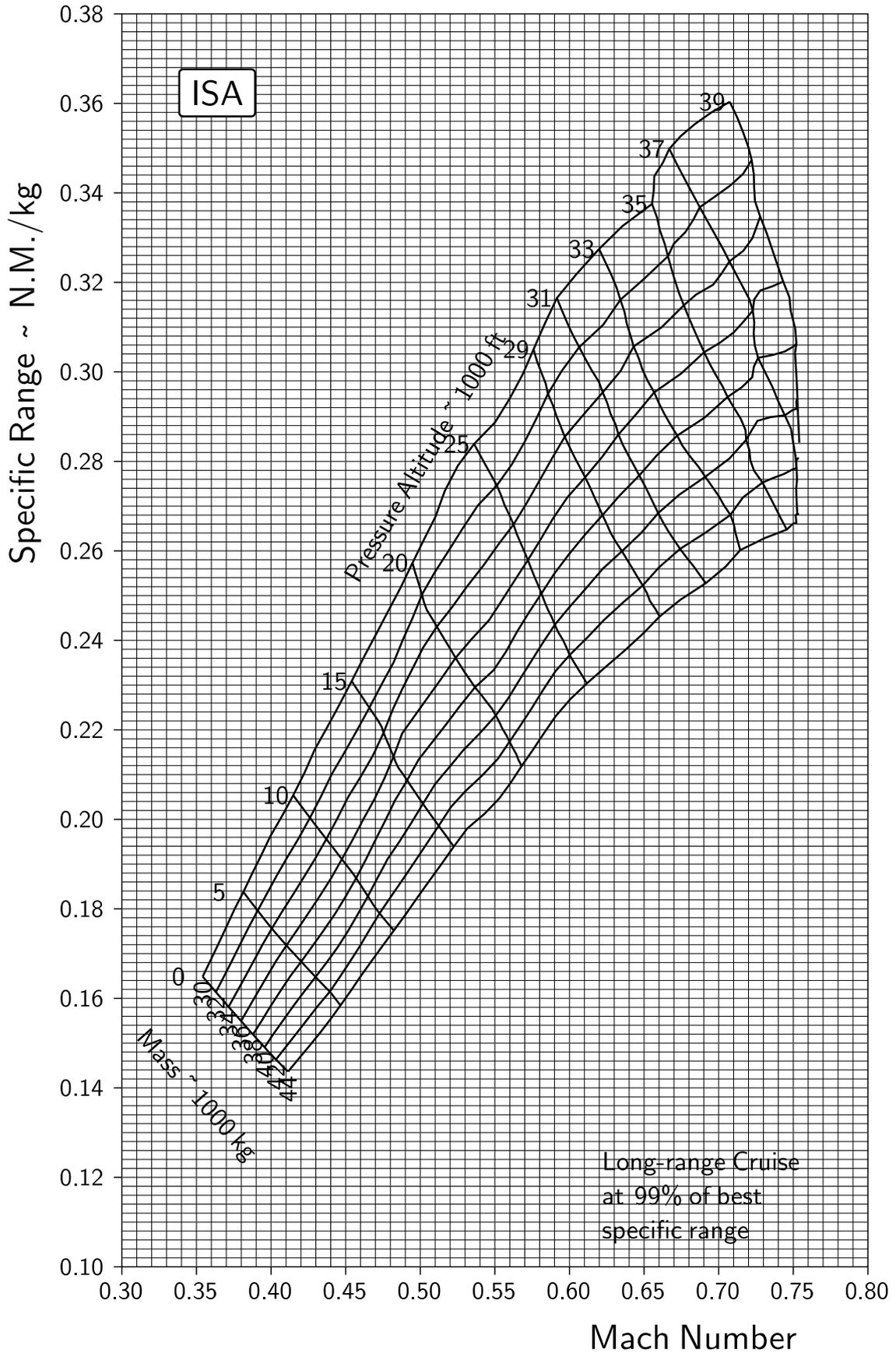


Figure 6.14: Long-range specific range composite at ISA.

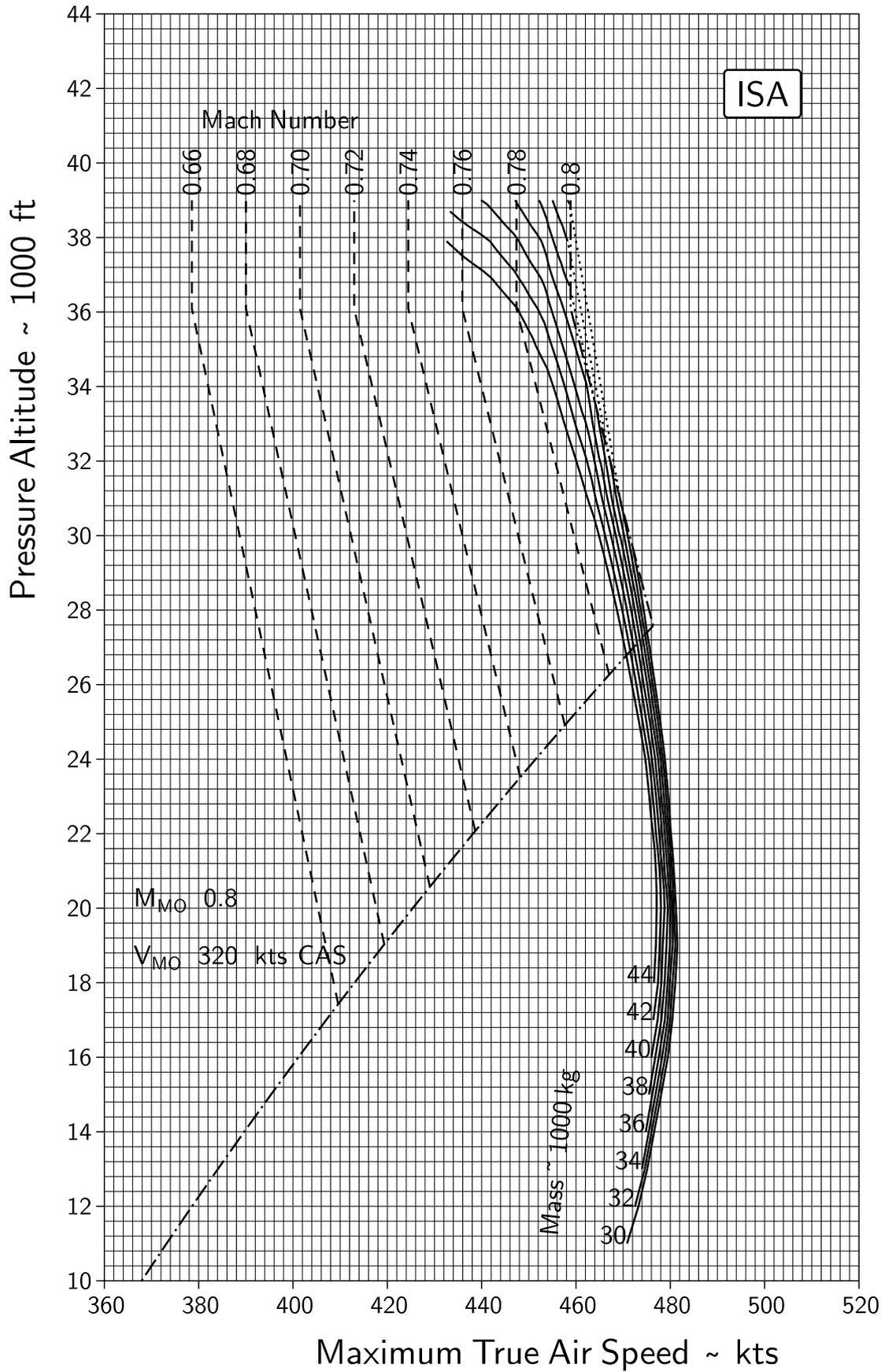


Figure 6.15: Maximum level speed at ISA.

# Chapter 7

## Descent

### Assumptions

- Operational speed restriction of 250 kts CAS below 10 000 ft.
- Maximum aircraft rate of descent 3 000 ft/min.
- Maximum cabin rate of descent 300 ft/min.
- No wind.

### Figures

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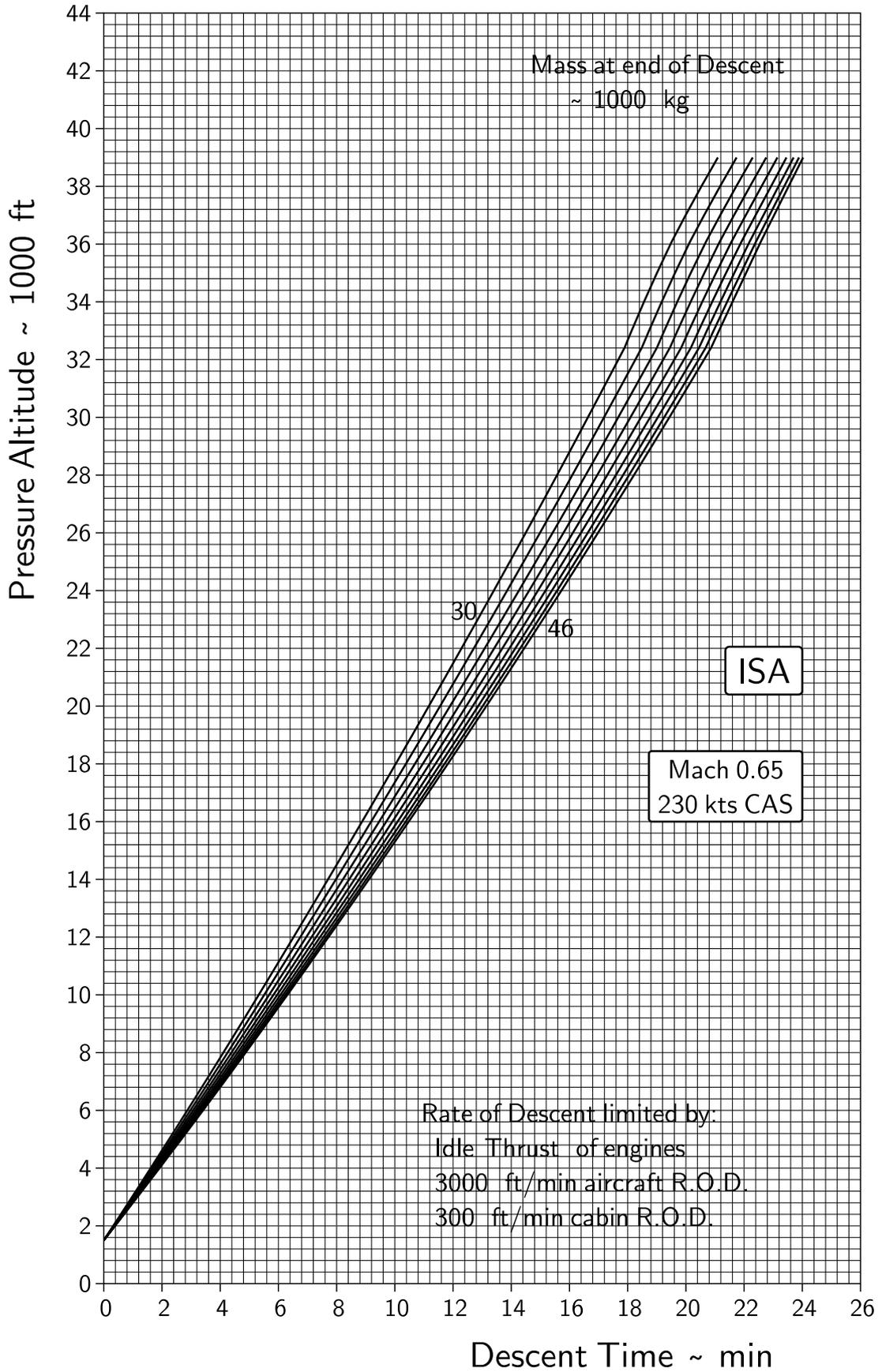


Figure 7.1: Descent time at 230 kts CAS / Mach 0.65 at ISA.

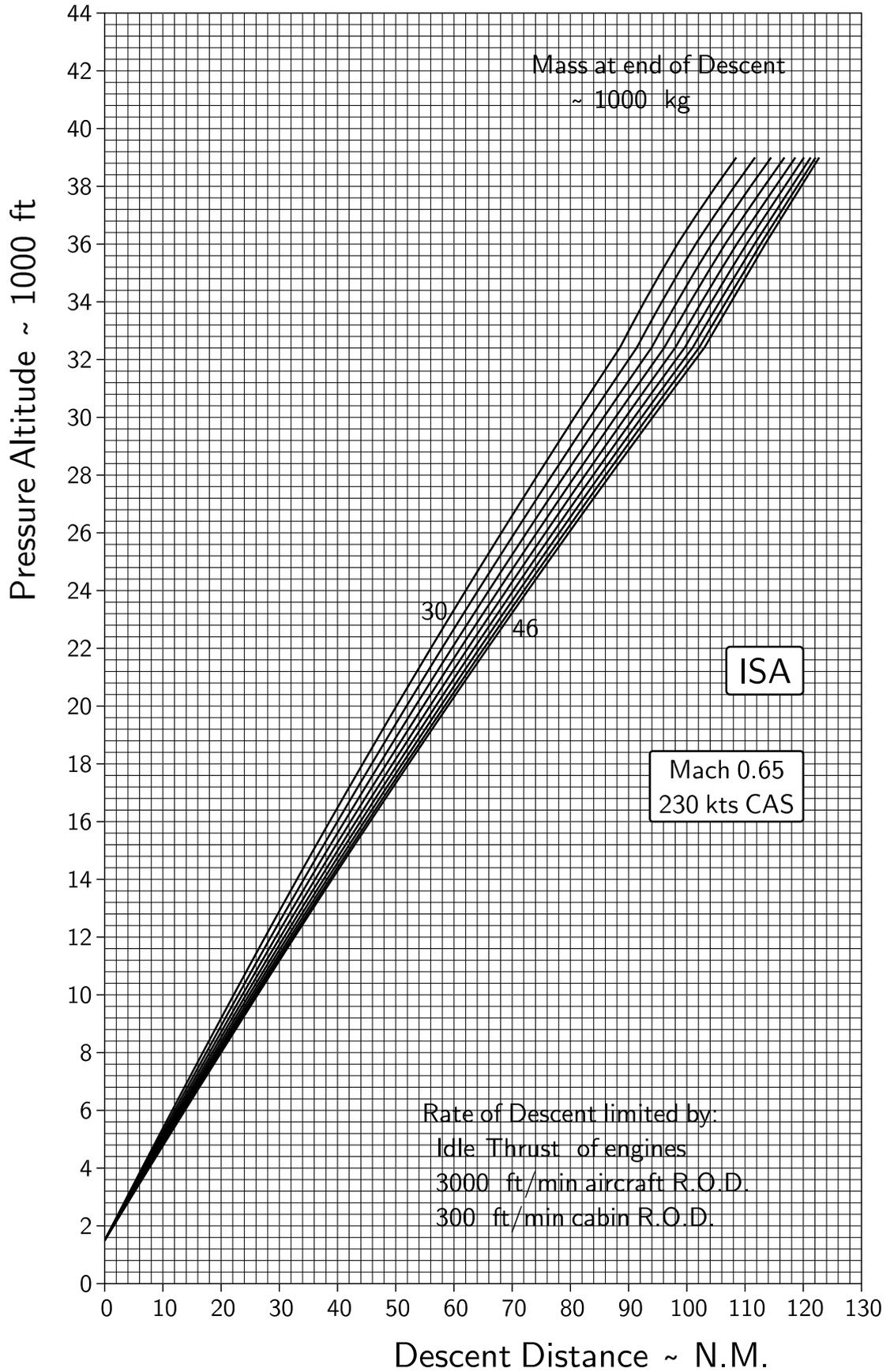


Figure 7.2: Descent distance at 230 kts CAS / Mach 0.65 at ISA.

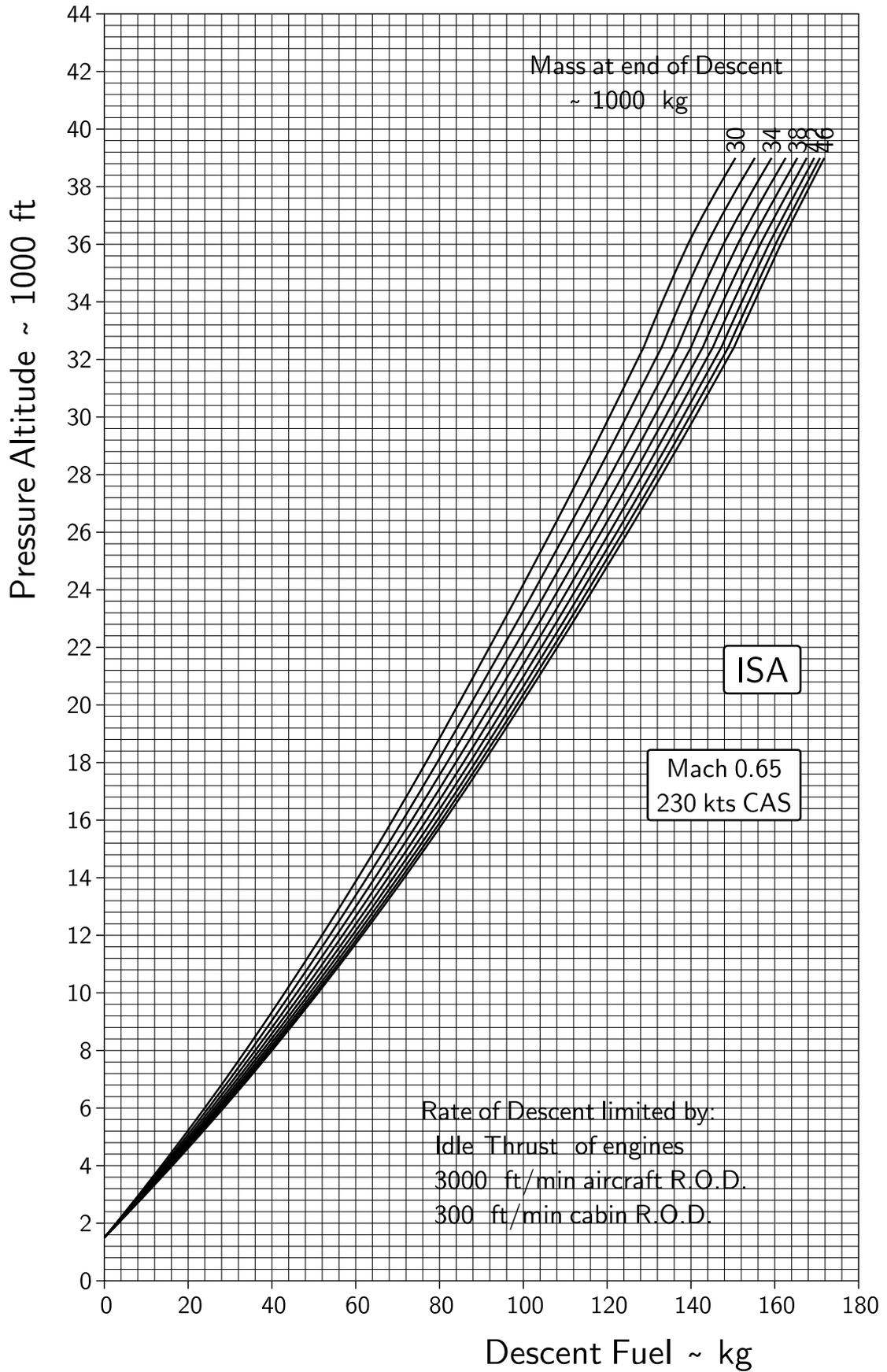


Figure 7.3: Descent fuel at 230 kts CAS / Mach 0.65 at ISA.

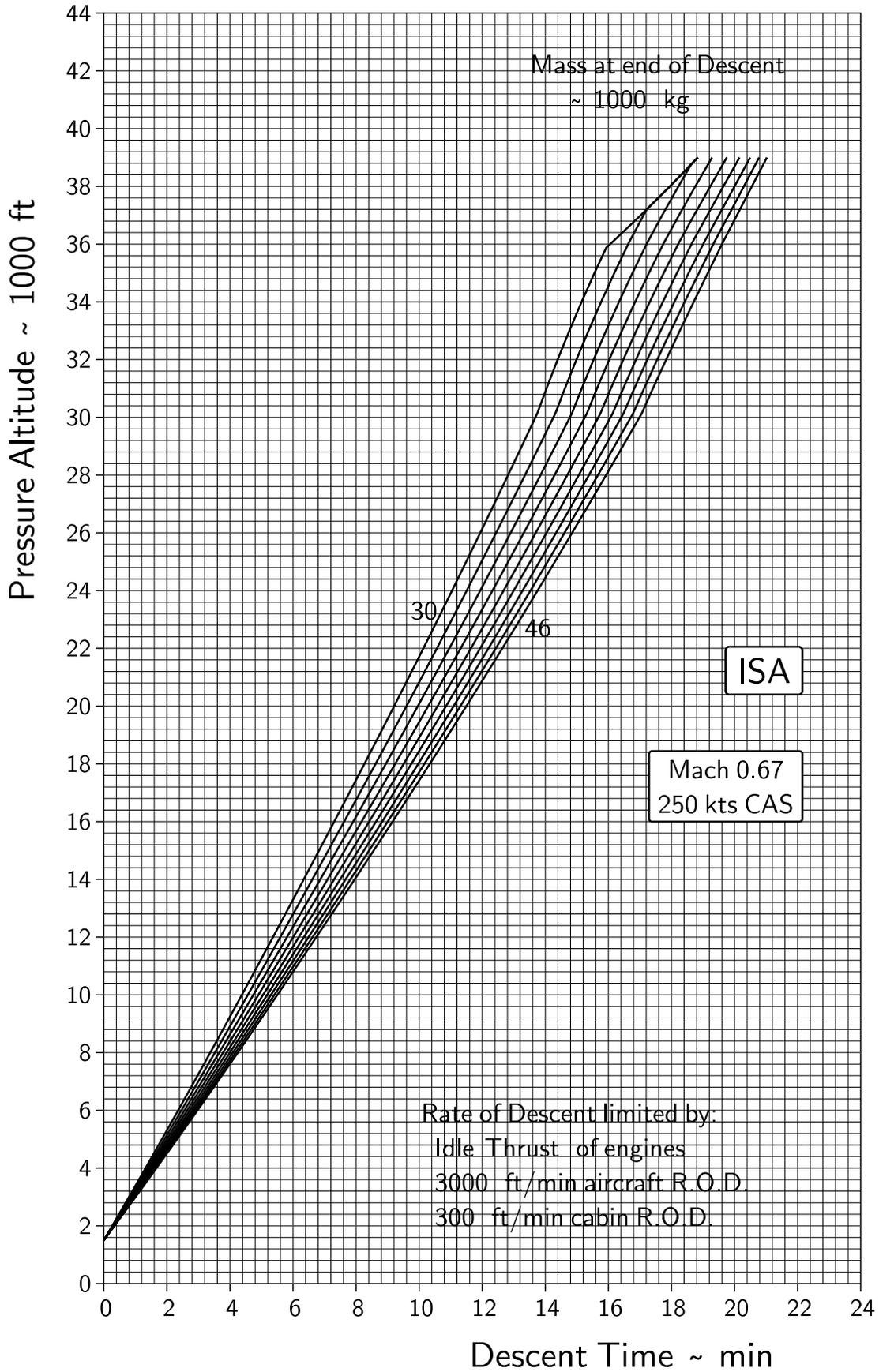


Figure 7.4: Descent time at 250 kts CAS / Mach 0.67 at ISA.

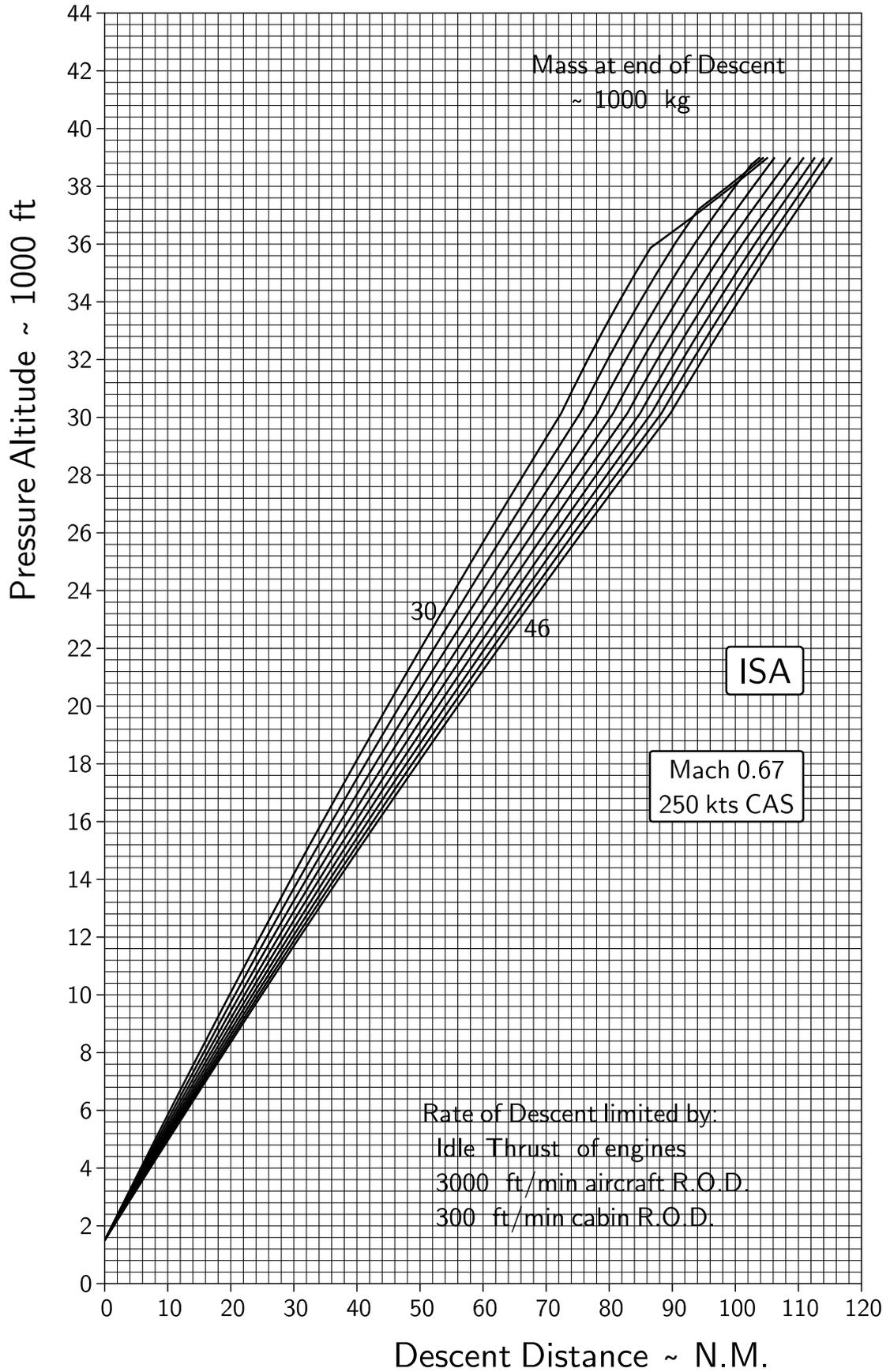


Figure 7.5: Descent distance at 250 kts CAS / Mach 0.67 at ISA.

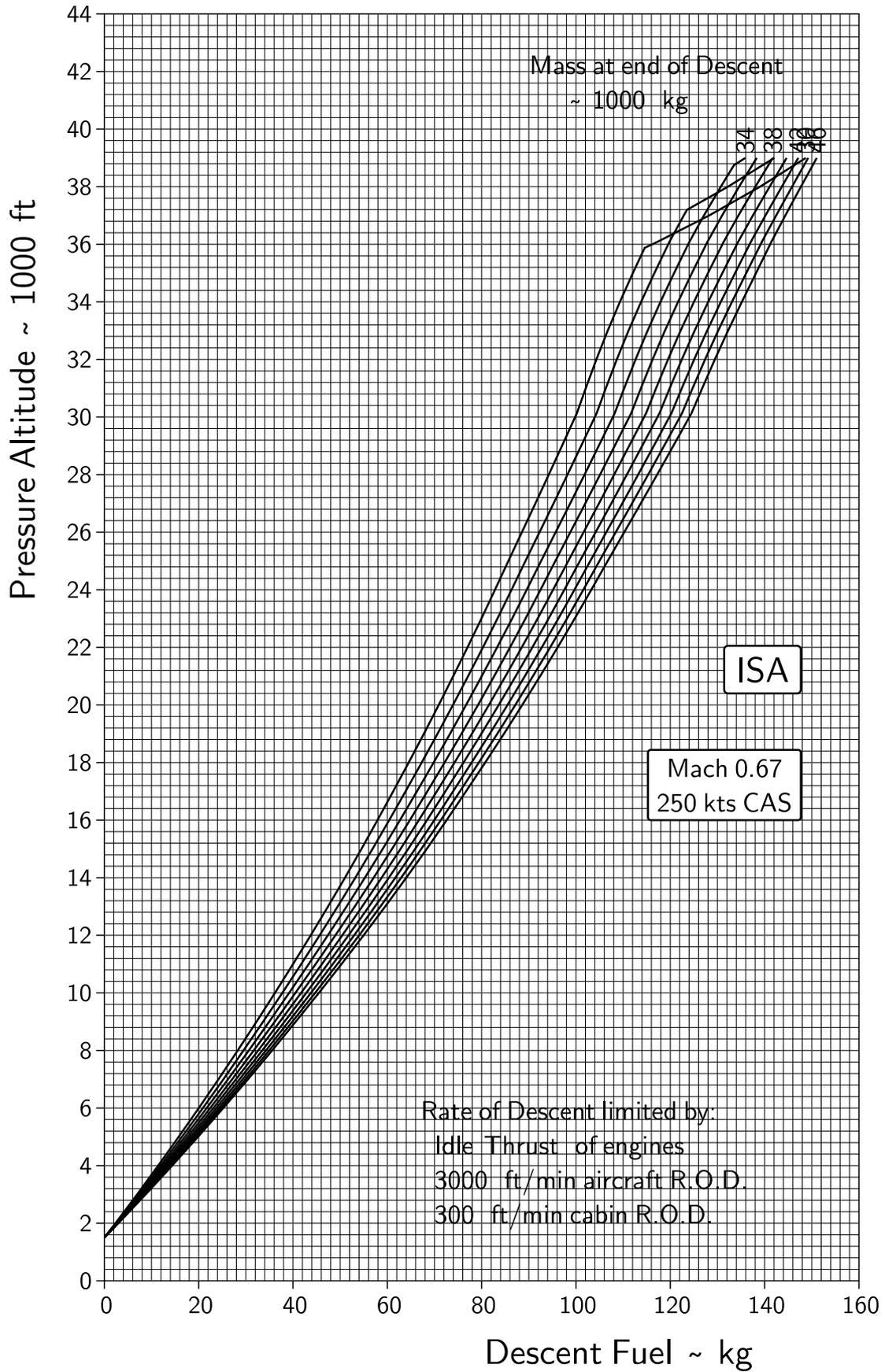


Figure 7.6: Descent fuel at 250 kts CAS / Mach 0.67 at ISA.

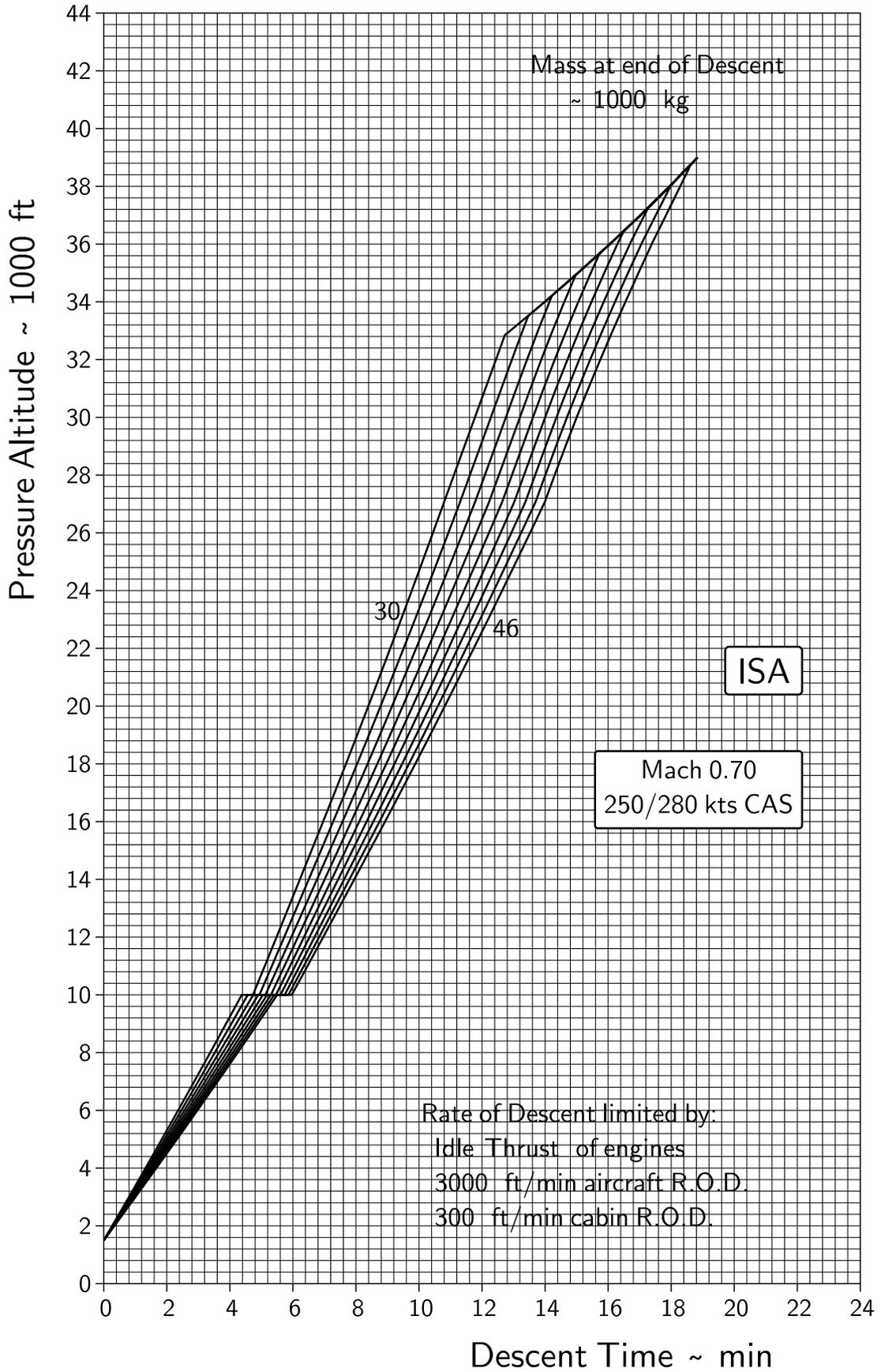


Figure 7.7: Descent time at 250/280 kts CAS / Mach 0.70 at ISA.

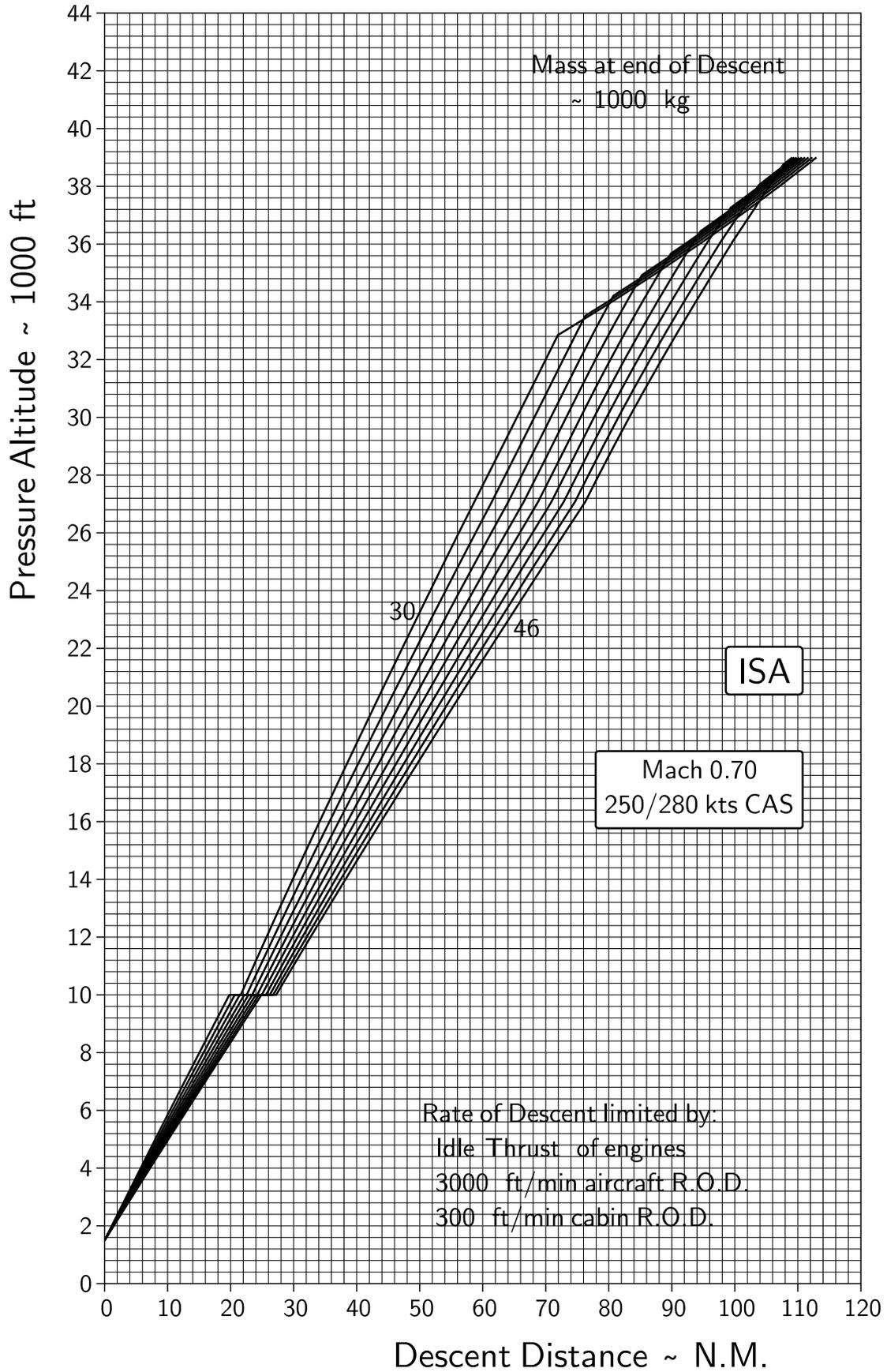


Figure 7.8: Descent distance at 250/280 kts CAS / Mach 0.70 at ISA.

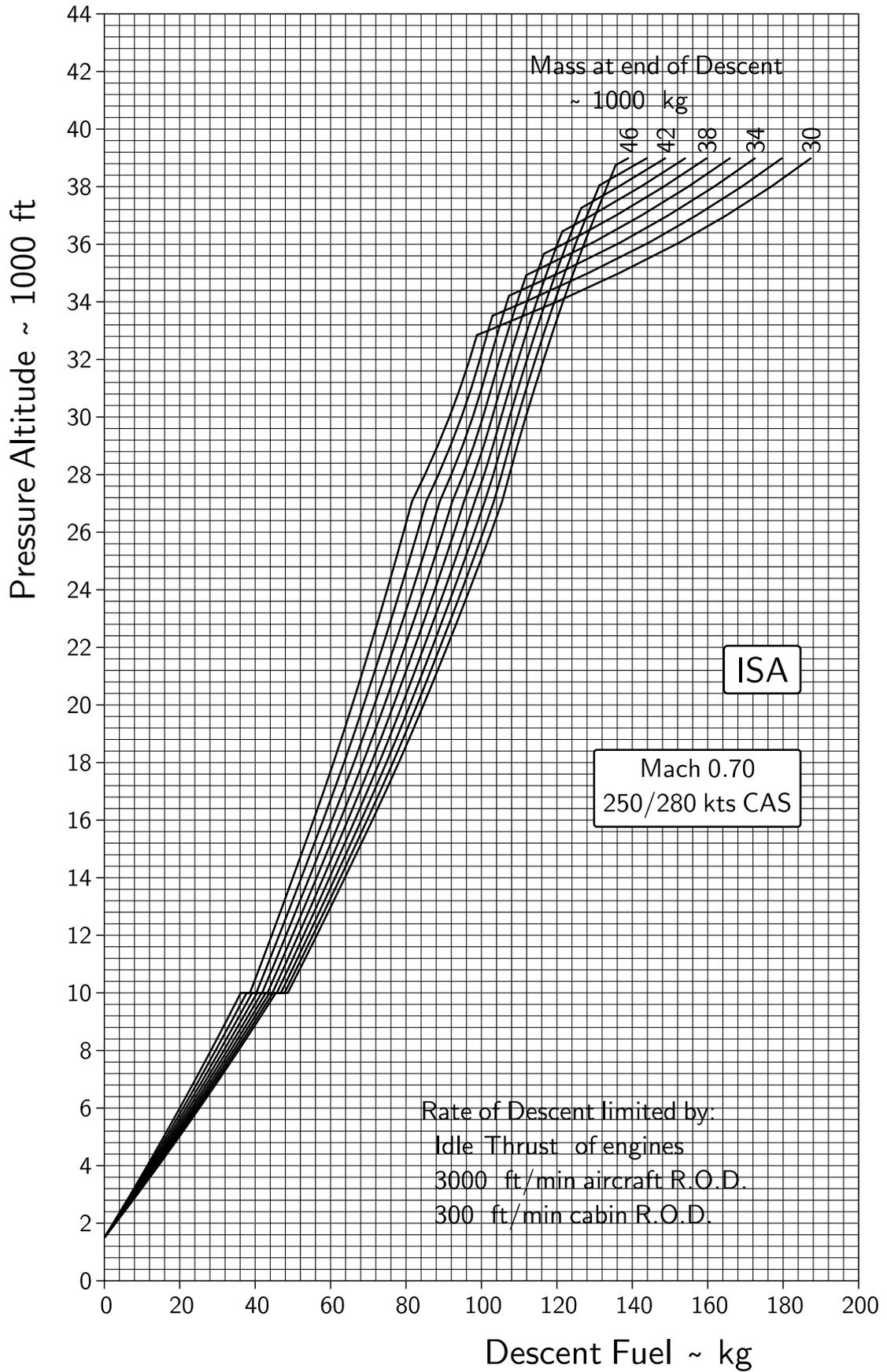


Figure 7.9: Descent fuel at 250/280 kts CAS / Mach 0.70 at ISA.

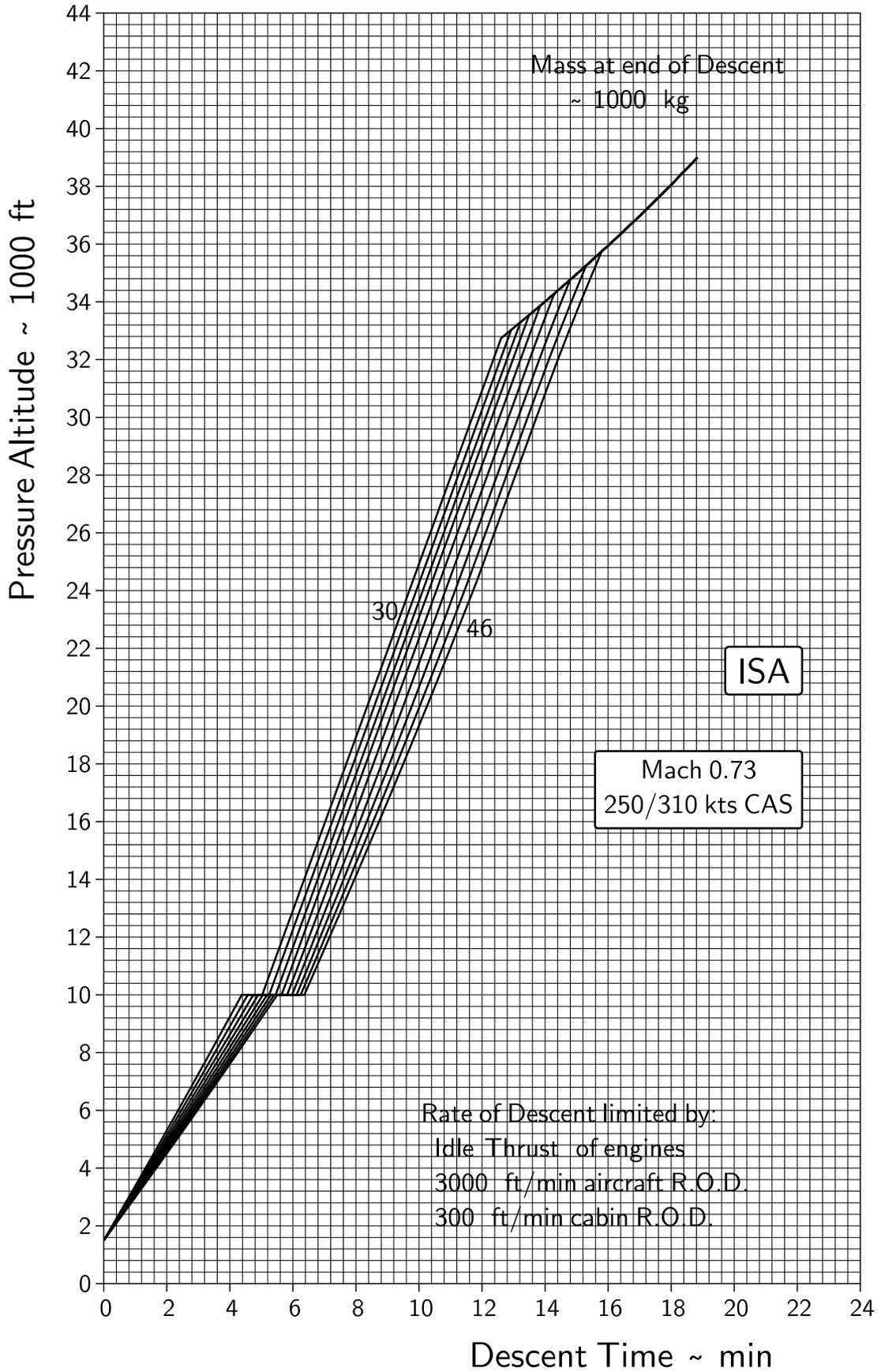


Figure 7.10: Descent time at 250/310 kts CAS / Mach 0.73 at ISA.

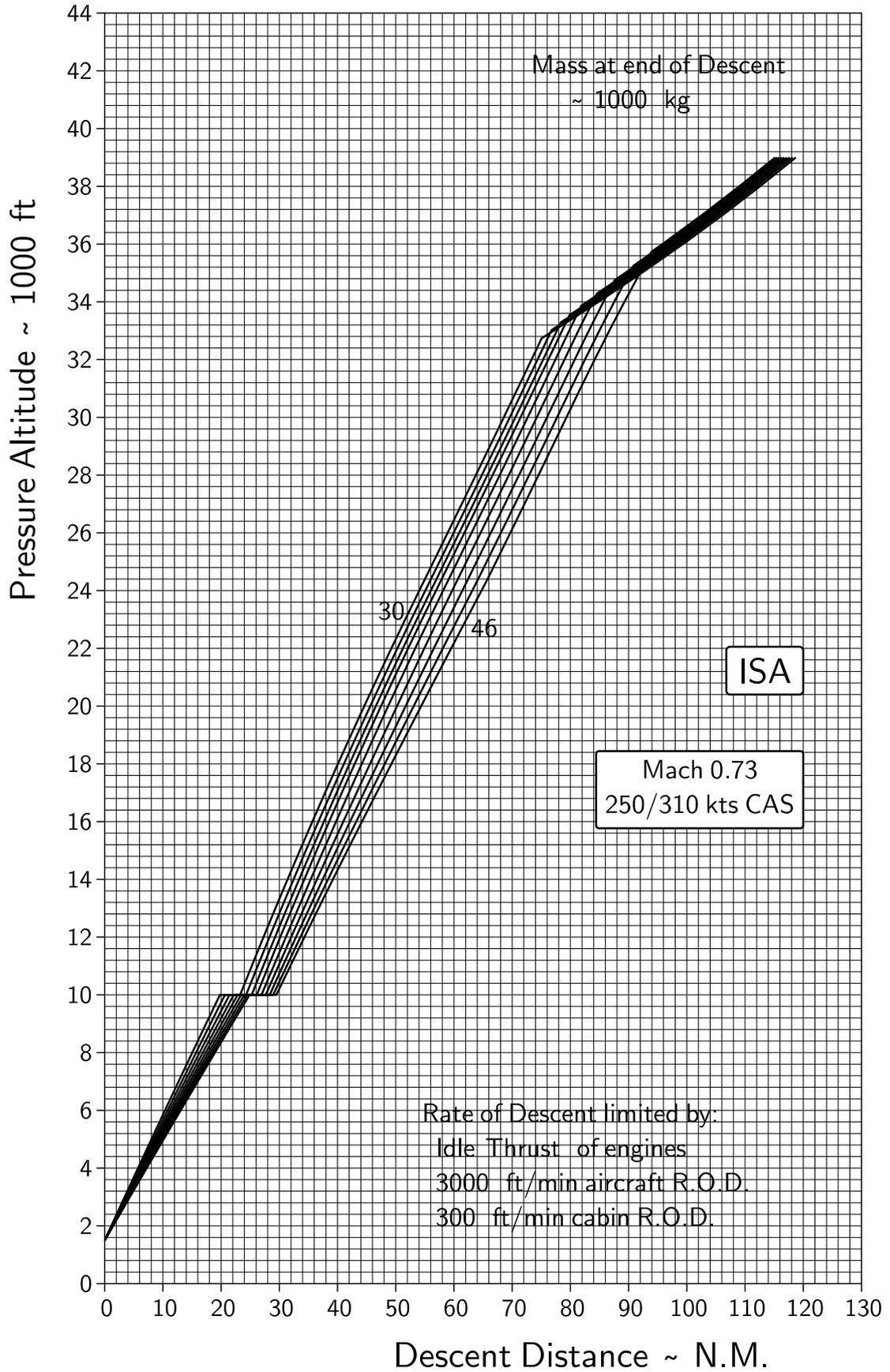


Figure 7.11: Descent distance at 250/310 kts CAS / Mach 0.73 at ISA.

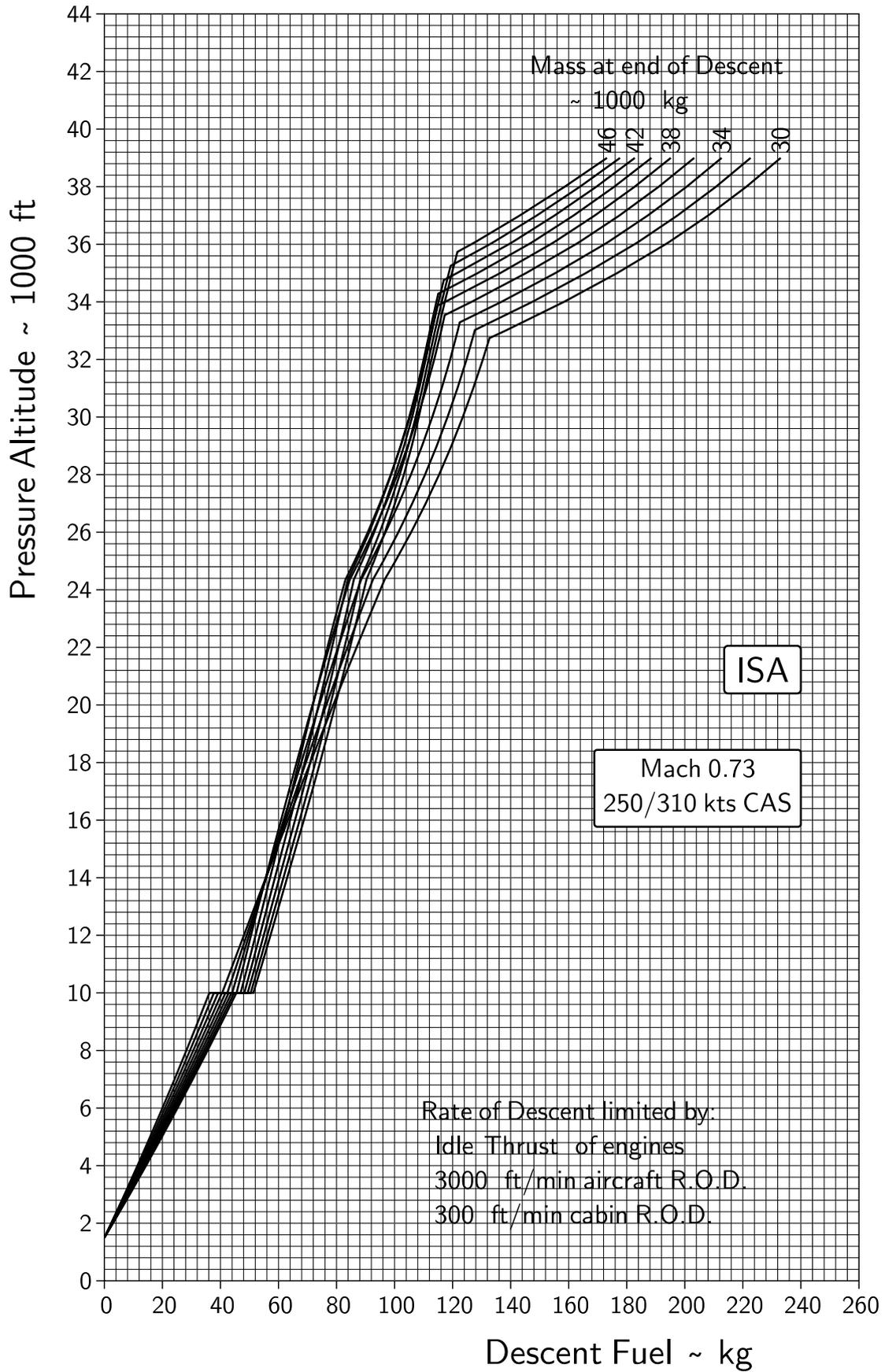


Figure 7.12: Descent fuel at 250/310 kts CAS / Mach 0.73 at ISA.



# Chapter 8

## Holding

### Assumptions

Holding at minimum-drag speed.

### Figures

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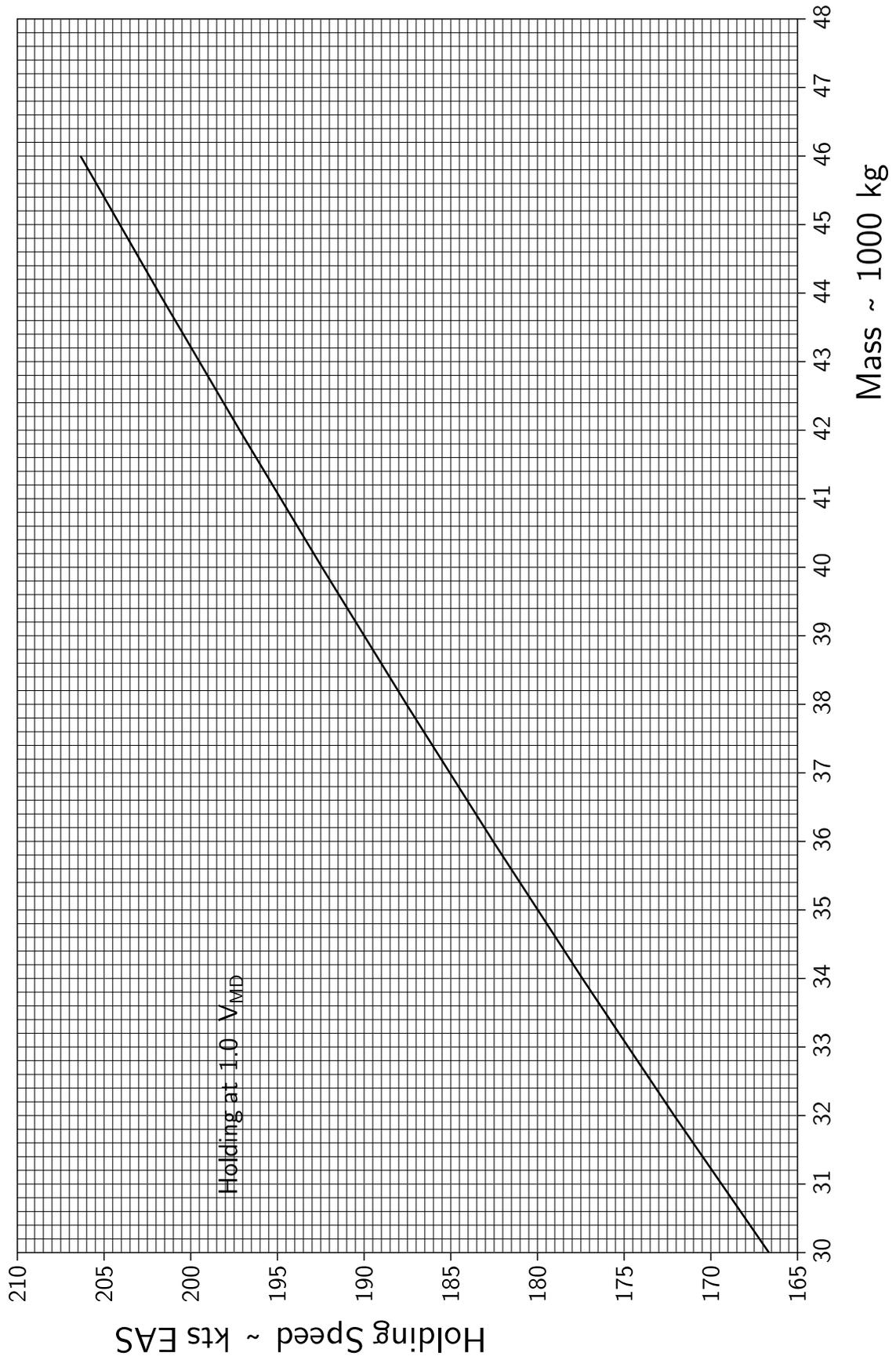


Figure 8.1: Holding speed.

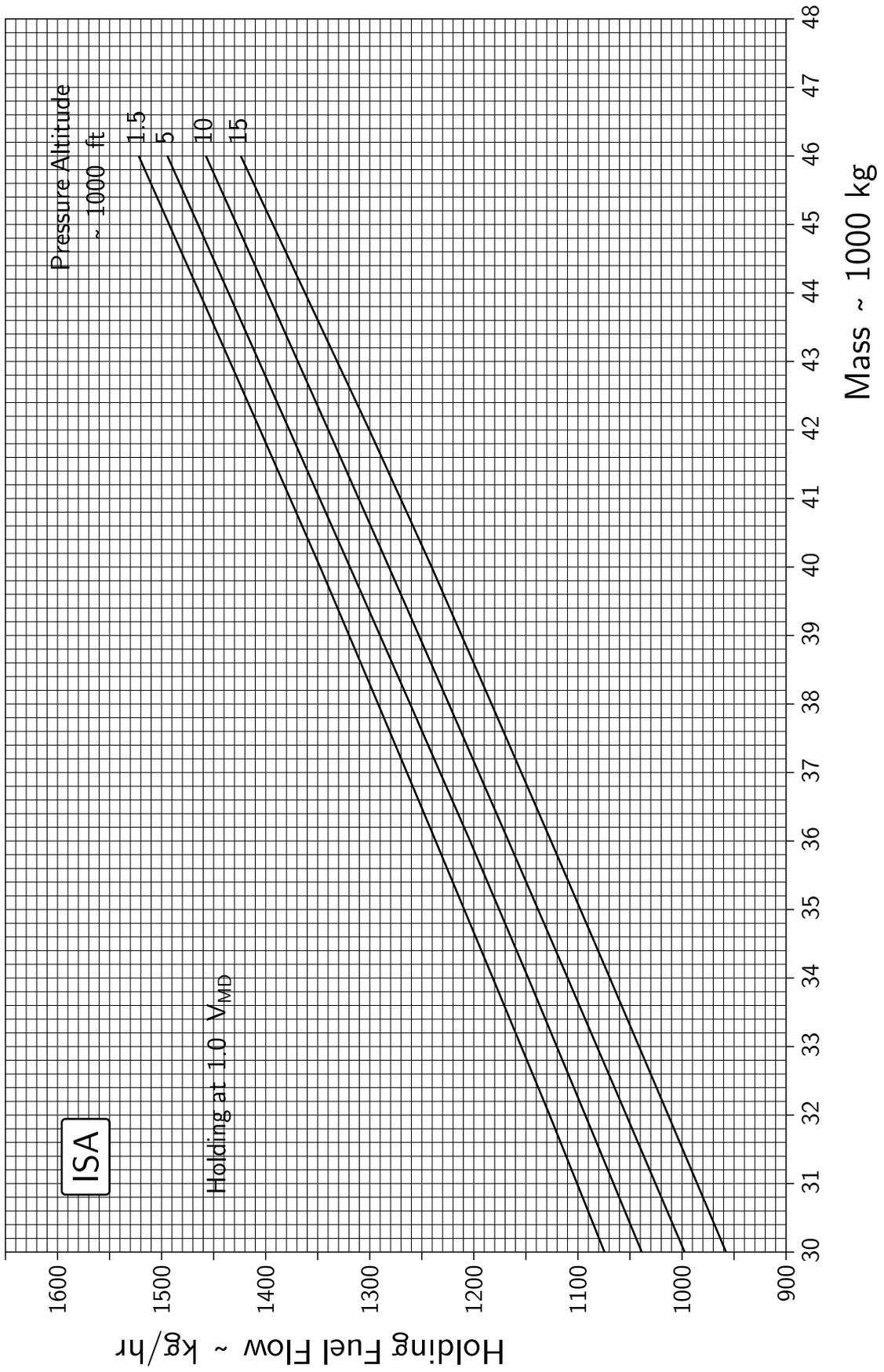


Figure 8.2: Holding fuel flow at ISA.



# Chapter 9

## Allowances

### Assumptions

Taxi with all engines at maximum take-off mass.

Take-off includes take-off, climb-out to 1 500 ft and acceleration to climb speed.

Approach includes deceleration and approach from 1 500 ft for a total time of 6.0 min.

Overshoot includes overshoot, climb-out to 1 500 ft and acceleration to climb speed.

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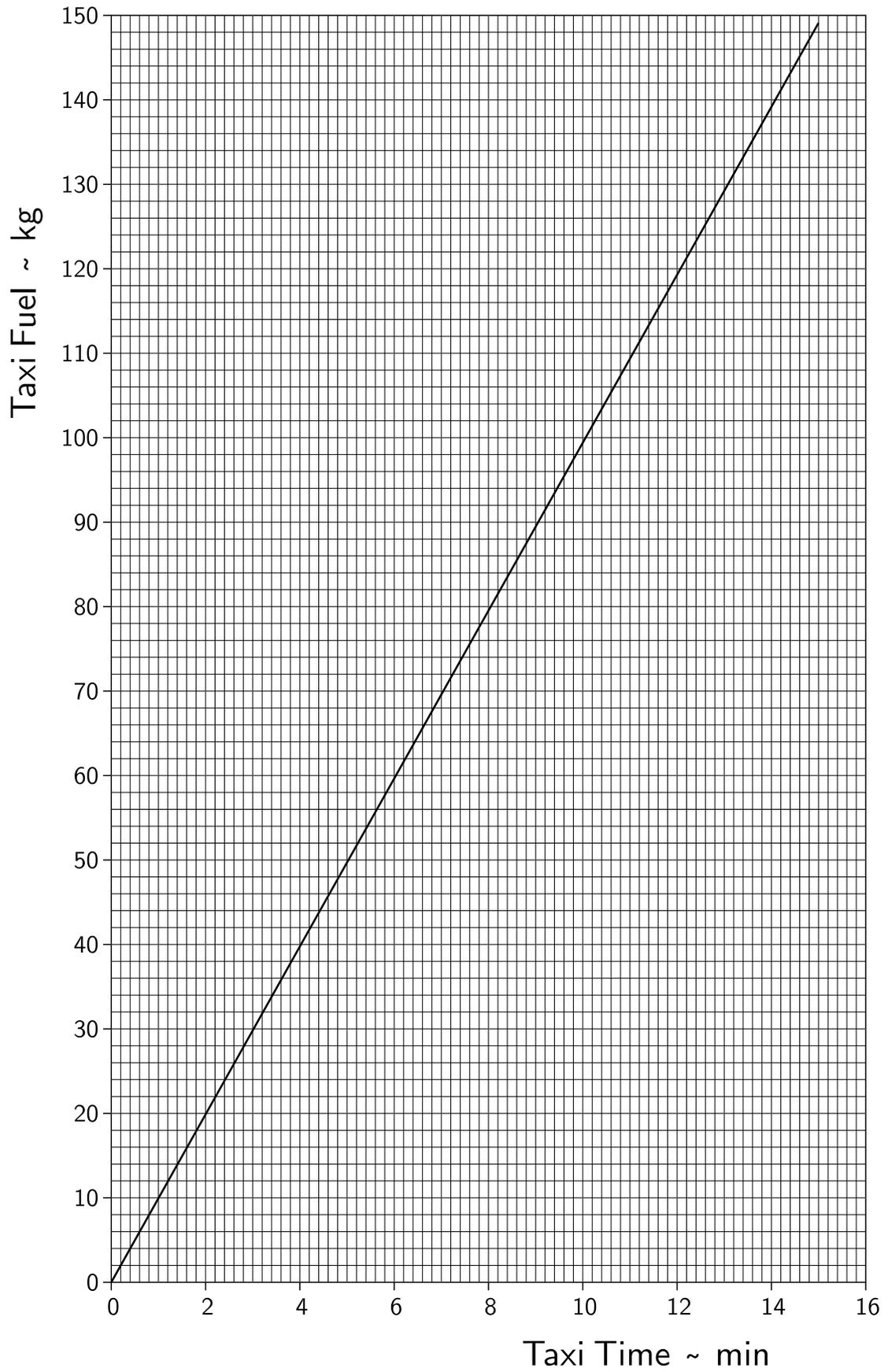


Figure 9.1: Taxi fuel.

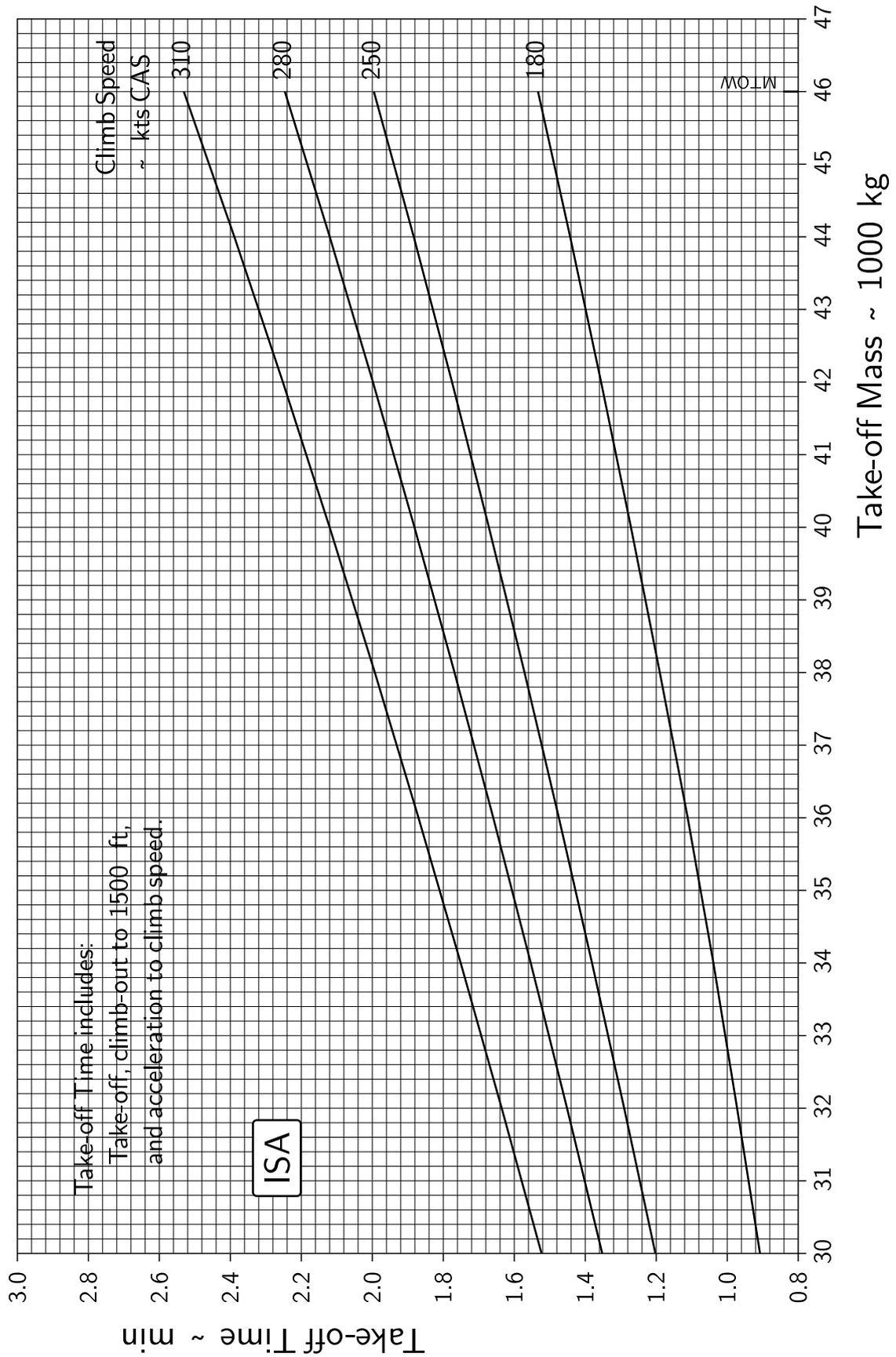


Figure 9.2: Take-off time at ISA.

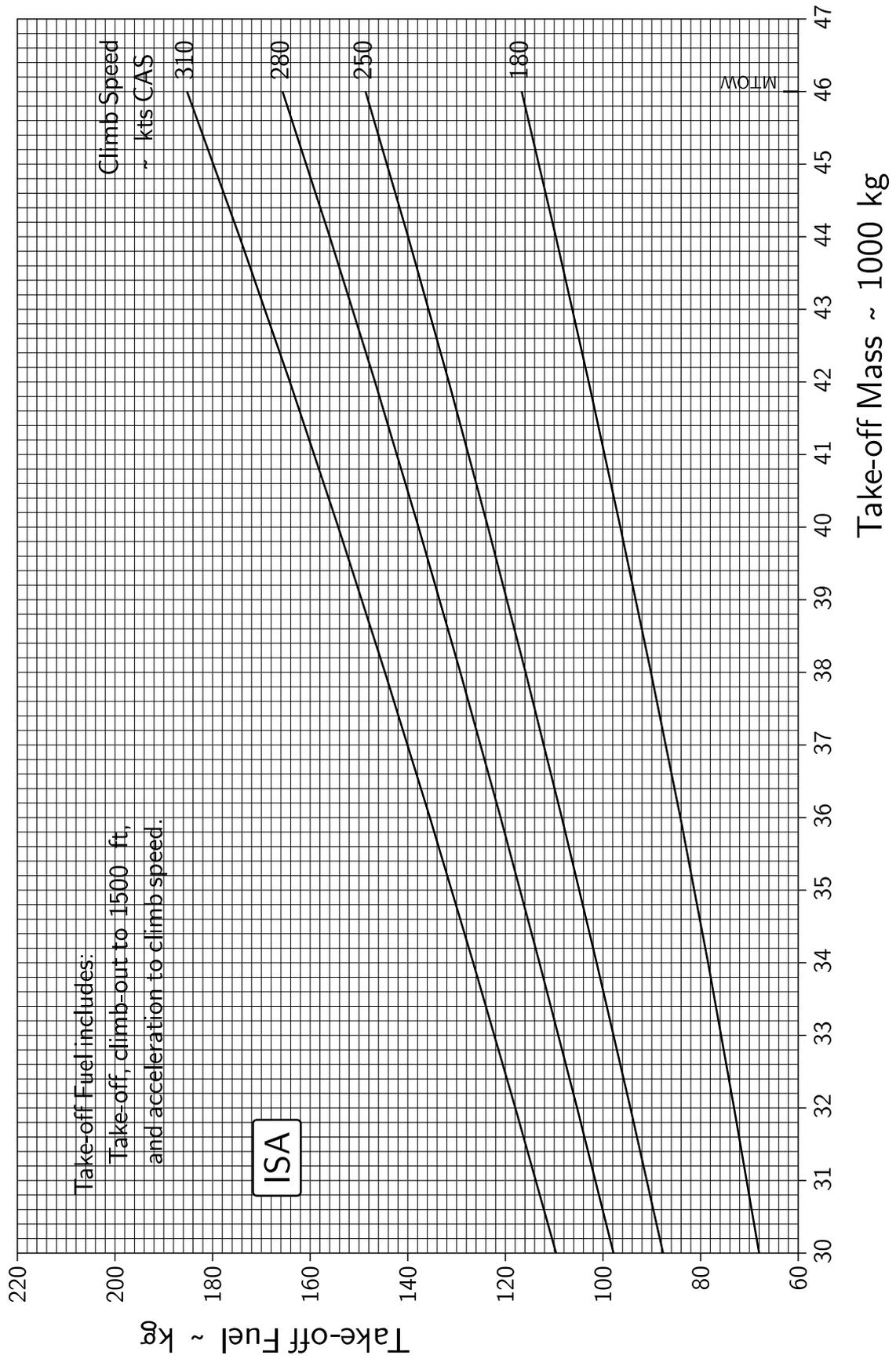


Figure 9.3: Take-off fuel at ISA.

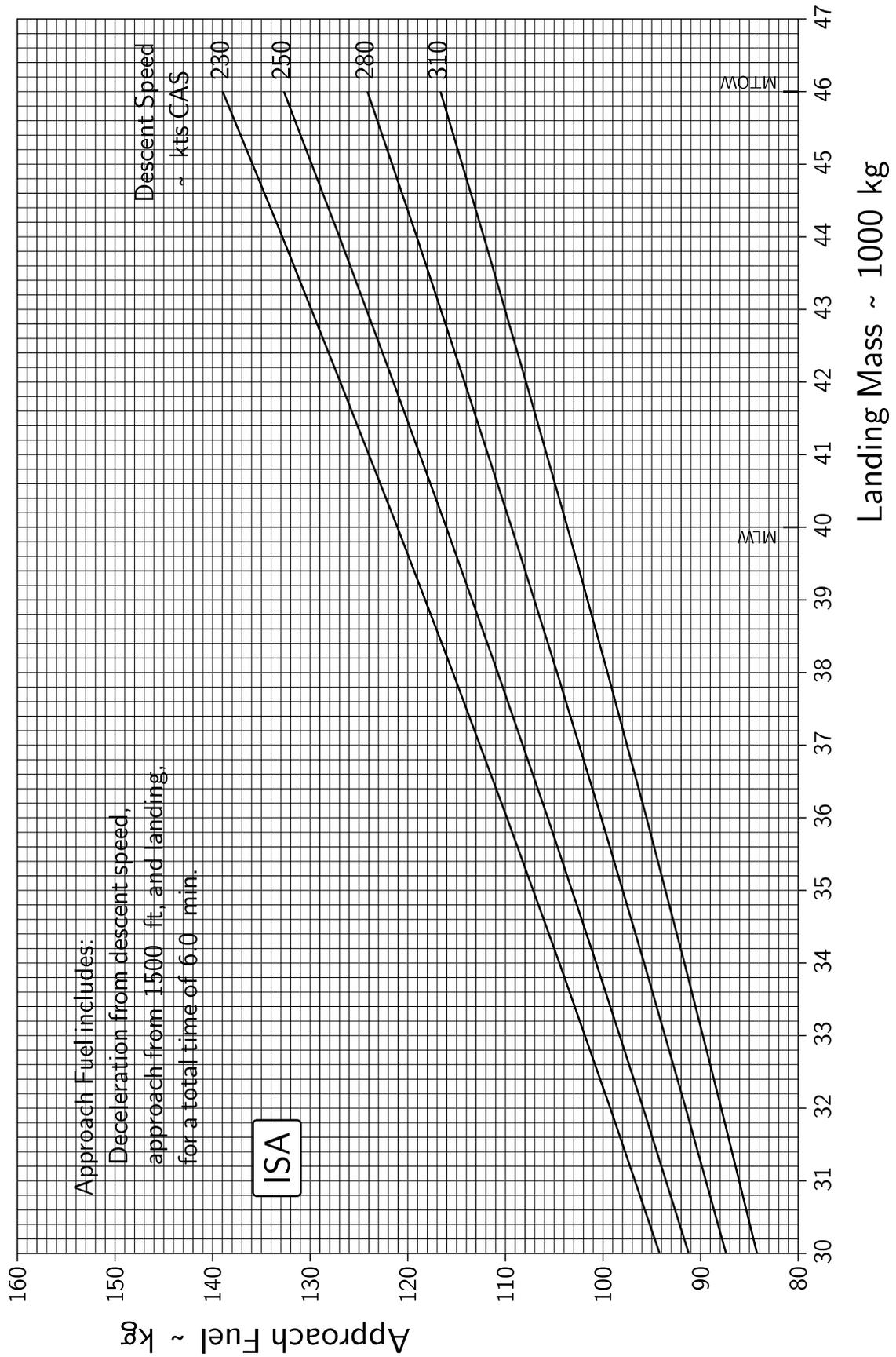


Figure 9.4: Approach fuel at ISA.

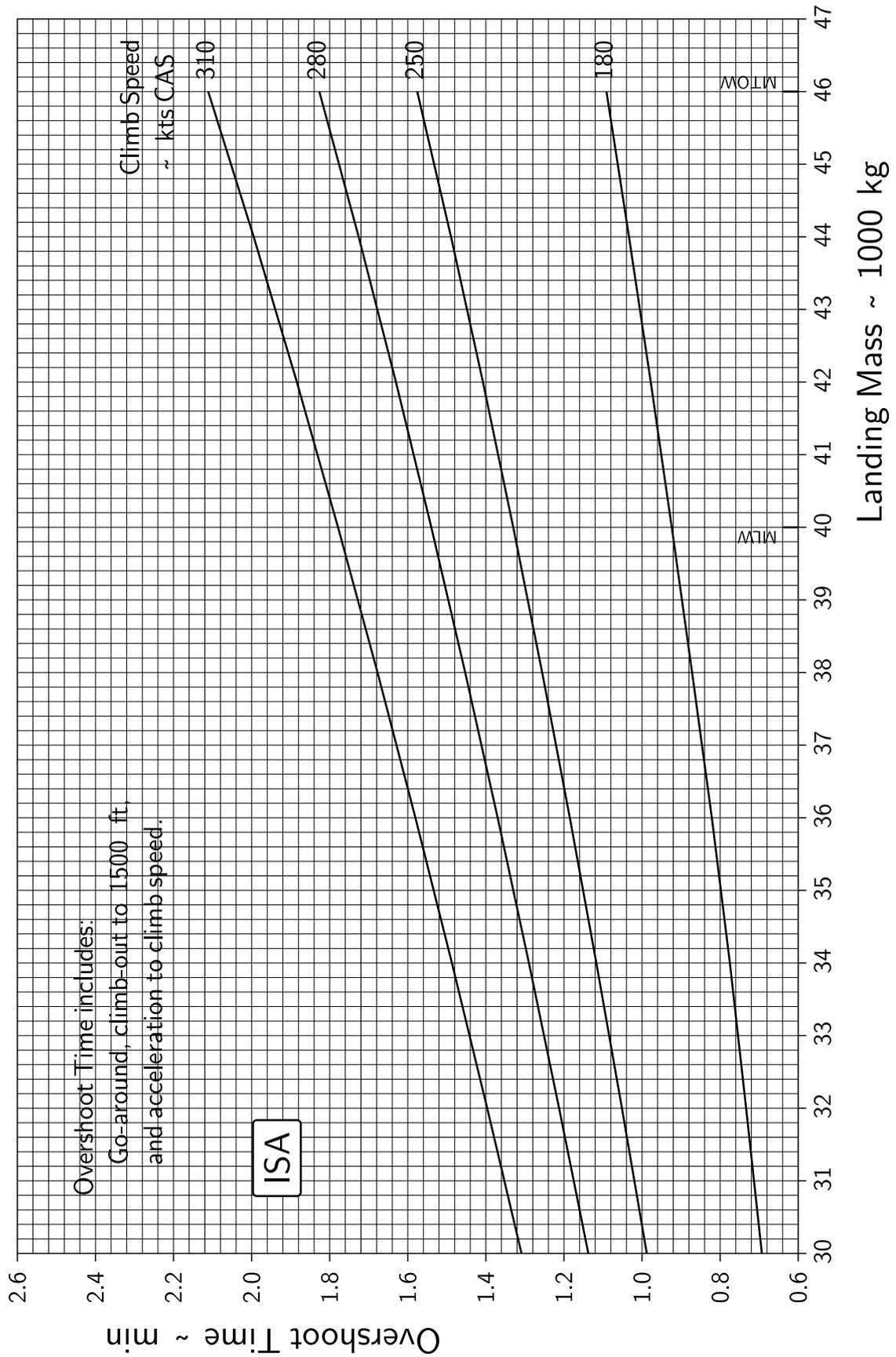


Figure 9.5: Overshoot time at ISA.

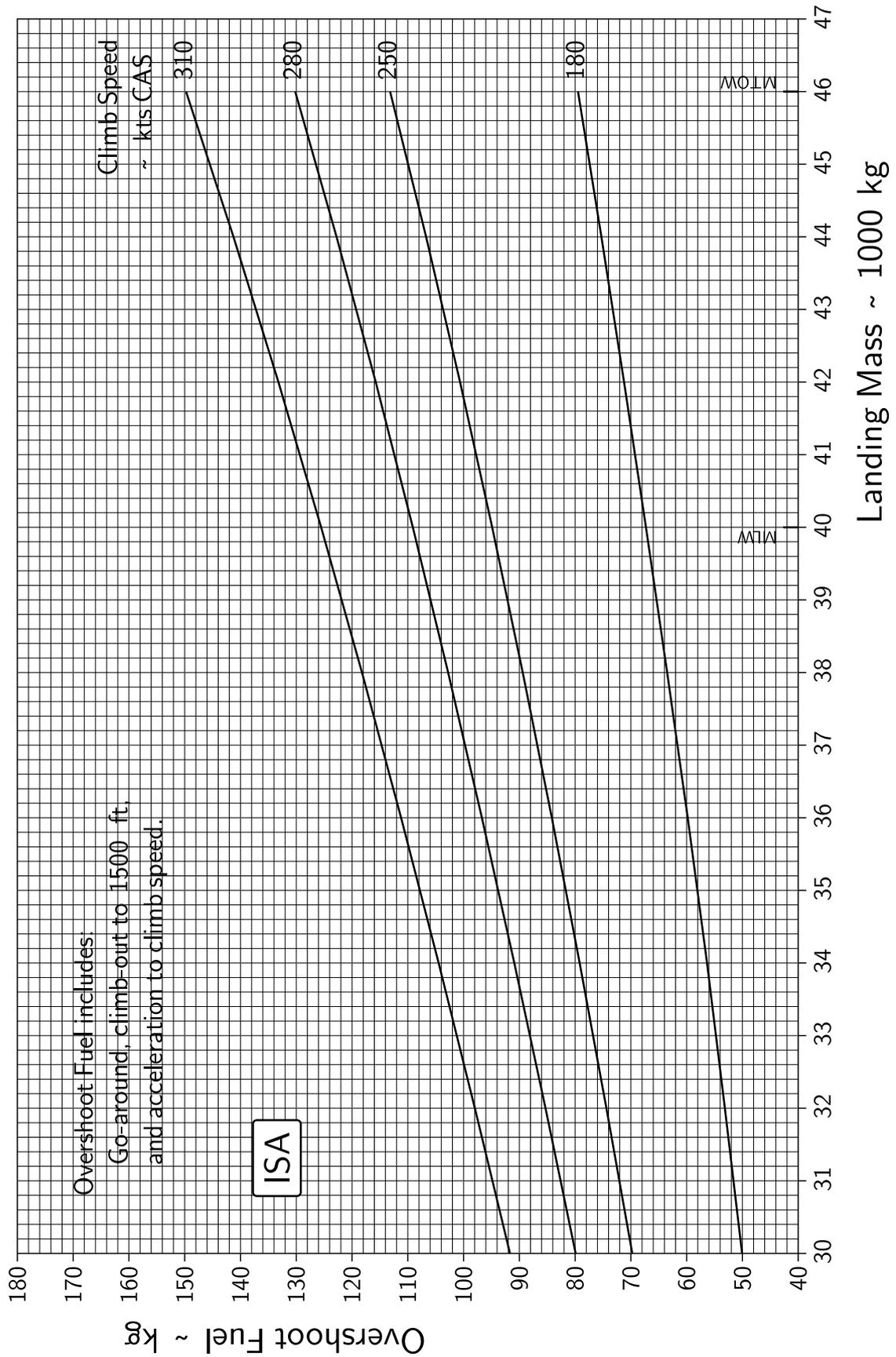


Figure 9.6: Overshoot fuel at ISA.



# Chapter 10

## Flight profile

### Assumptions

- ICAO Standard Flight Levels.
- Operational speed restriction of 250 kts CAS below 10 000 ft.
- Taxi-out 9.0 min, approach 6.0 min, and taxi-in 5.0 min.
- No wind.
- Zero-fuel mass 36 103 kg.
- Reserves: 200 N.M. diversion, 45 min holding at 1 500 ft over alternate.

### Figures

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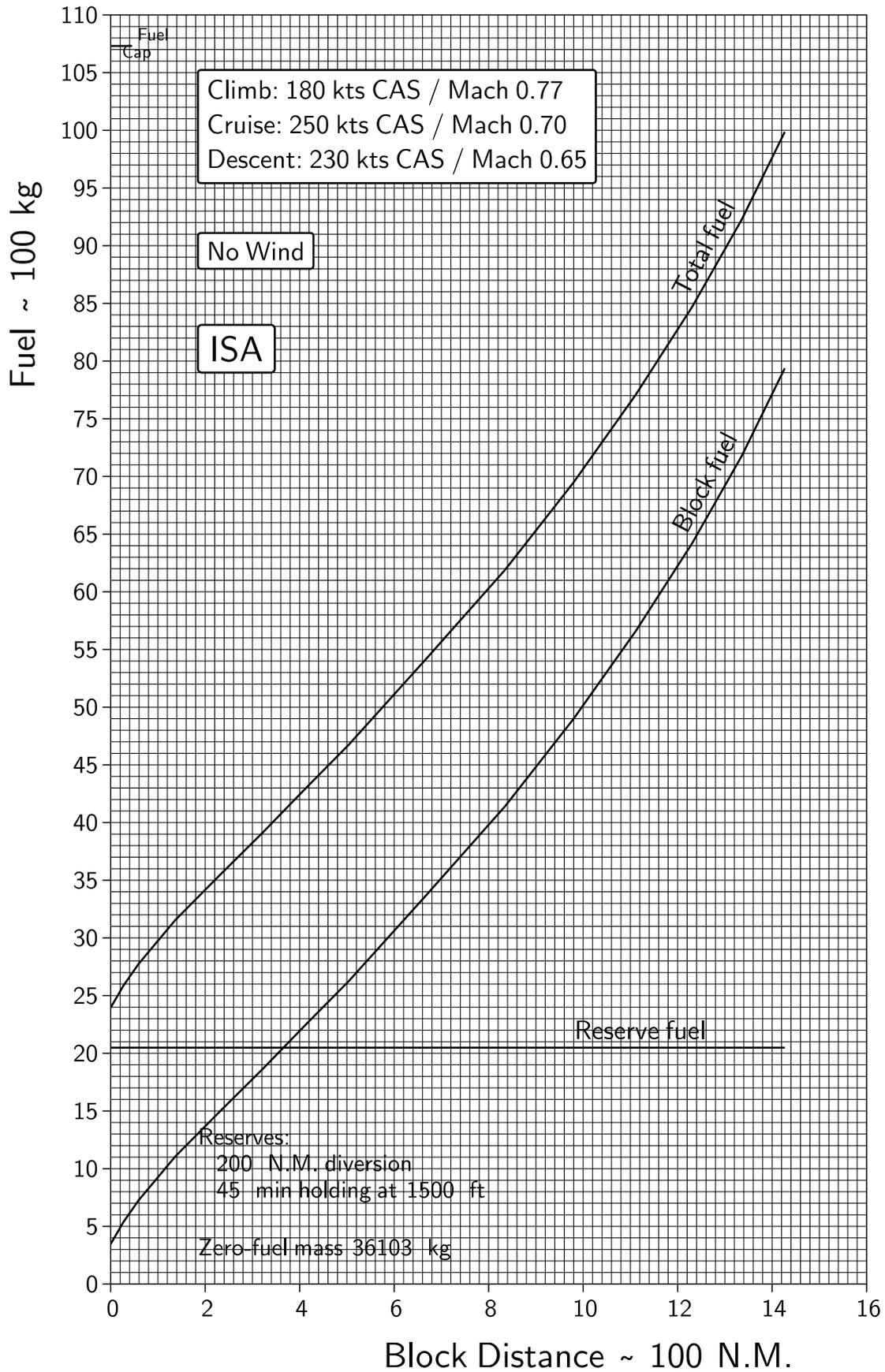


Figure 10.1: Fuel for climb at 180 kts CAS / Mach 0.77, cruise at 250 kts CAS / Mach 0.70, descent at 230 kts CAS / Mach 0.65 at ISA.

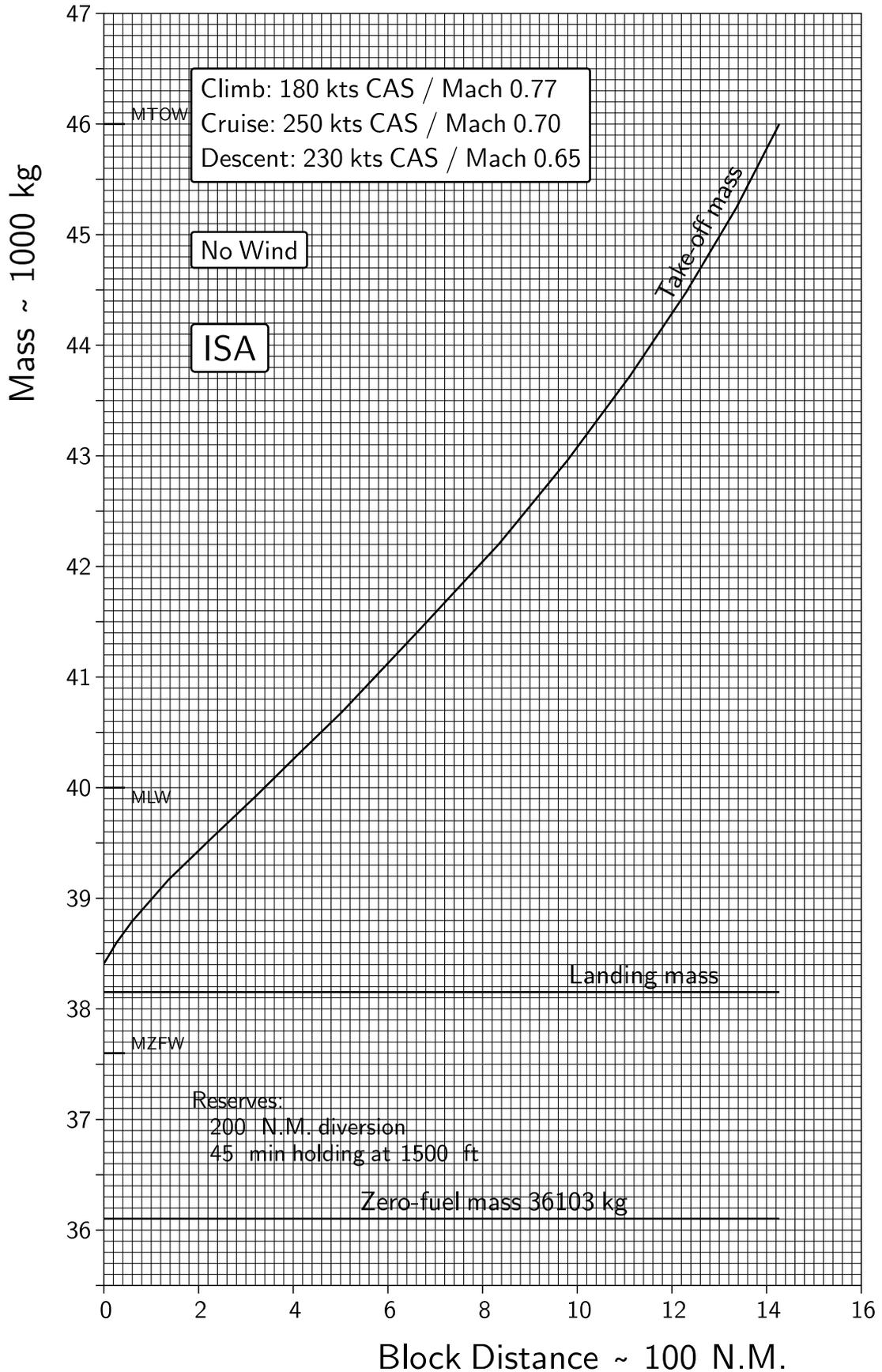


Figure 10.2: Mass for climb at 180 kts CAS / Mach 0.77, cruise at 250 kts CAS / Mach 0.70, descent at 230 kts CAS / Mach 0.65 at ISA.

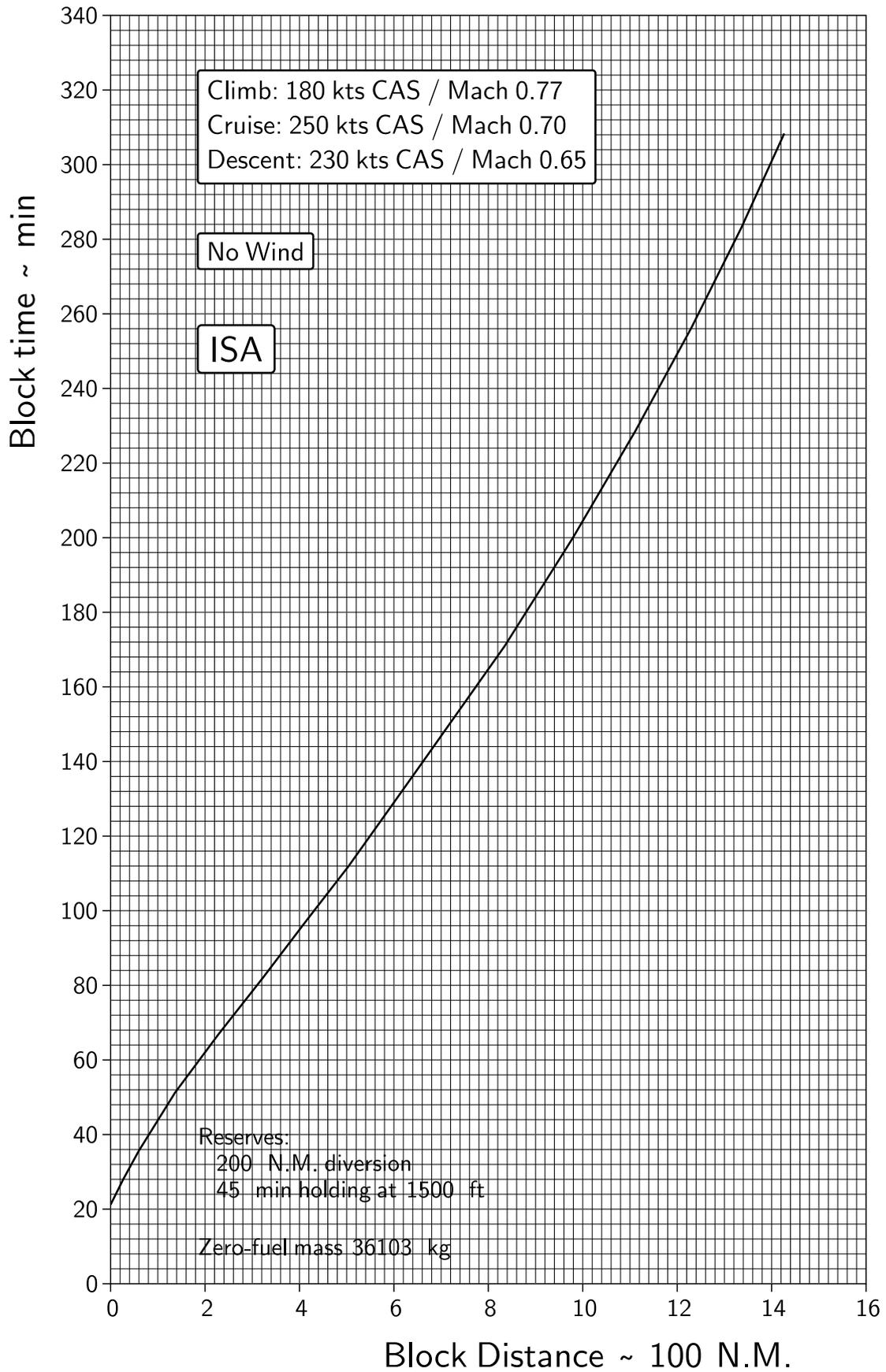


Figure 10.3: Block time for climb at 180 kts CAS / Mach 0.77, cruise at 250 kts CAS / Mach 0.70, descent at 230 kts CAS / Mach 0.65 at ISA.

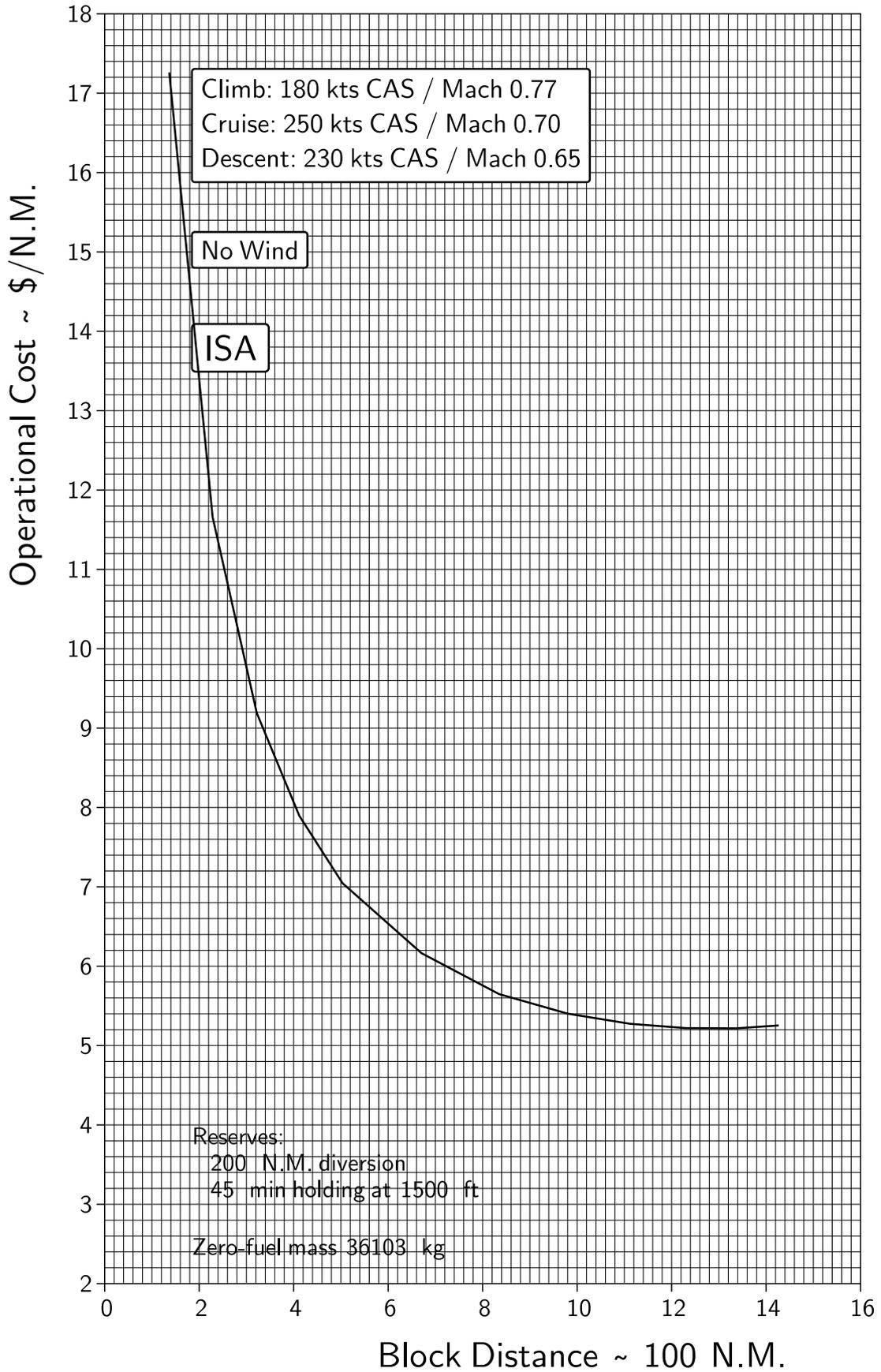


Figure 10.4: Cost/N.M. for climb at 180 kts CAS / Mach 0.77, cruise at 250 kts CAS / Mach 0.70, descent at 230 kts CAS / Mach 0.65 at ISA.

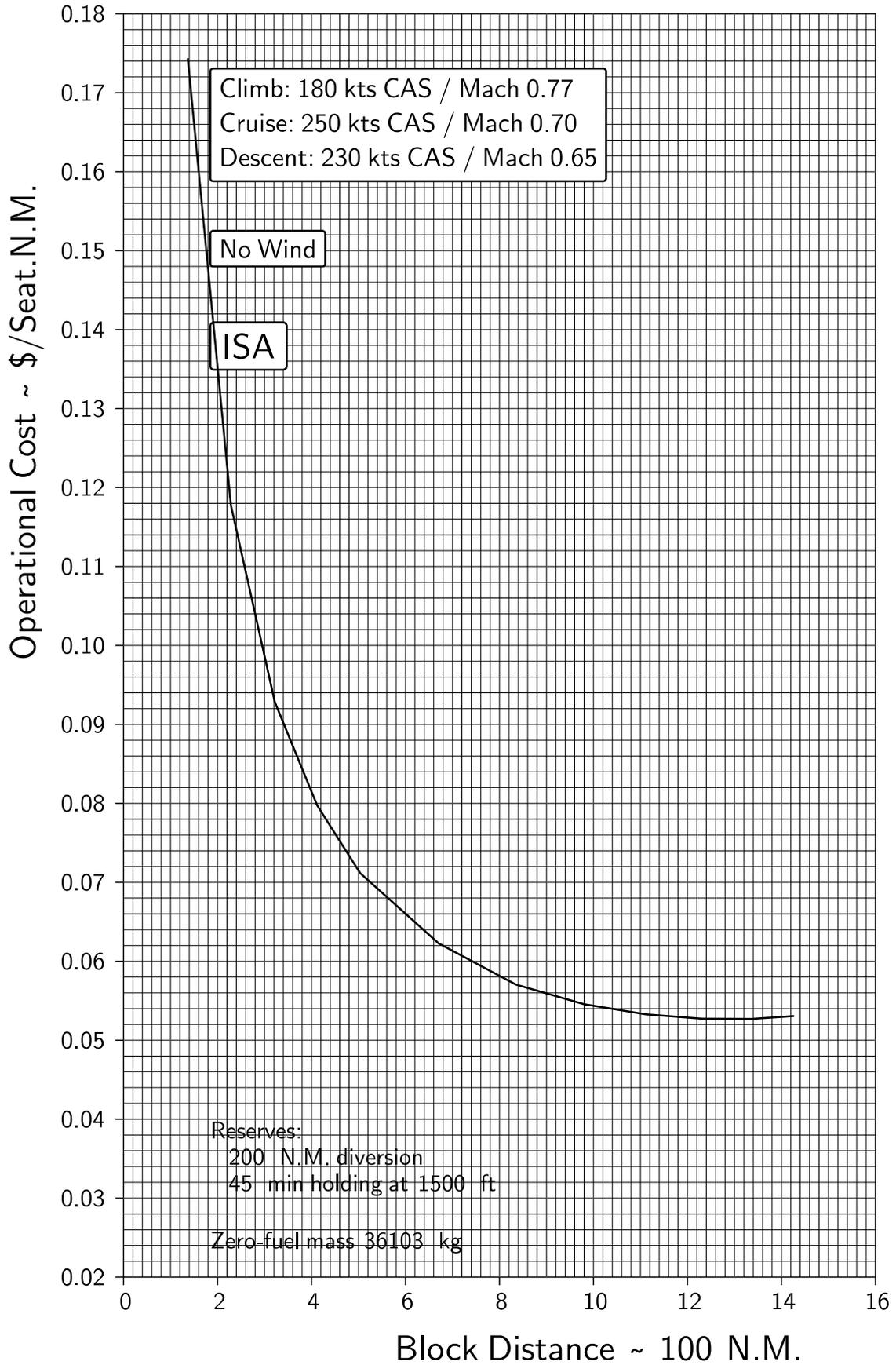


Figure 10.5: Cost/Seat.N.M. for climb at 180 kts CAS / Mach 0.77, cruise at 250 kts CAS / Mach 0.70, descent at 230 kts CAS / Mach 0.65 at ISA.

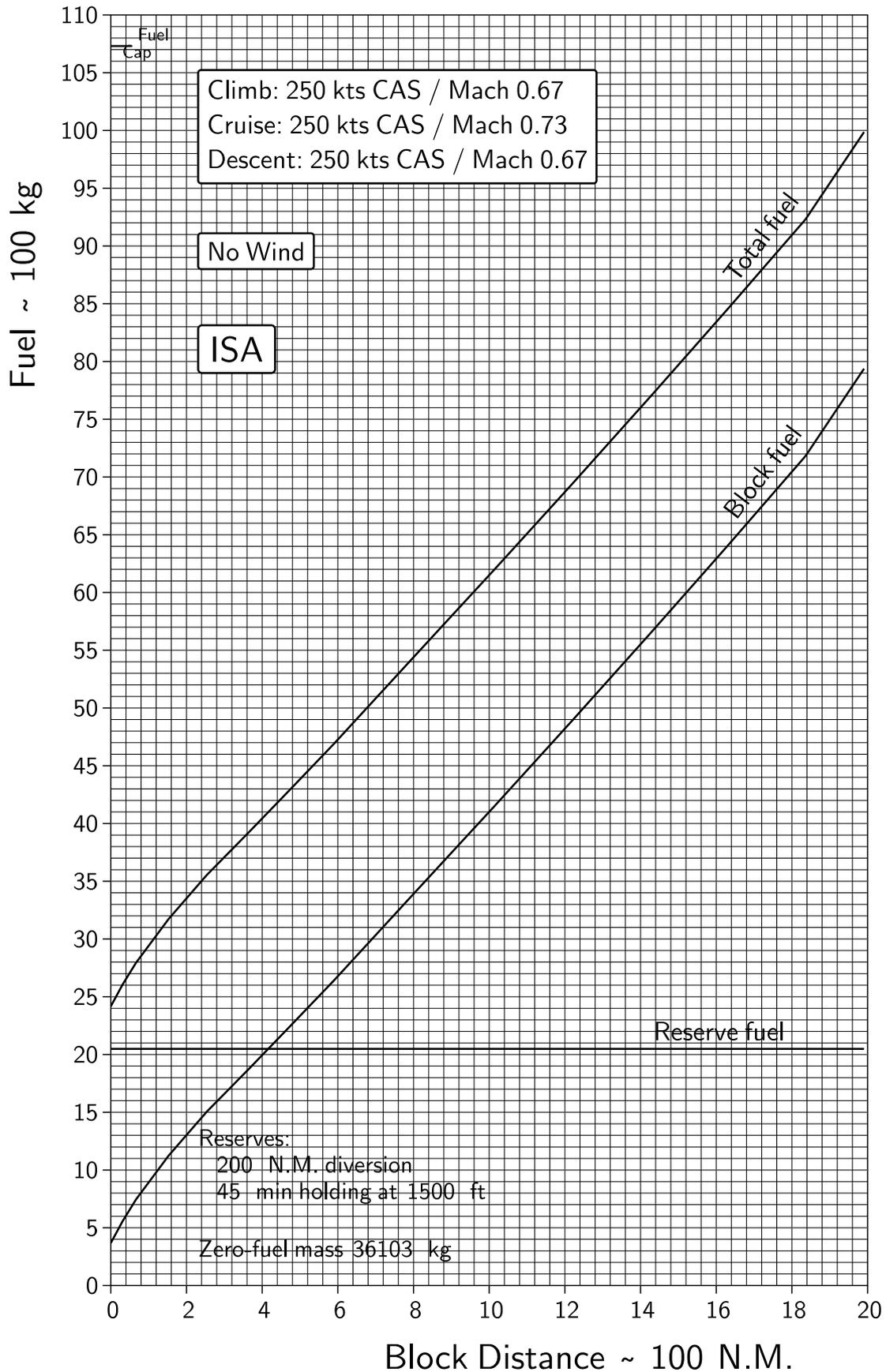


Figure 10.6: Fuel for climb at 250 kts CAS / Mach 0.67, cruise at 250 kts CAS / Mach 0.73, descent at 250 kts CAS / Mach 0.67 at ISA.

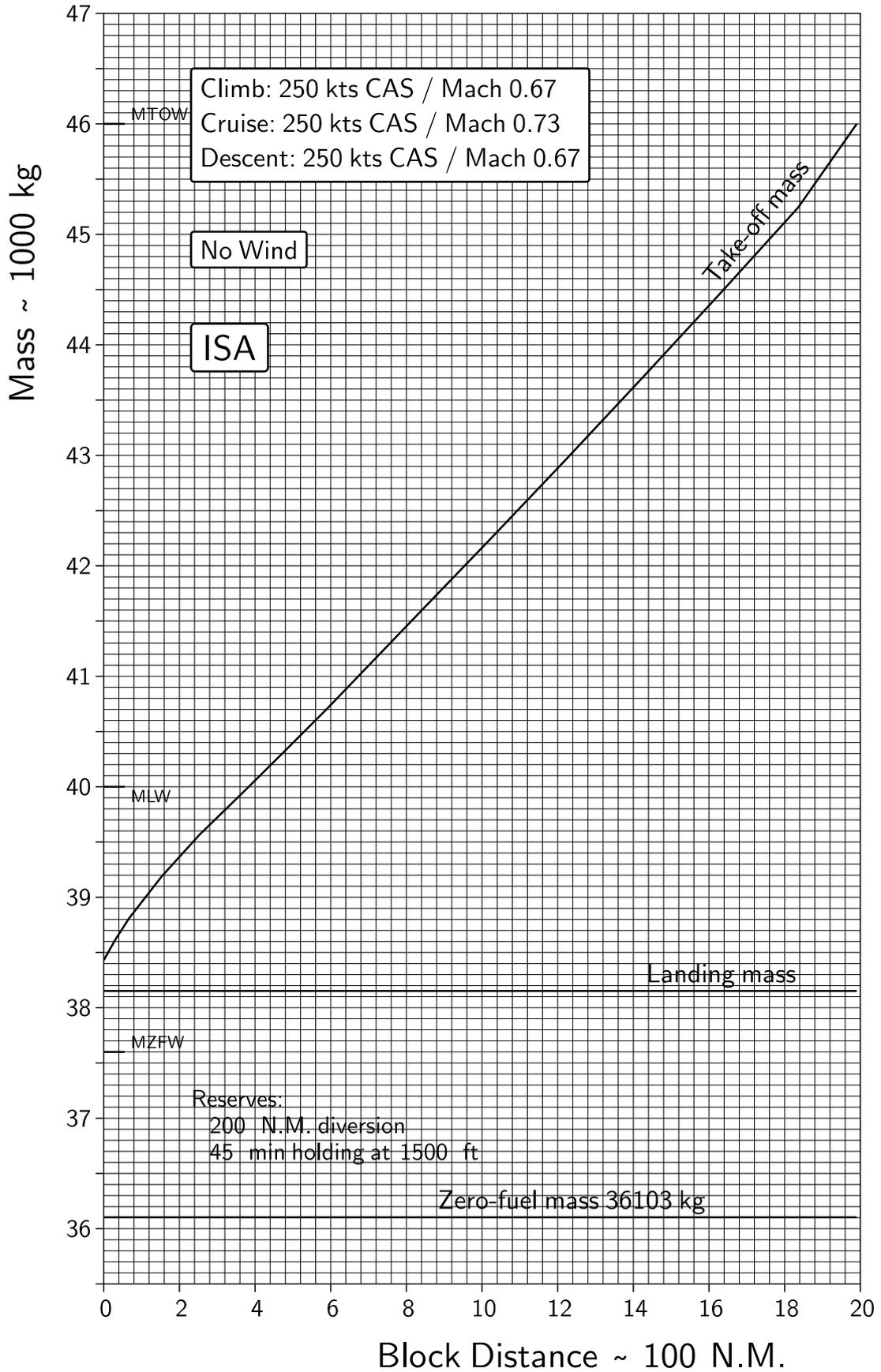


Figure 10.7: Mass for climb at 250 kts CAS / Mach 0.67, cruise at 250 kts CAS / Mach 0.73, descent at 250 kts CAS / Mach 0.67 at ISA.

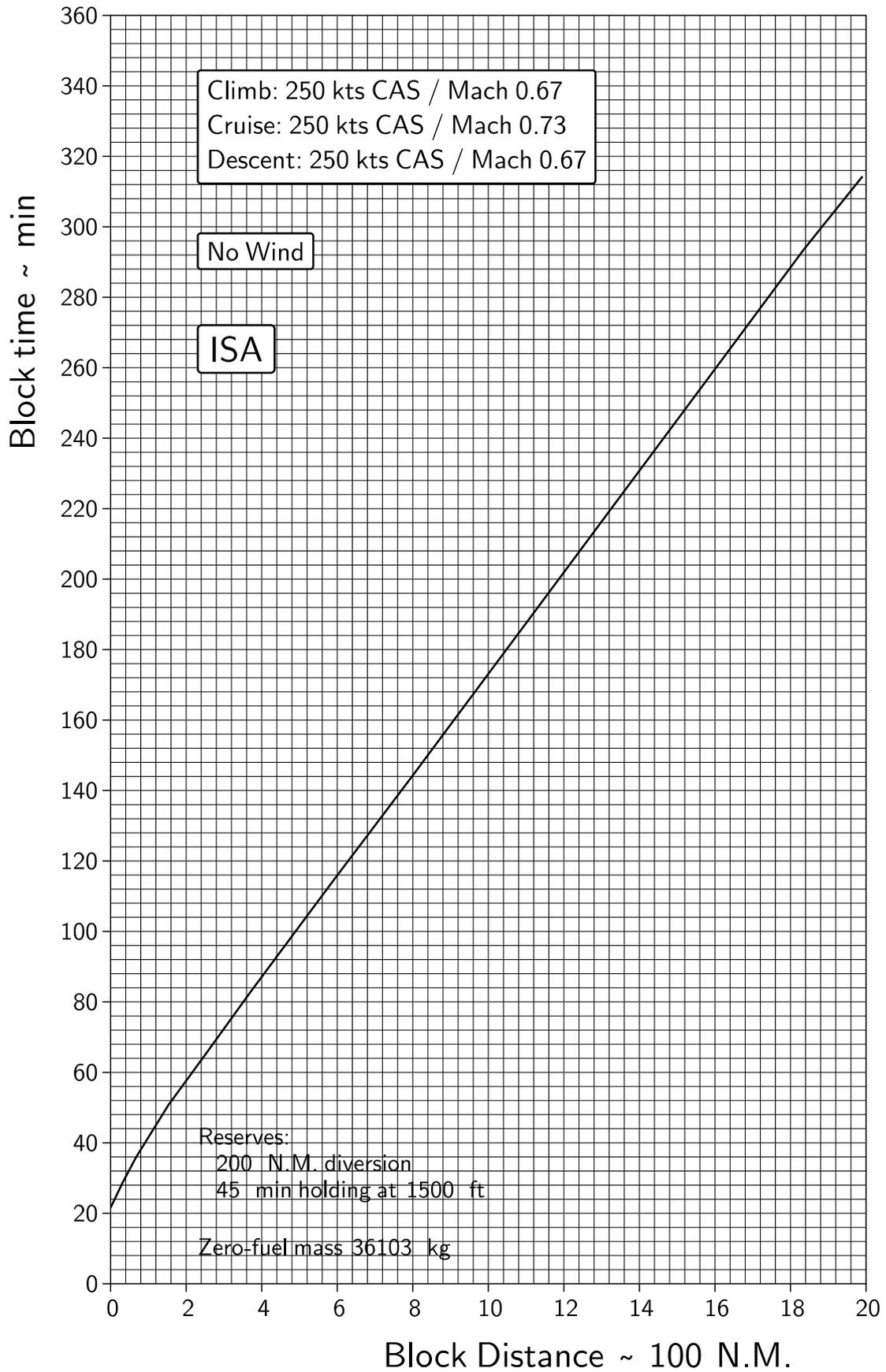


Figure 10.8: Block time for climb at 250 kts CAS / Mach 0.67, cruise at 250 kts CAS / Mach 0.73, descent at 250 kts CAS / Mach 0.67 at ISA.

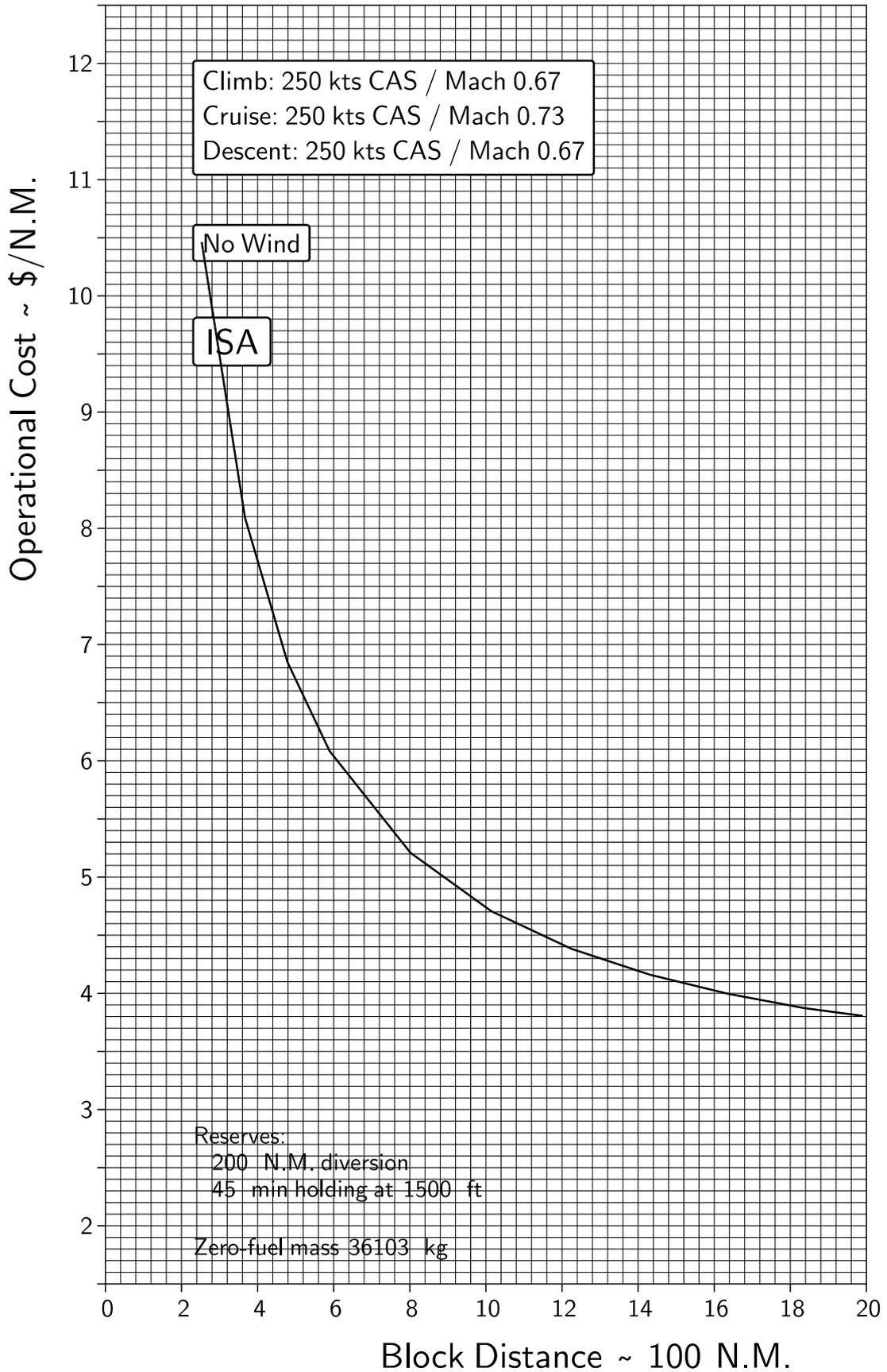


Figure 10.9: Cost/N.M. for climb at 250 kts CAS / Mach 0.67, cruise at 250 kts CAS / Mach 0.73, descent at 250 kts CAS / Mach 0.67 at ISA.

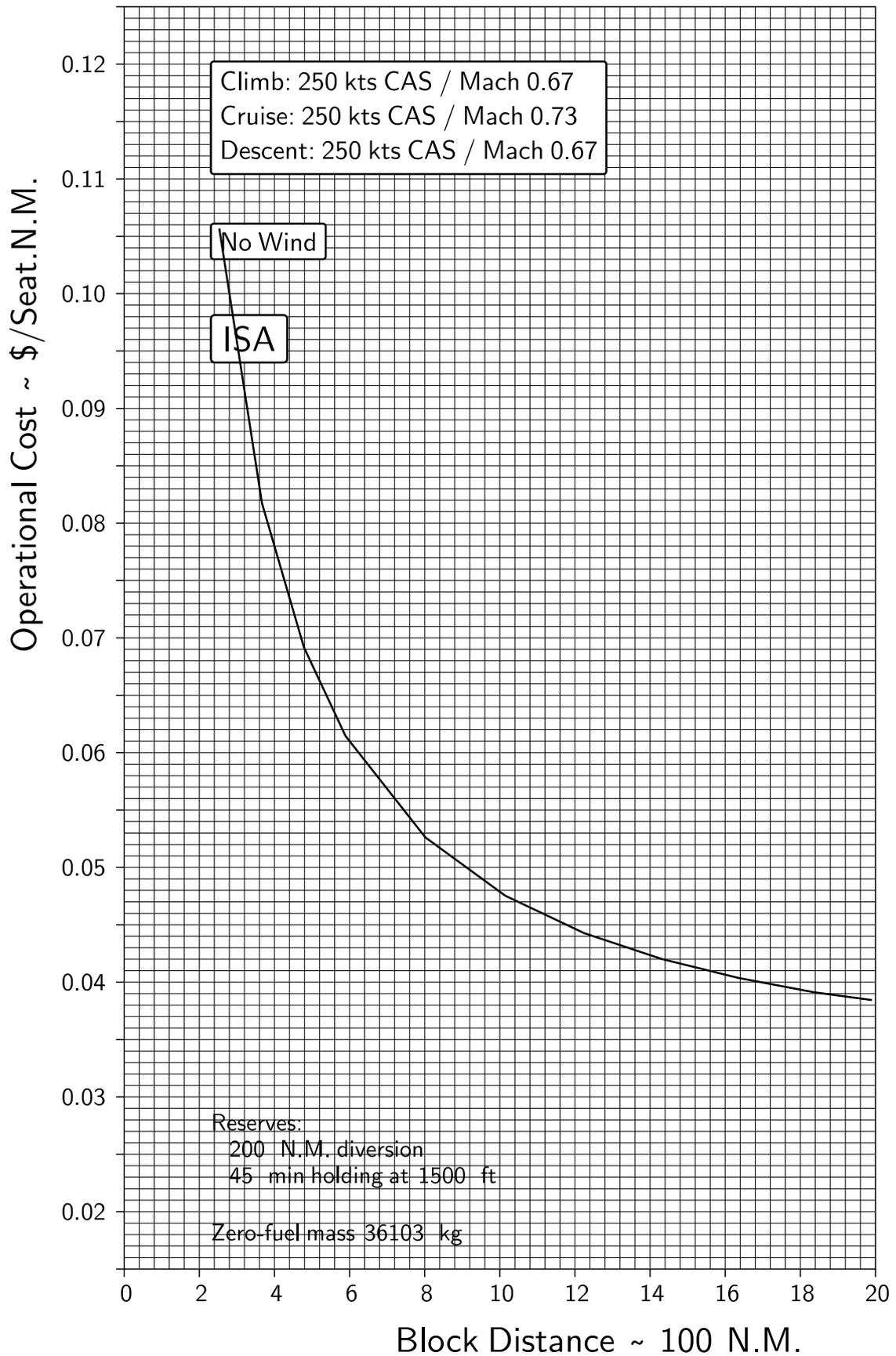


Figure 10.10: Cost/Seat.N.M. for climb at 250 kts CAS / Mach 0.67, cruise at 250 kts CAS / Mach 0.73, descent at 250 kts CAS / Mach 0.67 at ISA.

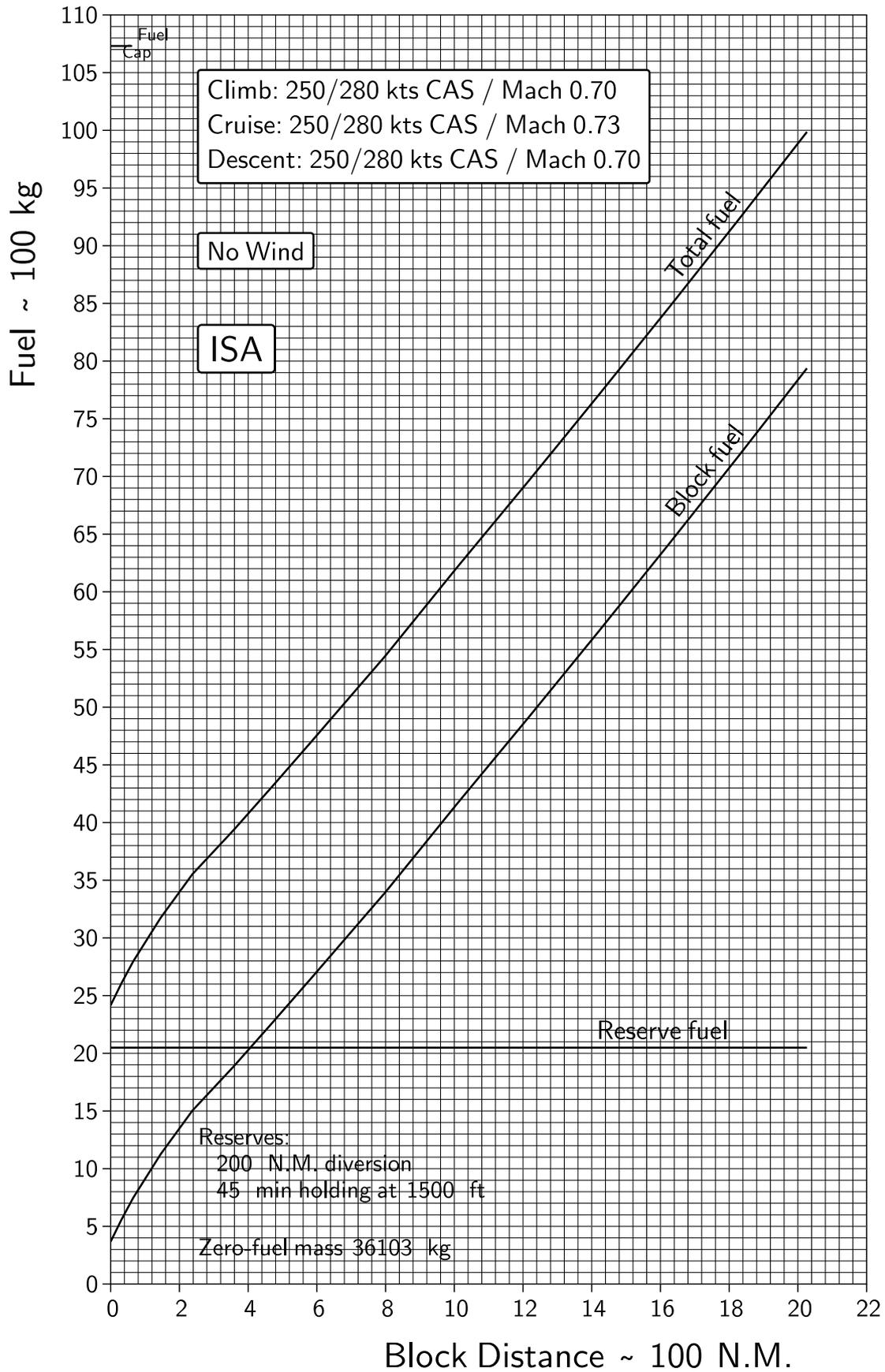


Figure 10.11: Fuel for climb at 250/280 kts CAS / Mach 0.70, cruise at 250/280 kts CAS / Mach 0.73, descent at 250/280 kts CAS / Mach 0.70 at ISA.

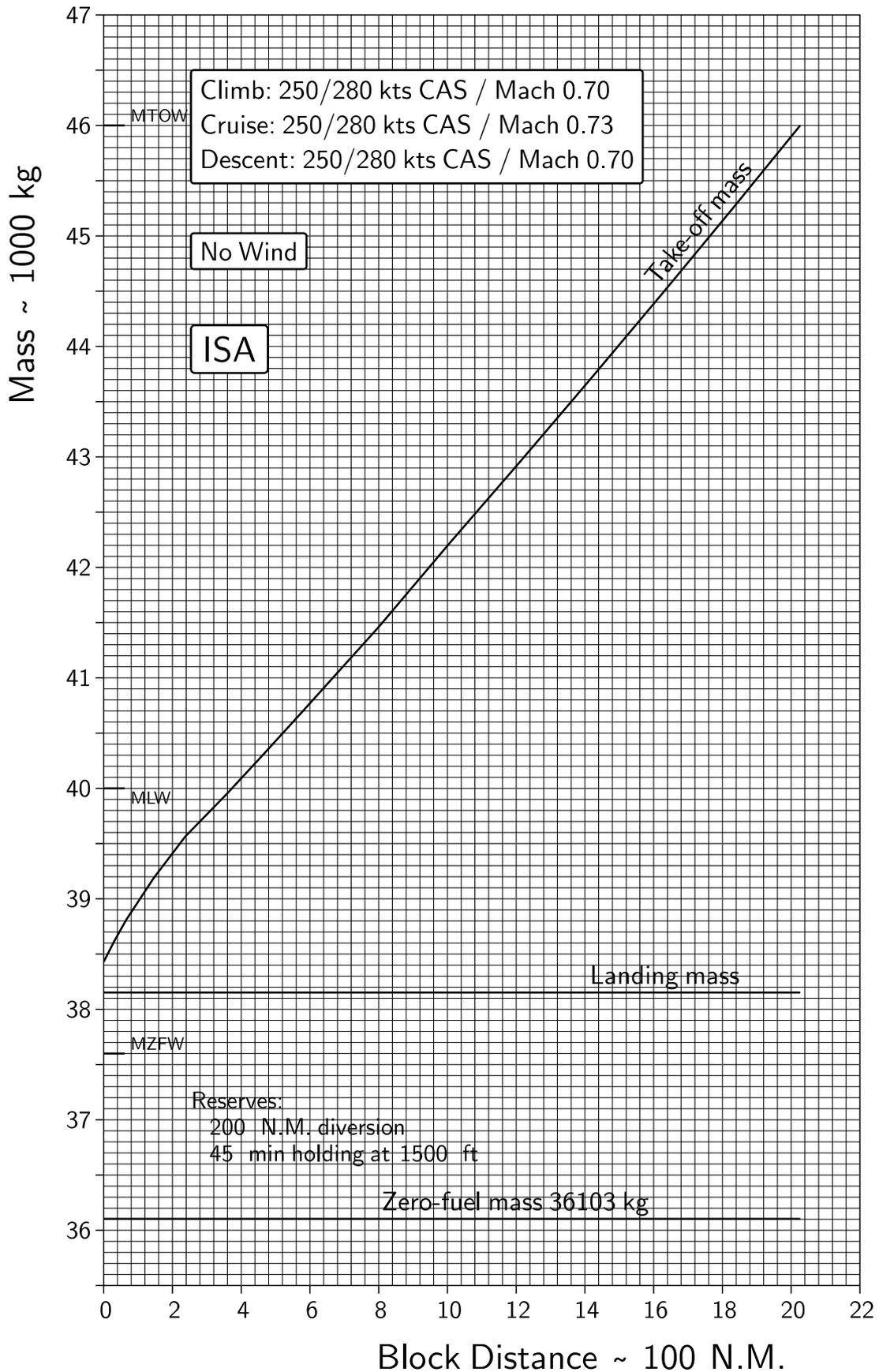


Figure 10.12: Mass for climb at 250/280 kts CAS / Mach 0.70, cruise at 250/280 kts CAS / Mach 0.73, descent at 250/280 kts CAS / Mach 0.70 at ISA.

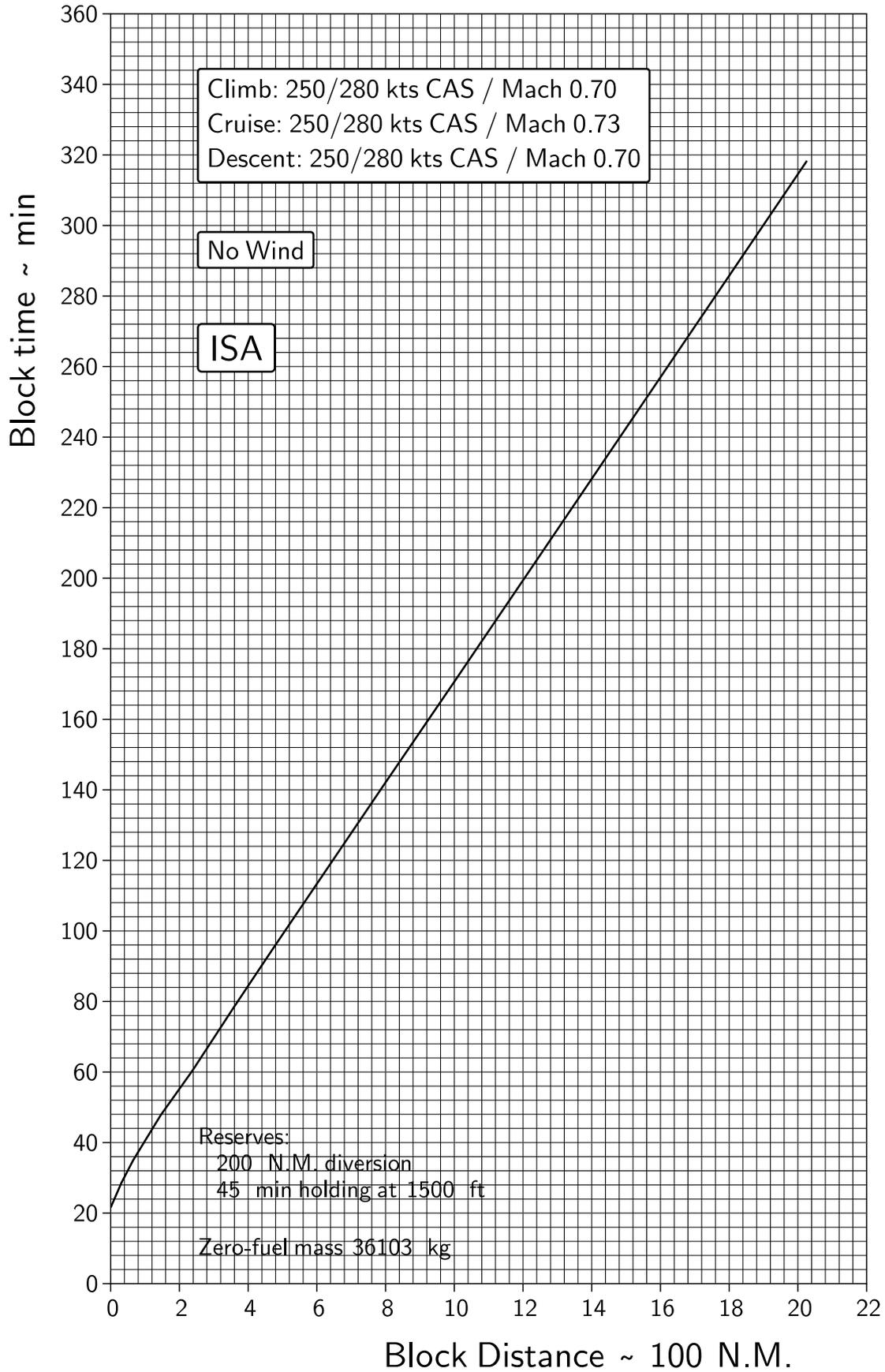


Figure 10.13: Block time for climb at 250/280 kts CAS / Mach 0.70, cruise at 250/280 kts CAS / Mach 0.73, descent at 250/280 kts CAS / Mach 0.70 at ISA.

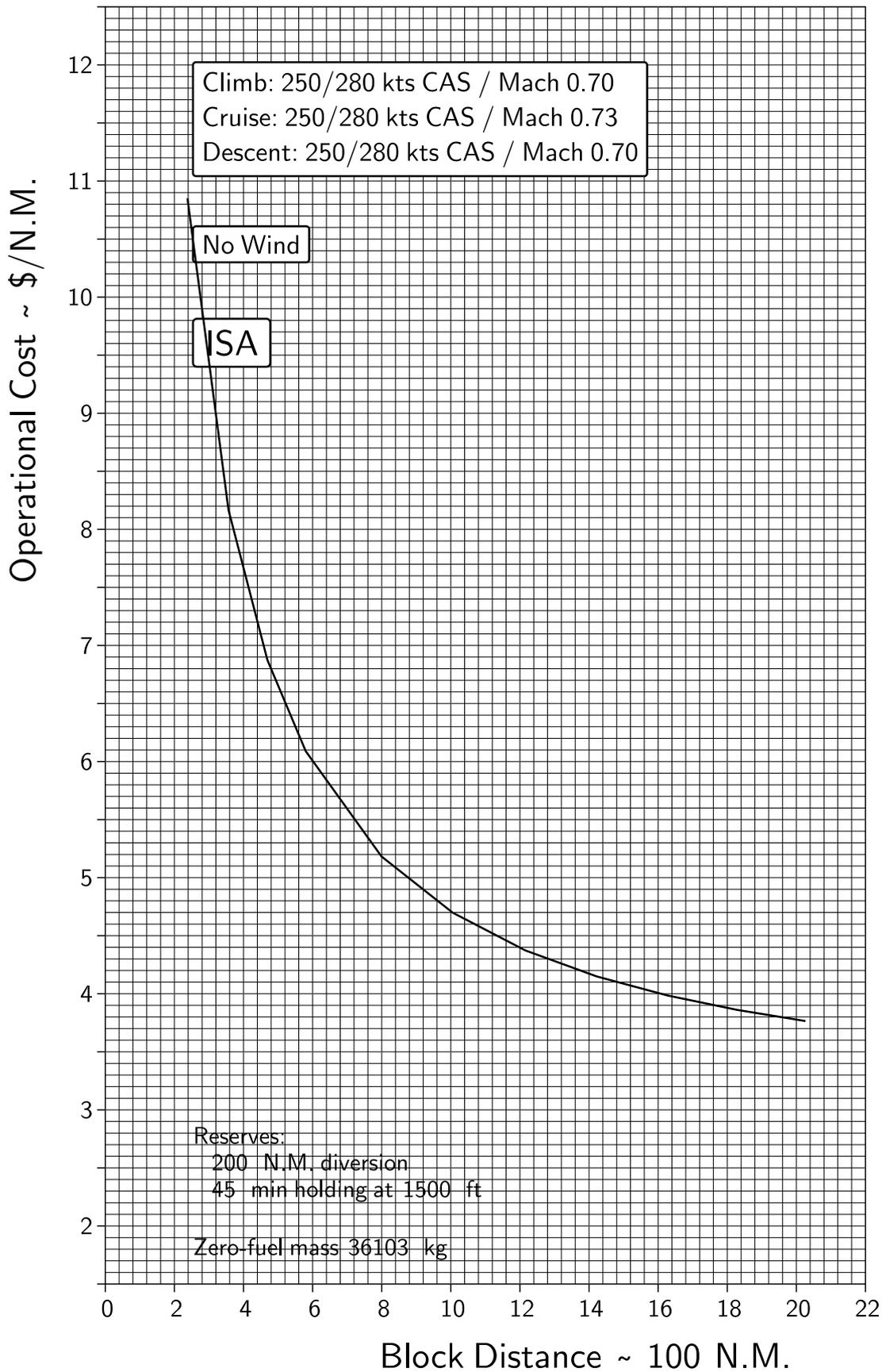


Figure 10.14: Cost/N.M. for climb at 250/280 kts CAS / Mach 0.70, cruise at 250/280 kts CAS / Mach 0.73, descent at 250/280 kts CAS / Mach 0.70 at ISA.

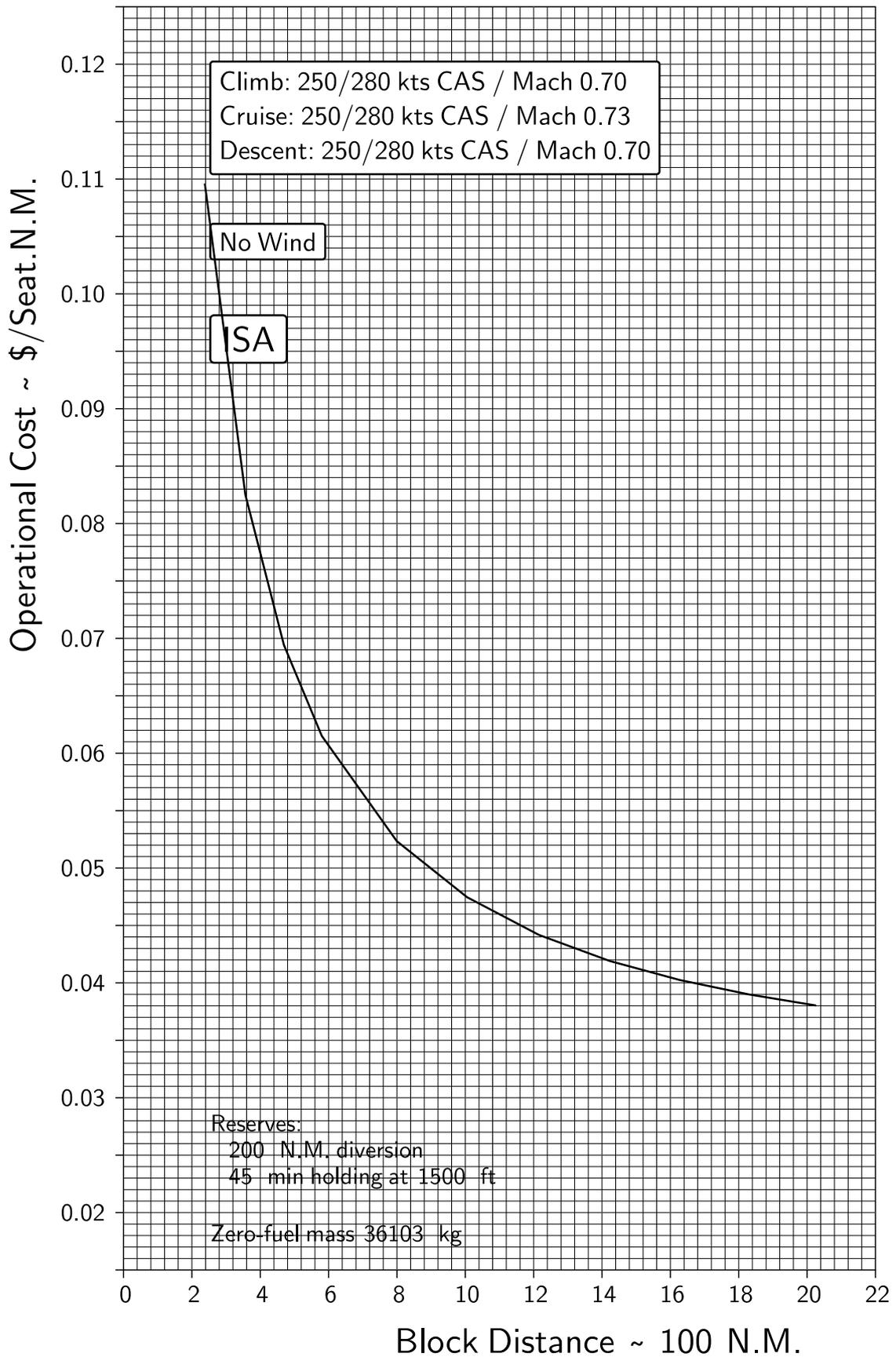


Figure 10.15: Cost/Seat.N.M. for climb at 250/280 kts CAS / Mach 0.70, cruise at 250/280 kts CAS / Mach 0.73, descent at 250/280 kts CAS / Mach 0.70 at ISA.

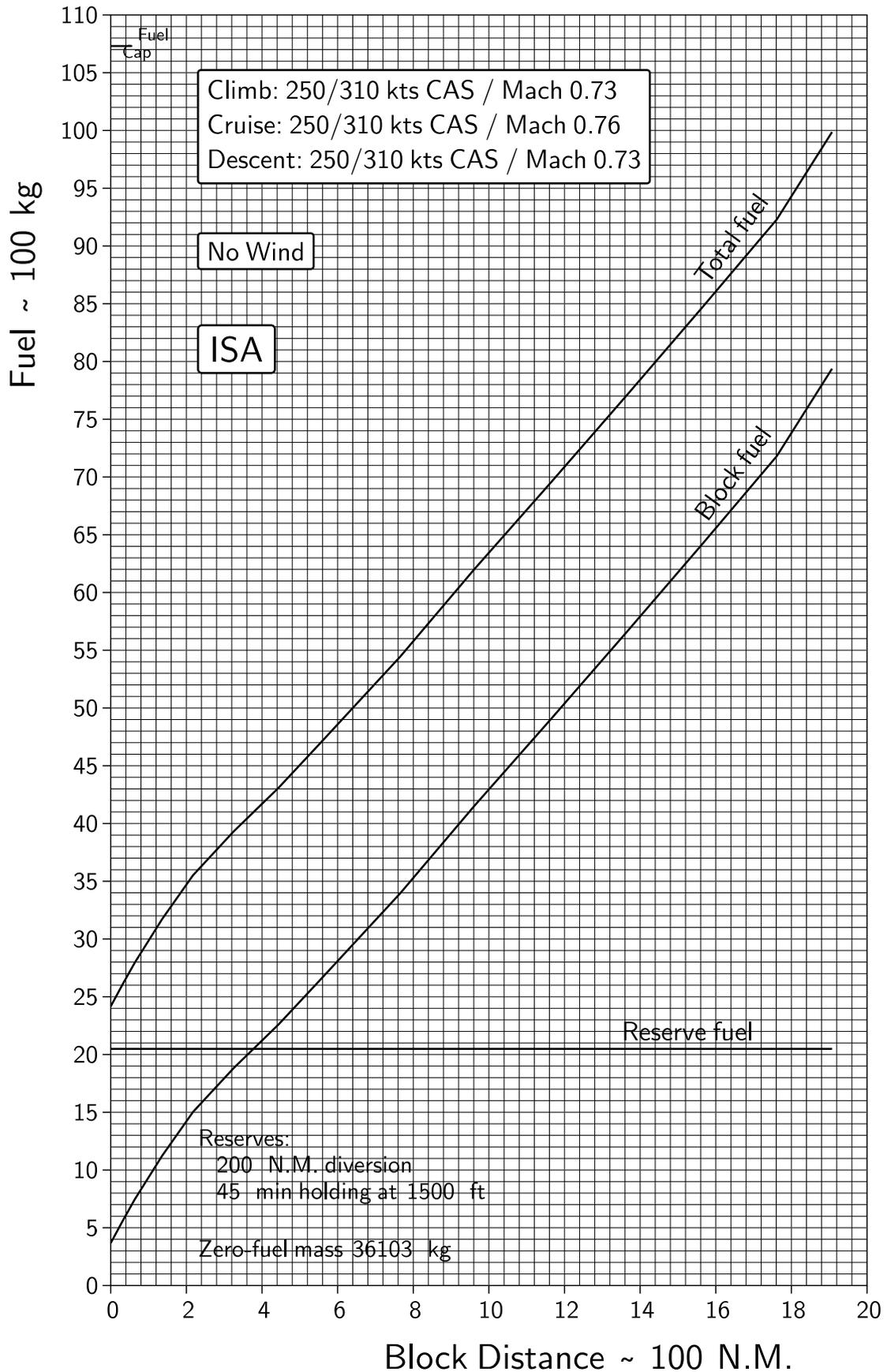


Figure 10.16: Fuel for climb at 250/310 kts CAS / Mach 0.73, cruise at 250/310 kts CAS / Mach 0.76, descent at 250/310 kts CAS / Mach 0.73 at ISA.

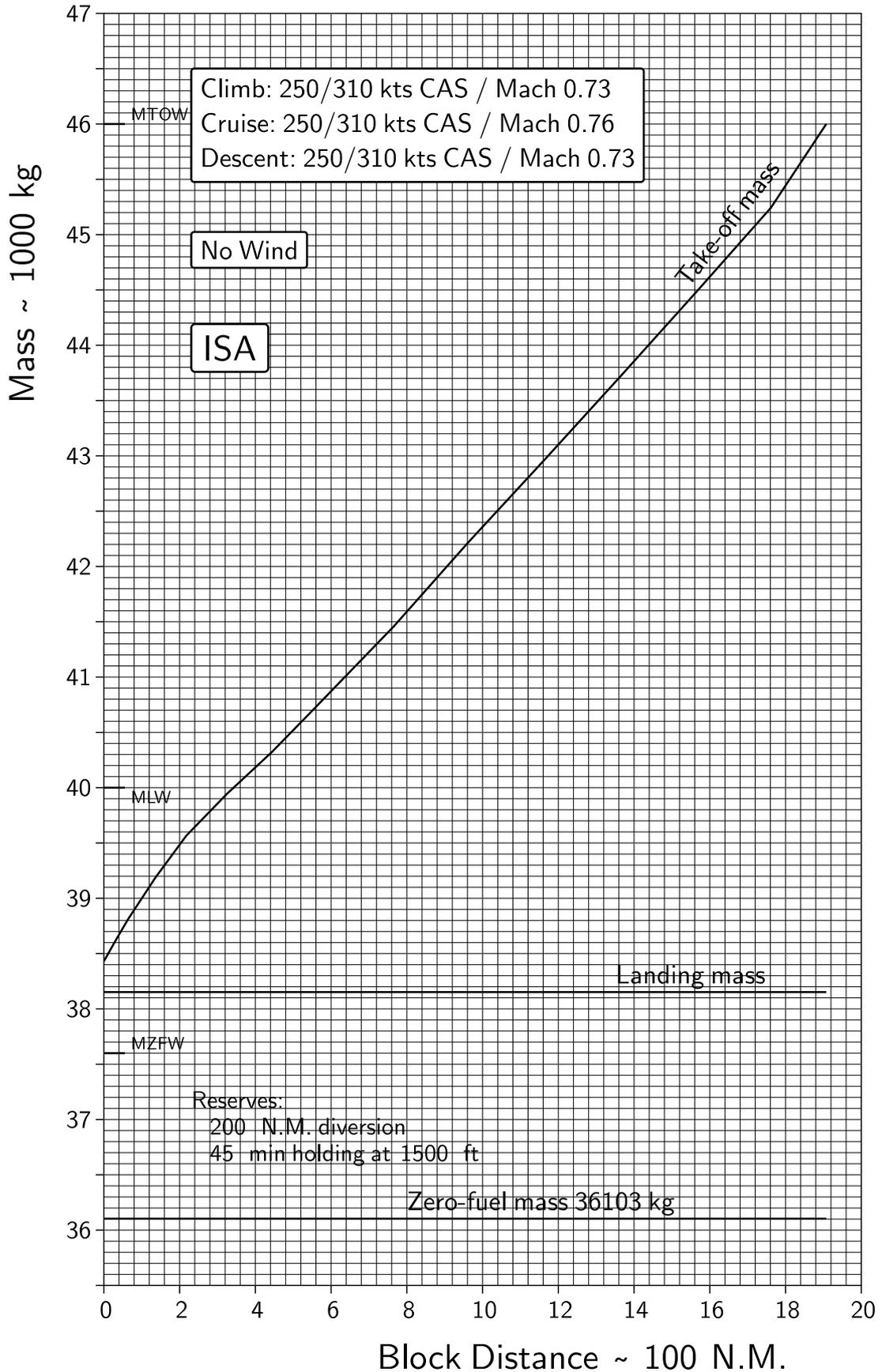


Figure 10.17: Mass for climb at 250/310 kts CAS / Mach 0.73, cruise at 250/310 kts CAS / Mach 0.76, descent at 250/310 kts CAS / Mach 0.73 at ISA.

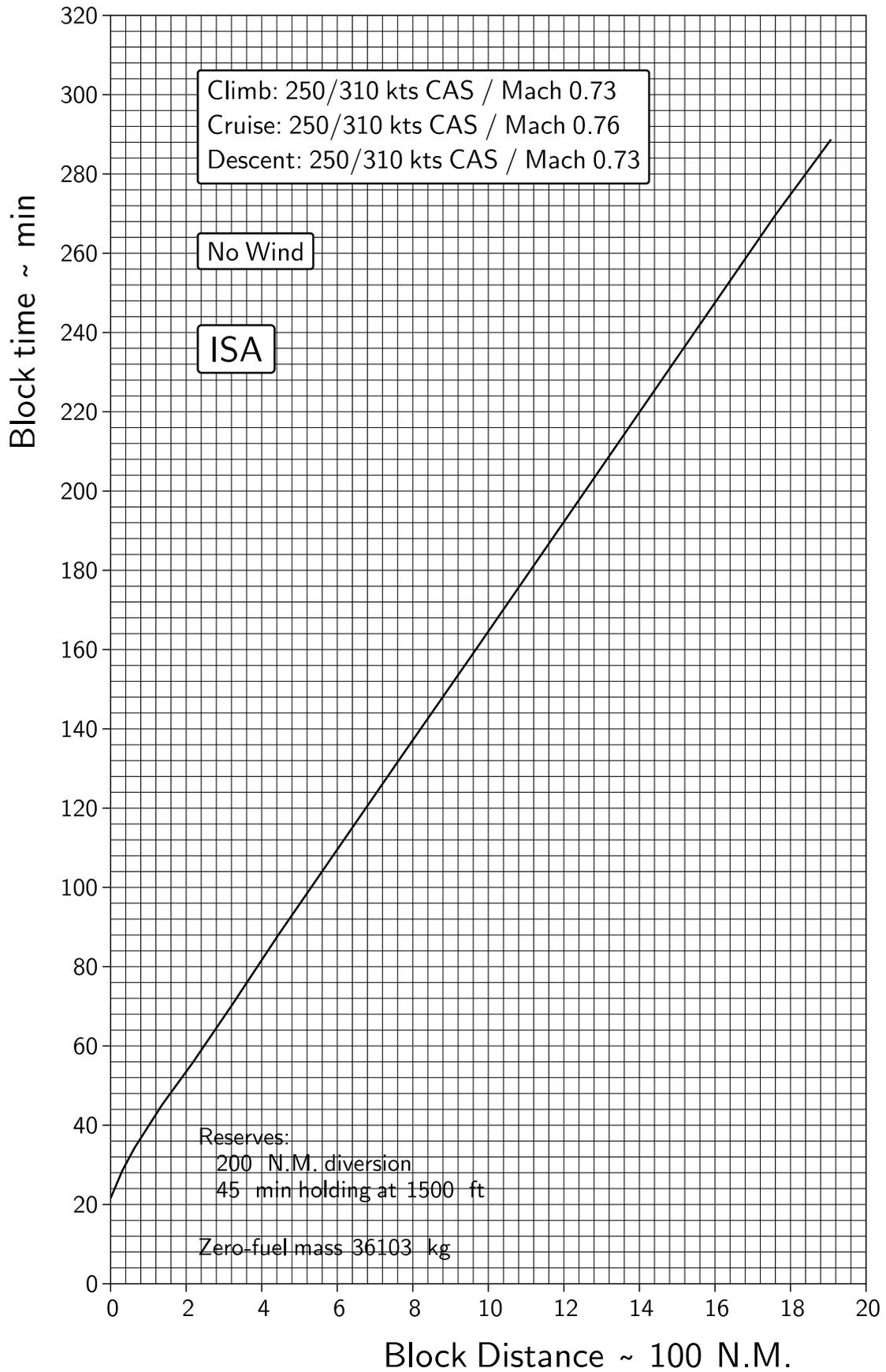


Figure 10.18: Block time for climb at 250/310 kts CAS / Mach 0.73, cruise at 250/310 kts CAS / Mach 0.76, descent at 250/310 kts CAS / Mach 0.73 at ISA.

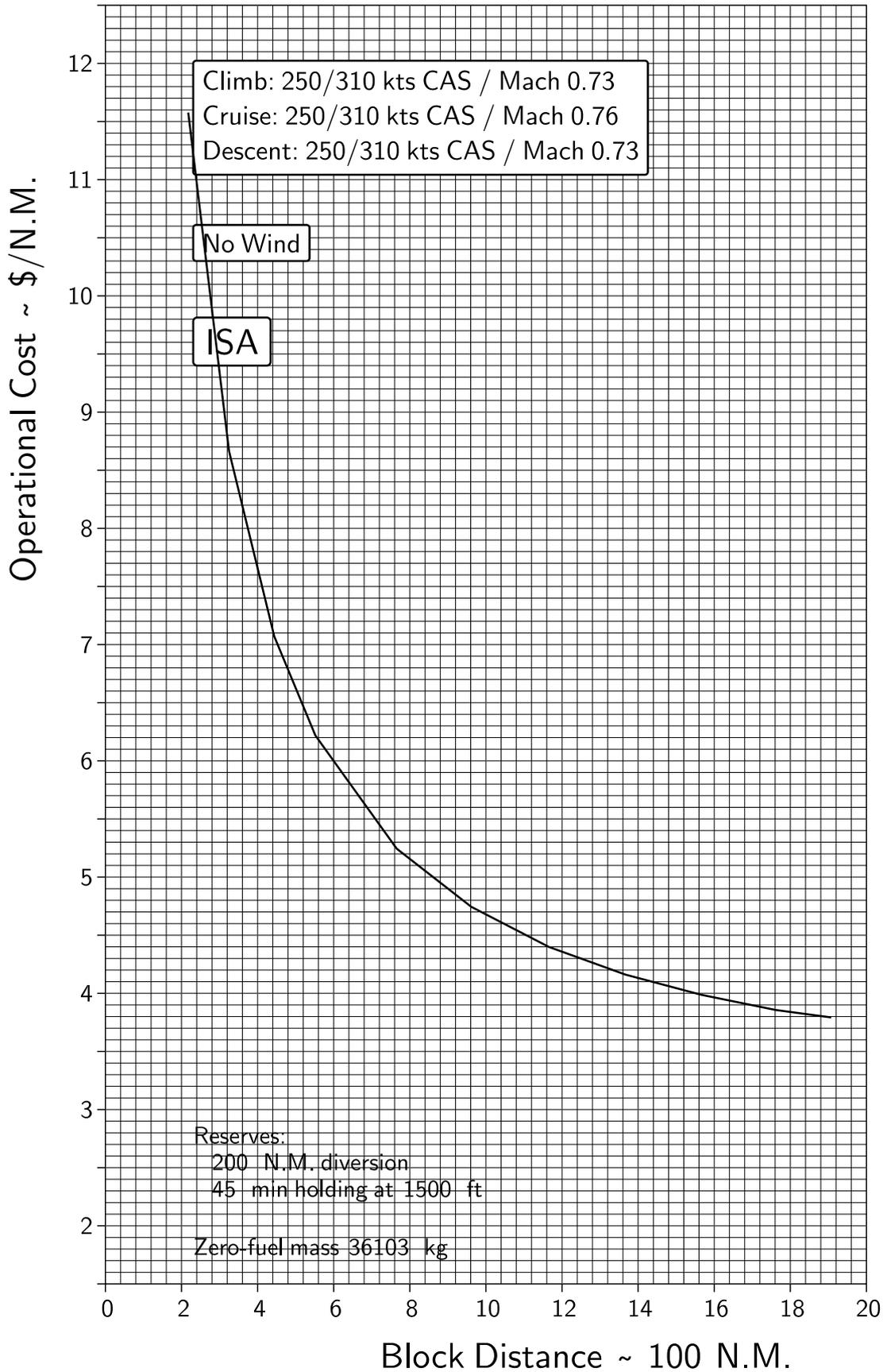


Figure 10.19: Cost/N.M. for climb at 250/310 kts CAS / Mach 0.73, cruise at 250/310 kts CAS / Mach 0.76, descent at 250/310 kts CAS / Mach 0.73 at ISA.

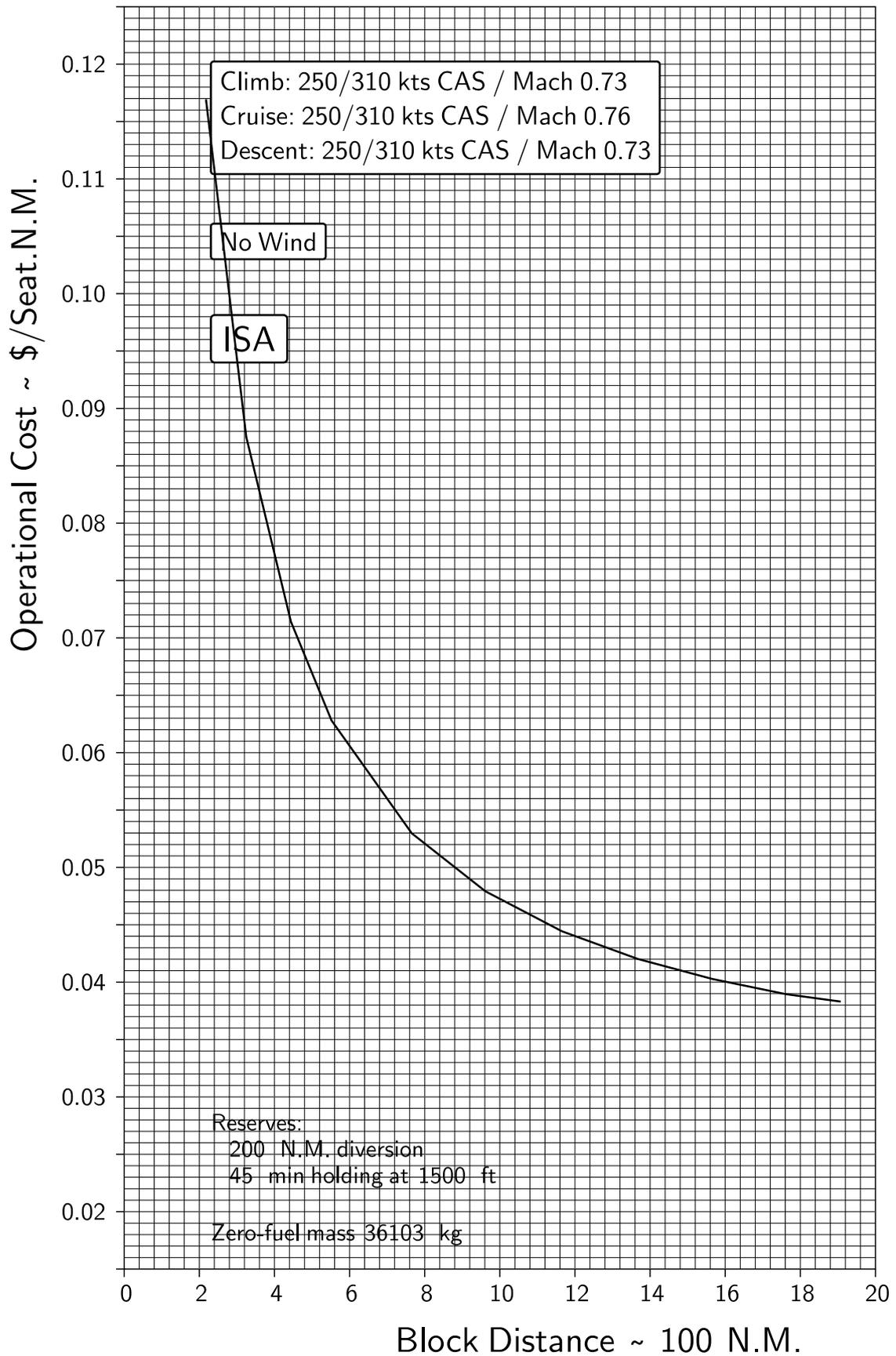


Figure 10.20: Cost/Seat.N.M. for climb at 250/310 kts CAS / Mach 0.73, cruise at 250/310 kts CAS / Mach 0.76, descent at 250/310 kts CAS / Mach 0.73 at ISA.

# Chapter 11

## Payload-range

### Assumptions

ICAO Standard Flight Levels.

Operational speed restriction of 250 kts CAS below 10 000 ft.

Taxi-out 9.0 min, approach 6.0 min, and taxi-in 5.0 min.

No wind.

Operating empty mass 26 500 kg.

Reserves: 200 N.M. diversion, 45 min holding at 1 500 ft over alternate.

### Figures

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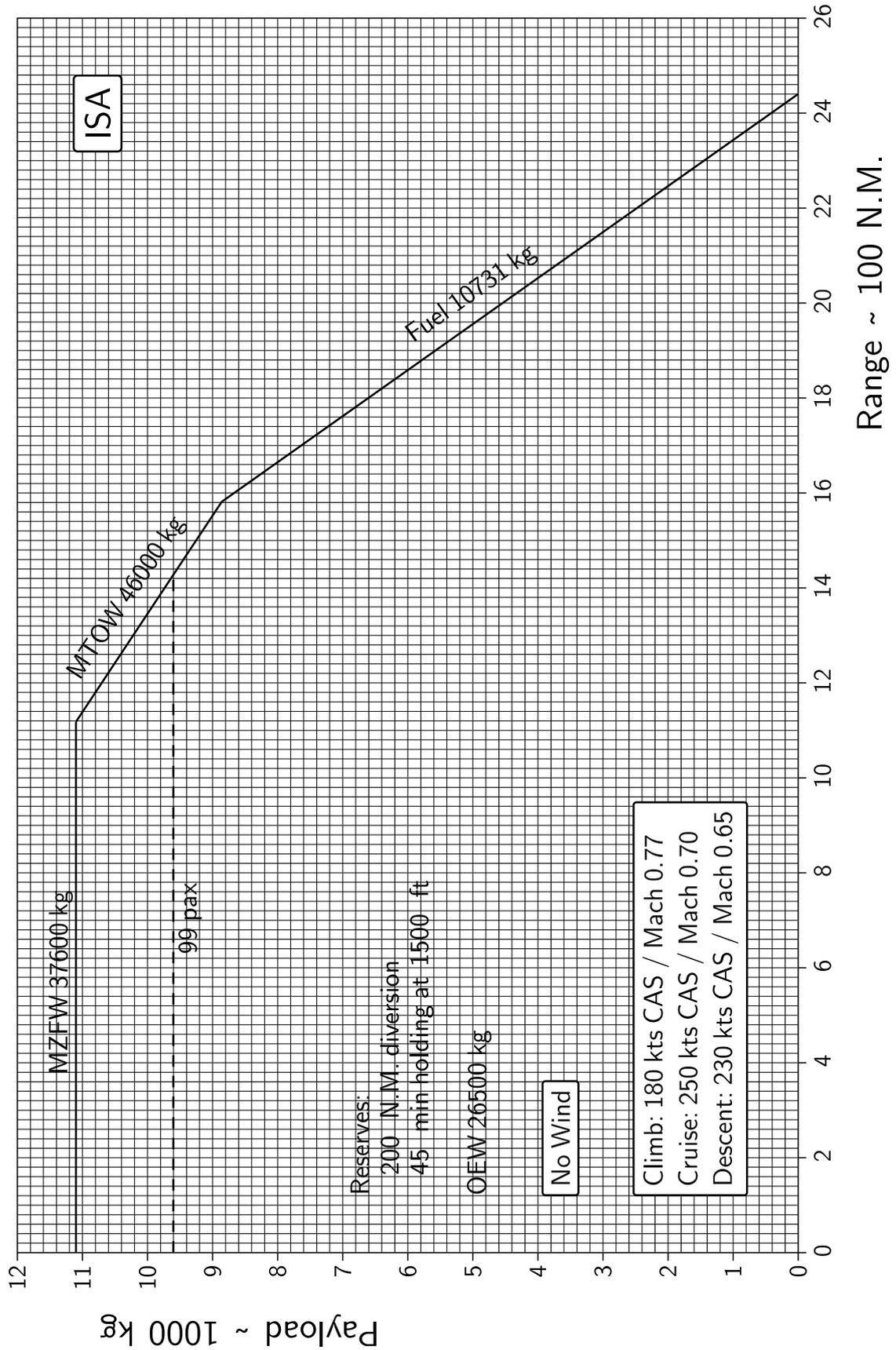


Figure 11.1: Payload-range for climb at 180 kts CAS / Mach 0.77, cruise at 250 kts CAS / Mach 0.70, descent at 230 kts CAS / Mach 0.65 at ISA.

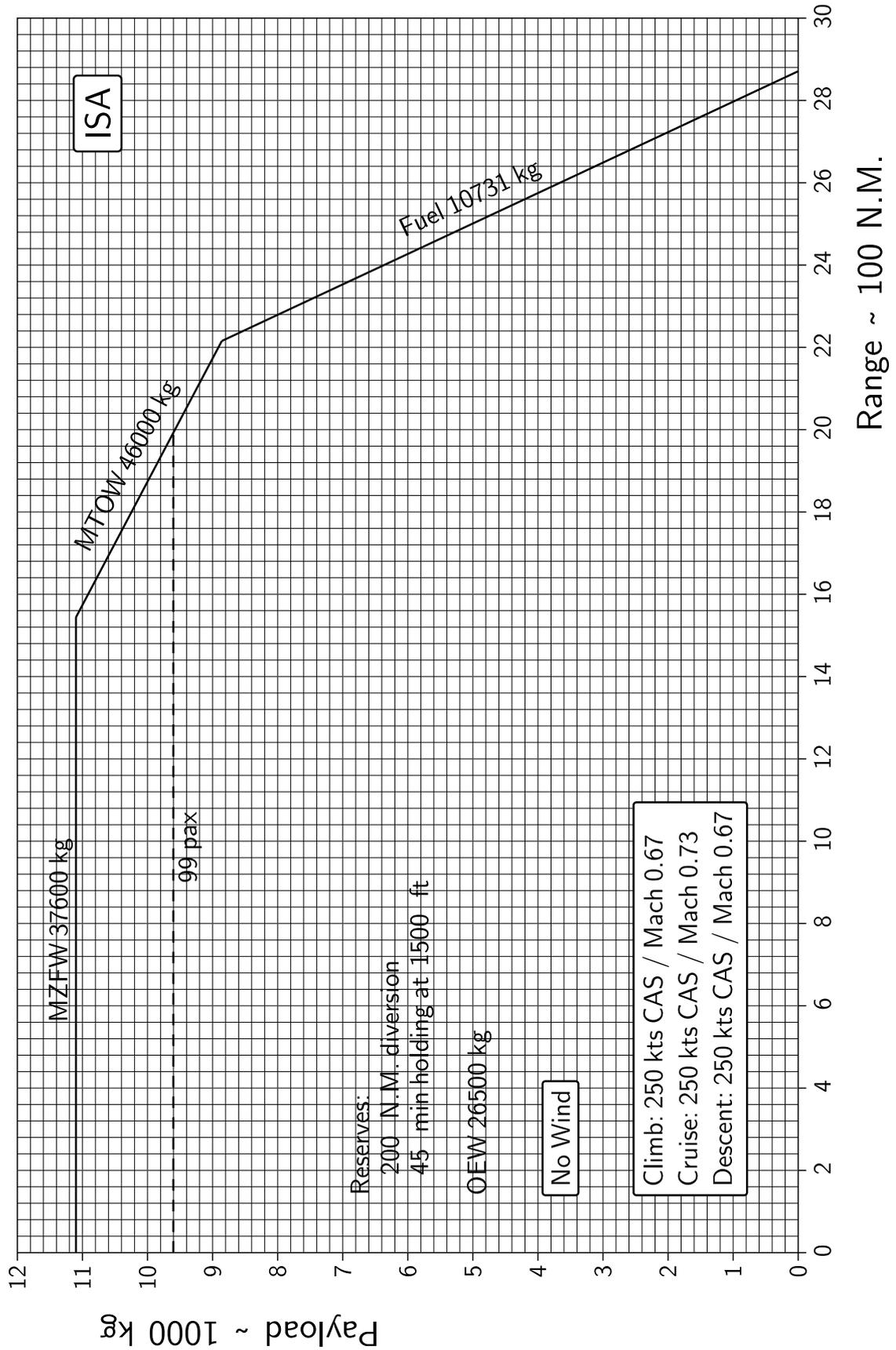


Figure 11.2: Payload-range for climb at 250 kts CAS / Mach 0.67, cruise at 250 kts CAS / Mach 0.73, descent at 250 kts CAS / Mach 0.67 at ISA.

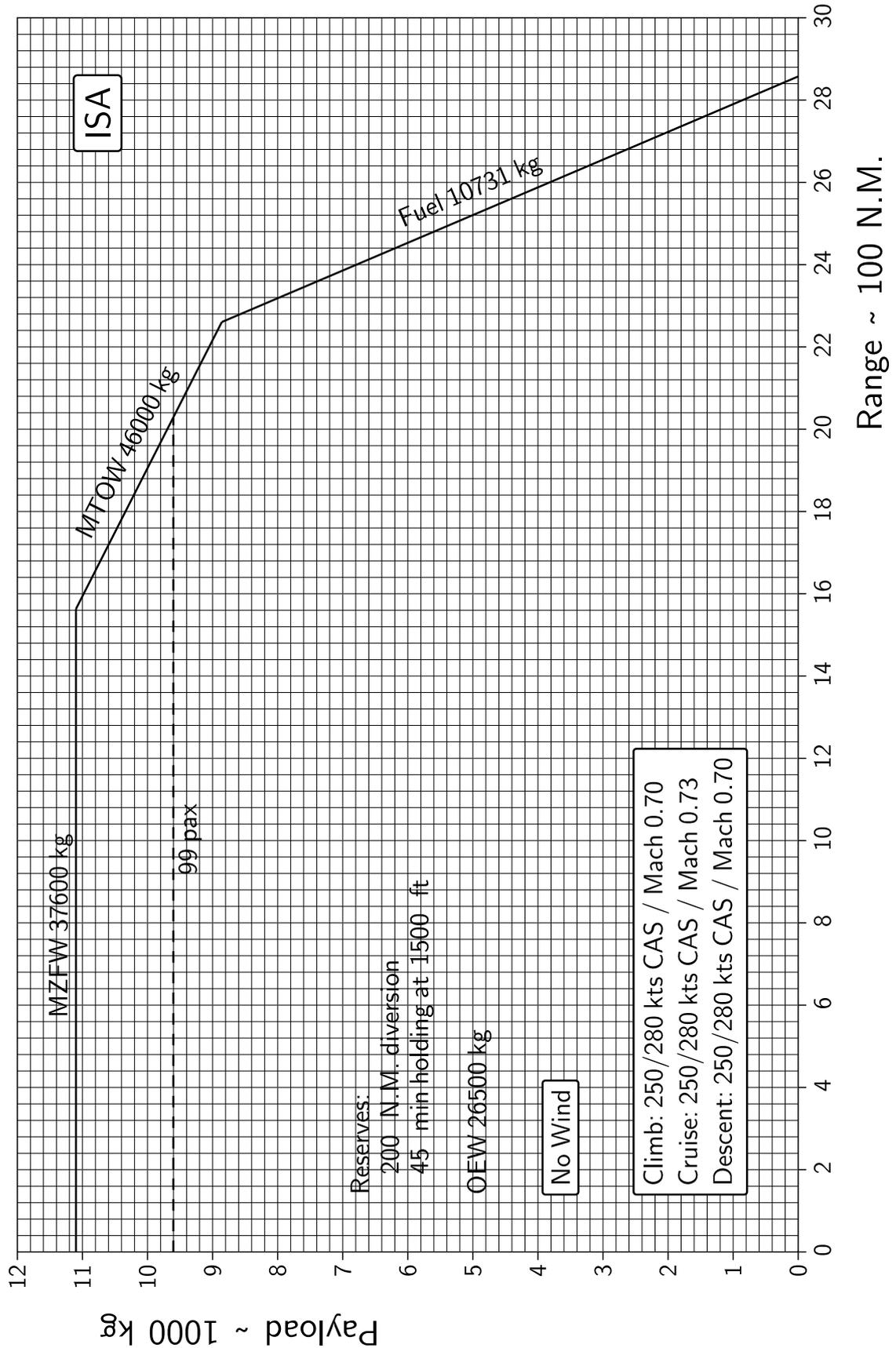


Figure 11.3: Payload-range for climb at 250/280 kts CAS / Mach 0.70, cruise at 250/280 kts CAS / Mach 0.73, descent at 250/280 kts CAS / Mach 0.70 at ISA.

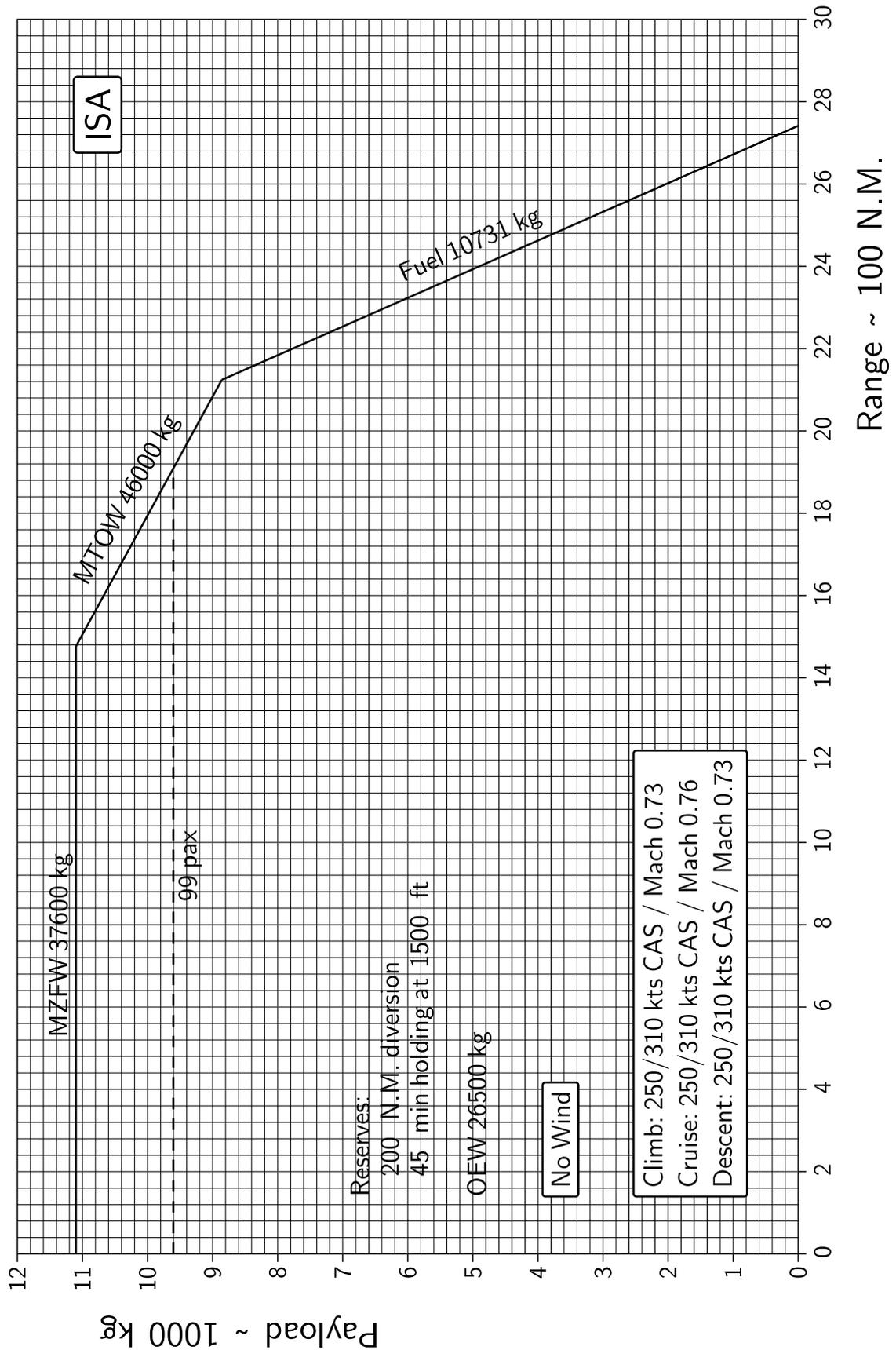


Figure 11.4: Payload-range for climb at 250/310 kts CAS / Mach 0.73, cruise at 250/310 kts CAS / Mach 0.76, descent at 250/310 kts CAS / Mach 0.73 at ISA.



# Chapter 12

## Ceiling with one engine inoperative

### Assumptions

One engine inoperative.

The ceiling is defined by a gross gradient of 1.1 %.

Anti-icing off, airconditioning off below 13 500 ft.

### Figures

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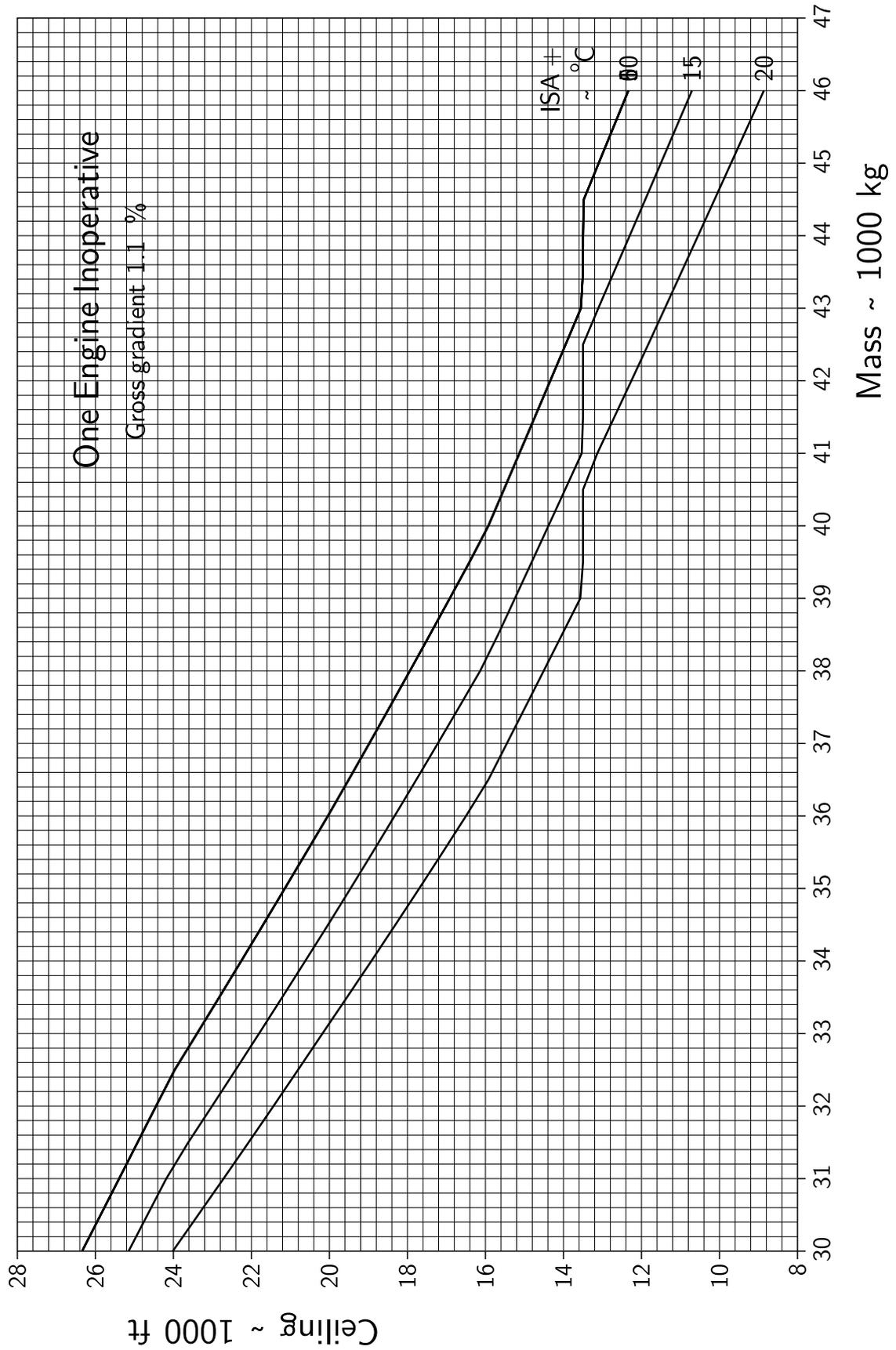


Figure 12.1: Ceiling with one engine inoperative.

# Chapter 13

## Driftdown with one engine inoperative

### Assumptions

One engine inoperative.

The net flight path is the gross flight path diminished by 1.1 %.

Anti-icing off, airconditioning off below 13 500 ft.

No wind.

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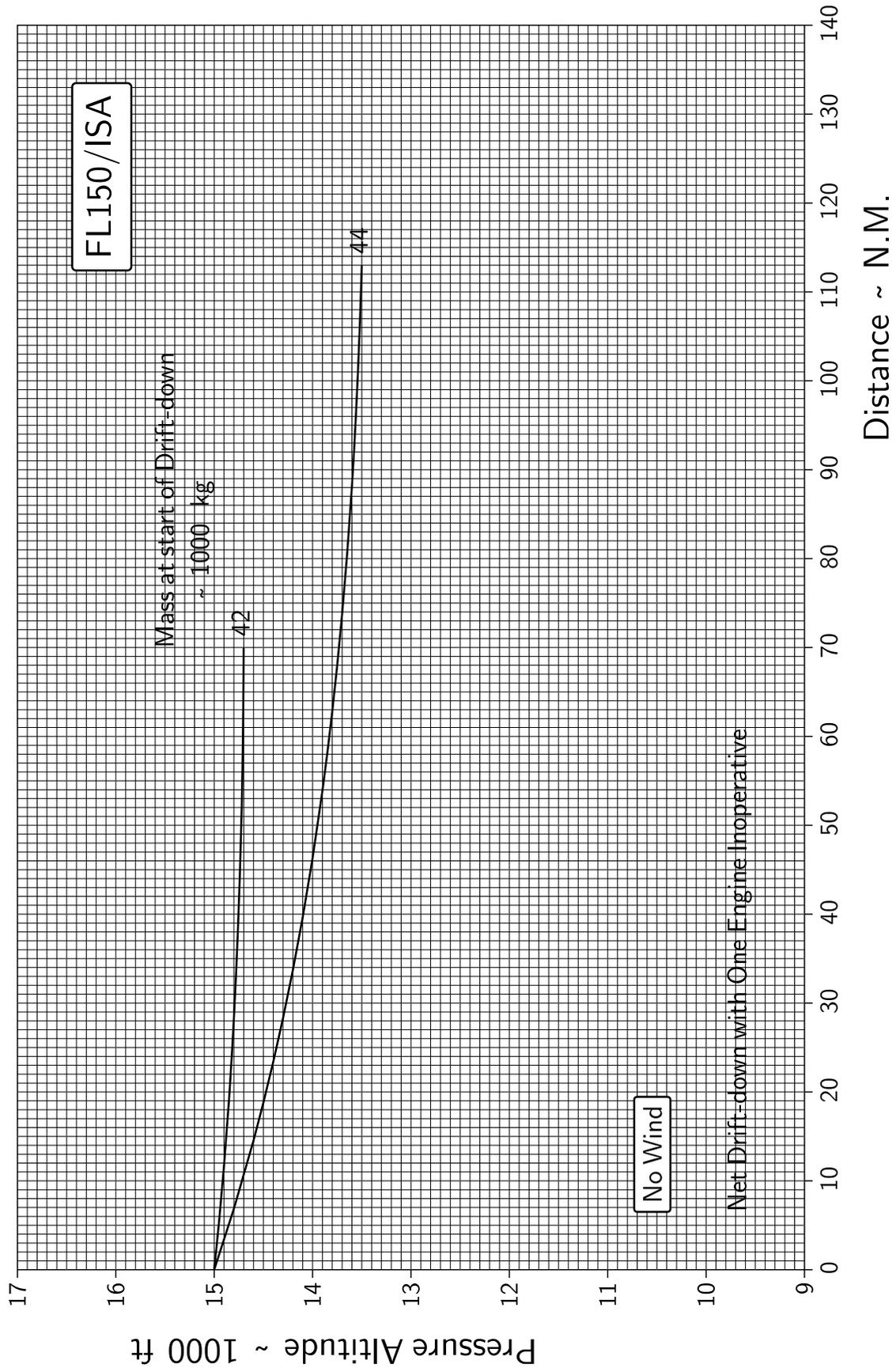


Figure 13.1: Driftdown from FL150 at ISA.

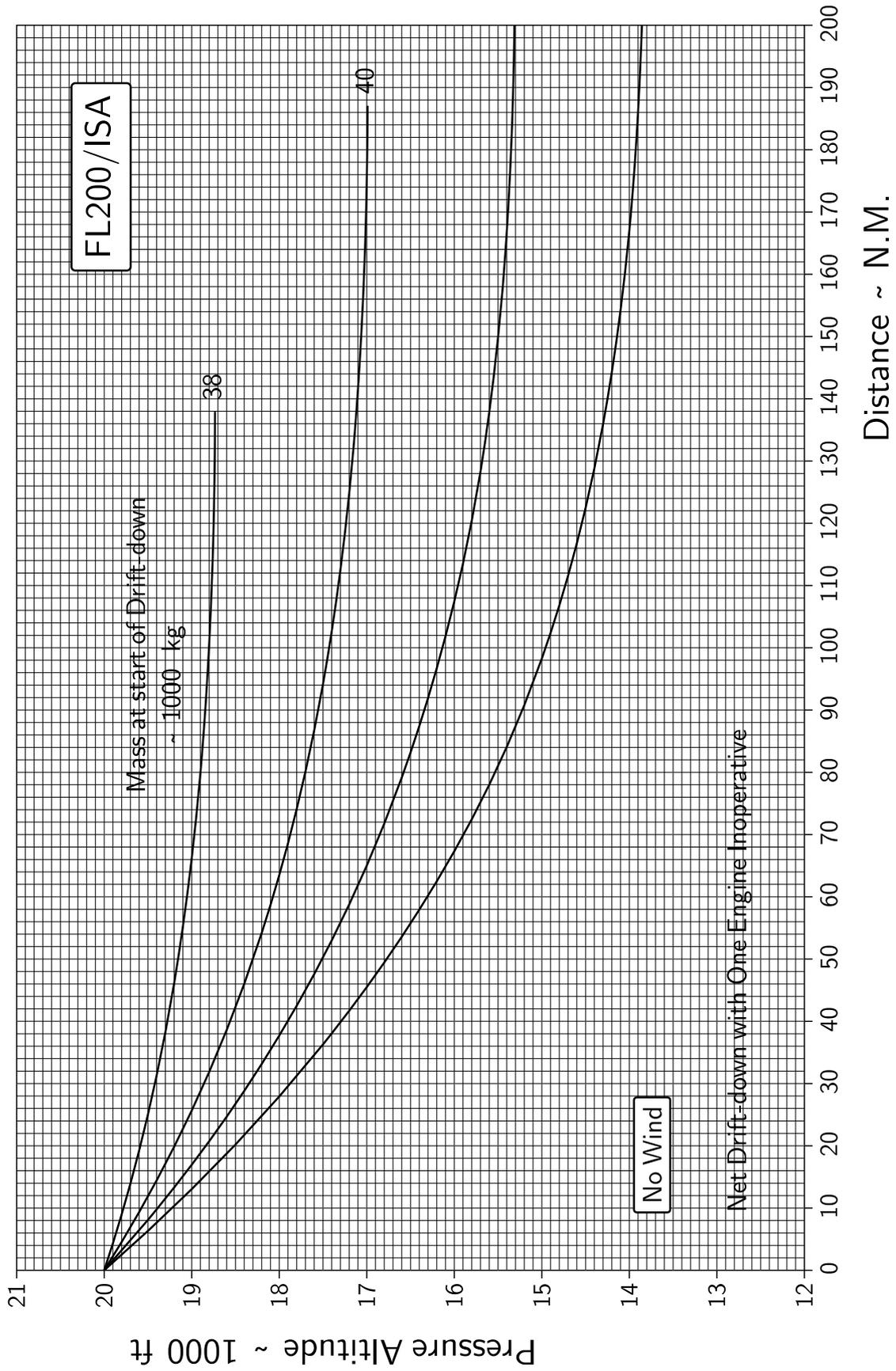


Figure 13.2: Driftdown from FL200 at ISA.

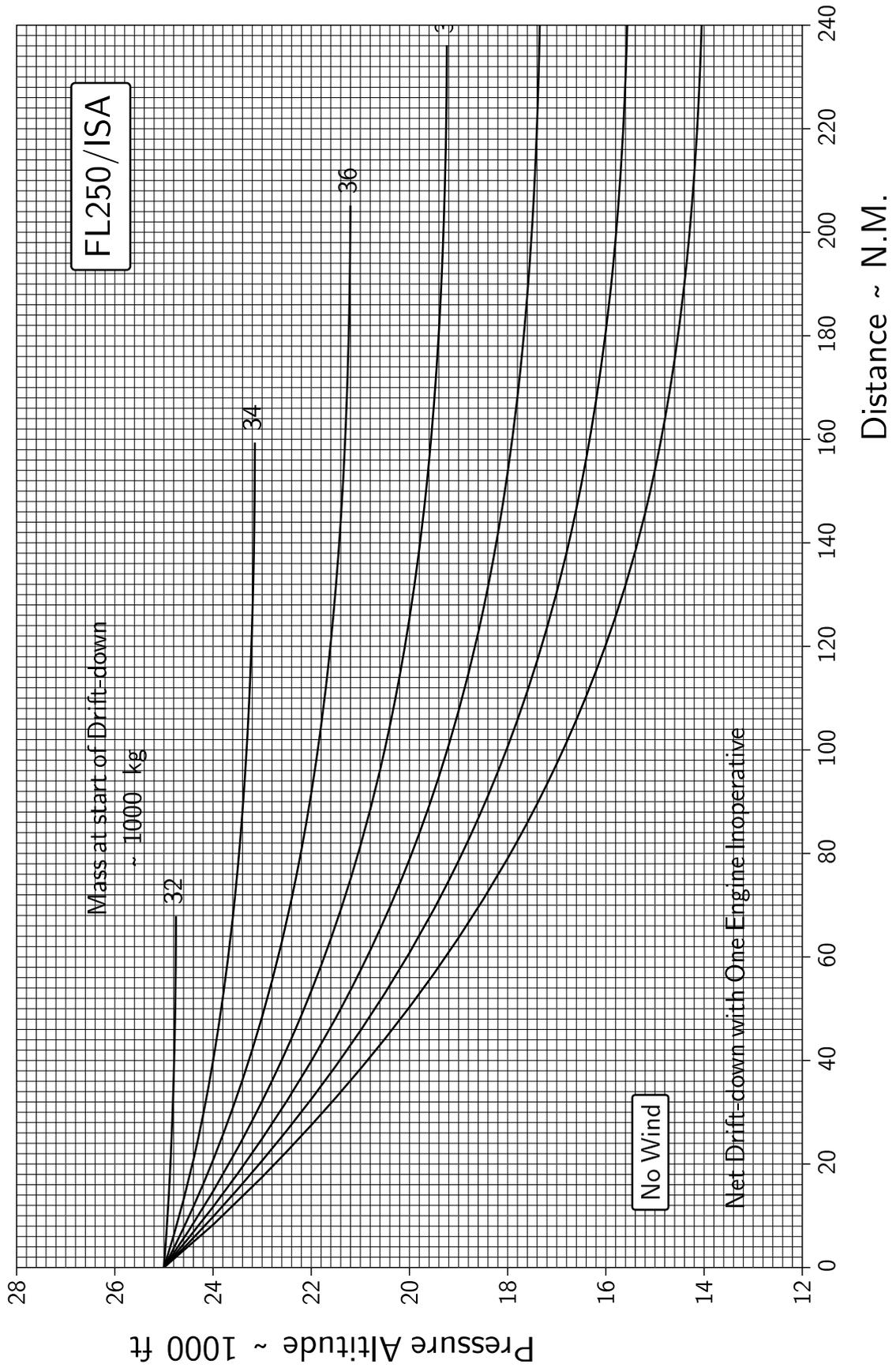


Figure 13.3: Driftdown from FL250 at ISA.

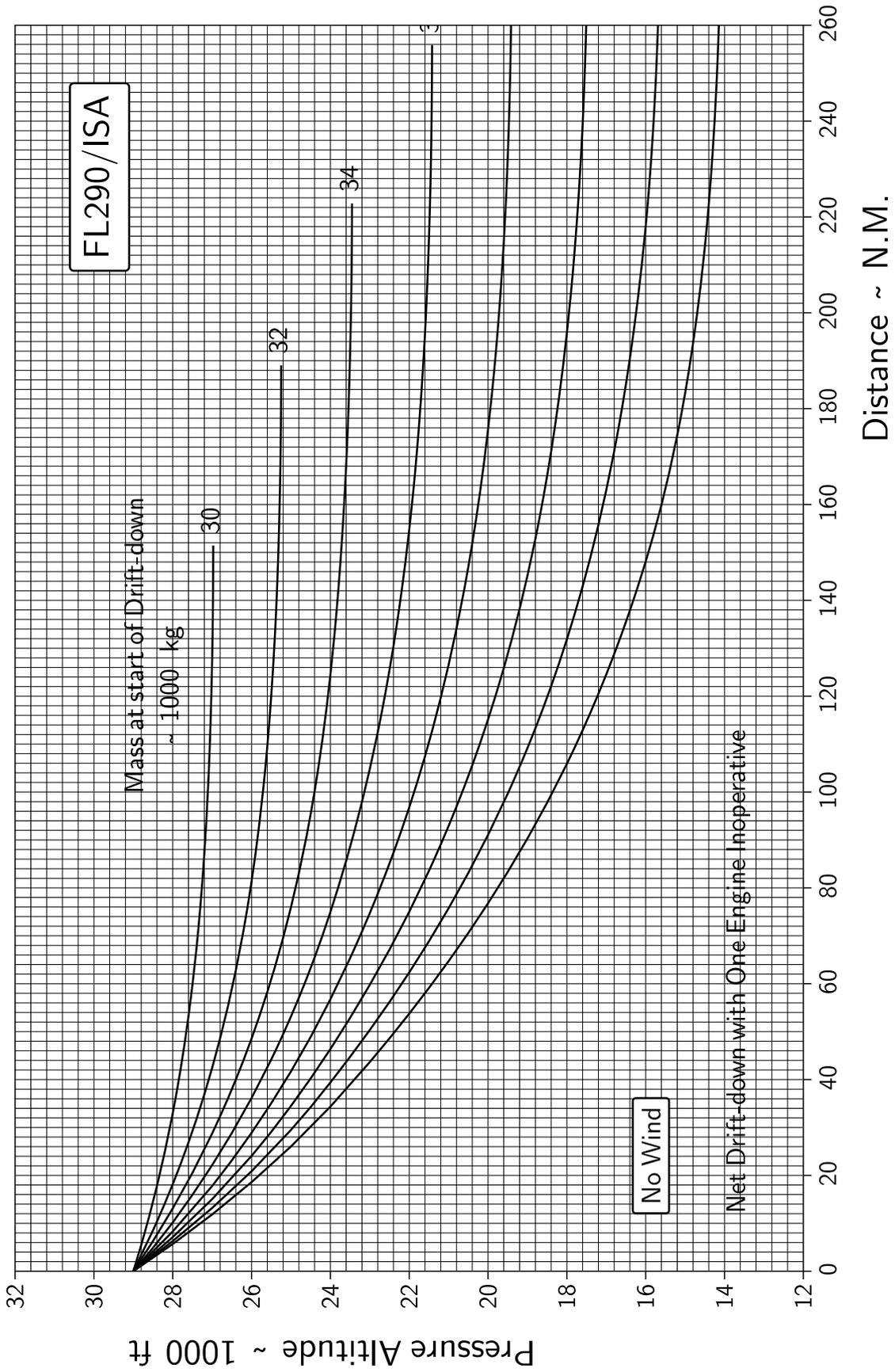


Figure 13.4: Driftdown from FL290 at ISA.

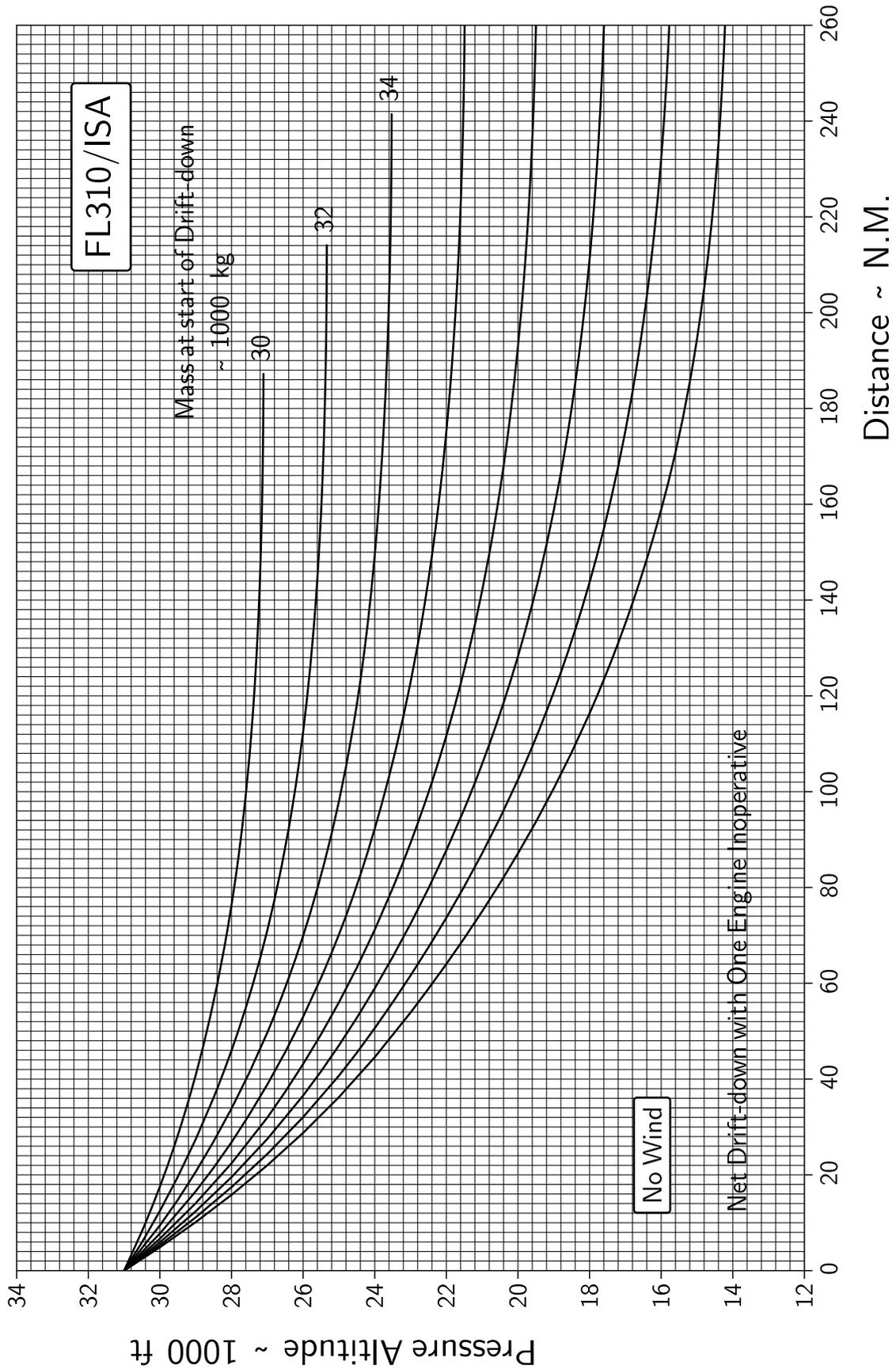


Figure 13.5: Driftdown from FL310 at ISA.

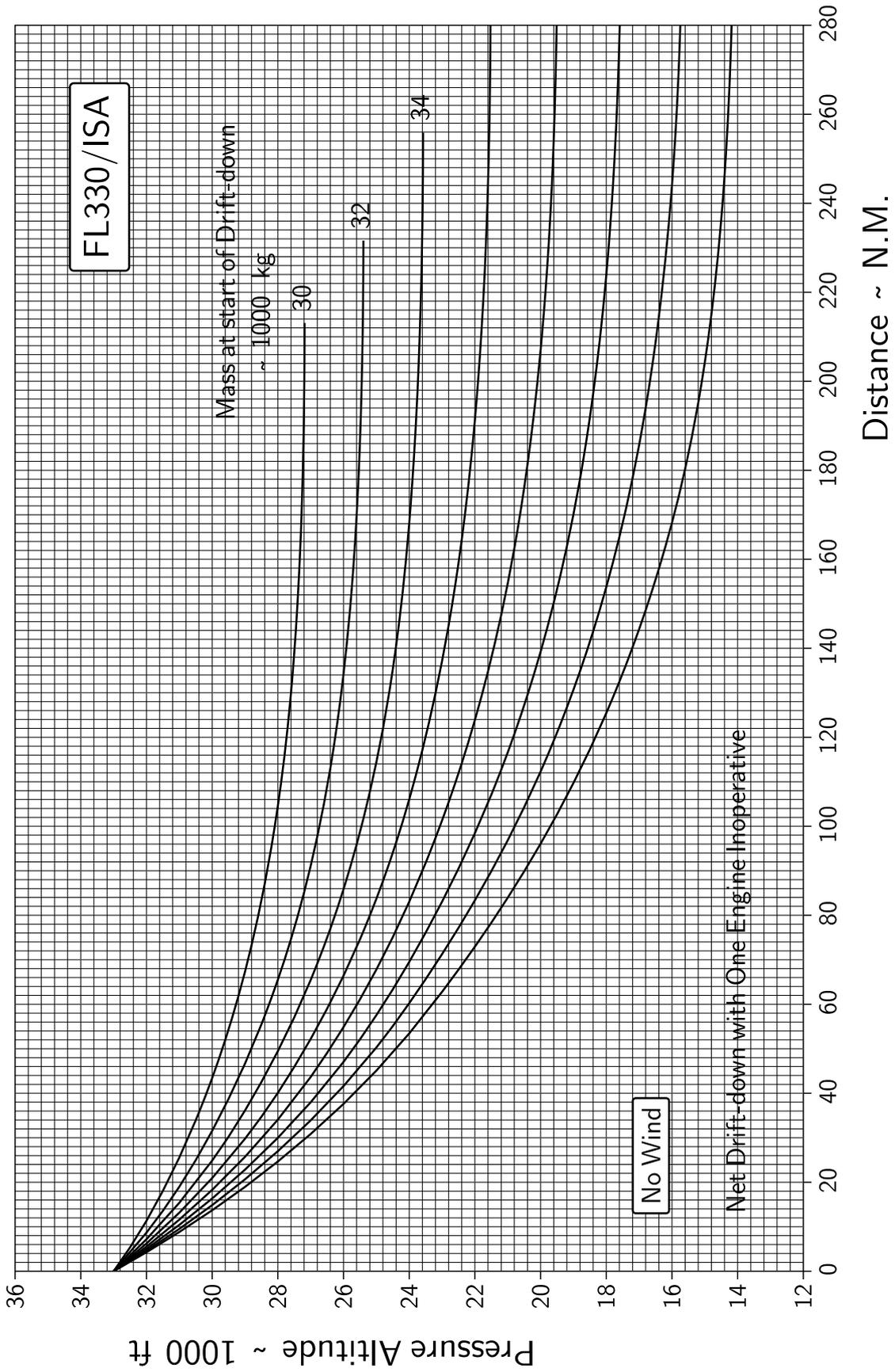


Figure 13.6: Driftdown from FL330 at ISA.

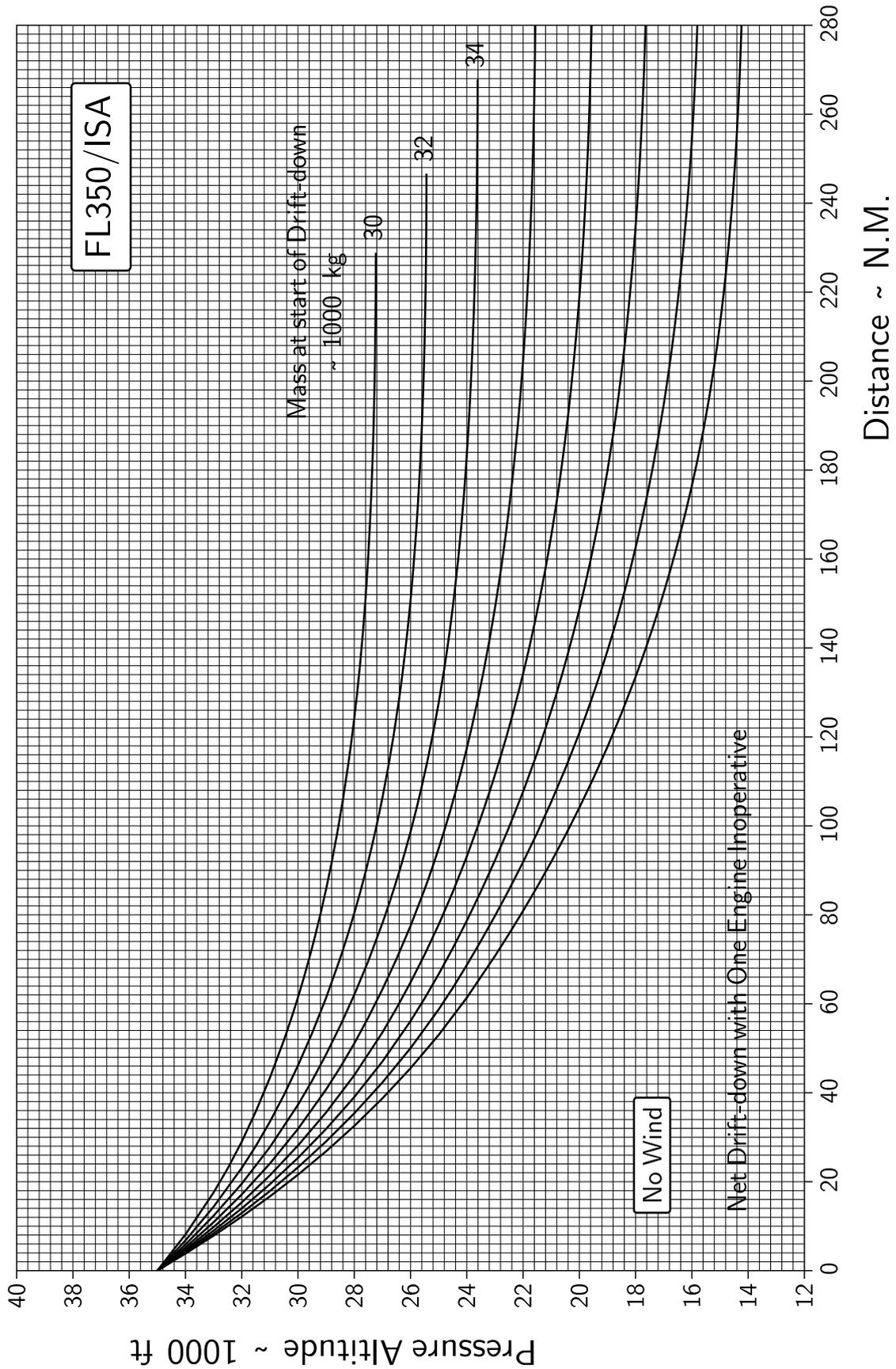


Figure 13.7: Driftdown from FL350 at ISA.

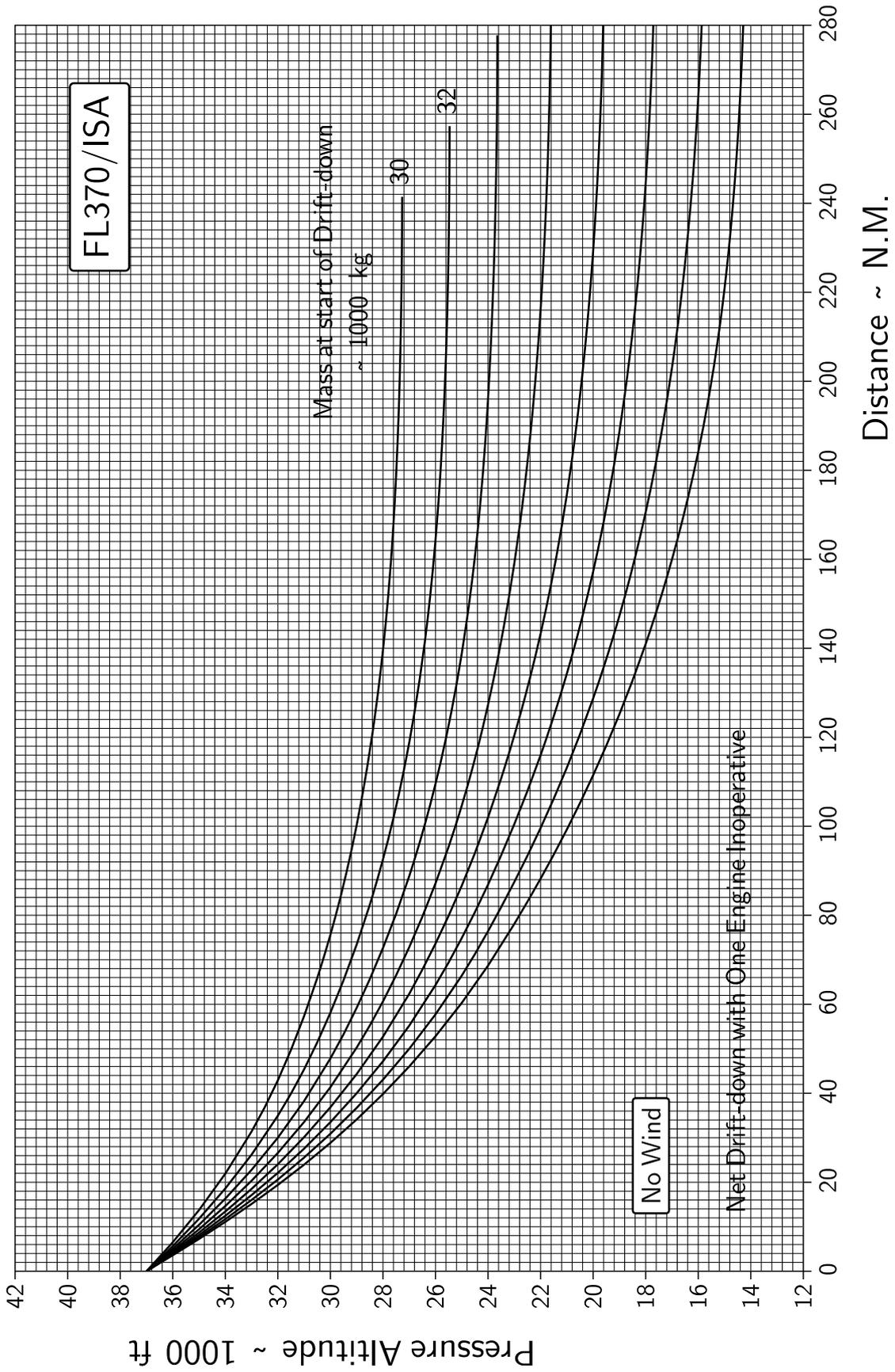


Figure 13.8: Driftdown from FL370 at ISA.

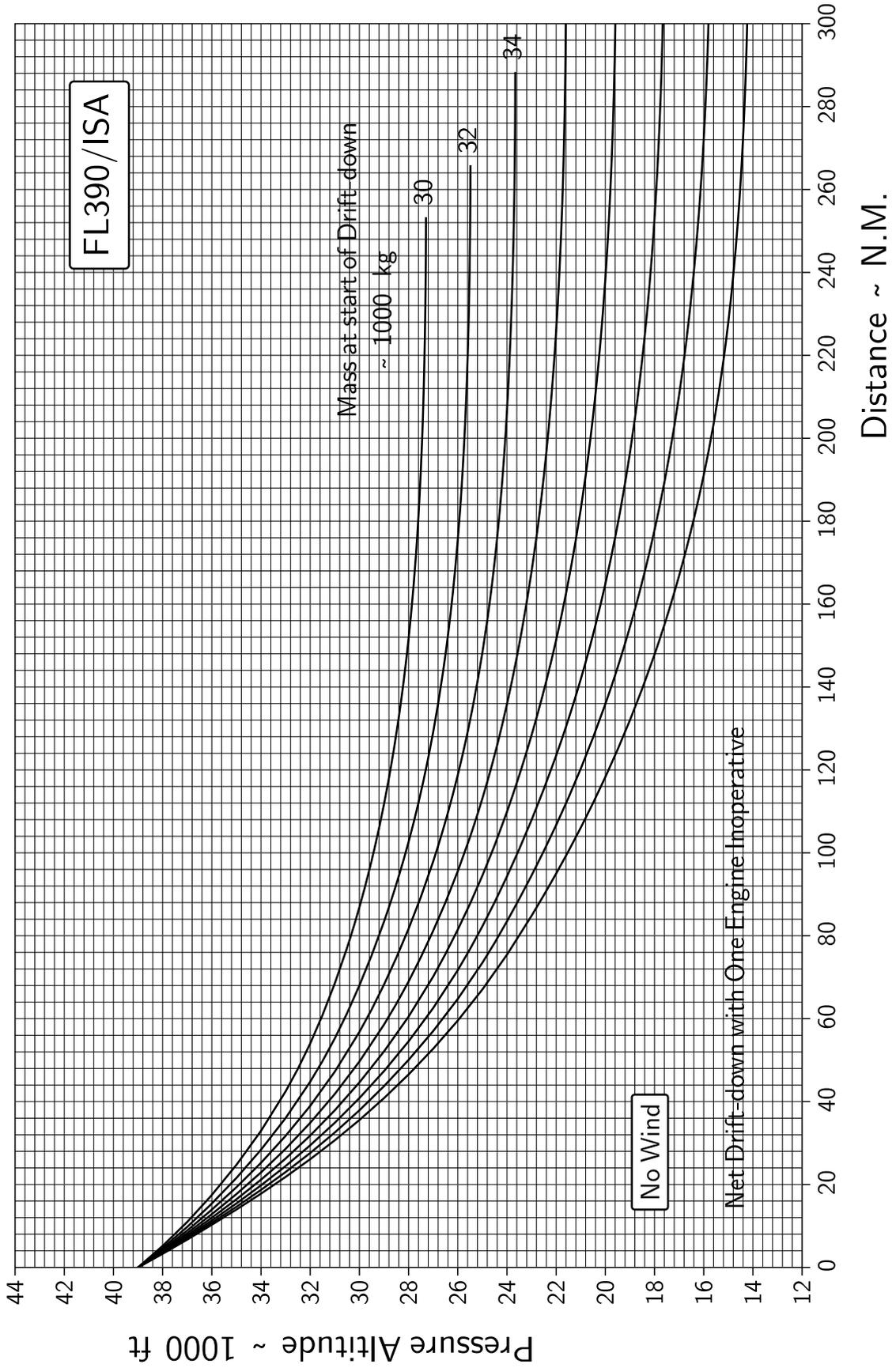


Figure 13.9: Driftdown from FL390 at ISA.

# Chapter 14

## Airspeed conversion

### Assumptions

International Standard Atmosphere defined by International Organization for Standardization, ISO 2533, 1975

### Figures

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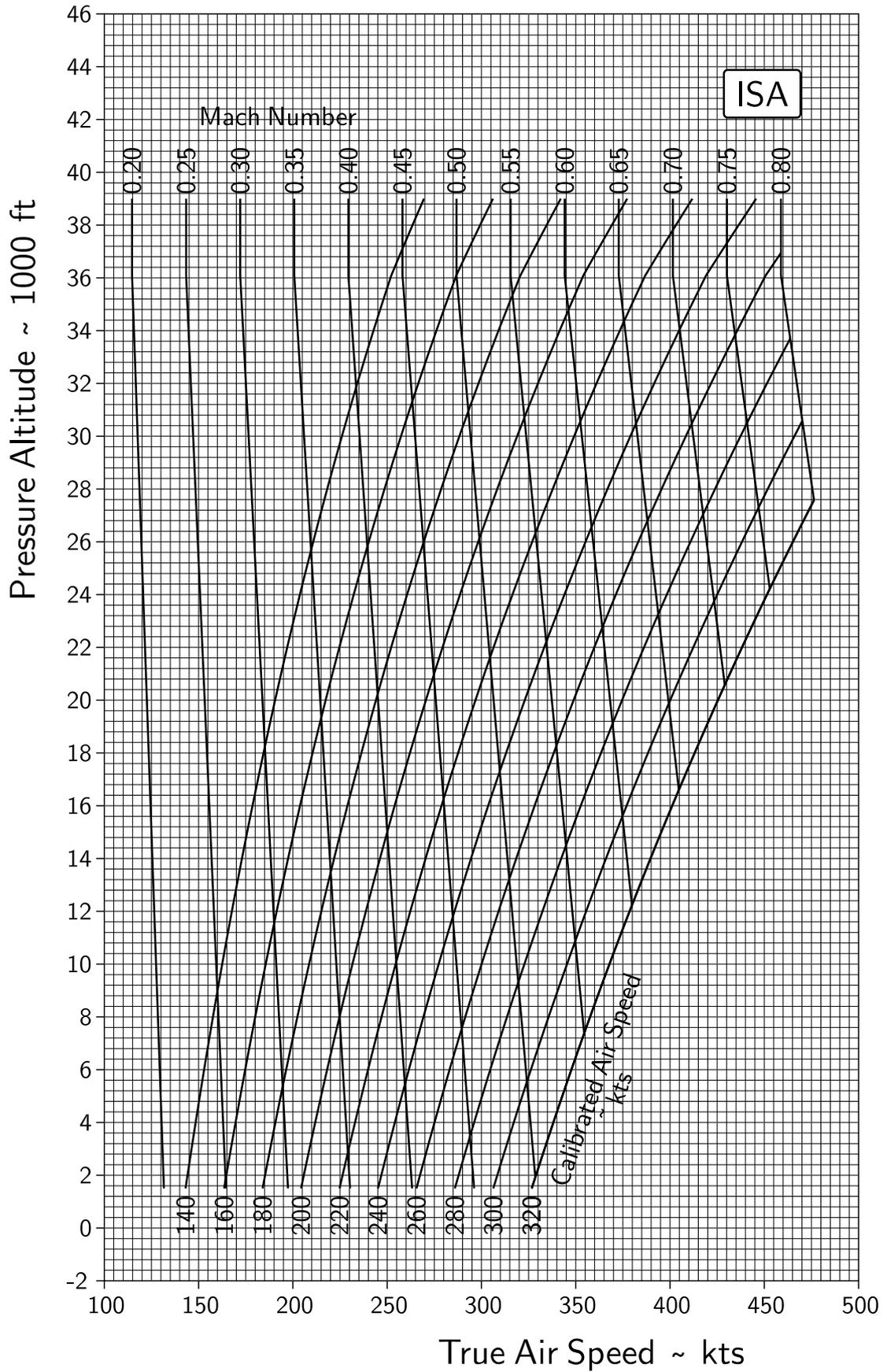


Figure 14.1: Airspeed conversion chart at ISA.