TUCANO T Mk 1

OPERATING DATA MANUAL

Amendment Information

This electronic publication represents the latest/current at time version of the publication and includes:

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Ministry of Defence
Handling Squadron
July 2015

Amendment Instruction
1st Edition
AP101B-4901-16

TUCANO T MK 1

OPERATING DATA MANUAL

AP101B-4901-16 (FIRST EDITION)

This is the 1st Edition of AP101B-4901-16 Operating Data Manual and in conjunction with the 1st Edition of AP101B-4901-15 Aircrew Manual, it replaces AP101B-4901-15 & 16. The 1st Edition of the Operating Data Manual has been re-structured to become a standalone document, whilst no actual operating data or graphs have been changed from the previous combined Aircrew Manual & Operating Data Manual, advice has been clarified.

This Foreword does not form part of the Operating Data Manual and may be destroyed together with AP101B-4901-15 & 16 Aircrew Manual & Operating Data Manual.

AP101B-4901-16
1st Edition
Jul 2015

TUCANO T Mk 1

OPERATING DATA MANUAL

Ministry of Defence

SPONSORED FOR USE IN THE ROYAL AIR FORCE

BY THE TUCANO PT

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AMENDMENT RECORD SHEET

The person responsible for incorporating each change in the Operating Data Manual should complete the details

Amendment List (AL) Record

Amendment List		Section(s) Amended	Entered By	Date AL Incorporated
No.	Date			
1				
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Advanced Notification of Amendment (ANA) Record

ANA No.	DTG	Section(s) Affected	Signature	Date	Cancelled By	Signature	Date
1							
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Advanced Information Leaflet (AIL) Record

AIL No.	Date of Issue	Section Affected	Signature	Date	Cancelled By	Signature	Date

NOTES TO USERS

1. This is the 1st Edition of the Tucano T Mk 1 Operating Data Manual (ODM) dated July 2015. This ODM is only valid when used in support of a current MOD RTS. This ODM replaces Part 6 of the combined Tucano T Mk 1 Aircrew Manual and Operating Data Manual, 3rd Edition April 2005. The ODM is complementary to the Tucano T Mk 1 Aircrew Manual and Tucano T Mk 1 Flight Reference Cards. The performance and flight planning information given in the manual is subject to the aircraft/engine operating limitations given in the Release to Service.

2. This ODM is divided by marker cards into the sections listed on page v of the Preliminaries.

3. The limitations (if quoted) unless over-ridden by the Release to Service are mandatory. The contents of other parts of the Manual are mainly advisory but instructions containing the words ‘is to’ and ‘are to’ are also mandatory.

4. The ODM aims to provide aircrew with operating data that delivers an acceptable level of safety when the aircraft is flown using the procedures and drills in the Aircrew Manual. Nothing in these publications removes the obligation to comply with MAA regulations. The application of sound judgement and good airmanship applies at all times and is paramount. Any planned operation that reduces the explicit or implicit operating margins represented in this manual is likely to undermine the aircraft safety case and the basis on which the Release to Service is authorized: such operations should be fully justifiable and users are strongly advised to record this justification to aid any subsequent inquiry or investigation.

5. Amendment Lists (ALs) will be issued as necessary, together with an AL instruction sheet which states the main purpose of the amendment and includes a list of changes covered. New or amended matter of importance will be indicated by change bars, positioned in the outside margin alongside the amended text, to show the extent of the amended text. The number of the amendment list, by which a sheet is issued, appears at the bottom of the right-hand page and any amendment marks, on either side of the sheet, refer to that amendment. However, when a new Chapter is issued or an existing Chapter is completely revised, this fact is indicated within the heading of the Chapter and amendment marks (apart from the AL number) will not appear in that Chapter.

6. The following conventions are observed throughout this Manual:

a. The actual markings on controls are indicated in the text by capital letters.

b. Unless otherwise stated, all airspeeds, heights and temperatures are indicated values.

c. **WARNINGS** are ‘That which, if not observed, may result in death or injury’.

d. **CAUTIONS** are ‘That which, if not observed, may result in damage to the aircraft or its equipment’.

e. **NOTES** are inserted to clarify the reason for a procedure, or to give information which, while not essential to the understanding of the subject, is useful to the reader.

IMPORTANT
Proposals for change to this document are to be sent to the CFS Tucano Examiner, Training Wing HQ, RAF Linton-on-Ouse, York, YO30 2AJ, for onward transmission to the Tucano PT and the Publication Organisation (OC Handling Squadron, Boscombe Down, Salisbury, SP4 0JE). Proposals are to be submitted using a photocopy of the MoD Form 765X on the following two pages.

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MOD Form 765X
(Revised Jun 15)

AIRCREW PUBLICATIONS AMENDMENT REQUEST

References MAP-01 Chapter 8.2

Originating Unit
Title/Address

Reference

Date

Air Publication / Document*
Publication / Document No.
To Amdt / Issue / Revision Date*

Title

Section / Chapter / Page / Paragraph

Part 1 - Requested Amendment and Suggested Revision
(Use continuation sheet(s) if necessary and firmly attach all diagrams etc.)

Originator's Signature	Rank and Name	Tel No.	Appointment	Date

Part 2 - User Authenticator's Comments Serial No. / /

☐ Other publications affected have been reported at:

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Part 3 Project Team Action		Serial No.	/ /	
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Instructions for Use

1. MOD Form 765X has been introduced to maintain a full audit trail of changes to aircrew publications and documents to ensure that both the User Authenticator and Handling Sqn are involved at the earliest opportunity after the form has been raised.

2. MOD Form 765X is to be raised by the individual who observed a deficiency, omission or inaccuracy in the Aircrew Manual, Flight Reference Cards, Operating Data Manual, Mission Operating Procedure cards, Flight Test Schedule or Aircrew Landaway Flight Servicing Schedule. Apart from typographic errors, a separate MOD F765X is to be raised for each deficiency, omission or inaccuracy being reported.

3. When an individual raises a MOD Form 765X (by completing the header detail and Part 1) he is to send the form to the User Authenticator, (RAF: STANEVAL; Army: A Avn Stds, HQAAC; RN: Naval Flying Standards Flight, RNAS Culdrose or RNAS Yeovilton as appropriate)

4. On receipt the User Authenticator is to complete Part 2, enter a serial number consisting of a 3-letter MOB designator, a 3-digit number (starting with 001 from1Jan each year) and 2 digits for the year (eg BZN/016/05), comment as appropriate and pass the form to the Project Team (PT), with a copy to Handling Sqn and a copy to the appropriate Release to Service Authority (RTSA). An electronic version of the Form is available on the Defence Intranet and the Form can be submitted electronically by the UA in the first instance but must be followed up by a signed hard copy.

5. The User Authenticator is to keep a register of all MOD Form 765X arisings.

6. The PT is to complete Part 3 of the MOD Form 765X and forward it to Handling Sqn or the Publication Organisation (copy to Handling Sqn), as appropriate, for action.

7. When the change proposed in the F765X is deemed by the UA or PT to be of an urgent flight safety or operational nature, the PT can authorize HS by e-mail to proceed with the appropriate amendment action in advance of the completion and signature of Part 3 of the F765X. When issue of an ANA closes a F765X, the Publication Organisation is to raise a Tech Pubs task to ensure that the change is incorporated at the next routine amendment.

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LIST OF PAGES

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Tucano T Mk 1 - Flying Trainer

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CONTENTS

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SECTION 1

GENERAL INFORMATION

CONTENTS

APPENDICES

LIST OF FIGURES

Some of the data given in the ODM extend to conditions beyond the MOD RTS. Reference must be made to the RTS for overriding current limitations.

Introduction

1. The information given in this manual applies to the Tucano T Mk 1 aircraft. The aircraft is powered by a Garrett TPE331-12B-701A1 engine, rated to 1151 equivalent shaft horse power, driving a 4-bladed, aluminium, variable pitch Hartzell propeller. The general arrangement of the aircraft is shown in Figure 1.3. The performance data in this Manual are applicable to the approved fuels listed in AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual, provided that the associated engine control adjustments have been made to maintain engine performance at the minimum acceptance standard (‘minimum engine’).

Standard of Performance

2. The standard of performance presented in this Manual (average performance) is the mean level to be expected from the ‘average’ airframe fitted with a ‘minimum’ engine. Where average performance is significantly affected by piloting/operating techniques, the relevant techniques are either defined or a cross reference is given.

3. The use of ‘minimum’ engine standard means that the aircraft scheduled performance should be achievable when the engine is delivering the specified minimum level of performance. New or overhauled engines have exhaust gas temperature (EGT) margins which are available for maintaining engine performance at the minimum standard to offset power deterioration in service use. This is achieved in practice by compensation of the engine electronic control (EEC) computer.

Data Basis

4. All performance data presented are based on the analysis of contractor's flight test results except where otherwise indicated. Where any unresolved scatter was noted, the data are based on a conservative interpretation of the results.

Atmospheric Conditions

5. The performance data assume that the aircraft is operating in the International Standard Atmosphere (ISA), or in an atmosphere in which the ambient temperature at any given altitude differs from ISA by a constant amount, e.g. ISA +15°C. Figure 1.1 shows the variation of temperature with altitude in ISA.

Note: Where the term ‘altitude’ is used it denotes pressure altitude.

Wind Components

6. Wind components relative to the heading of the aircraft may be obtained from Figure 1.2.

7. Where the effect of wind component on take-off or landing is presented, safety factors of 0.5 and 1.5 have been applied in the charts to the reported headwind and tailwind components respectively, thus allowing for a possible difference between reported and actual wind.

Runway Surface

8. A hard surface, such as concrete or tarmacadam, which is suitable for take-off or landing, has been assumed for the take-off and landing distances given in Section 3 and Section 7 respectively.

Performance Charts

9. Various forms of data presentation are used, dependent on the variables involved and the complexity of their relationships. These include the carpet plot, where the variable depends on two others, and simple graphs or sets of graphs.

10. Most of the take-off and landing charts are of the graphical chain variety in which the effect of each variable is accounted for in a separate block within the chart. Such charts are used by entering the first block, proceeding to the reference line (RL), following a guideline to the required value of the variable, then moving to the next block and repeating the procedure.

11. In most cases examples of use are shown on the charts, with a description either on the associated chart or in the accompanying text.

12. In general, flight planning data are presented in terms of true quantities (e.g. true outside air temperature).

13. Tables giving pressure error corrections (PEC) are included in Section 2. In most cases these corrections are small.

Aircraft Loading and Pavement Bearing Strength

14. **Aircraft Load Classification.** At the maximum ramp mass (3010 kg), the load classification number (LCN) is 3 and the load classification group (LCG) is VII.

15. **Pavement Load Classification.** According to its bearing strength, the pavement is allocated a pavement LCN and a pavement LCG. Pavement LCG range from I (highest bearing strength) to VII (low bearing strength,

suitable to take only light aircraft). Pavement LCG are published in flight information publications and En-route Supplements.

16. Aircraft of a given LCG may operate without restriction on pavements of lower or equal-numbered LCG; only on an occasional basis, with prior permission only, on pavements with an LCG rated one group higher numbered than that of the aircraft. Group VII aircraft may be operated continuously on pavements of LCG I to VII inclusive.

Aircraft Mass

17. The aircraft Maximum Basic Empty Weight (MBEW) is 2228 kg, which includes 3 kg of unusable fuel. The aircraft Maximum Zero Fuel Mass (MZFM) with two aircrew (108.2 kg each) and 20 kg of baggage is 2465 kg. The Maximum Take-Off Mass (MTOM) is 3000 kg and the Maximum Ramp Mass is 3010 kg.

Aircraft Centre of Gravity

18. Centre of gravity (CG) data for the aircraft is given in AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual, Part 3, Chapter 1 and in AP101B-4901-1B, the Tucano T Mk 1 Aircraft Maintenance Manual, Chapter 10.

Fuel Capacity and Mass.

19. With Avtur fuel at a specific gravity (SG) of 0.8 the usable fuel capacity is 554 kg.

Leading Particulars

20. The leading particulars are given in Appendix 1 to this Section.

Abbreviations and Definitions of Terms

21. The abbreviations used in this ODM are given in Appendix 2 and the Definition of Terms used are given in Appendix 3 to this Section.

DETERMINATION OF AIR TEMPERATURE IN RELATION TO ISA

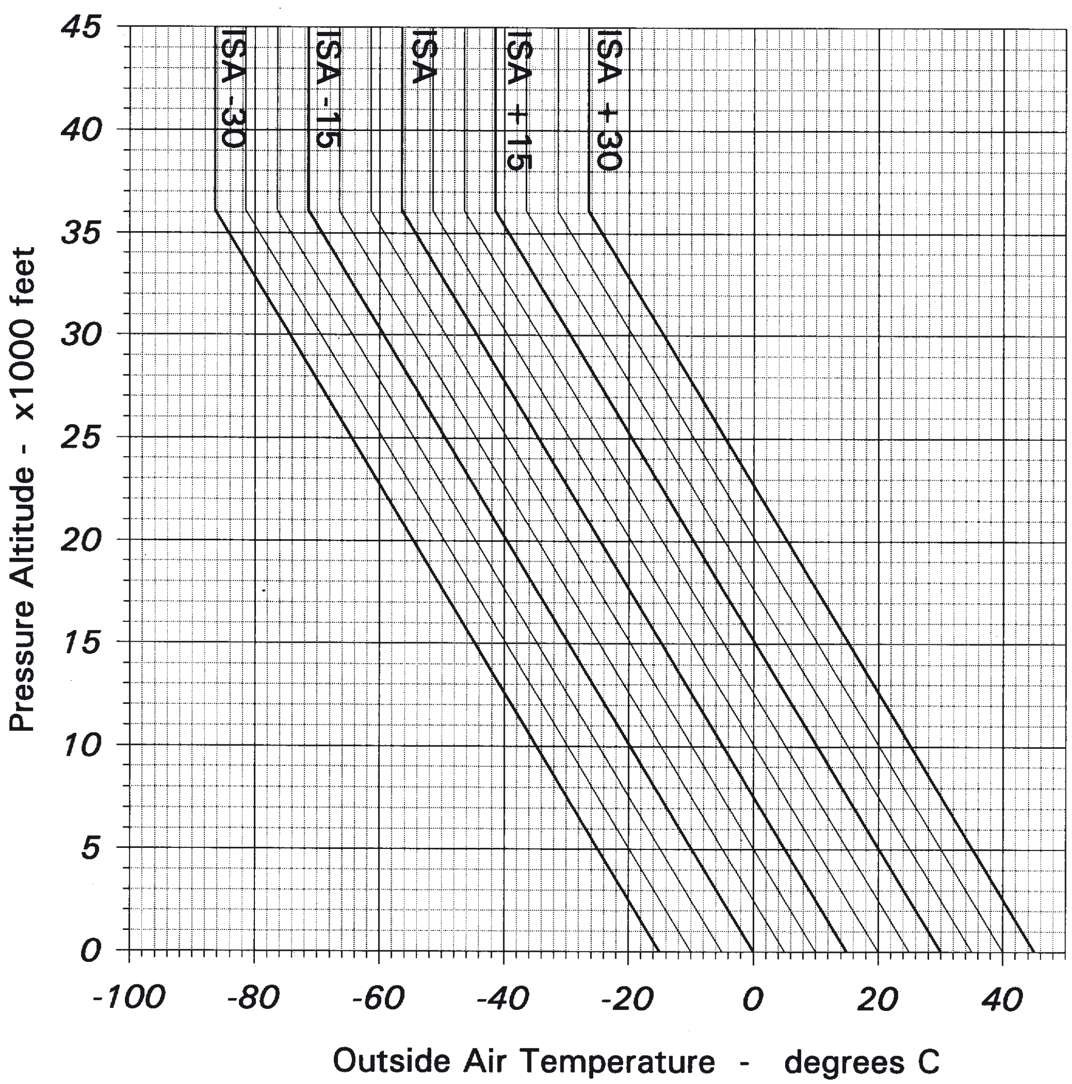

Figure 1.1

WIND COMPONENT

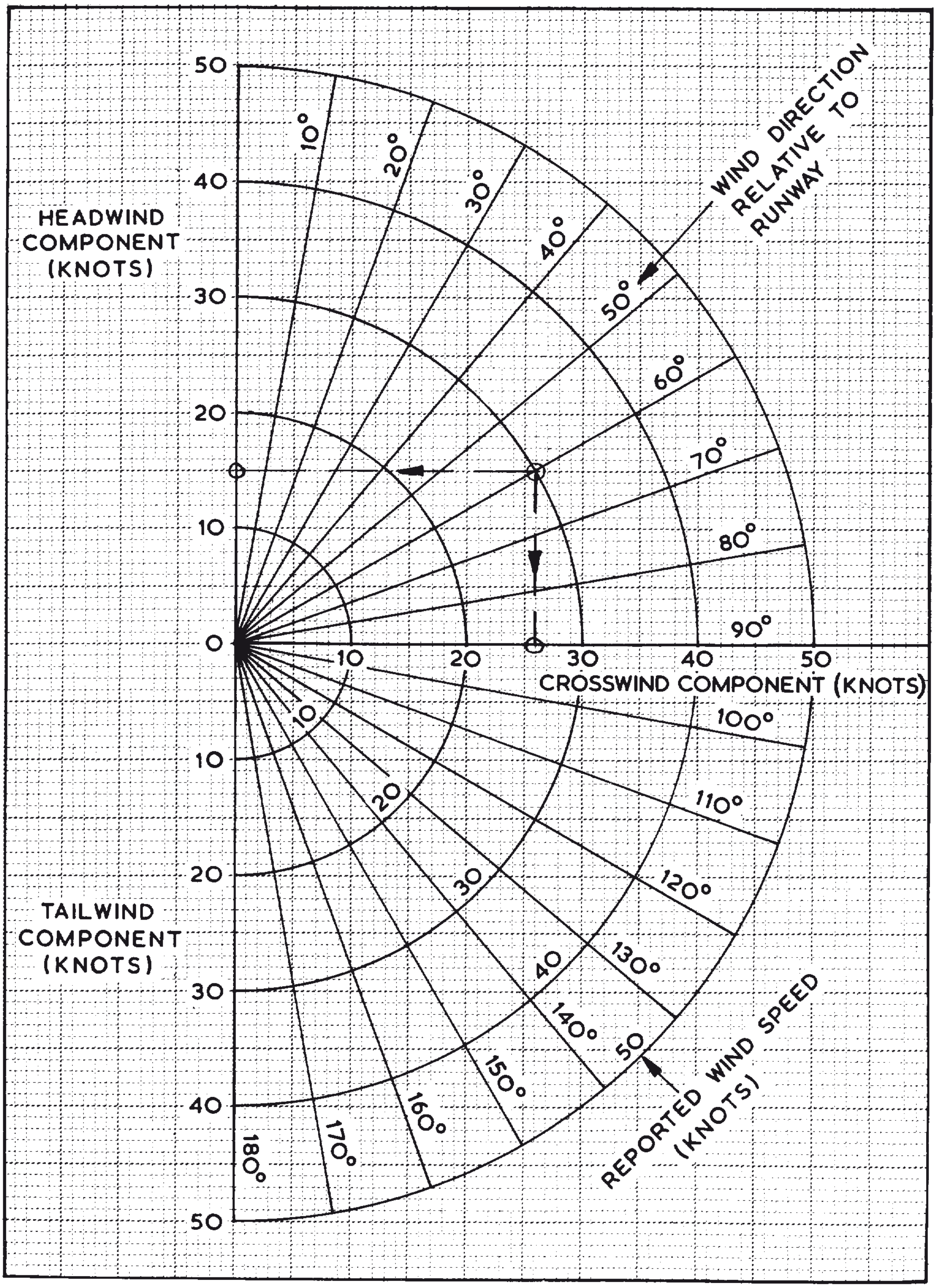

Figure 1.2

GENERAL ARRANGEMENT

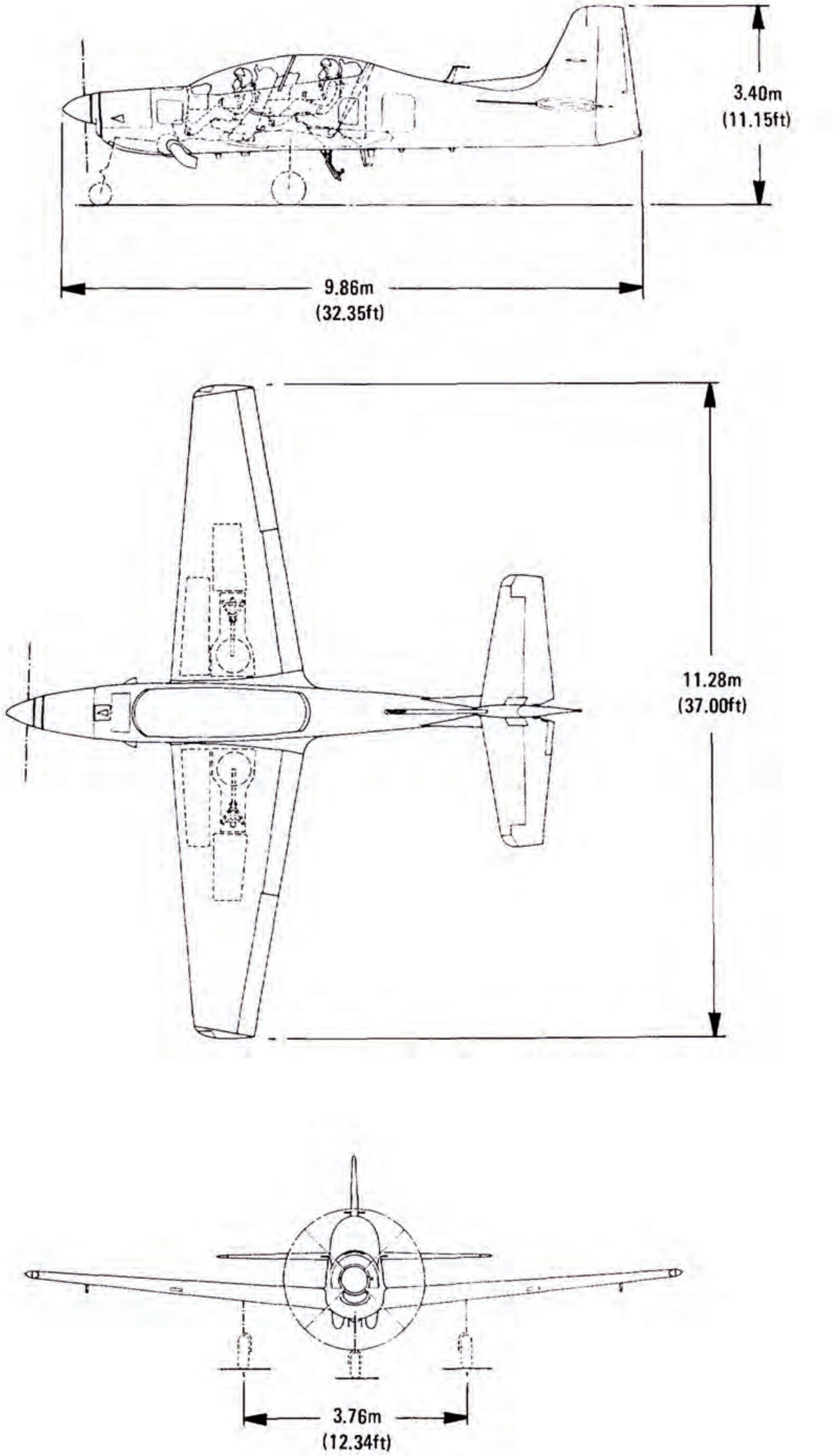

Figure 1.3

APPENDIX 1

LEADING PARTICULARS

Name:	Tucano T Mk I
Type:	Single turboprop, tandem trainer
Crew:	One or two
Duties:	Flying training

Main Dimensions

Wing span:	11·28 m (37 feet)
Wing area (total):	19·40 m^2 (208·8 $feet^2$)
Overall length:	9·86 m (32 feet 4 inches)
Height (level with landing gear down):	3.40 m (11 feet 2 inches)
Landing gear track:	3·76 m (12 feet 4 inches)
Wheelbase:	3·16 m (10 feet 4 inches)
Propeller disc diameter:	2·39 m (7 feet 10 inches)
Static propeller clearance:	0·32 m (1 foot 1 inch)
Maximum Basic Empty Weight:	2228 kg (includes 3 kg of unusable fuel)
Mass (maximum for take-off):	3000 kg
Mass (maximum normal for landing):	3000 kg

Power Plant

Engine change unit:	Garrett TPE331-12B-701A
Engine Type:	Single shaft, turboprop
Propeller:	Hartzell HC-D4N-5C/D9327K
Propeller type:	4-bladed, aluminium, variable pitch
Performance (ISA sea level):	1151 equivalent shaft horse power

Fuel System

Fuel system capacity (usable fuel):	554 kg (153 gallons)

APPENDIX 2

ABBREVIATIONS

AGL	Above ground level
AIL	Advance information leaflet
ANA	Advance notification of amendment
ANM	Air nautical miles
AOA	Angle of attack
ASDA	Accelerate stop distance available
AUM	All up mass
C	Celsius
CAS	Corrected airspeed
CSI	Combined speed indicator
CG	Centre of gravity
EAS	Equivalent airspeed
EMBS	Emergency maximum braking speed
FF	Fuel flow
FRC	Flight Reference Card(s)
IAS	Indicated airspeed
IMN	Indicated mach number
IOAT	Indicated outside air temperature
ISA	International standard atmosphere
kg	Kilogram(s)
lb	Pound(s)
LCG	Load classification group
LCN	Load classification number
m	Metre(s)
MBEW	Maximum basic empty weight
mph	Miles per hour
MSL	Mean sea level
MTOM	Maximum take-off mass
MZFM	Maximum zero fuel mass
NM	Nautical mile(s)
NTS	Negative torque sensing
OAT	Outside air temperature
ODM	Operating Data Manual
RPM	Revolutions per minute
SG	Specific gravity
SHP	Shaft horse power
SR	Specific air range
TAS	True airspeed
TORA	Take-off run available
V_2	Speed at 50-foot screen height
V_{AT}	Threshold speed
V_{LOF}	Lift off speed
V_R	Rotation speed
V_{STOP}	Stop speed

APPENDIX 3

DEFINITION OF TERMS

TERM	*DEFINITION*
Accelerate/stop distance available (ASDA)	The length of runway take-off run available plus the length of stopway available
Airfield elevation	The vertical distance of an airfield above sea level
Altitude	In this Manual the term denotes pressure altitude
Average performance	The performance standard achieved by the mean of a fleet of aircraft with engines operating at the specified minimum ratings
Calibrated airspeed (CAS)	The IAS corrected for pressure error
Combat ceiling	The pressure altitude at which the rate of climb is equal to 500 feet per minute
Contaminated runway	A runway is considered to be contaminated when more than 25% of the runway surface area (whether in isolated areas or not) within the required length and width being used is covered by the following: a) Surface water more than 3 mm deep, or by slush or loose snow equivalent to more than 3 mm of water; b) Snow which has been compressed into a solid mass which resists further compression and will hold together or break into lumps if picked up (compacted snow); or c) Ice, including wet ice
Emergency maximum braking speed (EMBS)	The maximum IAS from which sustained maximum wheelbraking may be applied and the aircraft brought to rest (but with some probable damage to the brakes)
Equivalent airspeed (EAS)	CAS corrected for compressibility errors (TAS times the square root of the atmospheric relative density)
Exhaust gas temperature (EGT)	The indicated jet pipe temperature of the engine. the indicated EGT is compensated electronically so that every engine gives the specified propeller shaft power for the full power rating at the associated EGT limit of 650°C
Height	The vertical distance between a point and a specified datum
Indicated airspeed (IAS)	The CSI airspeed indication corrected for instrument error
Indicated altitude	The reading of the altimeter corrected for instrument error
Indicated mach number (IMN)	The CSI mach indication corrected for instrument error
Indicated outside air temperature (IOAT)	Outside air temperature plus adiabatic compression, as shown on the OAT indicator
Instrument error	The amount by which the reading of an instrument having a given input (e.g. pressure) differs from that of the same type of instrument behaving in exact accordance with the design calibration law, given the same input
International standard atmosphere (ISA)	The ICAO standard atmosphere, in which the air is a perfect dry gas with a sea level temperature of 15°C and a pressure of 1013.2 millibars, and in which the temperature gradient to the altitude at which the temperature becomes minus 56.5°C is 3.25°C per 500 metres (1.98°C per 1000 feet)

TERM	*DEFINITION*
Maximum take-off abort speed (V_{STOP})	The highest IAS during take-off from which the aircraft can be brought to rest within the ASDA, with wheelbraking delayed until the EMBS. Also referred to as 'stop speed'
Outside air temperature (OAT)	The static air temperature as measured by a thermometer at rest relative to the air. Also referred to as the Met temperature or ambient air temperature
Pressure altitude	The atmospheric pressure expressed in terms of the altitude which corresponds to that pressure in the standard atmosphere (ISA). In this Manual the term is denoted by 'altitude'
Pressure error correction (PEC)	The correction applied to IAS, IMN and indicated altitude to eliminate the errors in these quantities caused by the pitot and static pressures being different from the stream values (the difference being caused by the presence of the aircraft)
Stopway	The defined area of ground beyond the TORA designated and prepared for use by an aircraft in an aborted take-off
Take-off ground run	The ground distance covered during take-off from the points of 'wheel rolling' to the point of unstick
Take-off run available (TORA)	The length of runway available and suitable for the ground run of an aircraft during take-off. In most cases this corresponds to the length of the paved runway
Threshold	The beginning of the part of the runway which is usable for landing. For a runway with a sterile area the white bar beyond the sterile markings should be taken as the threshold
Target threshold speed	The planned IAS at the runway threshold during landing
True airspeed (TAS)	The speed of the aircraft relative to the undisturbed air (EAS divided by the square root of the relative density)
Wet runway	A runway where the surface is covered with water, but with no appreciable puddles of 3 mm or more in depth

SECTION 2

CORRECTION AND CONVERSION DATA

CONTENTS

LIST OF FIGURES

Introduction

1. This Section presents information on the pressure error corrections (PEC) required for the pressure instruments, and gives data for the conversion of IOAT to OAT.

2. The aircraft pitot-static system has two pitot tubes and four static vents which supply the following pressure-operated instruments in each cockpit:

a. main altimeter.

b. standby altimeter.

c. combined speed indicator.

d. vertical speed indicator.

Altimeter and Airspeed Pressure Error Corrections

3. **In Flight.** In steady level (1g) flight out of ground effect the PEC are to be added to the respective altimeter and airspeed readings in order to account for errors in the pitot-static system during the measurement of these airflow quantities.

a. Figure 2.1 to Figure 2.3 inclusive are the PEC to be added to the altimeter reading.

Note: True Value of Altitude (feet) = Indicated Altitude (feet) + Correction (feet)

b. Figure 2.4 to Figure 2.5 inclusive are the PEC to be added to the indicated airspeed reading.

Note: CAS (knots) = IAS (knots) + Correction (knots)

4. **On the Ground.** With the aircraft on the ground, the PEC to the indicated airspeed is minus 1 knot.

IOAT/OAT Conversion

5. Figure 2.6 enables OAT (the static air temperature as measured by a thermometer at rest relative to the air) to be obtained from IOAT (outside air temperature plus adiabatic compression, as shown on the OAT indicator), given the altitude and CAS.

PEC TO ALTIMETER FLAPS UP, LANDING GEAR UP

Altitude(feet)	*Correction (feet) for IAS (knots) of:*				
	100	*150*	*200*	*250*	*300*
Sea level	+20	+30	+45	+65	+85
5000	+20	+30	+50	+75	+100
10,000	+25	+40	+60	+85	+115
15,000	+30	+45	+70	+100	+130
20,000	+35	+55	+80	+120	+160
25,000	+40	+65	+95	+140	+185
30,000	+45	+75	+110	+160	+215

Figure 2.1

PEC TO ALTIMETER FLAPS MID, LANDING GEAR UP

Altitude(feet)	*Correction (feet) for IAS (knots) of:*				
	up to 100	*120*	*140*	*160*	*170*
Sea level	+14	+15	+17	+22	+25
5000	+16	+17	+20	+25	+28
10,000	+18	+20	+23	+29	+33
15,000	+22	+24	+27	+35	+40
20,000	+25	+27	+31	+40	+46
25,000	+30	+32	+37	+47	+53
30,000	+34	+37	+42	+54	+61

Figure 2.2

PEC TO ALTIMETER FLAPS DOWN, LANDING GEAR DOWN

Altitude(feet)	*Correction (feet) for IAS (knots) of:*						
	up to 90	*100*	*110*	*120*	*130*	*140*	*145*
Sea level	+8	+8	+9	+10	+12	+13	+14
5000	+10	+11	+12	+13	+14	+16	+17
10,000	+14	+14	+15	+16	+18	+20	+21
15,000	+17	+18	+18	+20	+21	+24	+25
20,000	+21	+21	+22	+24	+26	+28	+29
25,000	+25	+26	+27	+28	+30	+32	+34
30,000	+30	+31	+32	+33	+35	+37	+38

Figure 2.3

PEC TO AIRSPEED INDICATOR FLAPS MID/DOWN, GEAR UP/DOWN

Configuration	*Correction (knots) for IAS (knots) of:*			
	75	*100*	*125*	*150*
Flaps MID, Landing gear UP	+2	+3	+3	+4
Flaps DOWN, Landing gear DOWN	+2	+1	+1	+1

Figure 2.4

PEC TO AIRSPEED INDICATOR FLAPS UP, GEAR UP

Configuration	*Correction (knots) for IAS (knots) of:*					
	75	*100*	*150*	*200*	*250*	*300*
Flaps UP	+2	+3	+3	+4	+4	+4

Figure 2.5

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IOAT/OAT CONVERSION

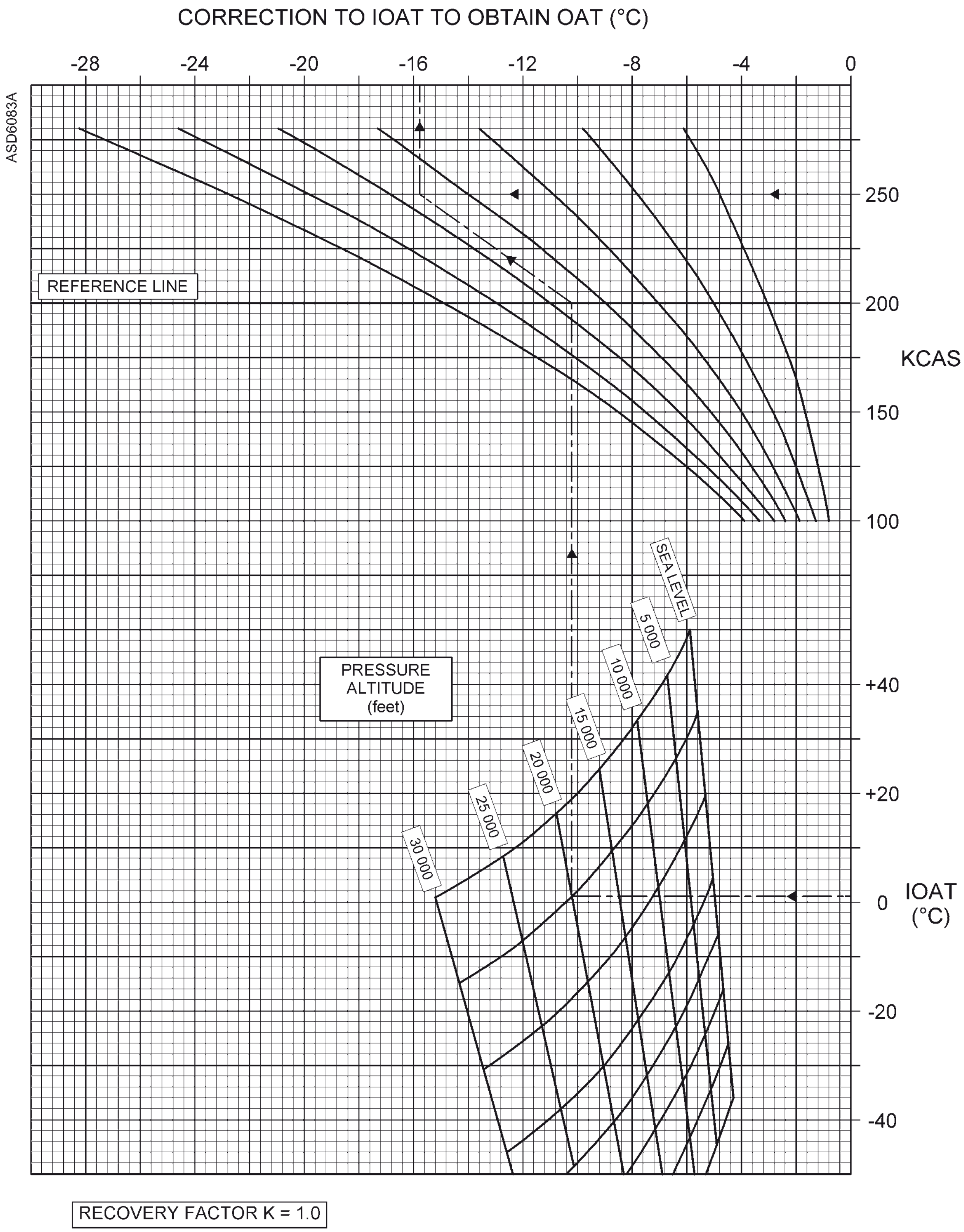

Figure 2.6

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SECTION 3

TAKE-OFF

CONTENTS

LIST OF FIGURES

Introduction

1. The charts in this Section give information on take-off speeds and distances using maximum take-off power with the flaps selected to the MID position for the normal take-off using the Bombardier technique (see parargraph 4) and the maximum performance take-off technique as defined in Part 3 of AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual. The data allow account to be taken of airfield outside air temperature (OAT) and altitude, runway slope, reported headwind or tailwind components, and assume that the air conditioning BLEED switch is selected to ON, the NORM/BOOST switch is set to NORM and the intake de-icing is selected OFF.

Note: It is stated in the Tucano T Mk1 Flight Reference Card in the Checks Before Take-Off that the air conditioning NORM/BOOST switch should be set to BOOST for take-off. However, the charts in this ODM have been produced with the air conditioning NORM/BOOST switch set to NORM. If maximum torque is required for take-off due to a limited take-off run being available, consideration should be given to selecting the NORM/ BOOST switch to NORM (see Part 1, Chapter 9, paragraph 22 of AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual).

2. Where the effect of wind component is presented, the regulatory safety factors of 0.5 and 1.5 have been applied in the charts to the reported headwind and tailwind components respectively.

3. Information is given on maximum take-off abort speed (V_{STOP}) and emergency maximum braking speed (EMBS) for dry and wet runway conditions. To ensure a take-off may be safely aborted up to the rotation speed (V_R), both the maximum takeoff abort speed (V_{STOP}) and the emergency maximum braking speed (EMBS), must be above V_R. Where either V_{STOP} or the EMBS are less than V_R there is a risk period between the lesser of V_{STOP} or the EMBS and V_R where the aircraft cannot be stopped within the ASDA should an abort be necessary.

Take-Off Speeds

4. For a normal take-off the (Bombardier) recommended rotation speed (V_R) is 75 knots and the corresponding lift-off speed (V_{LOF}) is approximately 80 knots at AUMs up to 2900 kg. Above 2900 kg, the recommended rotation speed (V_R) is 77 knots and the corresponding lift-off speed (V_{LOF}) is approximately 82 knots. This technique was used as the basis of the formulation of charts Figure 3.2 and Figure 3.3 in this Section. However, when using the take-off technique as defined in Part 3, Chapter 1 of AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual, a rotation speed (V_R) of 80 knots is to be used for all aircraft AUM and the correction at paragraph 8 applies.

5. For a take-off using the maximum performance take-off technique as defined in Part 3 of AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual, the recommended rotation speed (V_R) for a range of aircraft mass is given in Figure 3.1. Figure 3.1 also gives the approximate speed at the screen height of 50 feet (V_2).

Take-Off Distances

6. Take-off ground runs and total distances to 50 feet are shown for the normal (Bombardier) and maximum performance take-off techniques, assuming air conditioning BLEED switch is selected to ON, the NORM/ BOOST switch is set to NORM and intake de-icing OFF. Selecting intake de-icing ON increases both the ground run and total distance to 50 feet by 8% and this must be corrected for in any calculation.

7. Figure 3.2 to Figure 3.5 give the average values of ground run and total distance to 50 feet. When using Figure 3.4 and Figure 3.5 for a maximum performance take-off, it is implicit that the rotation speed (V_R) is that given by Figure 3.1.

8. If a rotation speed higher than than given by Figure 3.1 is used, both ground run and total distance to 50 feet increase by approximately 15% for each 5-knot increase and this must be corrected for in any calculation.

Note: This correction will apply if using the take-off technique as defined in Part 3, Chapter 1 of AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual.

9. Take-off performance is sensitive to piloting technique, and a variation of ±10% in ground run and ±15% in total distance to 50 feet about the average distances given in this Manual is to be expected. After the relevant corrections have been applied, the resulting ground run and total distance to 50 feet are to be multiplied by 1.1 and 1.15 respectively. To ensure a safe take-off can be carried out, the resulting calculated distance should be compared with the declared take-off distance available for the runway in use.

Maximum Take-Off Abort Speed

10. Figure 3.6 and Figure 3.7 show the variation of V_{STOP} for dry and wet runways, but do not allow for the loss of braking action if V_{STOP} exceeds EMBS. Unless a risk period is to be accepted, aircraft mass for airfield conditions should be adjusted to avoid V_{STOP} exceeding EMBS. However, because V_{STOP} is relatively insensitive to mass, it is not practical to adjust mass to avoid V_{STOP} being less than V_R on short runways (i.e. ASDA less than 2700 feet in ISA/sea level conditions). When operating from these runways, a risk period must be accepted.

Emergency Maximum Braking Speed

11. The basic consideration in the formulation of EMBS data is the aircraft energy absorption capacity of the wheelbrakes during ‘emergency braking'. Account has been taken of the increased wheelbrake energy required for stopping in crosswind conditions.

12. Unlike the landing case, where the brakes are initially ‘cold’, for aborted take-off the brakes are already ‘hot’ as a result of taxying and the energy absorption allowable is therefore set at a level corresponding to the landing ‘emergency’ level minus the equivalent of the typical take-off brake temperature. This is referred to as the ‘normal maximum’ energy absorption level; it ensures that, although the brakes will probably be damaged during the aborted take-off, braking effectiveness is retained throughout.

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13. Figure 3.8 and Figure 3.9 present EMBS values (with the engine stopped) for a range of atmospheric conditions, aircraft mass, wind component and runway slope, for dry and wet surfaces.

Engine Performance Checking

14. Figure 3.10 shows the engine torque (for a range of ambient temperatures and airfield altitudes) which should be attained when full power is applied against the brakes prior to take-off. The performance data given in this Section are dependent upon this level of torque being achieved.

Take-Off using Manual Throttle

15. If, for reasons of operational necessity following EEC failure, it is necessary to take-off using manual throttle control, the take-off distances given by Figure 3.2 to Figure 3.5 inclusive are to be increased by 40%.

Take-Off on a Contaminated Runway

CAUTION: The aircraft is not cleared for operation in snow or from surfaces covered with snow/slush. Unavoidable operations from contaminated runways should be treated with caution. The additional drag caused by the contaminate may reduce the take-off ground acceleration and cause the take-off distances to be exceeded; in addition the reduced runway surface friction characteristics may degrade the braking effort available such that should the take-off be aborted from V_{STOP} stopping within the declared ASDA cannot be guaranteed.

Examples

16. **Example 1.** A take-off using the normal (Bombardier) take-off technique is to be made with the intake de-icing selected OFF at an aircraft mass of 2700 kg from a dry, 1.5% uphill runway at sea level where the reported headwind component is 5 knots and the OAT is +15°C. What are the following values?

a. The recommended V_R?

b. The ground run required?

c. The total distance to 50 feet required?

17. **Example 1 Solution.**

a. From paragraph 4, V_R is 75 knots.

b. From Figure 3.2, the ground run is 1125 feet. From paragraph 9 the factored ground run is 1125 x 1.1 = 1237 feet.

c. From Figure 3.3, the average distance to 50 feet is 1900 feet. From paragraph 9, the corrected distance to 50 feet is 1900 x 1.15 = 2185 feet.

18. If using the take-off technique as defined in the Tucano T Mk 1 Aircrew Manual, a rotation speed V_R of 80 knots is used. Correcting for the higher V_R (as per paragraph 8) gives:

a. From Figure 3.2, the average ground run is 1125 feet. Correcting for the higher V_R, the corrected ground run is 1125 x 1.15 = 1294 feet.

b. Correcting for variations in pilot technique (as per paragraph 9) the factored ground run is 1125 x 1.10 = 1423 feet.

c. From Figure 3.3, the average distance to 50 feet is 1900 feet. Correcting for the higher V_R, the factored distance to 50 feet is 1900 x 1.15 = 2185 feet.

d. Correcting for variations in pilot technique (as per paragraph 9) the factored distance to 50 feet is 2185 x 1.15 = 2513 feet.

19. **Example 2.** What are V_{STOP} and EMBS for a take-off mass of 2700 kg from a 1.5% uphill, dry runway at sea level, ASDA 1600 feet, OAT +15°C and reported headwind component 5 knots?

20. **Example 2 Solution.**

a. From Figure 3.6, V_{STOP} is 73 knots.

b. From Figure 3.8, EMBS is 85 knots. V_{STOP} is less than EMBS and so is not restricted by brake energy considerations.

c. In the above example, V_{STOP} is less than V_R and hence there is a period of risk between these speeds where the aircraft cannot be stopped within the ASDA following a take-off abort.

TAKE-OFF SPEEDS, MAXIMUM PERFORMANCE TAKE-OFF

Aircraft Mass	*IAS (knots)*	
(kg)	*V_R*	*V_2*
2300	71	80
2400	72	82
2500	73	83
2600	74	84
2700	75	86
2800	76	88
2900	77	89
3000	78	91

Figure 3.1

TAKE-OFF GROUND RUN, NORMAL (BOMBARDIER) TAKE-OFF TECHNIQUE
AIR CONDITIONING NORMAL, INTAKE DE-ICING OFF

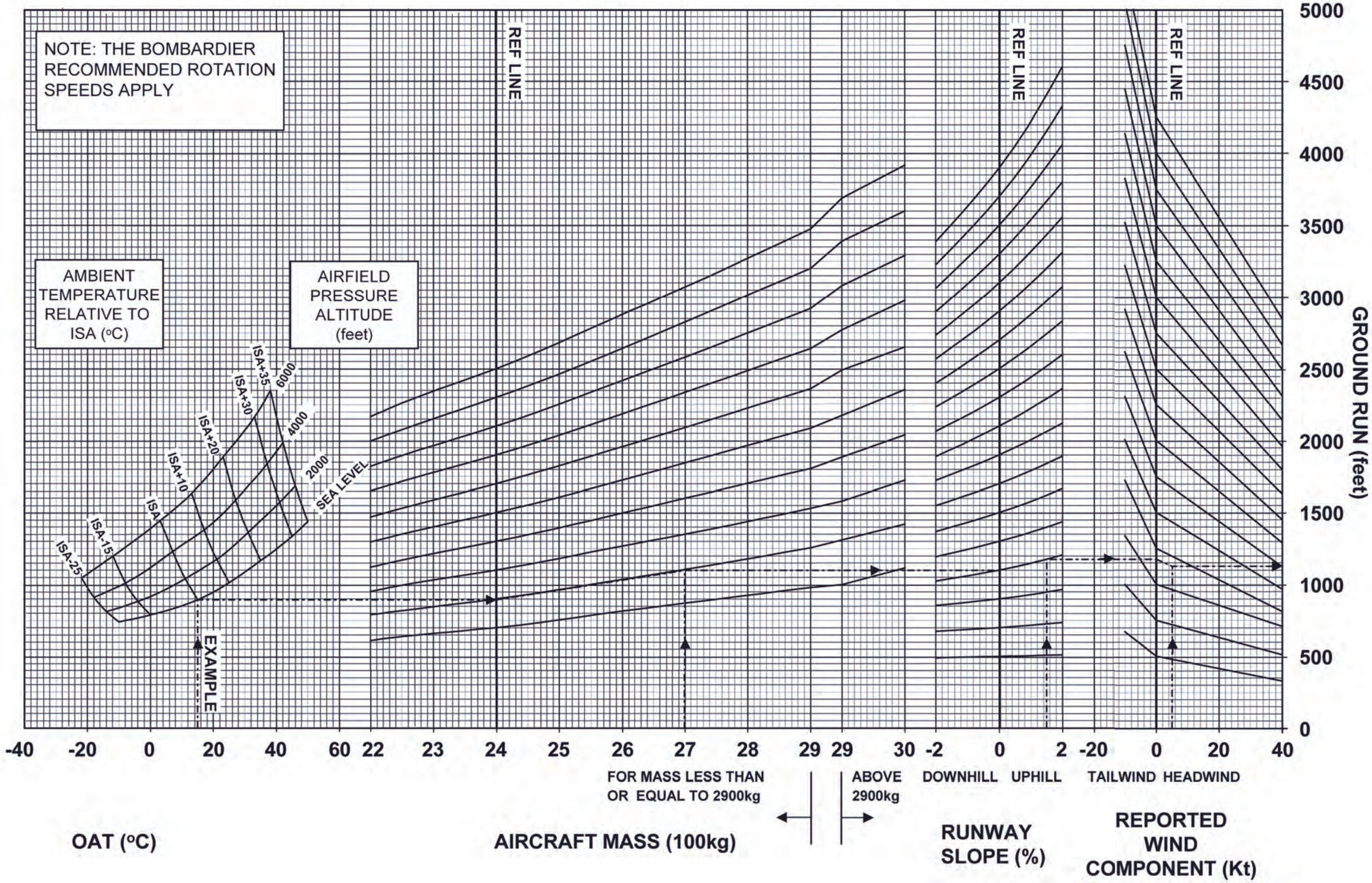

Figure 3.2

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**TAKE-OFF TOTAL DISTANCE TO 50 FEET, NORMAL (BOMBARDIER) TAKE-OFF TECHNIQUE
AIR CONDITIONING NORMAL, INTAKE DE-ICING OFF**

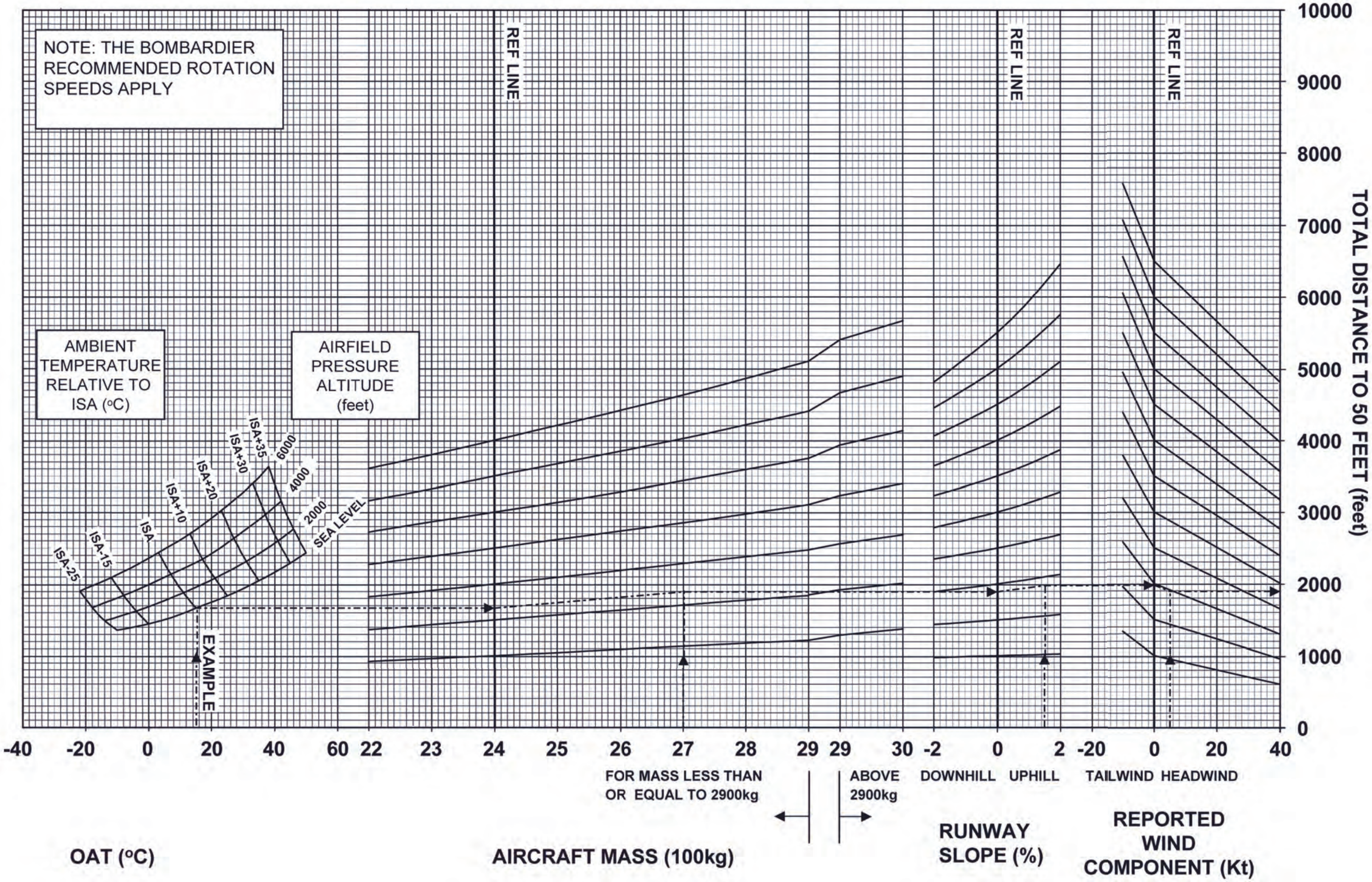

Figure 3.3

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TAKE-OFF GROUND RUN, MAXIMUM PERFORMANCE TECHNIQUE
AIR CONDITIONING NORMAL, INTAKE DE-ICING OFF

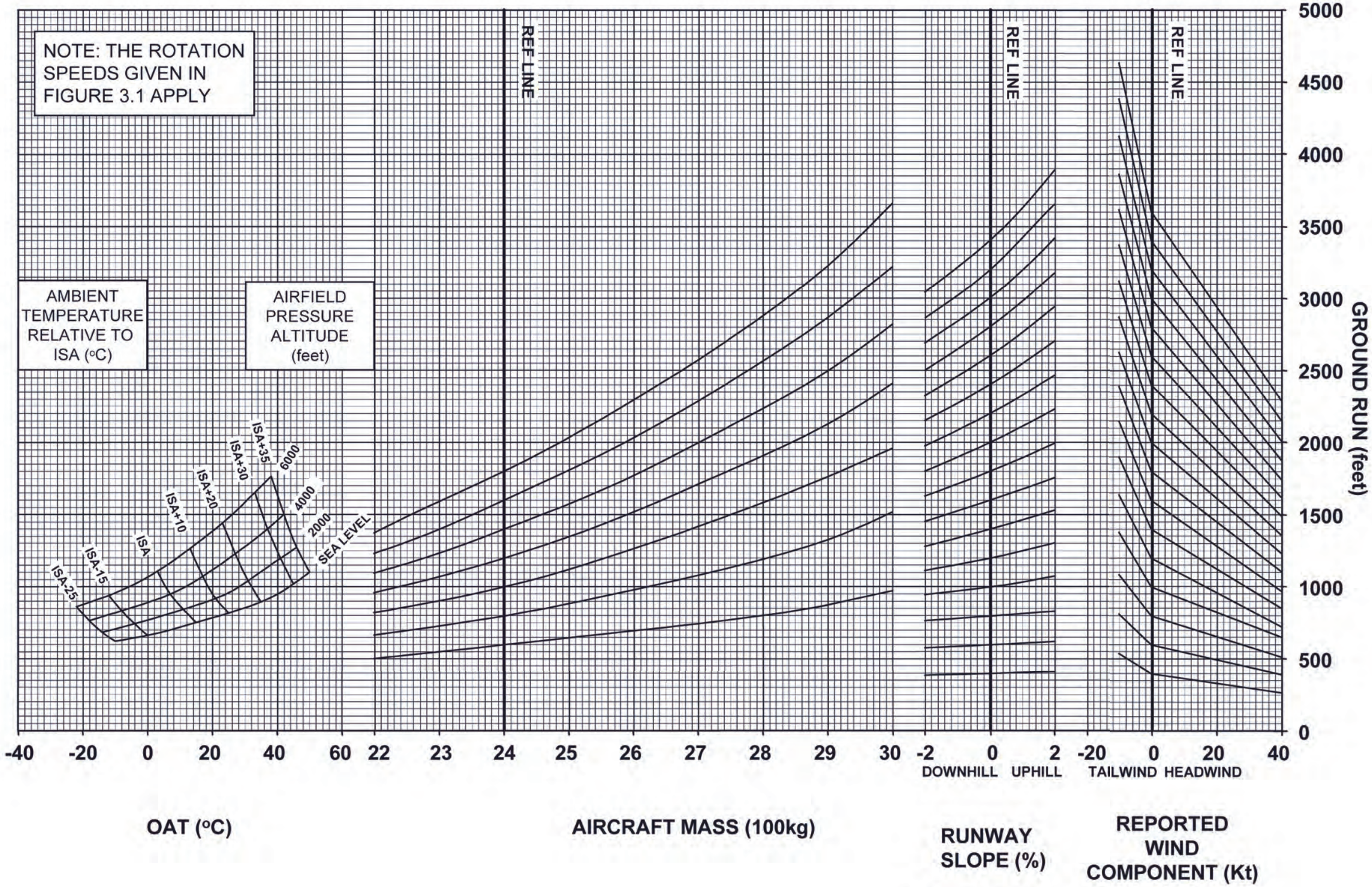

Figure 3.4

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TAKE-OFF TOTAL DISTANCE TO 50 FEET, MAXIMUM PERFORMANCE TAKE-OFF TECHNIQUE AIR CONDITIONING NORMAL, INTAKE DE-ICING OFF

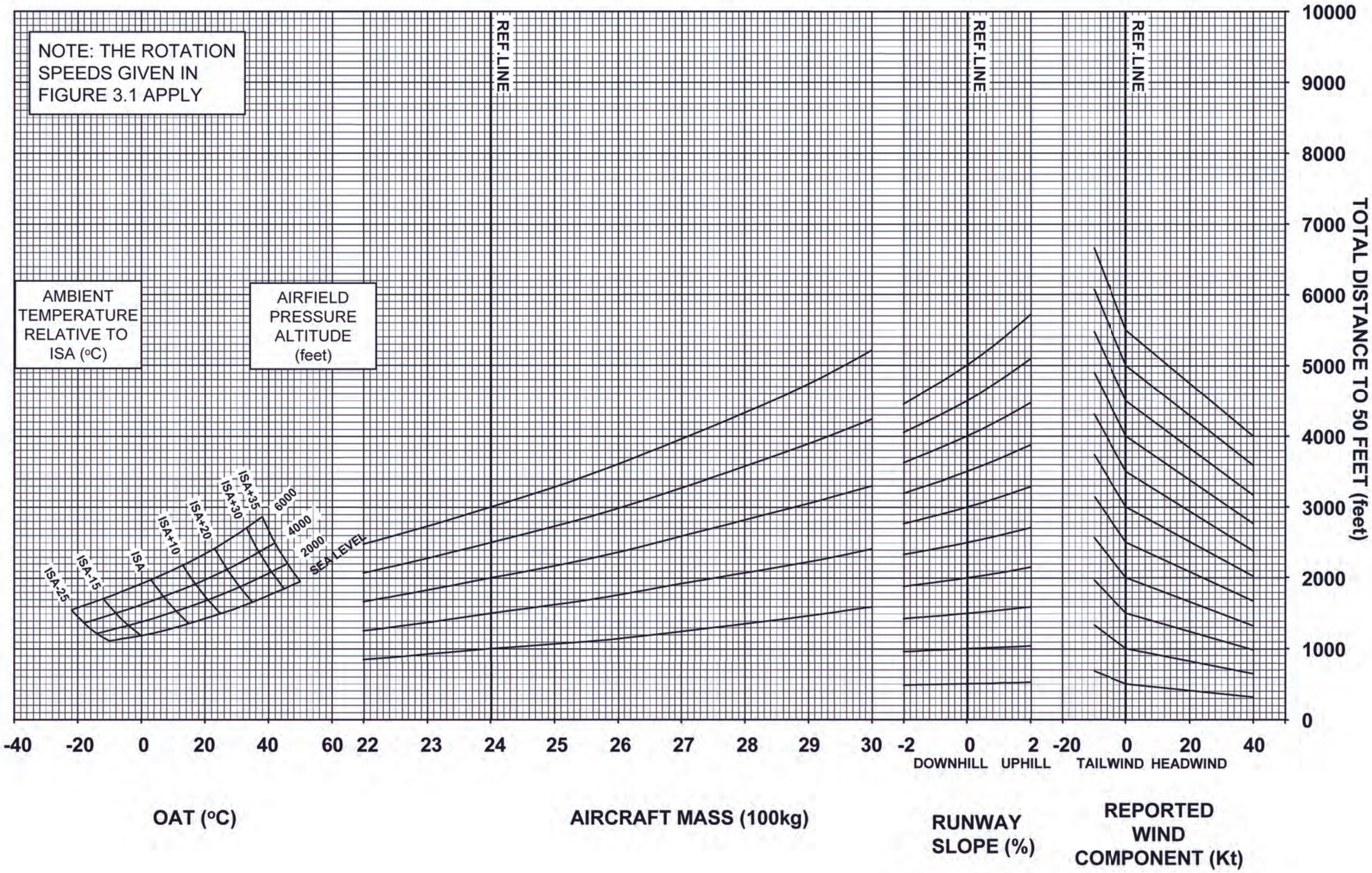

Figure 3.5

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MAXIMUM TAKE-OFF ABORT SPEED, DRY RUNWAY

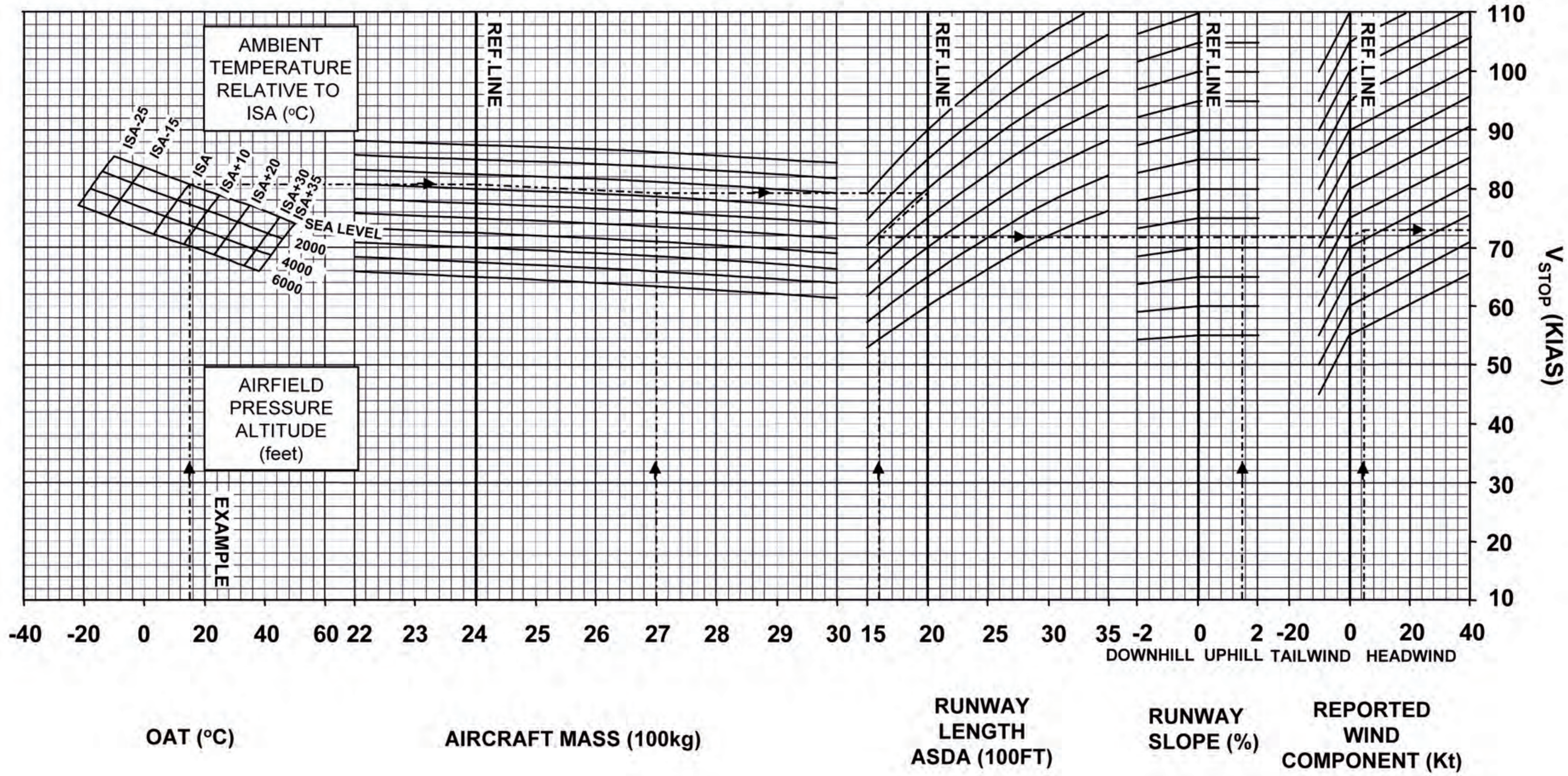

Figure 3.6

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MAXIMUM TAKE-OFF ABORT SPEED, WET RUNWAY

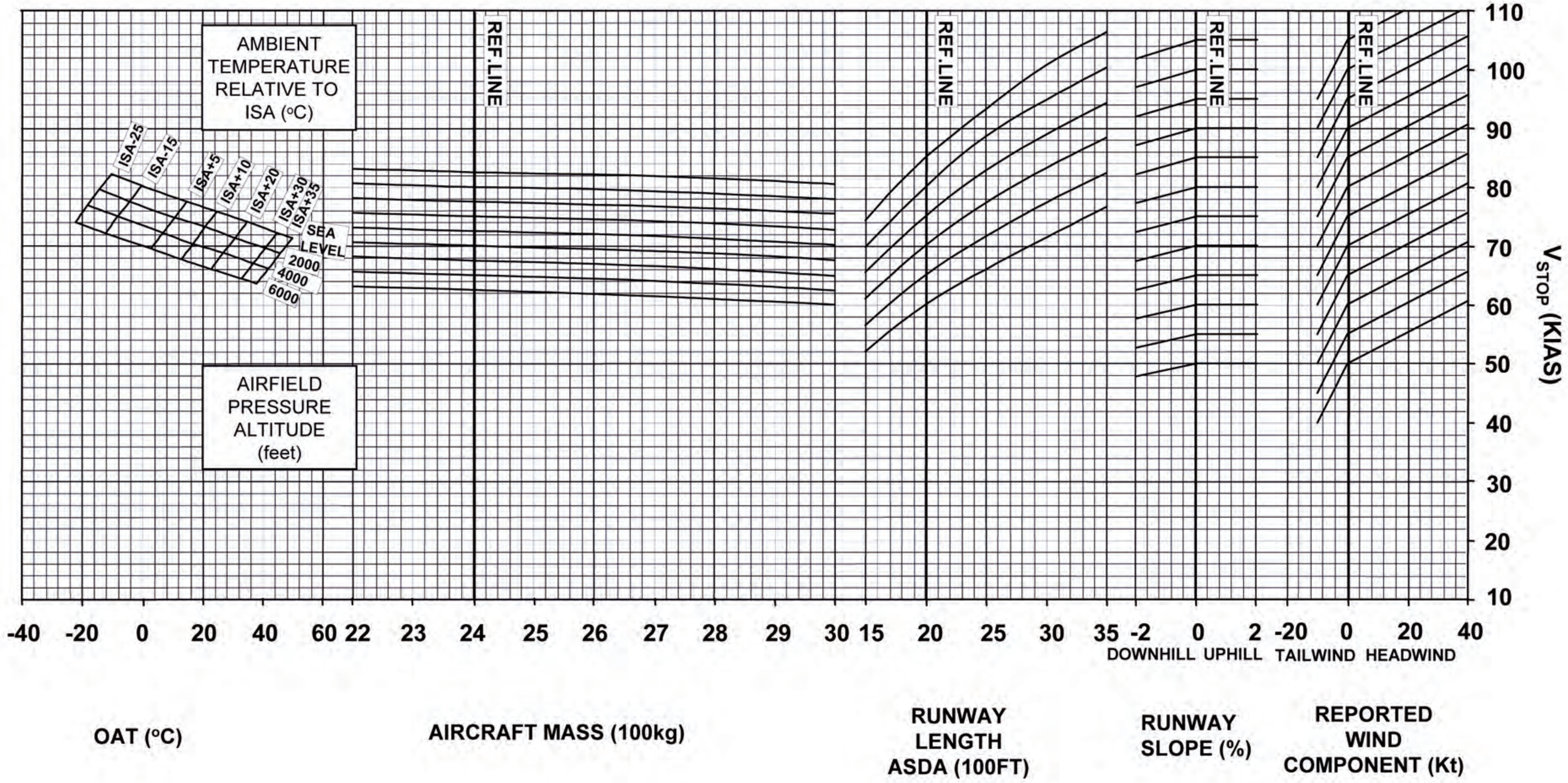

Figure 3.7

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EMERGENCY MAXIMUM BRAKING SPEED, DRY RUNWAY
AIR CONDITIONING NORMAL, INTAKE DE-ICING OFF

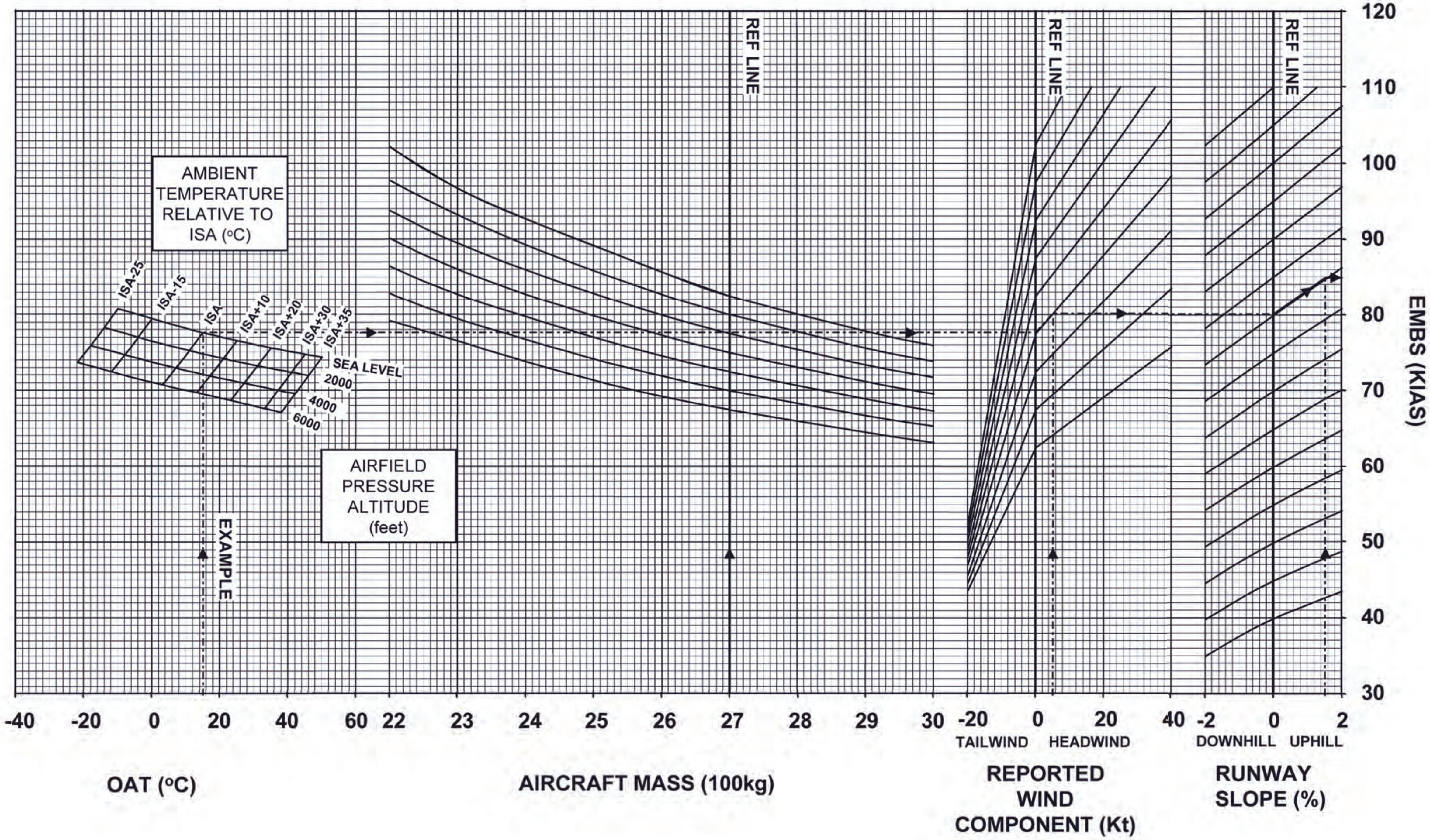

Figure 3.8

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EMERGENCY MAXIMUM BRAKING SPEED, WET RUNWAY
AIR CONDITIONING NORMAL, INTAKE DE-ICING OFF

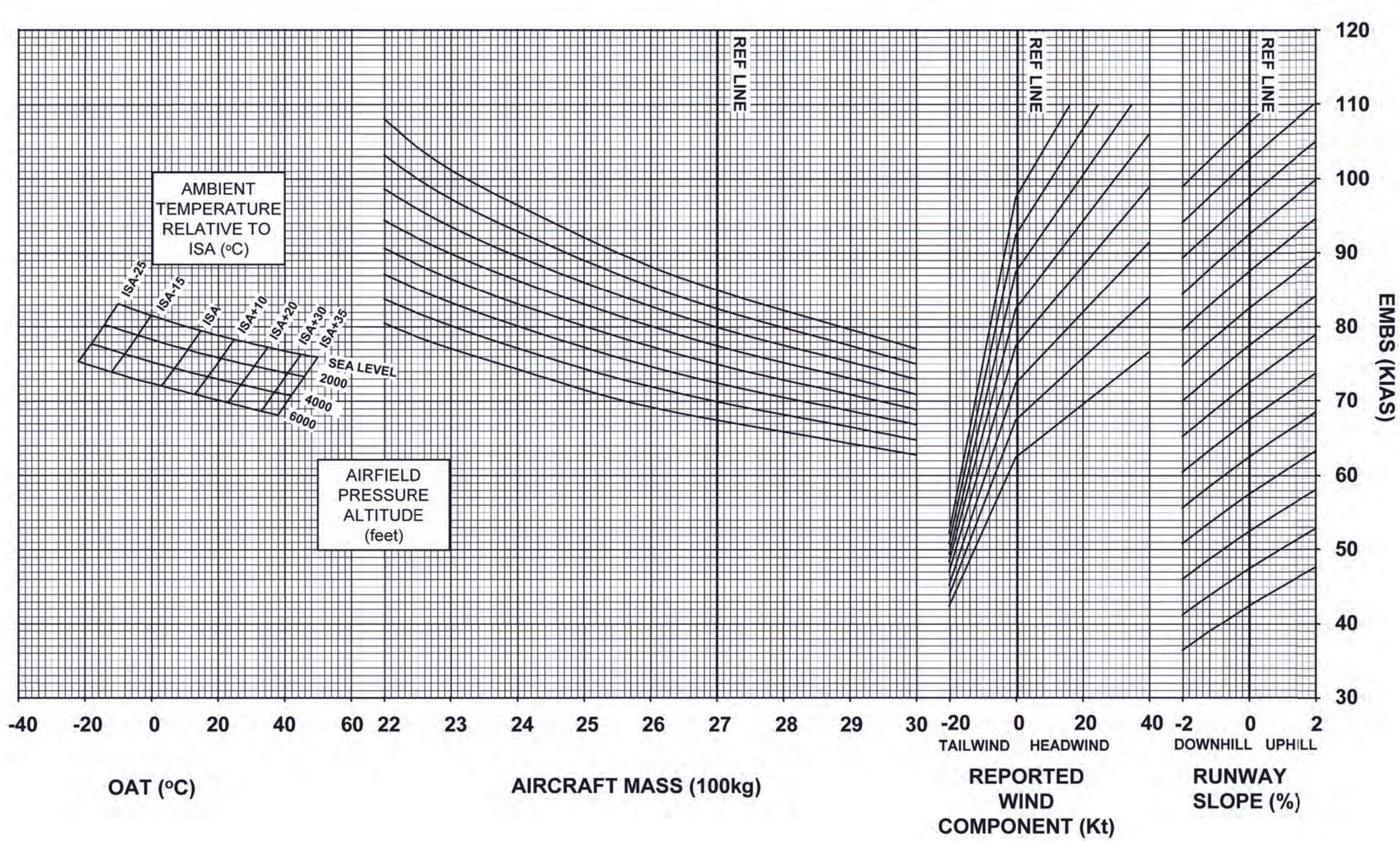

Figure 3.9

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TORQUE, FULL POWER, STATIC

AIR CONDITIONING NORMAL, INTAKE DE-ICING OFF

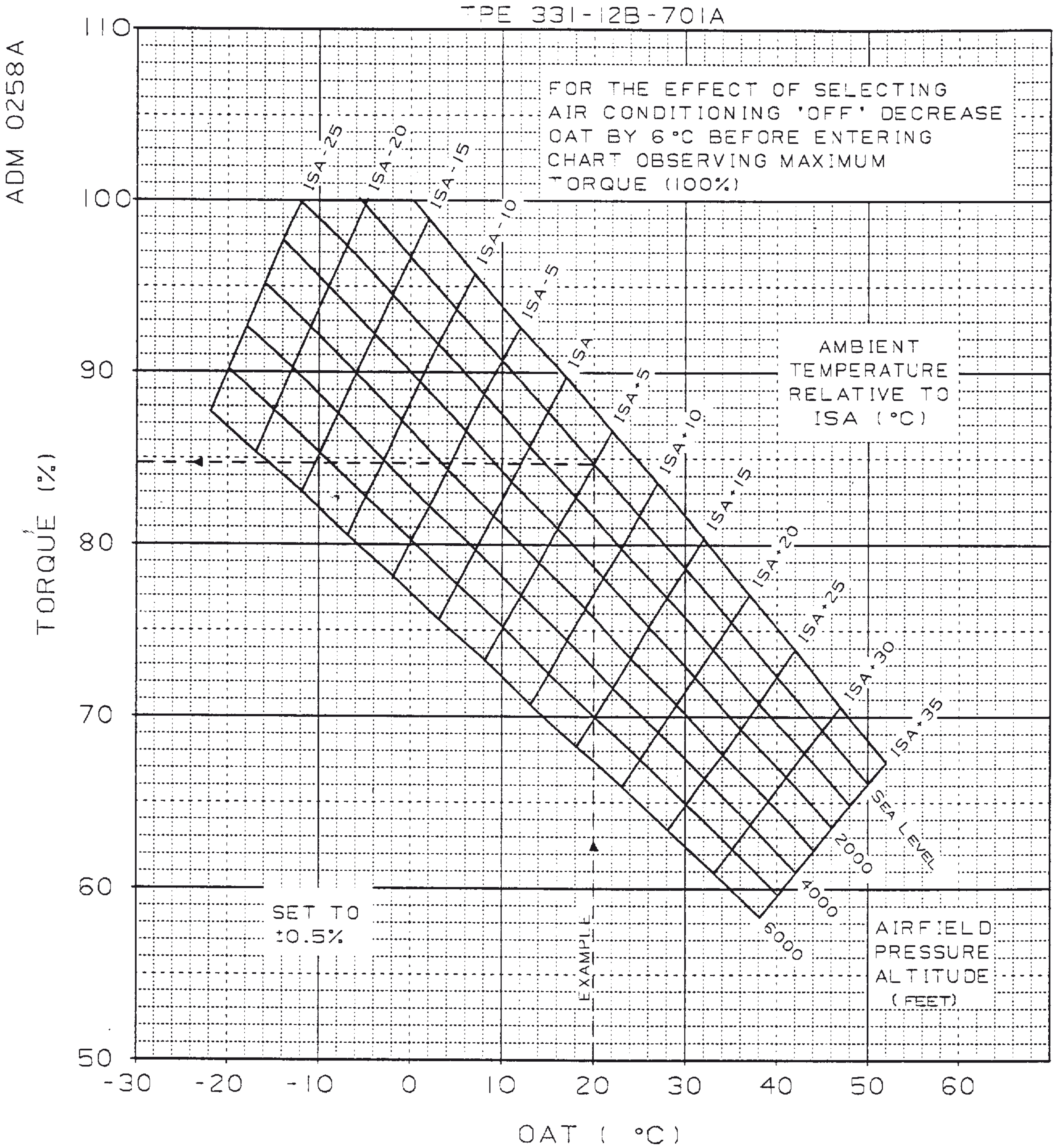

Figure 3.10

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SECTION 4

CLIMB

CONTENTS

LIST OF FIGURES

Introduction

1. This Section gives still-air climb performance for a range of aircraft mass, presented as time elapsed, distance covered and fuel used.

2. The data are presented for a climb at full power using the normal climbing speeds, namely:

150 knots up to l0,000 feet

140 knots from 10,000 feet to 20,000 feet

130 knots above 20,000 feet

3. All figures assume air conditioning selected ON/NORM (1.2% bleed) and intake de-icing selected OFF. The effects of selecting air conditioning OFF or ON/BOOST, and intake de-icing ON are given in paragraph 7 and paragraph 8 respectively.

4. Each chart gives data for climbs commencing at sea level and continuing to 25,000 feet. For climbs between altitudes, data are obtained by reading the associated chart at the finish and start altitudes, and subtracting.

Pre-Climb Fuel Requirements

5. The total fuel required from initiation of engine starting to commencement of climb is typically 12 kg. This comprises 0.6 kg for engine start-up, 2.7 kg for cockpit checks, 6.7 kg for taxying (using flight idle power and an average fuel flow of approximately 3 kg per minute) and 2.0 kg for take-off and acceleration to climb speed.

Use of the Climb Charts

6. When the atmospheric temperature combination is one for which a chart is presented (e.g., ISA +15°C, Figure 4.3) the climb data can be taken directly from the figure. If the temperature for a particular climb falls

between charts, interpolation is necessary; however, an approximation can be quickly achieved by taking the next warmest temperature.

7. The effects of selecting air conditioning OFF may be obtained by subtracting 4°C from the OAT before entering the climb performance charts. Similarly, the effect of selecting BOOST (4% bleed) may be obtained by adding 10°C to the OAT before entering the climb performance charts.

8. The effects of selecting intake de-icing ON may be obtained by adding 4°C to the OAT before entering the climb performance charts.

Example

9. An aircraft with start-climb mass of 2300 kg is to climb at normal climb speed and full power with air conditioning ON/NORM and intake de-icing OFF to 15,000 feet in an ISA minus 15°C atmosphere, commencing the climb at sea level. What are, the time taken, distance covered and fuel used?

10. From Figure 4.1, the time taken, distance covered and fuel used are:

Time:	4 minutes
Distance:	11 NM
Fuel:	16 kg

CLIMB, MASS 2300 KG, ISA MINUS 15°C

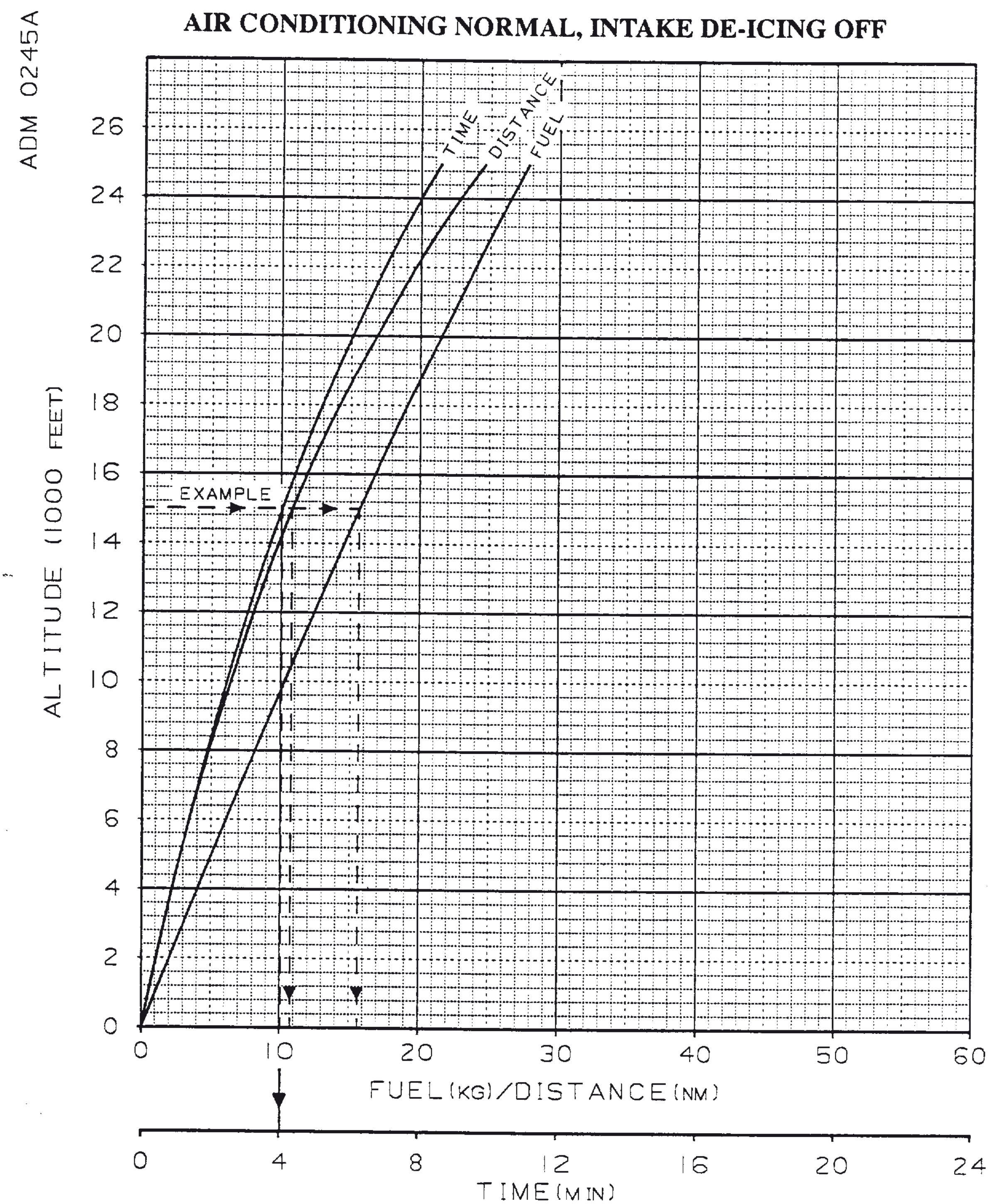

Figure 4.1

CLIMB, MASS 2300 KG, ISA

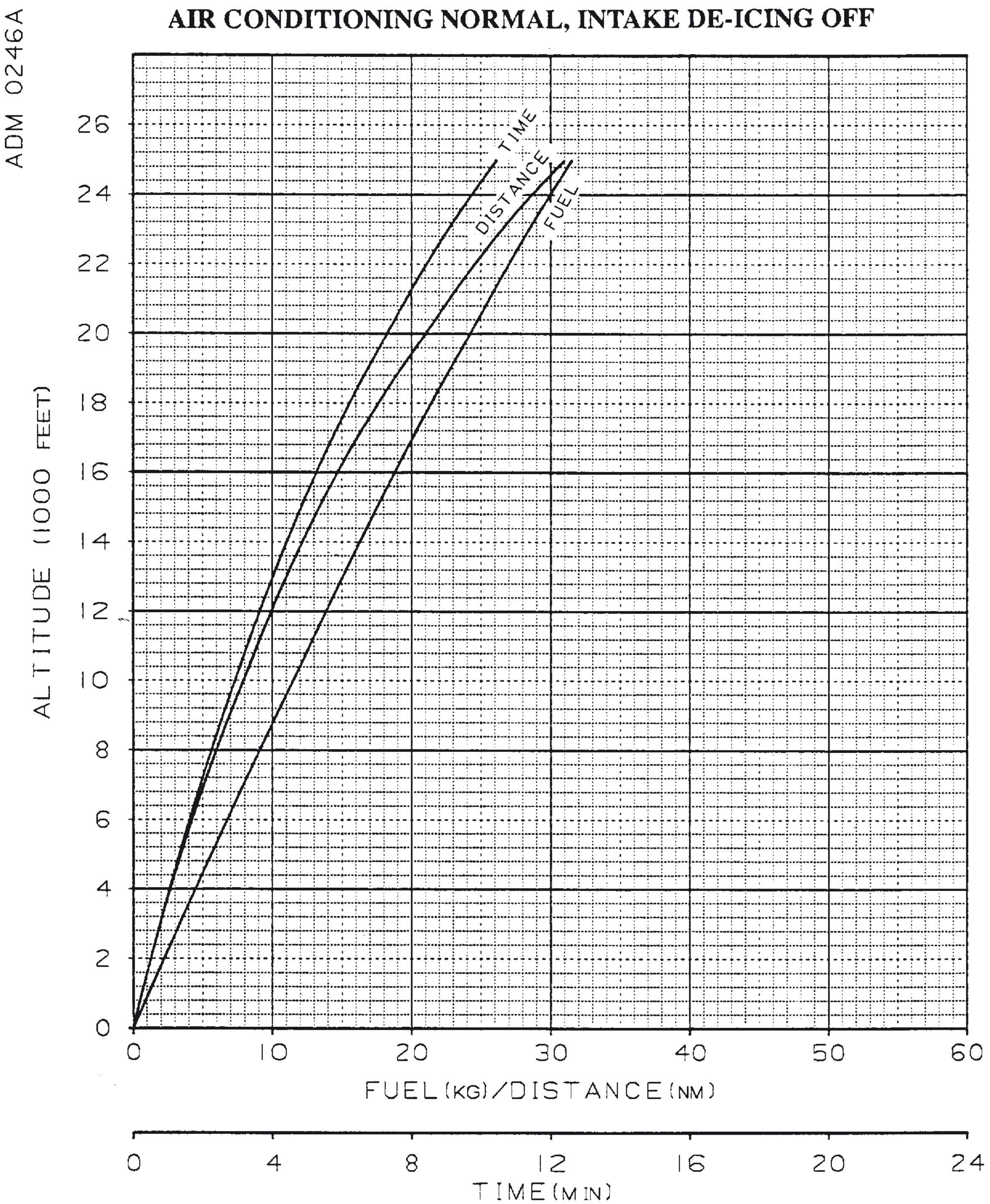

Figure 4.2

CLIMB, MASS 2300 KG, ISA PLUS 15°C

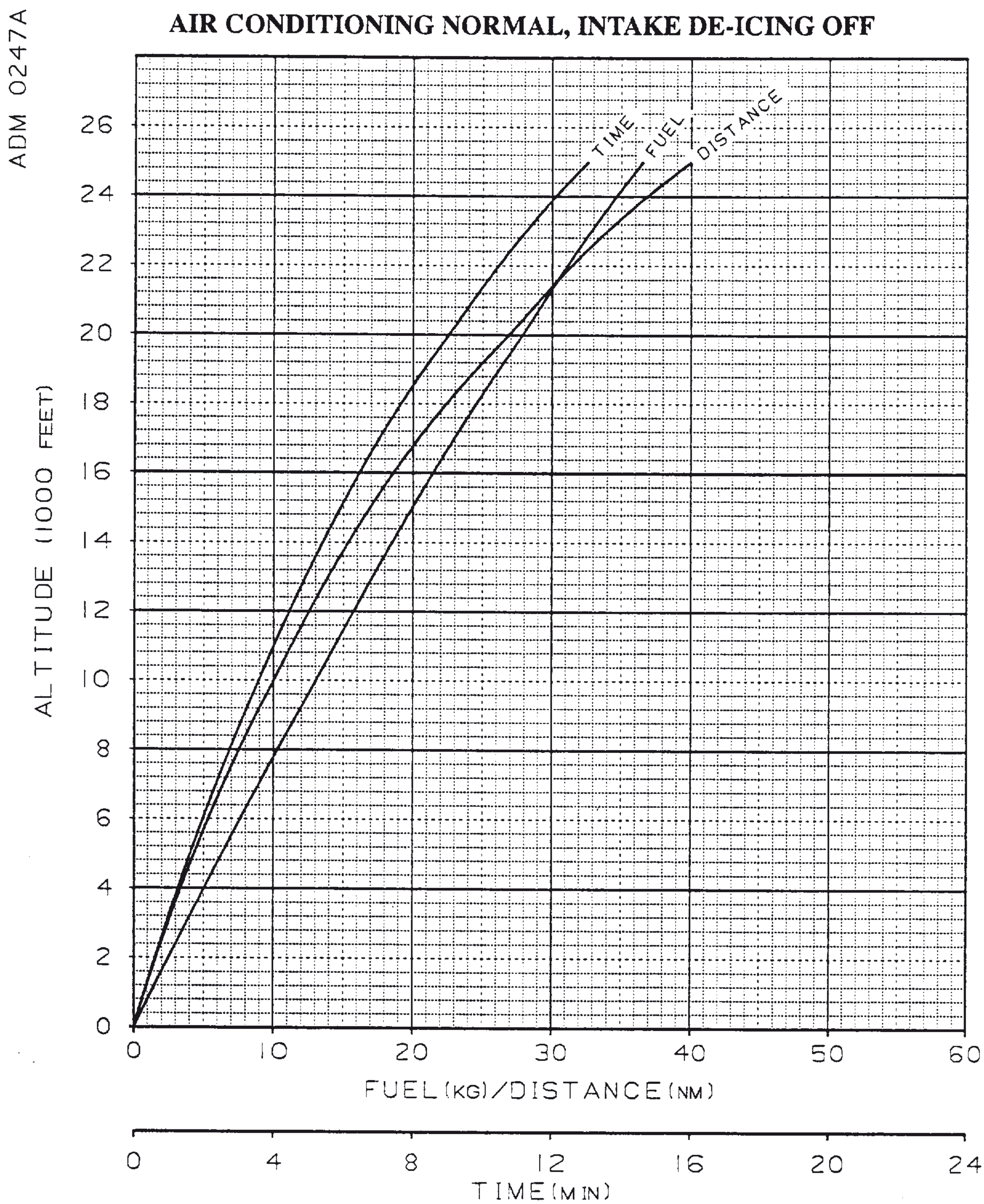

Figure 4.3

CLIMB, MASS 2600 KG, ISA MINUS 15°C

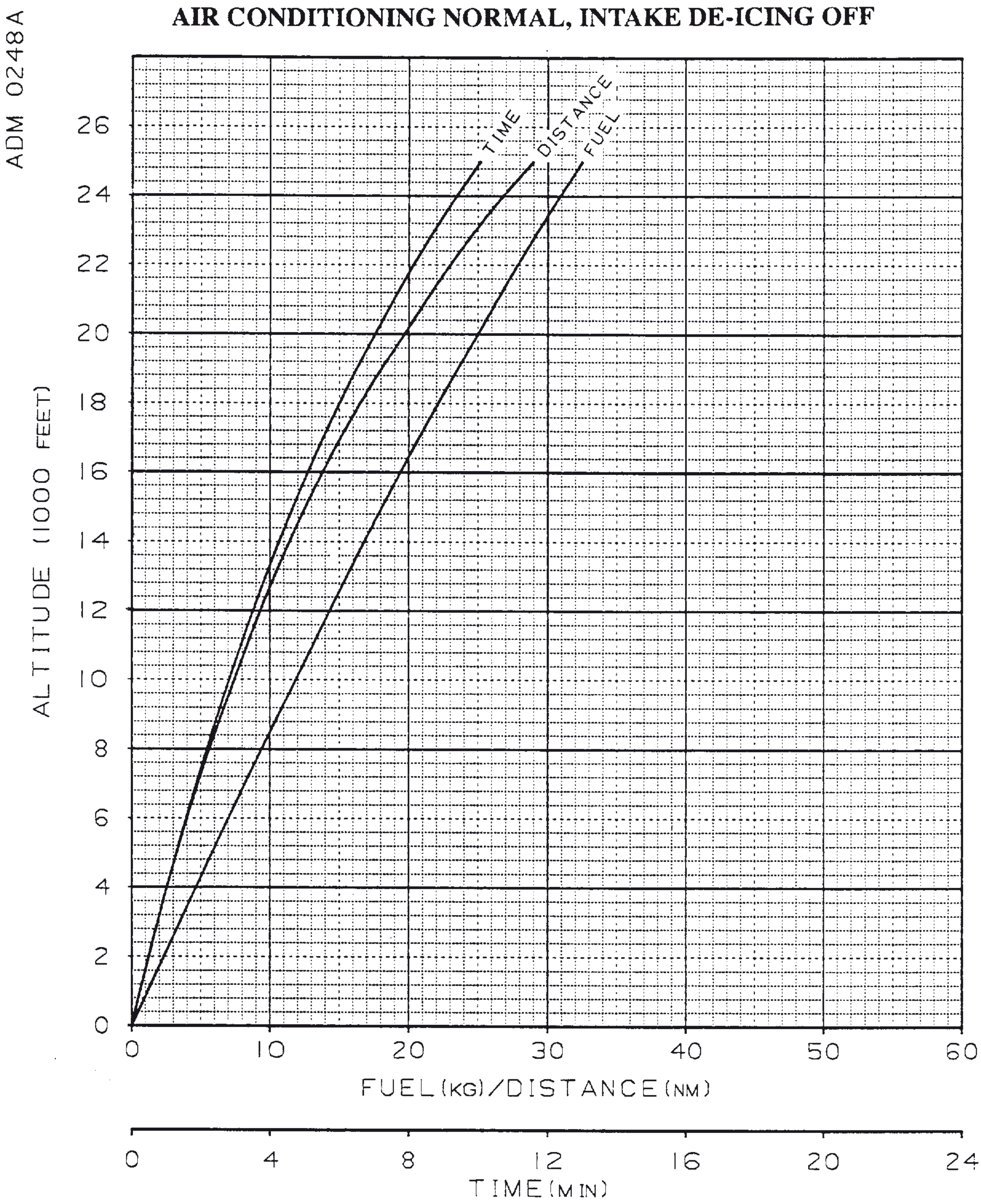

Figure 4.4

CLIMB, MASS 2600 KG, ISA

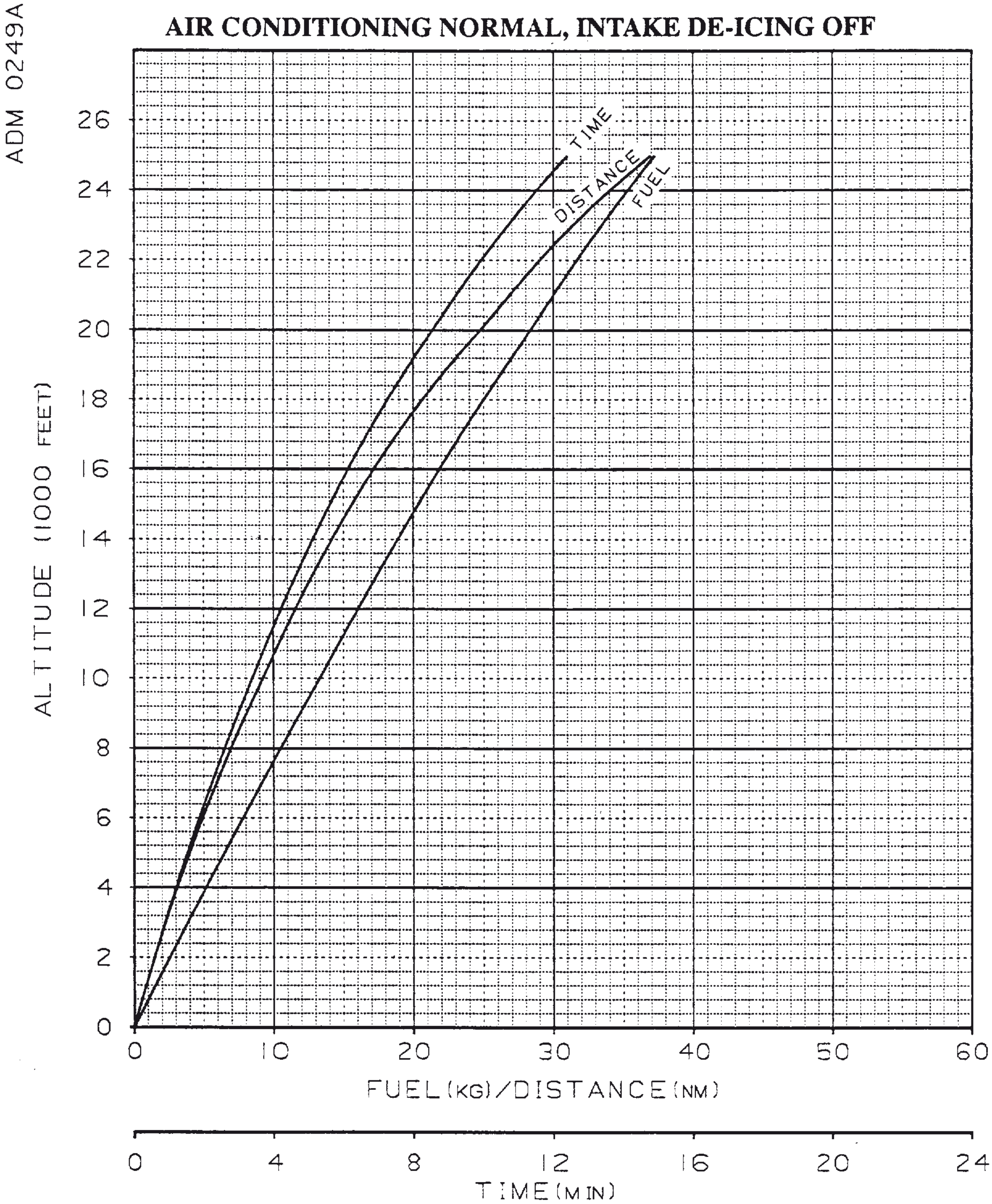

Figure 4.5

CLIMB, MASS 2600 KG, ISA PLUS 15°C

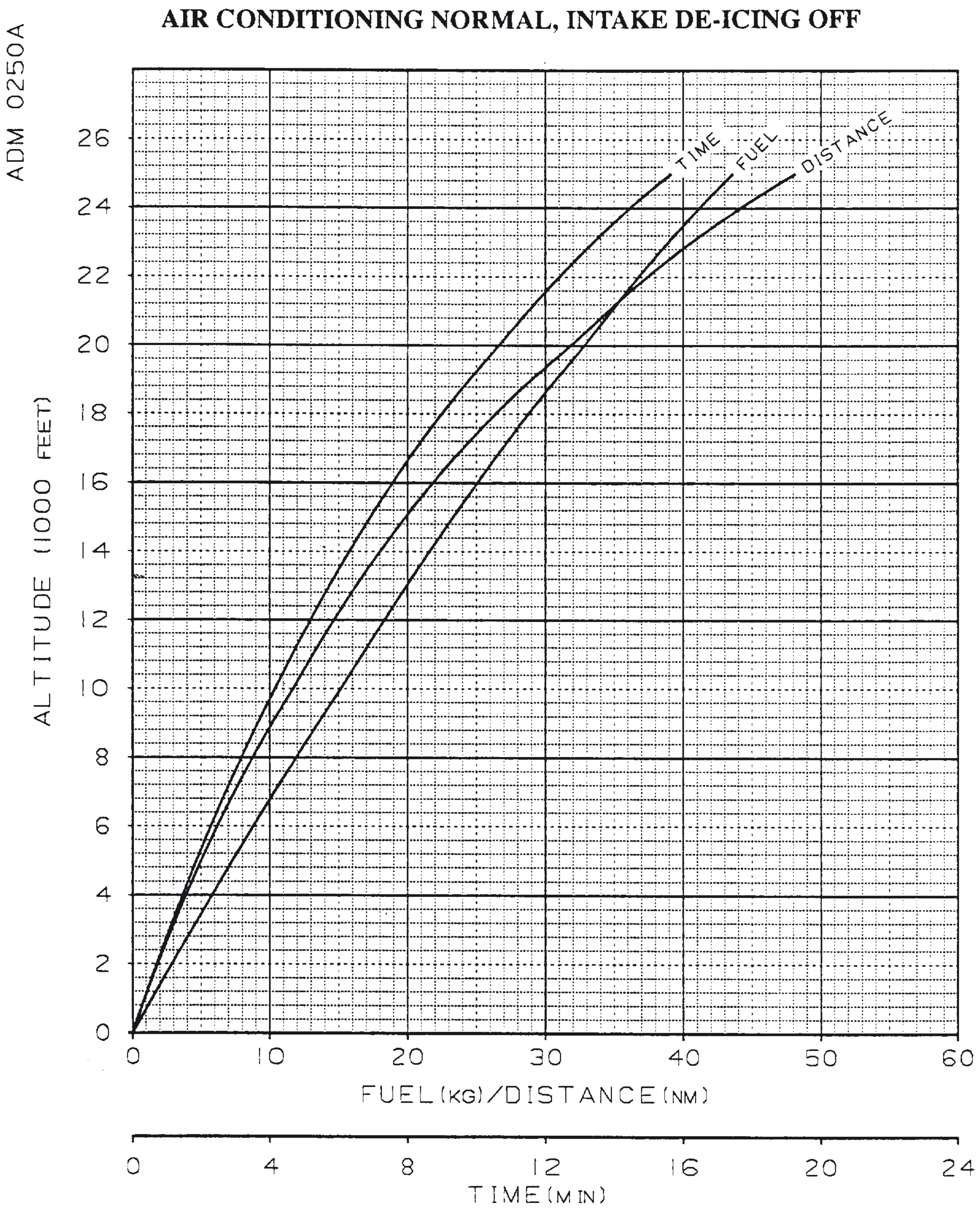

Figure 4.6

CLIMB, MASS 2900 KG, ISA MINUS 15°C

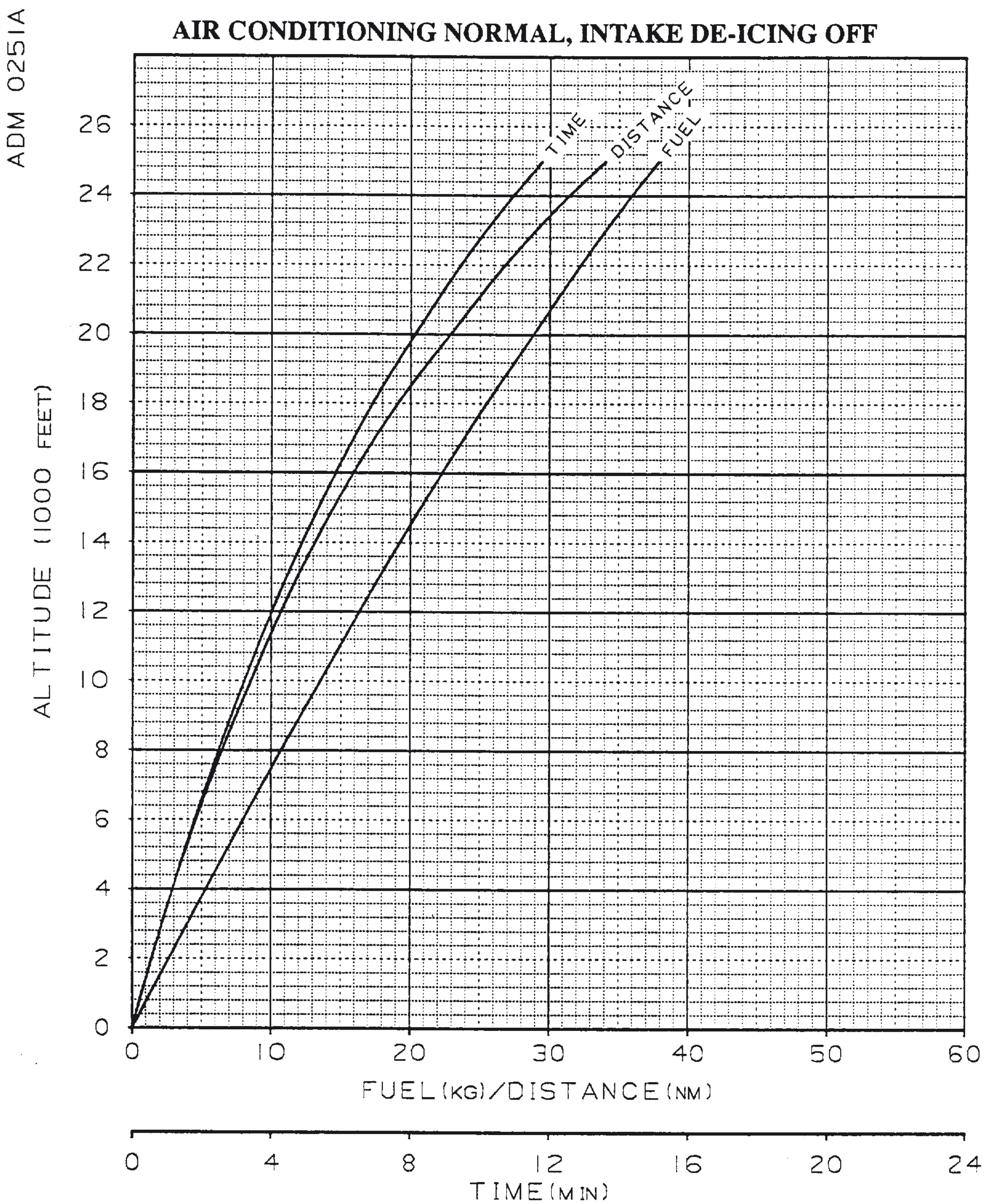

Figure 4.7

CLIMB, MASS 2900 KG, ISA

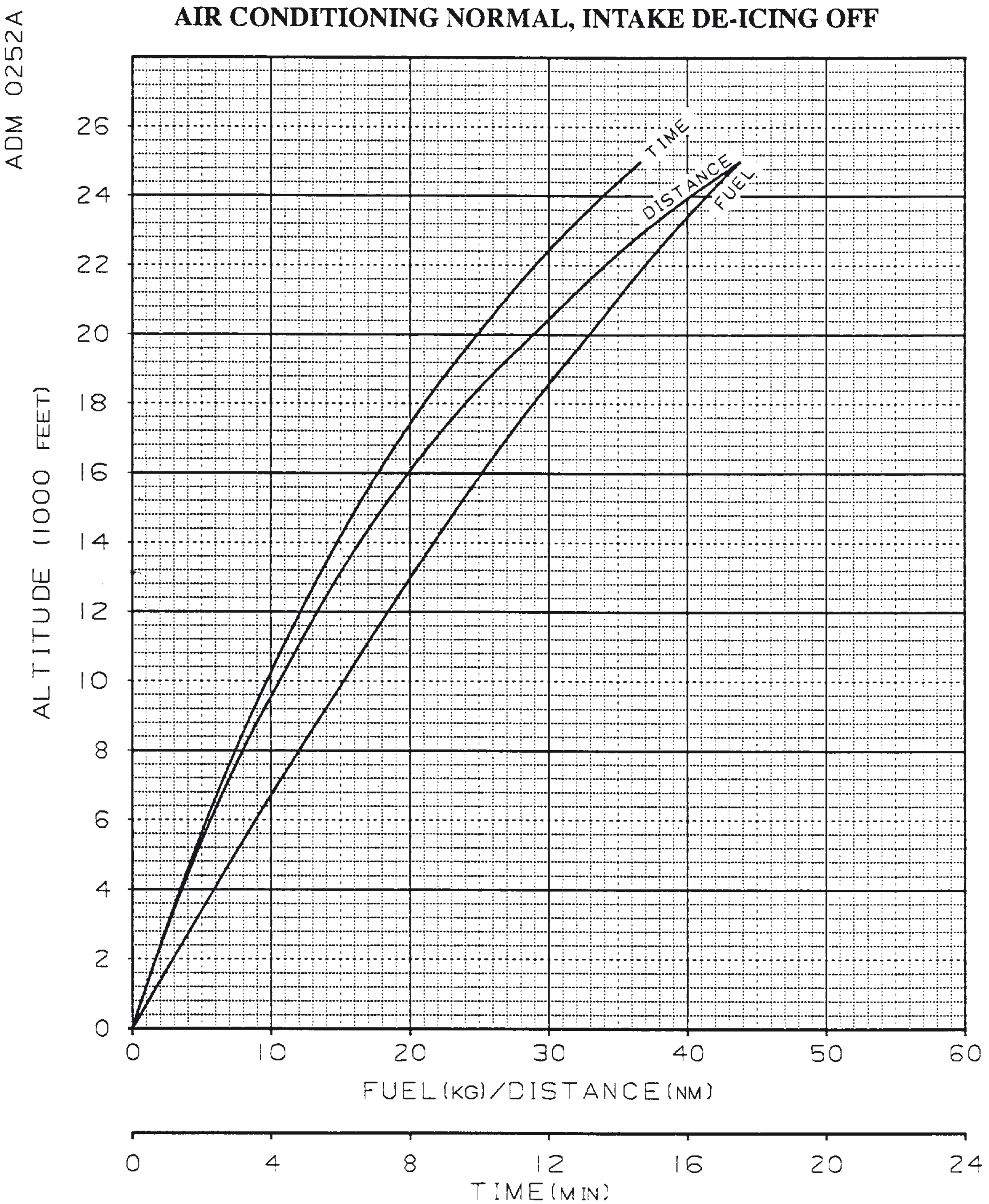

Figure 4.8

CLIMB, MASS 2900 KG, ISA PLUS 15°C

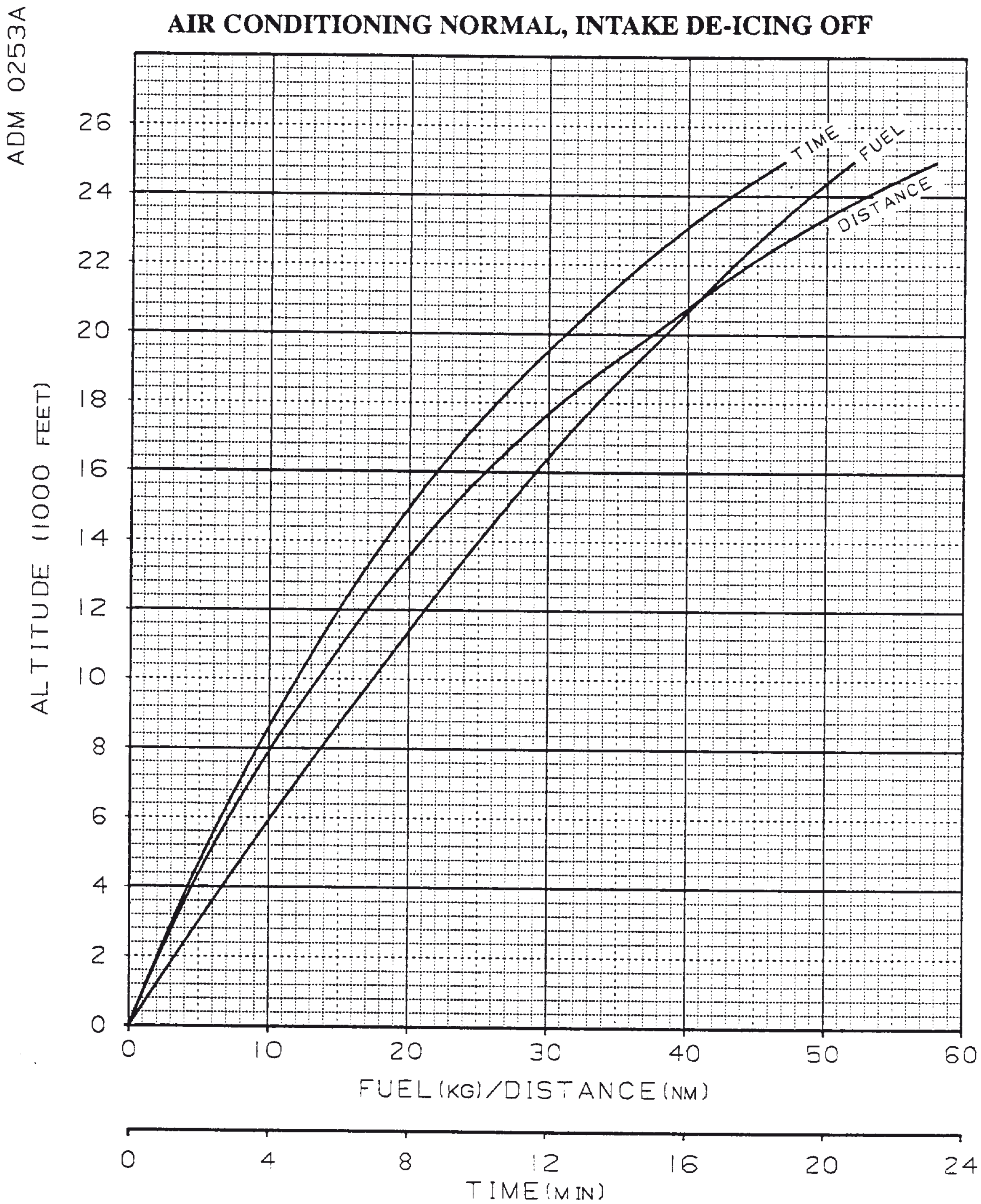

Figure 4.9

CLIMB, MASS 3000 KG, ISA MINUS 15°C

AIR CONDITIONING ON/INTAKE DE-ICING OFF

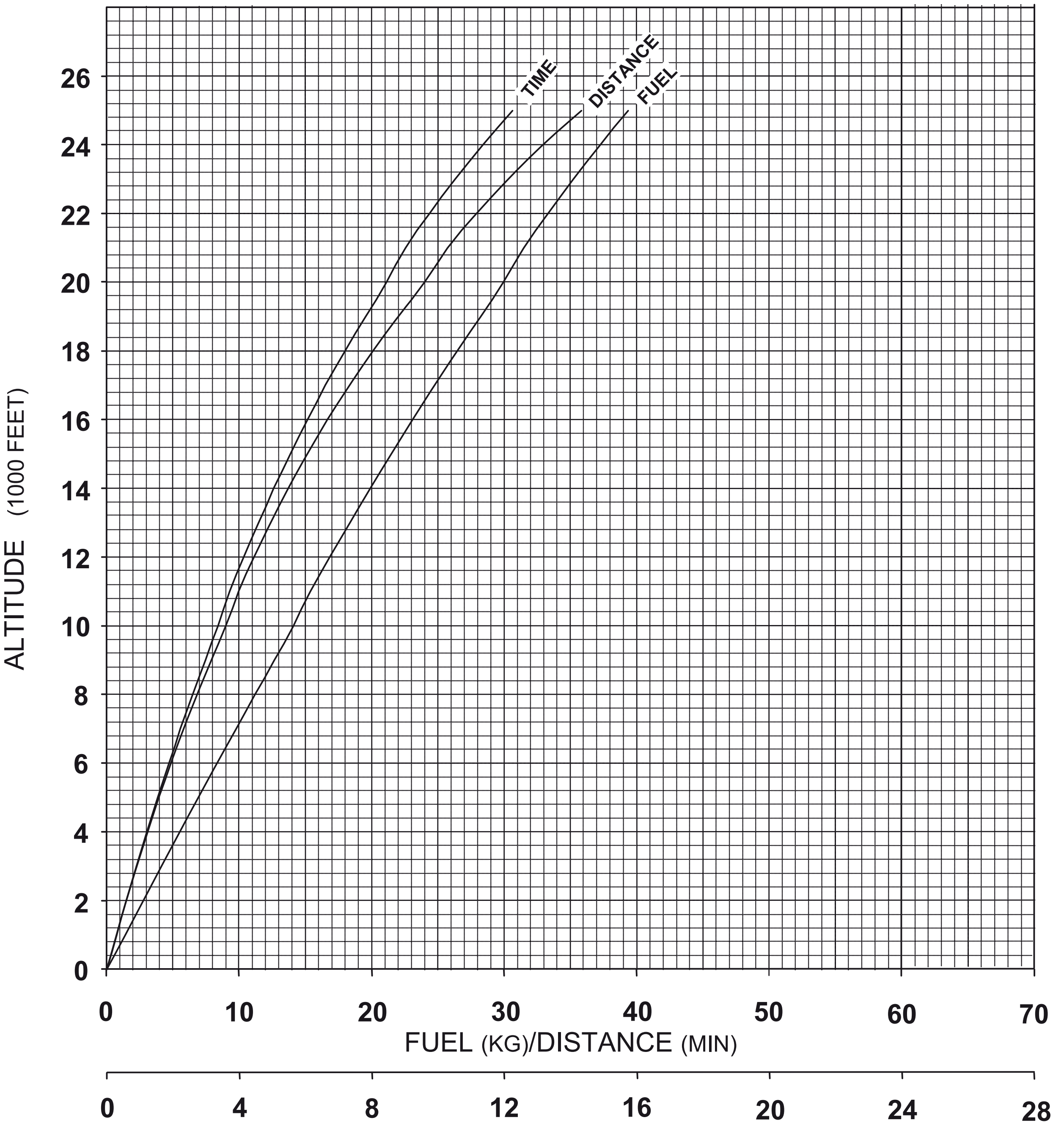

Figure 4.10

CLIMB, MASS 3000 KG, ISA

AIR CONDITIONING ON/INTAKE DE-ICING OFF

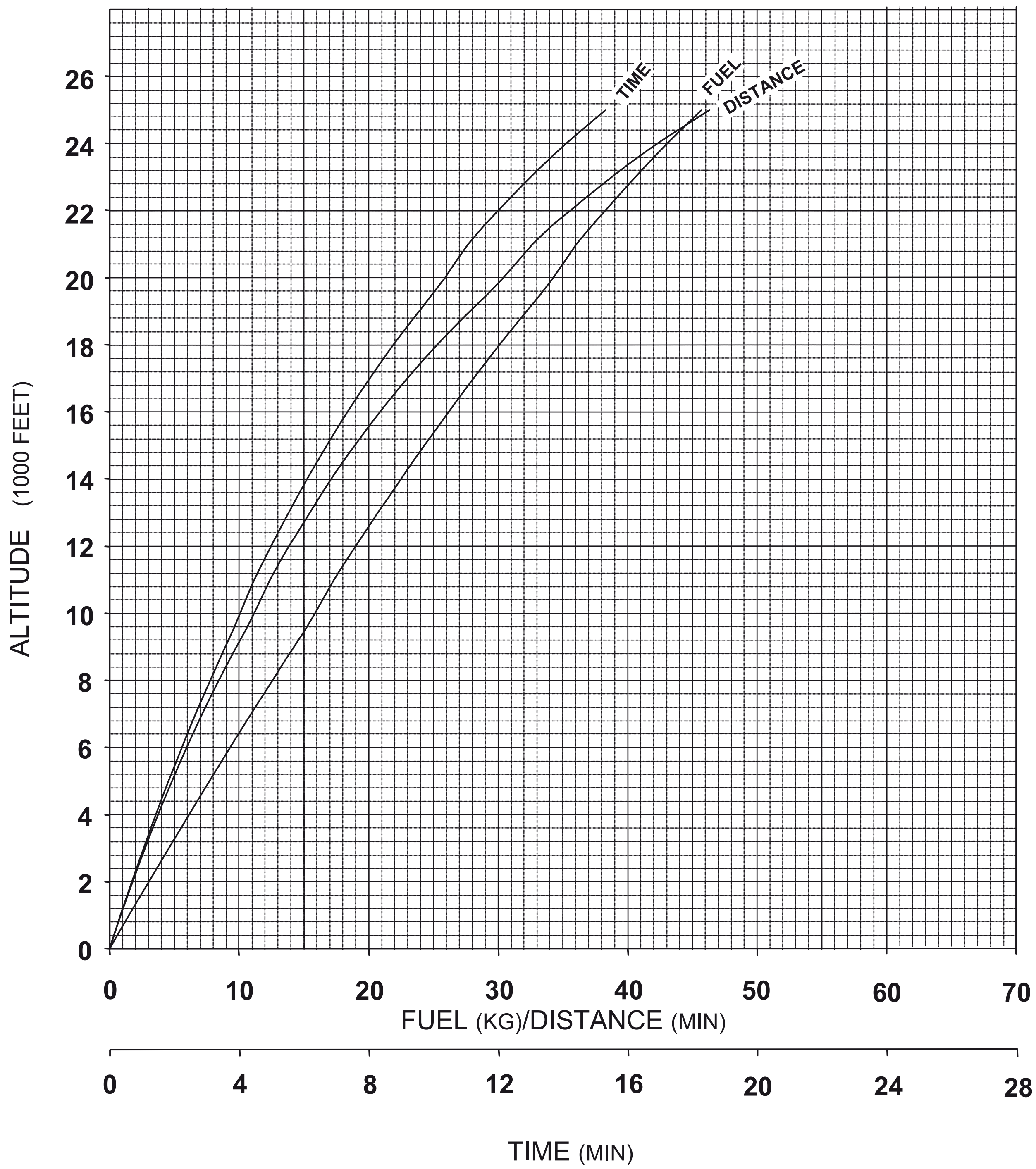

Figure 4.11

CLIMB, MASS 3000 KG, ISA PLUS 15°C

AIR CONDITIONING ON/INTAKE DE-ICING OFF

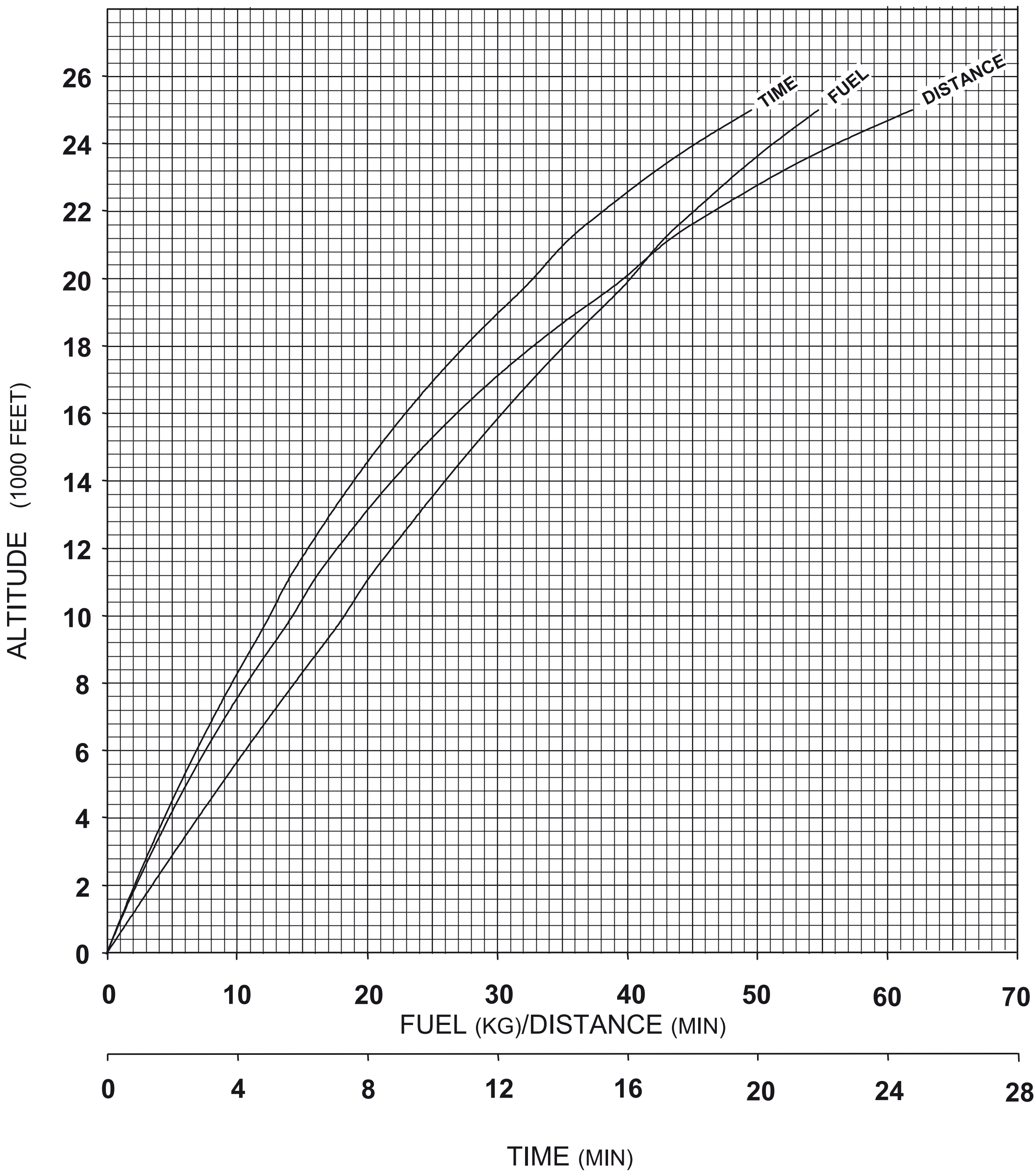

Figure 4.12

SECTION 5

CRUISE

CONTENTS

LIST OF FIGURES

Introduction

1. The level cruise performance data of the aircraft are presented in graphical form in Figure 5.3 to Figure 5.11. Included on the figures are lines for recommended maximum endurance airspeed and for constant TAS of 180, 210 and 240 knots.

2. Data are given for a range of aircraft mass and temperature. Where necessary, use linear interpolation.

EFFECT OF AIR CONDITIONING TO ON/NORM

	Airspeed	*Fuel Flow*
Full Power	+4%	+3%
Constant TAS	nil	minus 3%
Maximum Endurance	nil	minus 4%

Figure 5.1

Use of the Cruise Charts

3. The effects on the various cruise schedules of selecting the air conditioning to ON/NORM (1.2% bleed) are given in Figure 5.1.

4. The effects on the various cruise schedules of selecting the air conditioning OFF are given in Figure 5.2.

5. The effects of selecting engine intake de-icing ON may be obtained by increasing fuel flow by 3% and, for cruise at full power only, reducing fuel flow by 1.5% and airspeed by 5 knots.

EFFECT OF AIR CONDITIONING TO OFF

	Airspeed	*Fuel Flow*
Full Power	+6%	+5%
Constant TAS	nil	minus 5%
Maximum Endurance	nil	minus 6%

Figure 5.2

Examples

6. **Example 1.** An aircraft of mass 2450 kg is required to hold at 15,000 feet altitude (ambient temperature is minus 15°C). Only 50 kg of fuel are available for the hold before the briefed minimum descent fuel state is reached. What are the optimum speed, fuel flow and the maximum endurance time with the available fuel when the air conditioning is ON/BOOST and the engine intake de-icing is OFF?

7. **Example 1 Solution.** From Section 1, Figure 1.1, minus 15°C at 15,000 feet corresponds to ISA conditions. Therefore Figure 5.4 and 5.7 are to be used. From Figure 5.4 for 2300 kg the true airspeed is 141 knots and the fuel flow is 1.59 kg per minute. From Figure 5.7 for 2600 kg the true airspeed is 150 knots and the fuel flow is 1.66 kg per minute. By interpolation for 2450 kg the true airspeed is 145 knots and the fuel flow is 1.63 kg per minute. Thus the maximum endurance is 50 divided by 1.63 kg per minute which is 31 minutes.

8. **Example 2.** It is required to fly an aircraft of mass 2600 kg at 240 knots TAS at 15,000 feet (ambient temperature of minus 15°C with air conditioning ON/BOOST). What are the associated cruise conditions for a cruise fuel burn of 400 kg?

9. **Example 2 Solution.** From Section 1, Figure 1.1, minus 15°C at 15,000 feet corresponds to ISA conditions. Select the mean cruise mass associated with half the fuel burn of 400 kg (2600 kg minus half of 400 kg) i.e., 2400 kg. From Figure 5.4 for an aircraft mass of 2600 kg and 240 knots TAS the fuel flow is 2.44 kg per minute. From Figure 5.7 for an aircraft mass of 2300 kg and 240 knots TAS the fuel flow is 2.47 kg per minute. By interpolation for an aircraft mass of 2400 kg and 240 knots TAS the fuel flow is 2.45 kg per minute. Therefore the cruise time is 400 divided by 2.45 kg per minute which corresponds to a cruise time of 2 hours 43 minutes.

CRUISE PERFORMANCE, 2300 KG, ISA MINUS 15°C

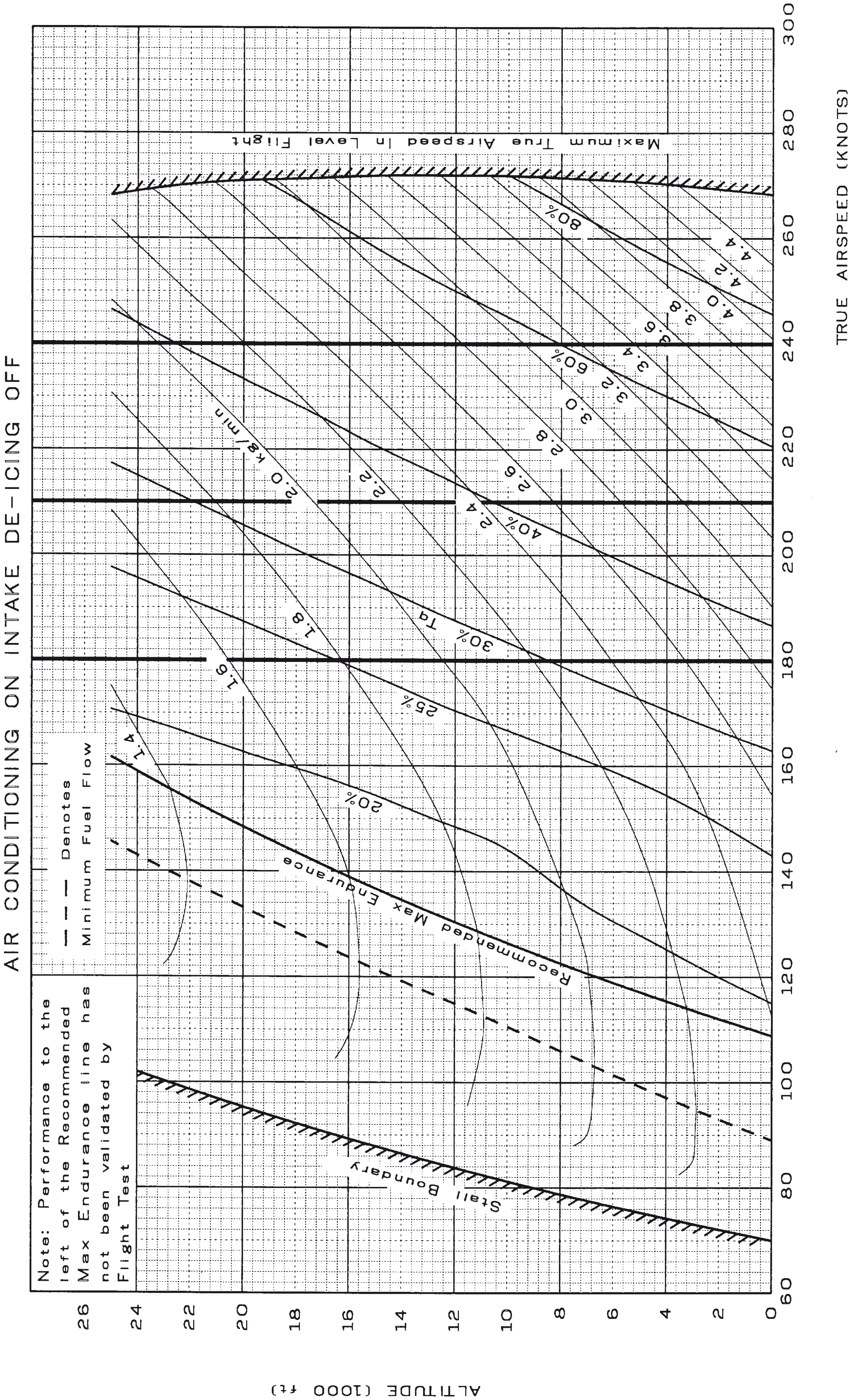

Figure 5.3

CRUISE PERFORMANCE, 2300 KG, ISA

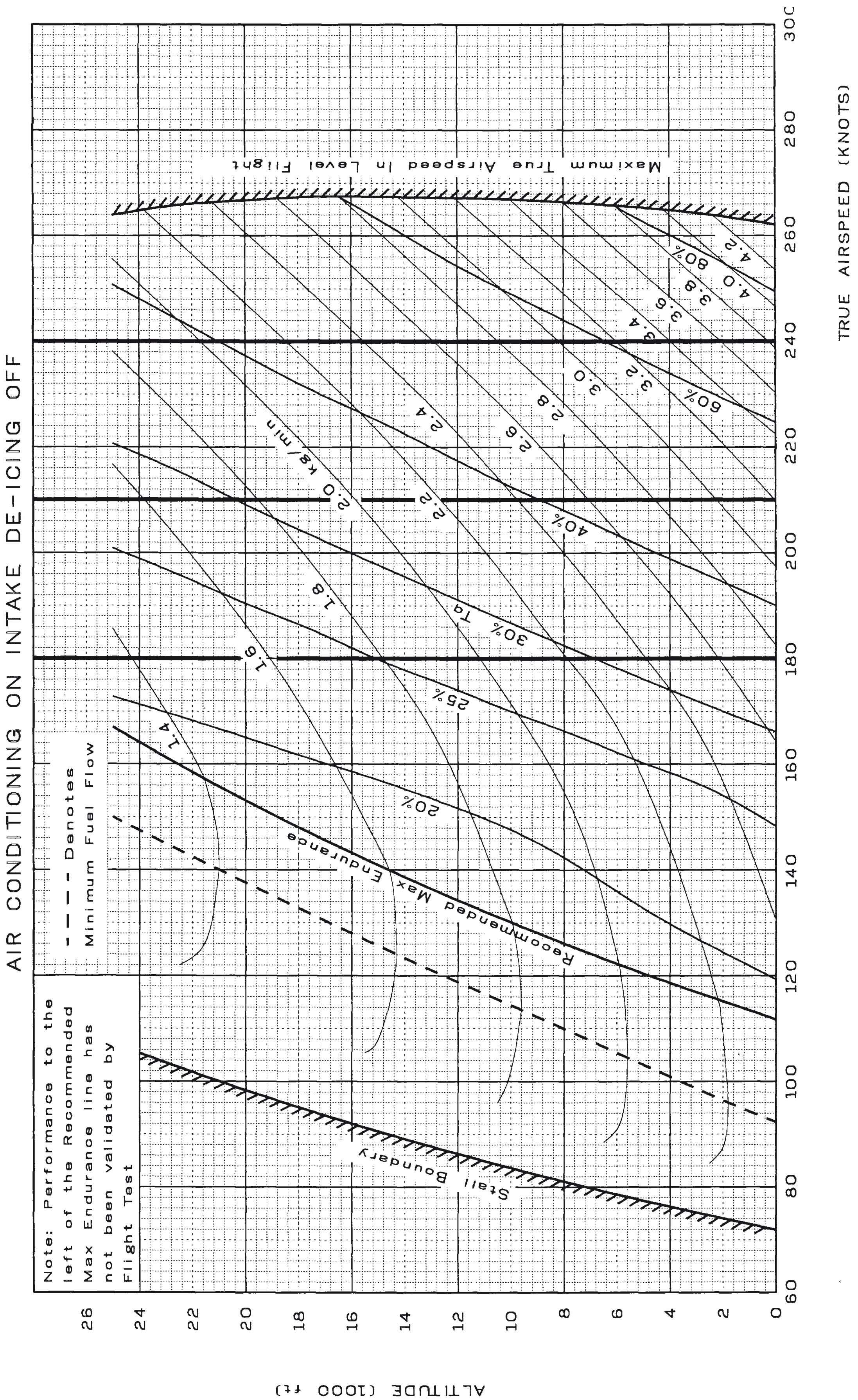

Figure 5.4

CRUISE PERFORMANCE, 2300 KG, ISA +15°C

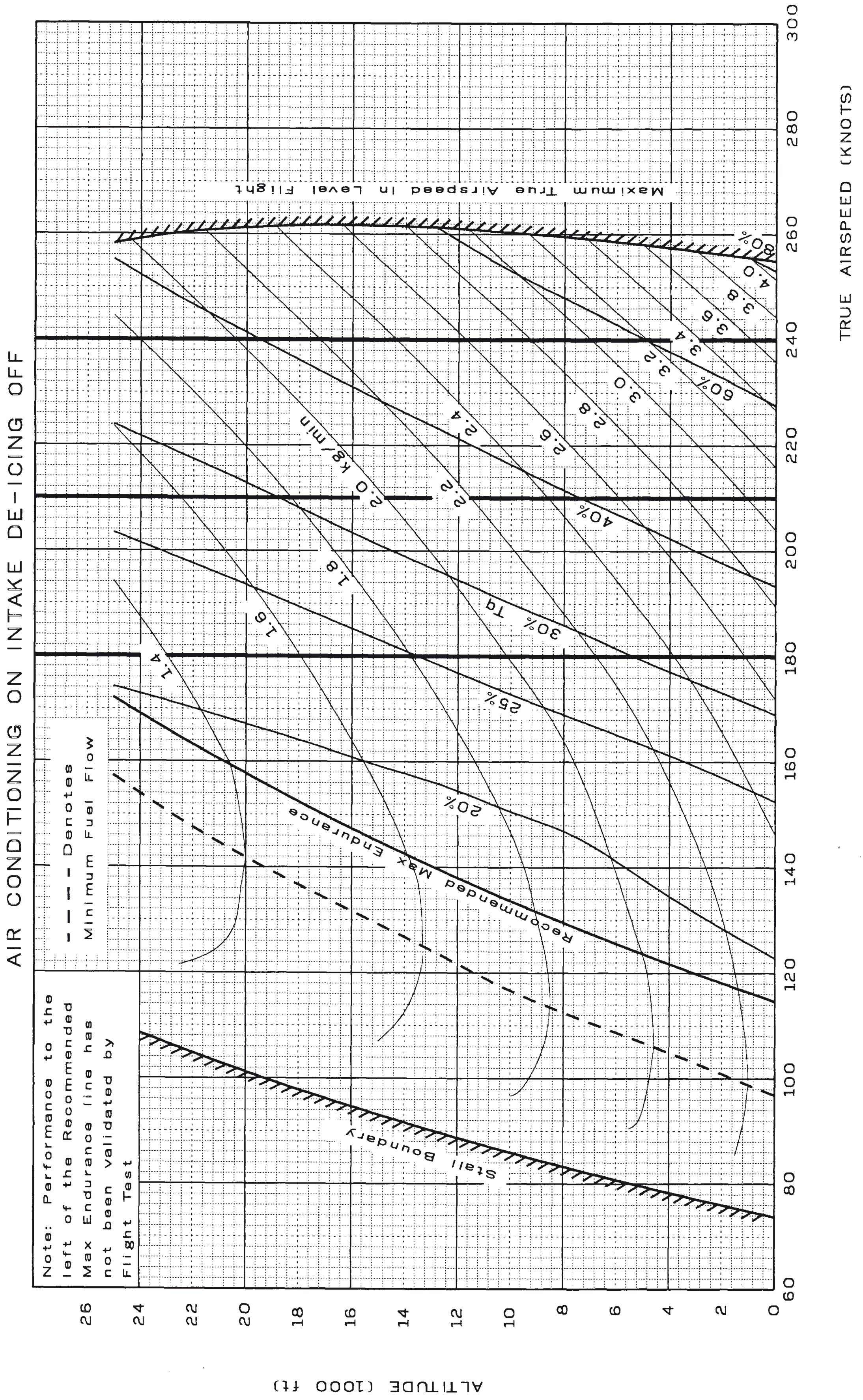

Figure 5.5

CRUISE PERFORMANCE, 2600 KG, ISA MINUS 15°C

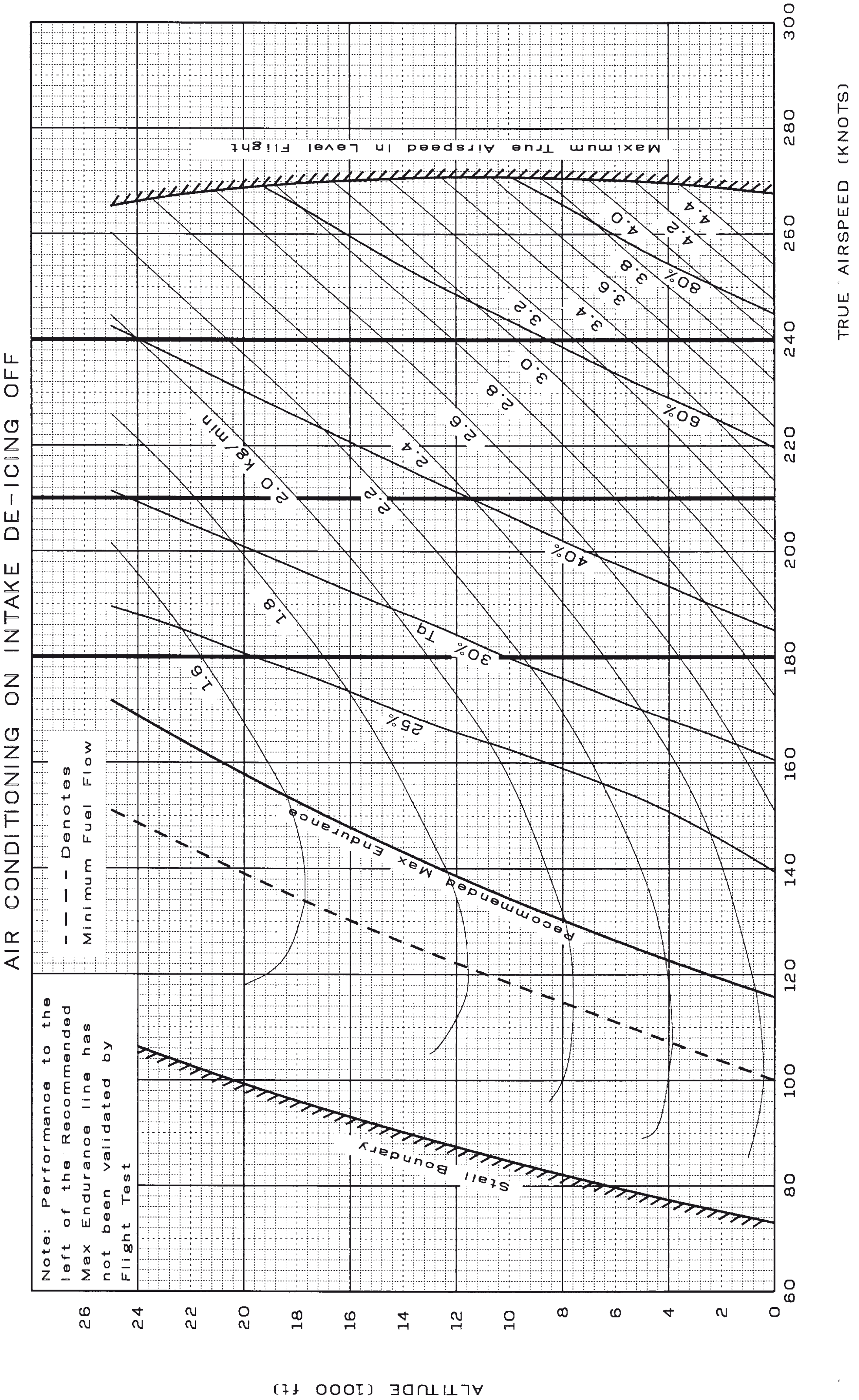

Figure 5.6

CRUISE PERFORMANCE, 2600 KG, ISA

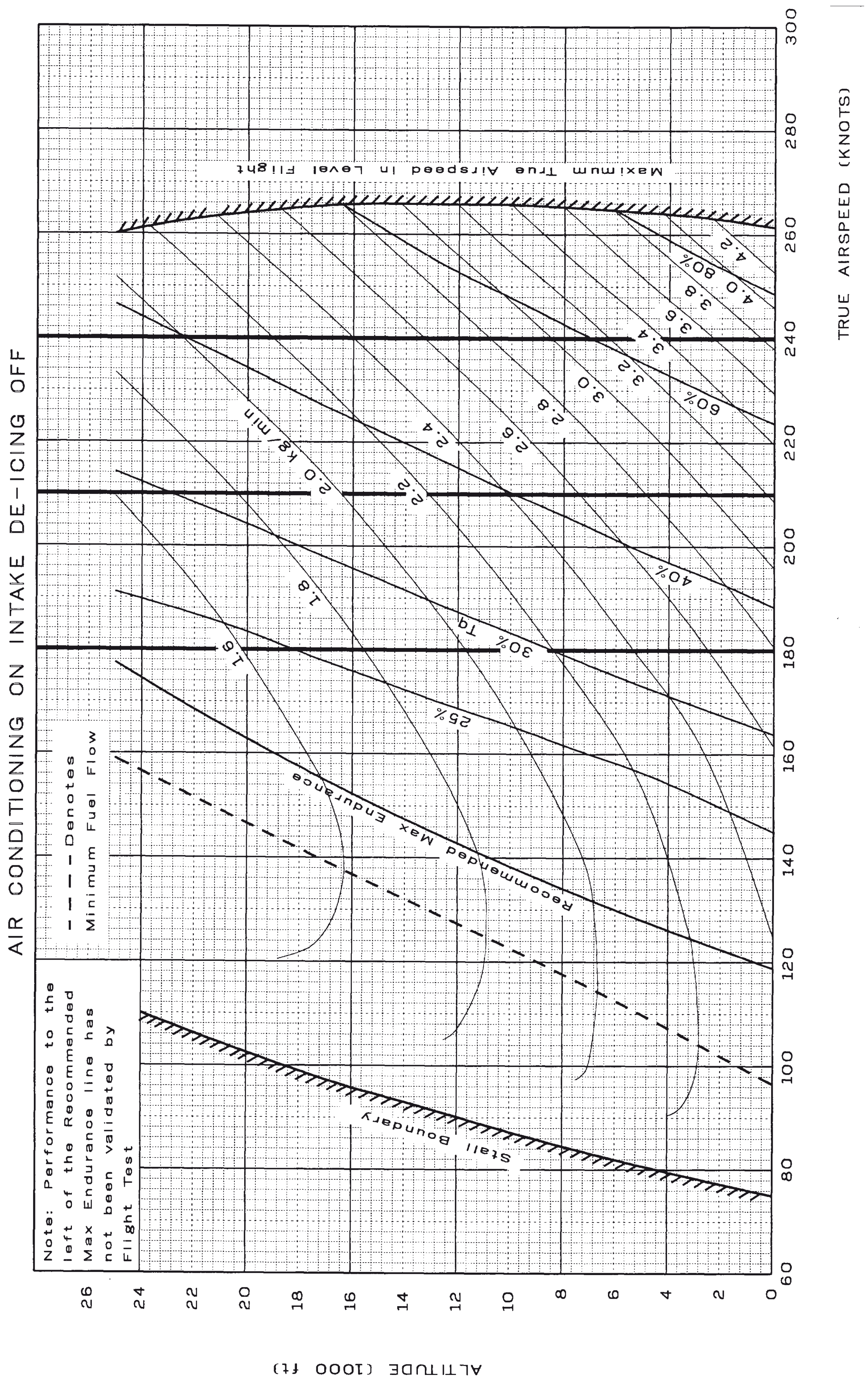

Figure 5.7

CRUISE PERFORMANCE, 2600 KG, ISA +15°C

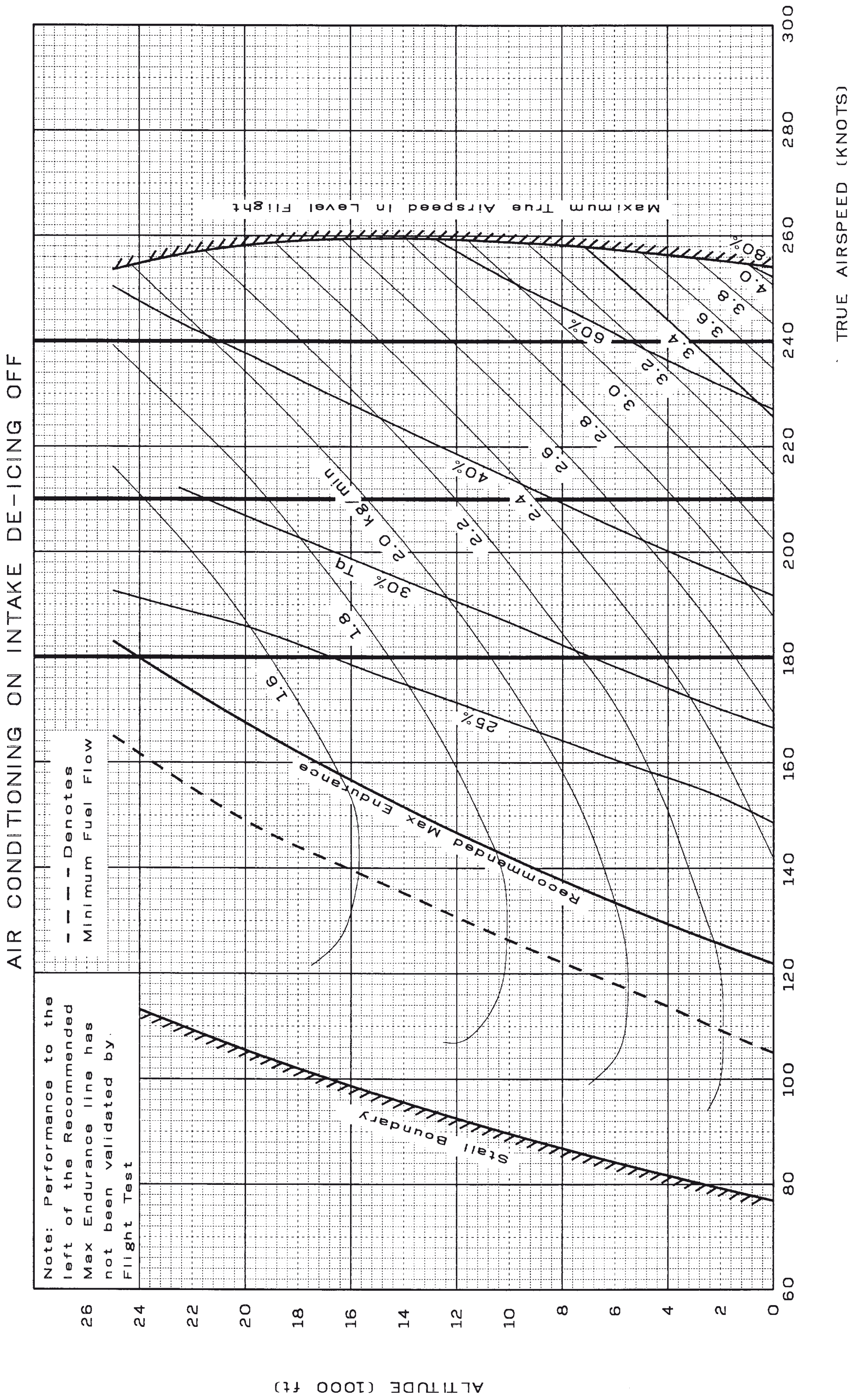

Figure 5.8

CRUISE PERFORMANCE, 2900 KG, ISA MINUS 15°C

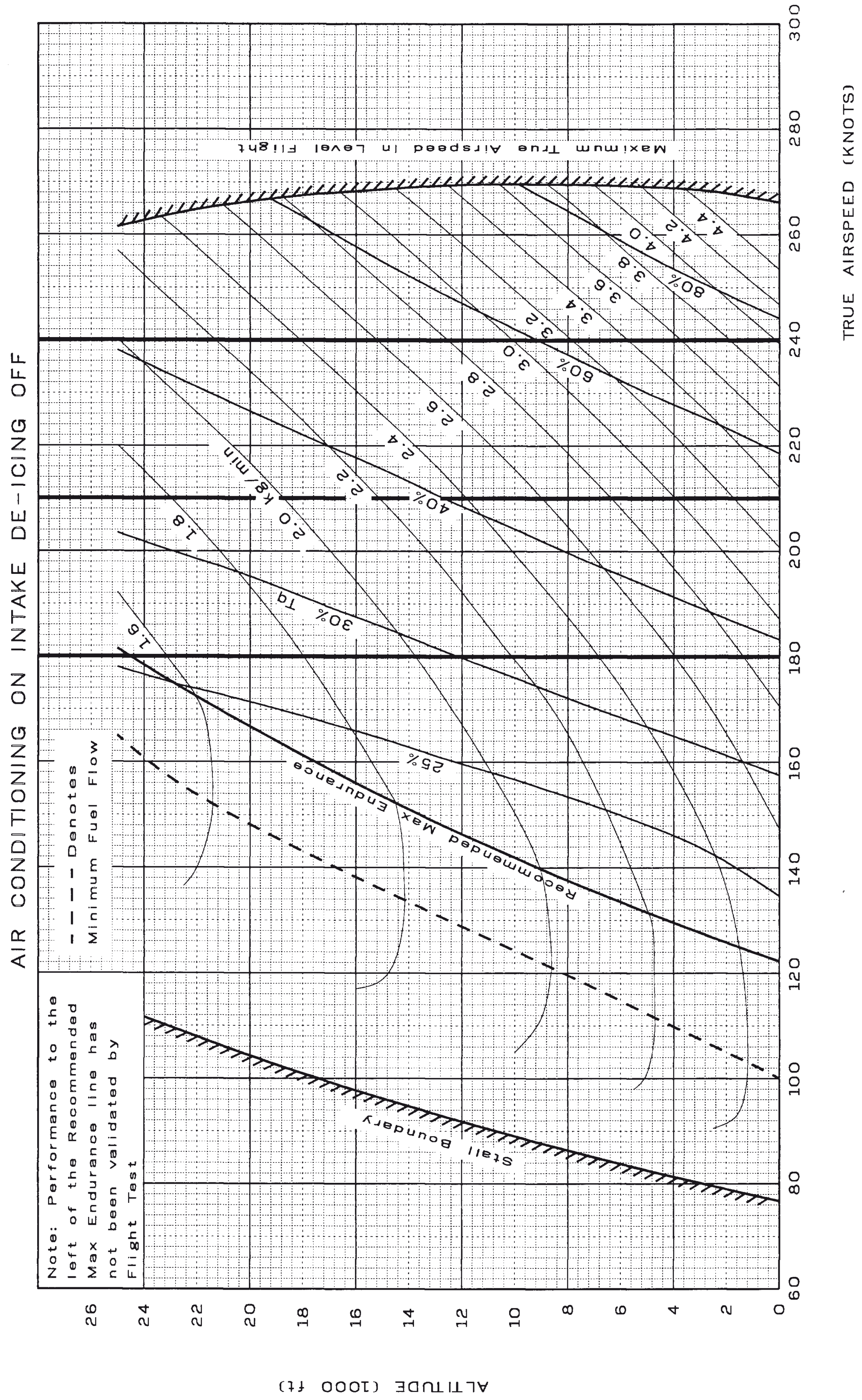

Figure 5.9

CRUISE PERFORMANCE, 2900 KG, ISA

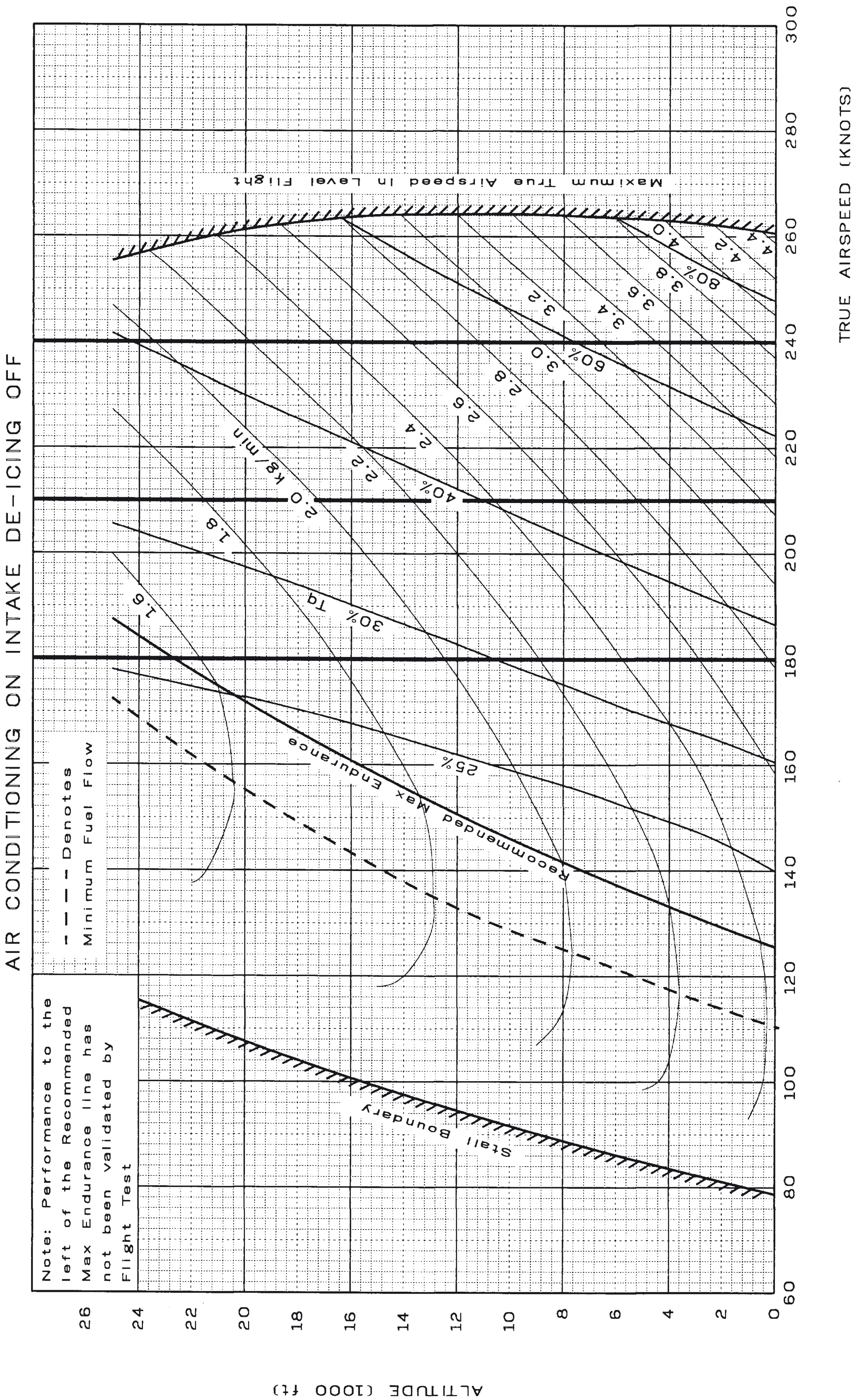

Figure 5.10

CRUISE PERFORMANCE, 2900 KG, ISA +15°C

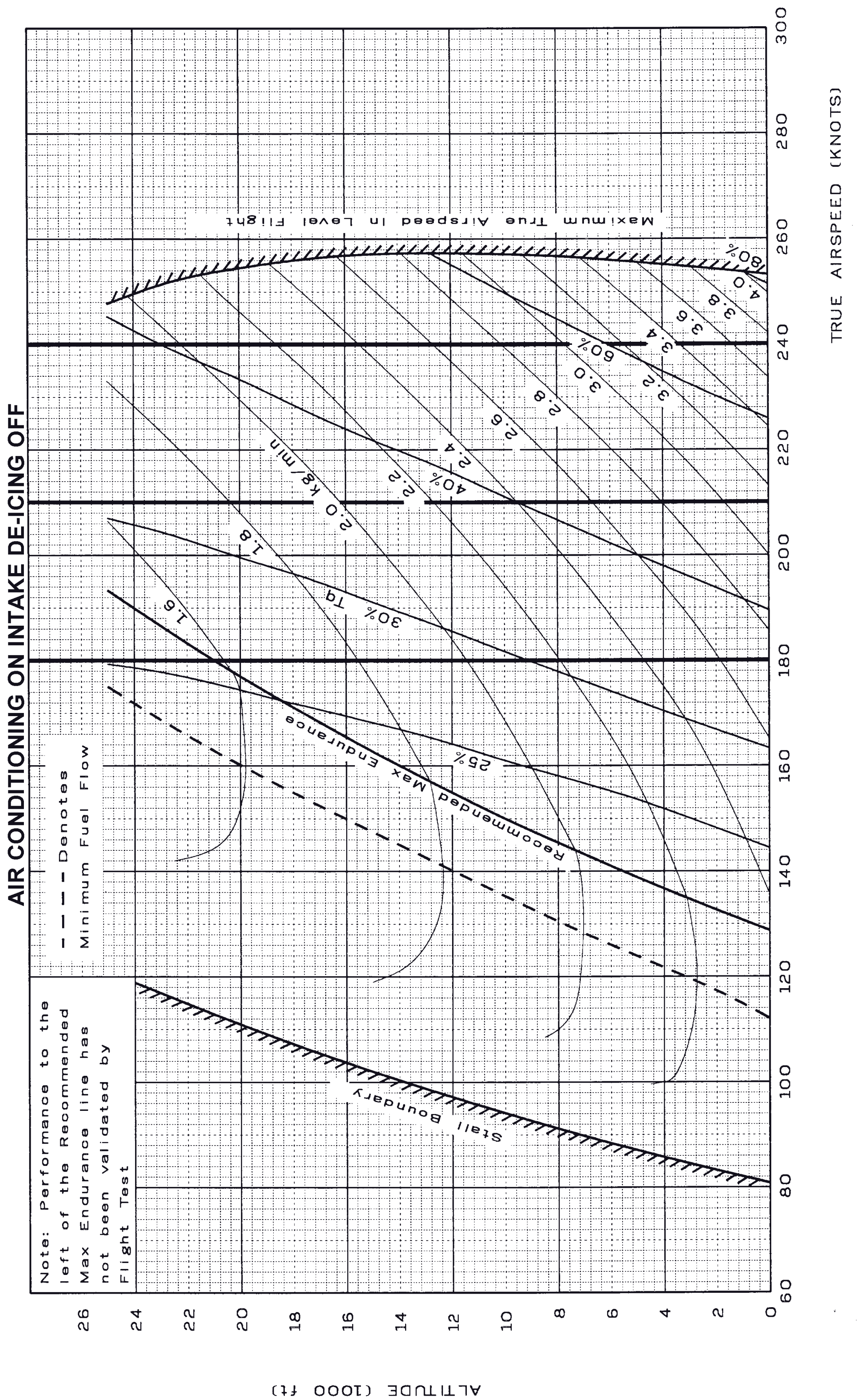

Figure 5.11

CRUISE PERFORMANCE, 3000 KG, ISA MINUS 15°C

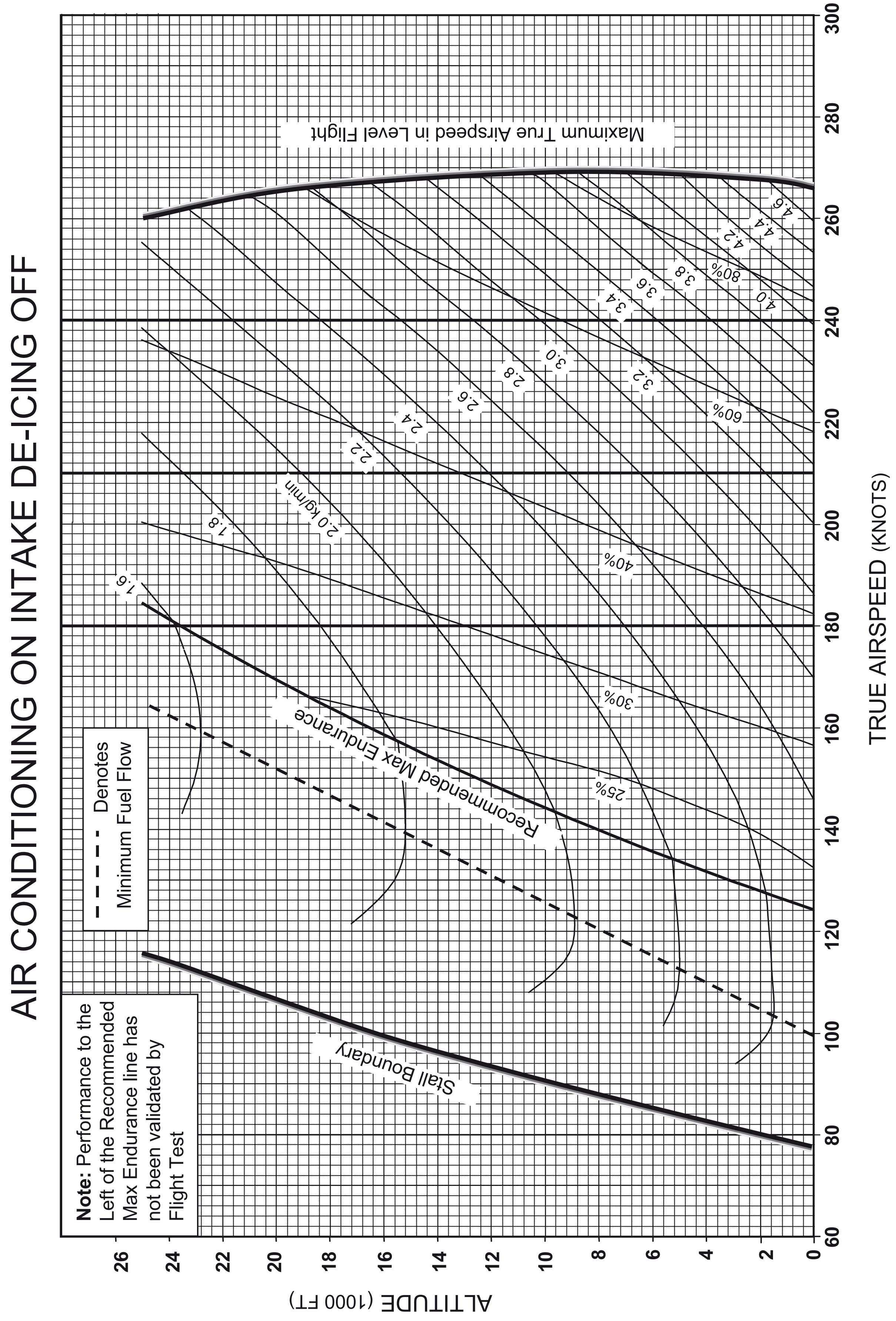

Figure 5.12

CRUISE PERFORMANCE, 3000 KG, ISA

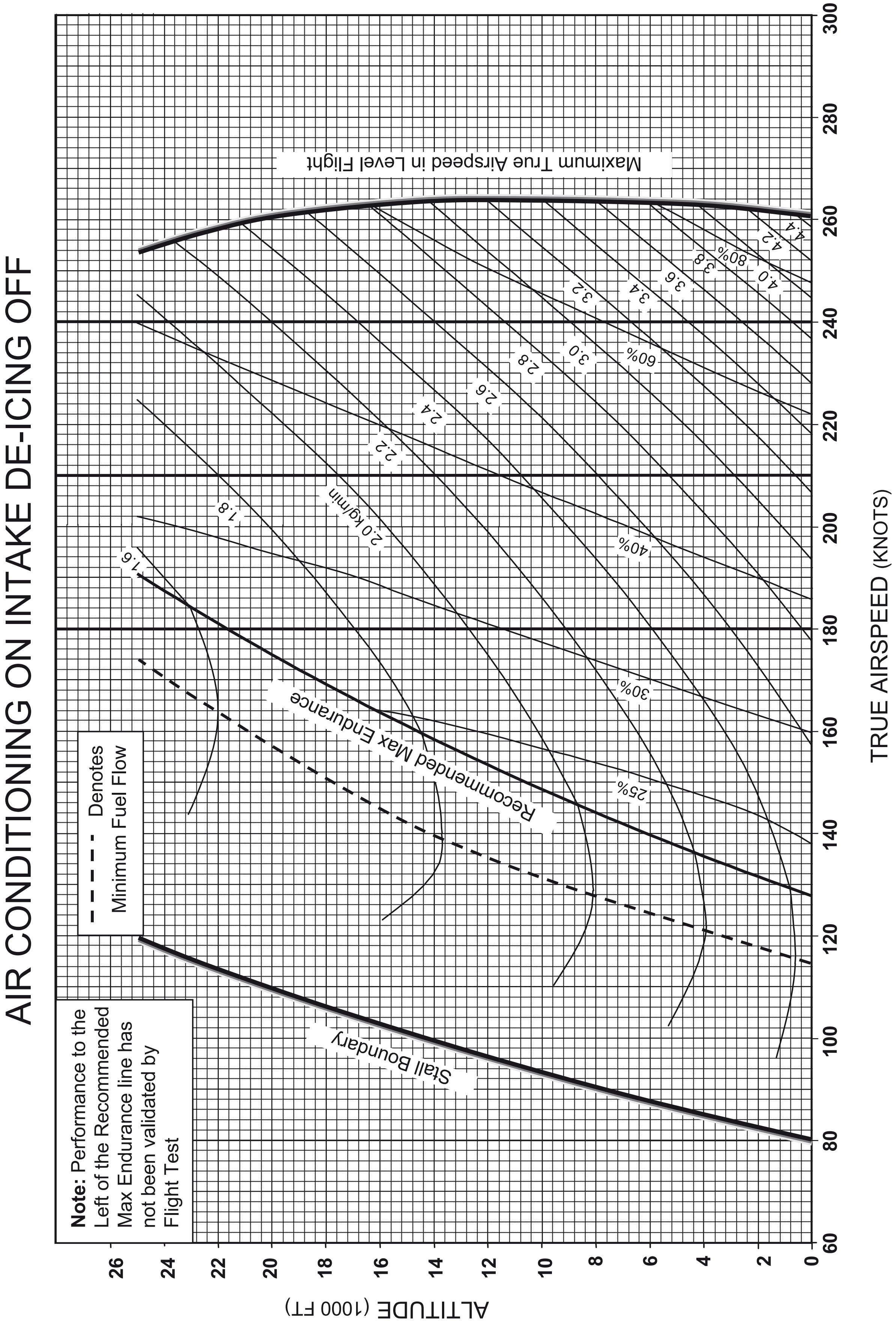

Figure 5.13

CRUISE PERFORMANCE, 3000 KG, ISA +15°C

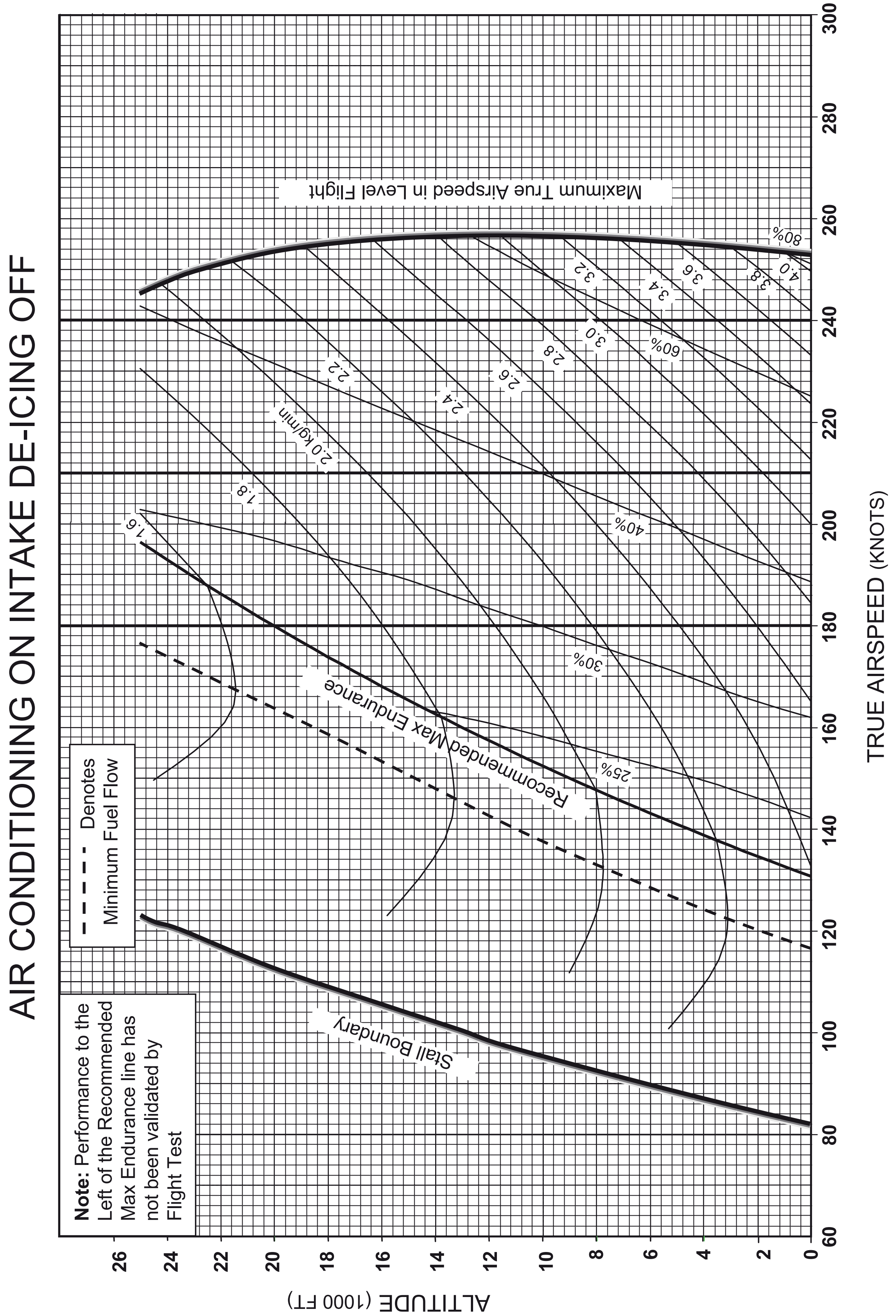

Figure 5.14

SECTION 6

DESCENT

CONTENTS

LIST OF FIGURES

Introduction

1. This Section gives still air performance data, presented as time elapsed, distance covered and fuel used, for the types of descent described below.

2. **Descent for Low Level.** Throttle is set to FLT IDLE. Speed is 200 knots. Airbrake is OUT.

3. **Normal Instrument Descent.** Throttle is set to FLT IDLE. Speed is 180 knots. Airbrake is OUT.

4. **Slow Descent.** Throttle is set to 10% torque and speed is 140 knots, or throttle is set to 20% torque and speed is 180 knots. Airbrake is IN.

Descent Performance

5. The data presented in Figure 6.1 to Figure 6.4 are applicable to ISA conditions at a mass of 2600 kg, with the air conditioning ON/BOOST (4% bleed) and the intake de-icing OFF. The effects of variations from these conditions are small and may be ignored.

6. The data terminate at an altitude of 1000 feet. If descent is to be made at a higher altitude, the data may be obtained by subtraction.

Gliding Distance

7. The maximum distance in gliding flight with the engine inoperative and the propeller feathered is achieved at 115 knots with the landing gear and flaps UP. In these conditions the rate of descent is approximately 900 feet per minute and the aircraft covers not less than 2 NM for each 1000 feet above the ground in still air.

Example

8. **Question.** What are the time elapsed, distance covered and fuel used during a Descent for Low Level from 25,000 feet to 5000 feet?

9. **Solution.**

a. From Figure 6.1, the following values are obtained:

(1) Descent from 5000 feet to 1000 feet:

Time:	1.25 minutes
Distance:	4 NM
Fuel:	2 kg

(2) Descent from 25,000 feet to 1000 feet:

Time:	6.5 minutes
Distance:	25 NM
Fuel:	8.25 kg

b. Subtracting the values at para 9.a.(1) from those at para 9.b.(2) above gives data for Descent for Low Level from 25,000 feet to 5000 feet:

Time:	5.25 minutes
Distance:	21 NM
Fuel:	6.25 kg

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DESCENT FOR LOW LEVEL

AIR CONDITIONING ON / BOOST, INTAKE DE-ICING OFF

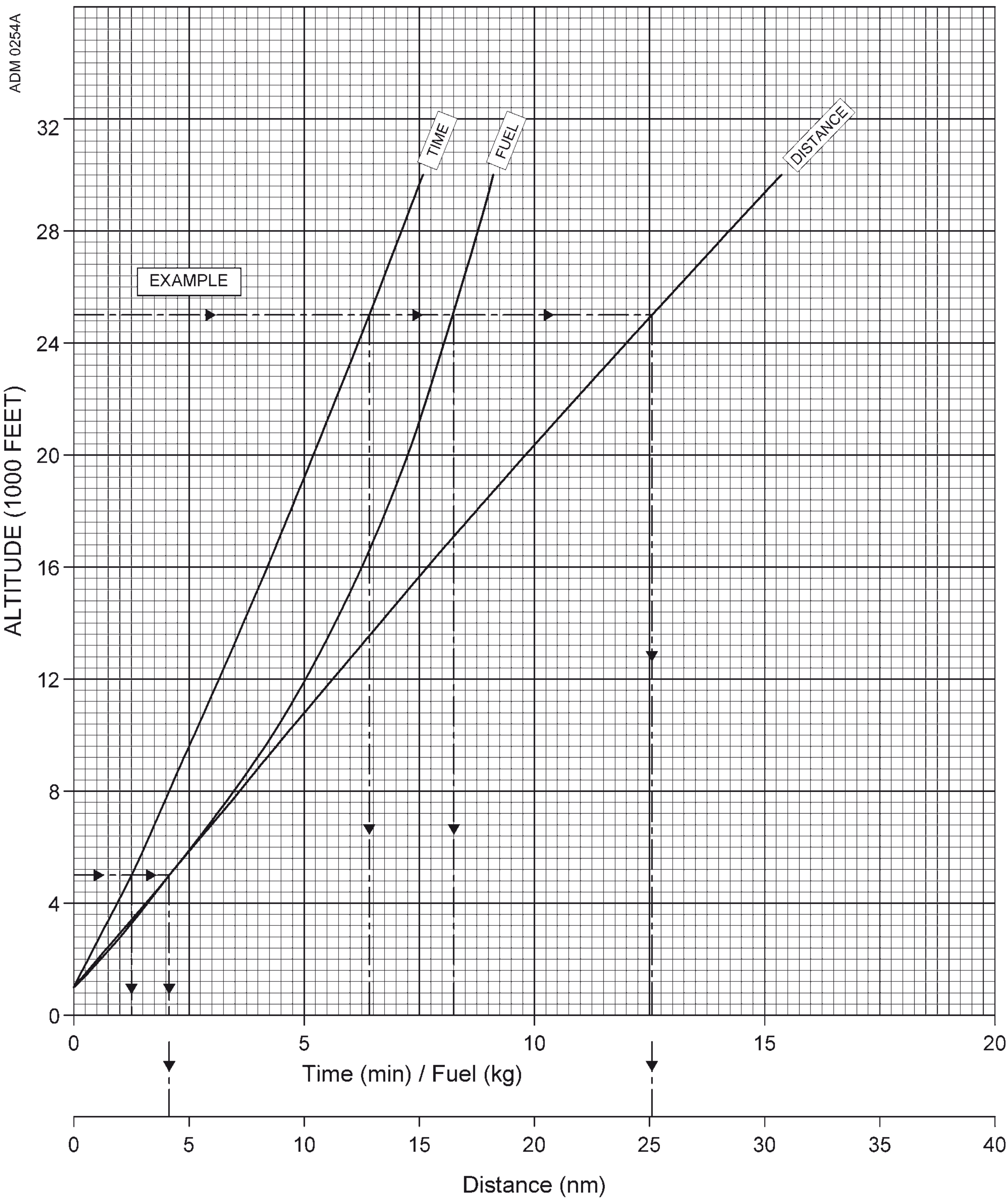

Figure 6.1

NORMAL/INSTRUMENT DESCENT

AIR CONDITIONING ON / BOOST, INTAKE DE-ICING OFF

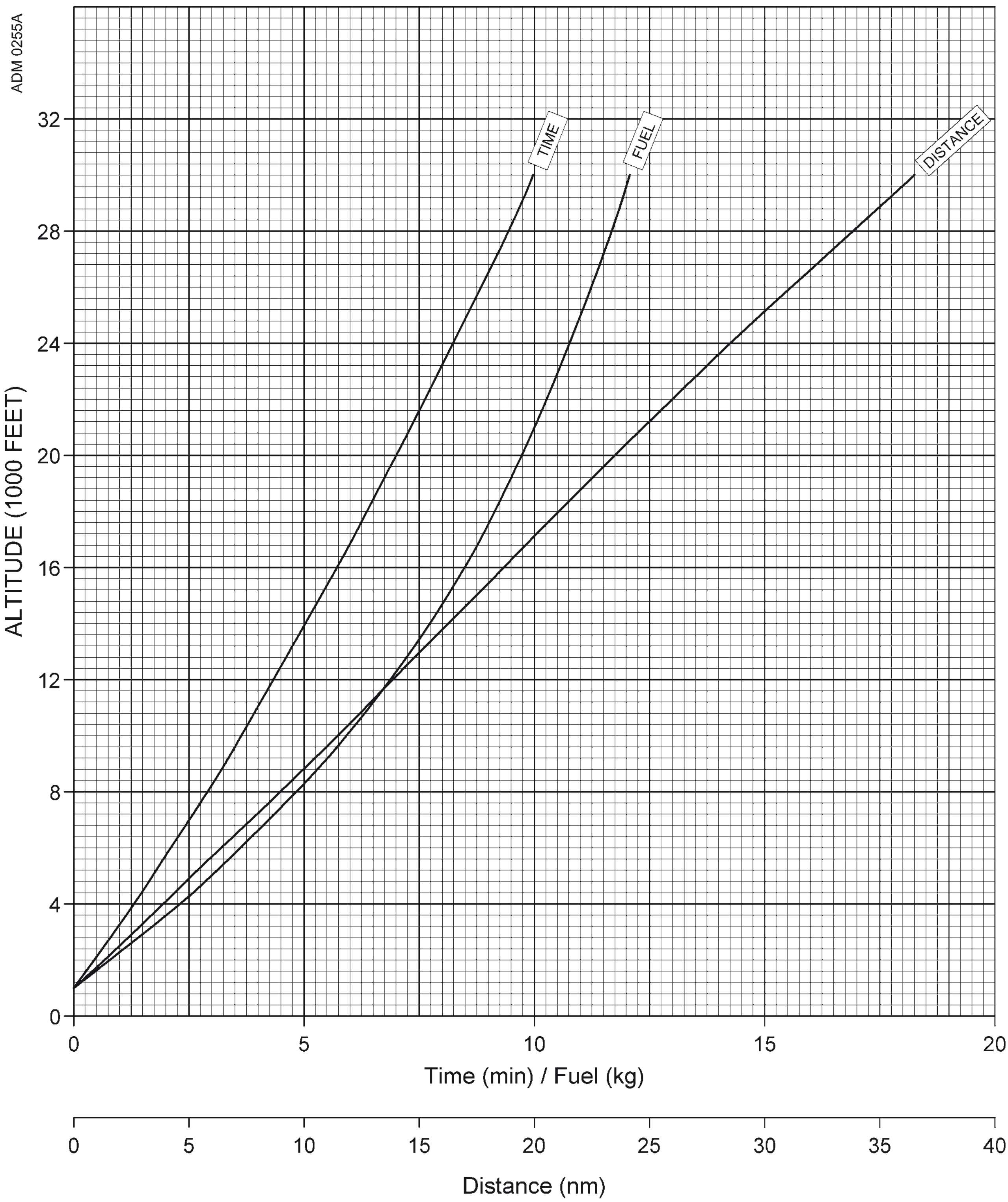

Figure 6.2

SLOW DESCENT, TORQUE 10%, 140 KNOTS

AIR CONDITIONING ON / BOOST, INTAKE DE-ICING OFF

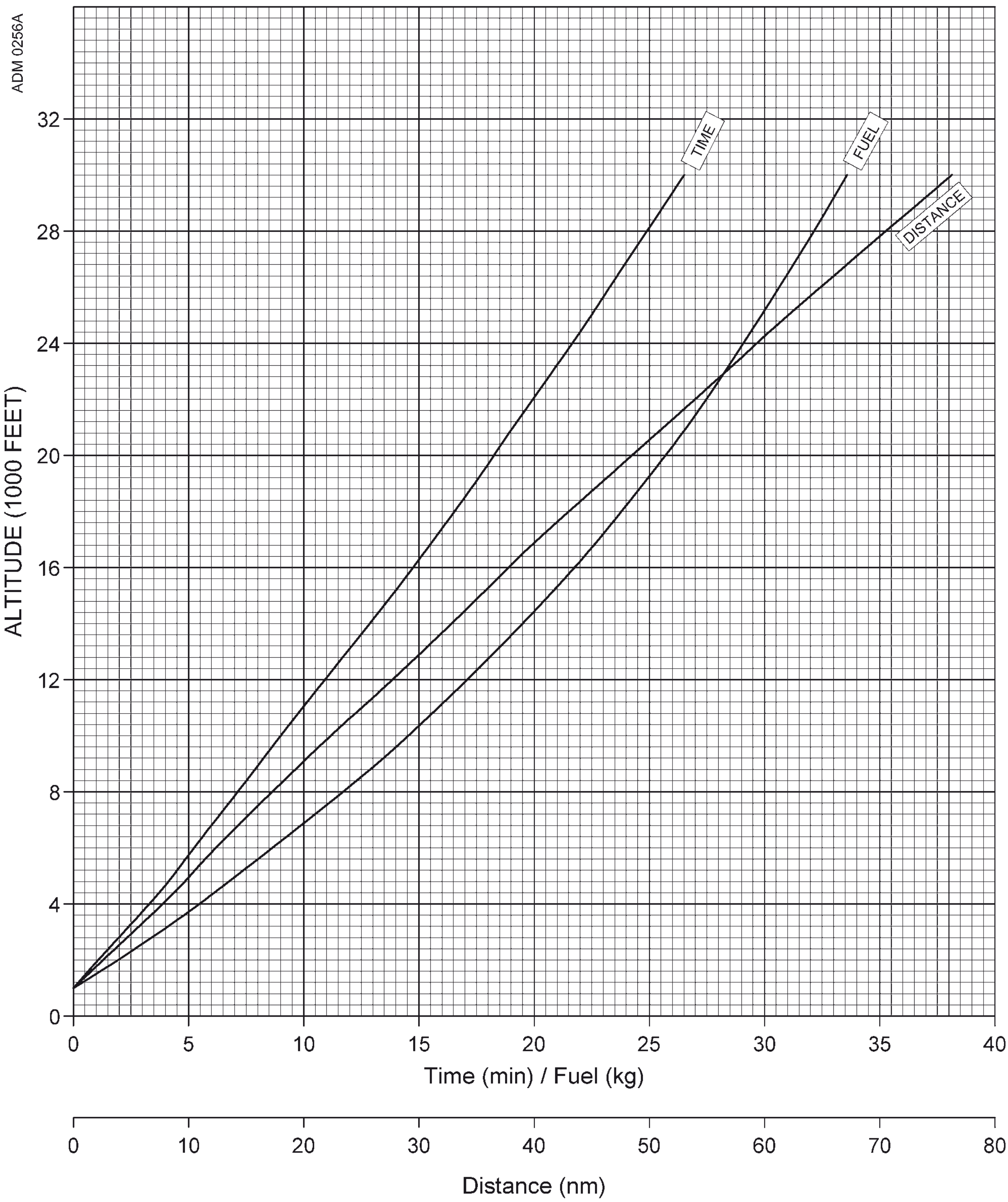

Figure 6.3

SLOW DESCENT, TORQUE 20%, 180 KNOTS

AIR CONDITIONING ON / BOOST, INTAKE DE-ICING OFF

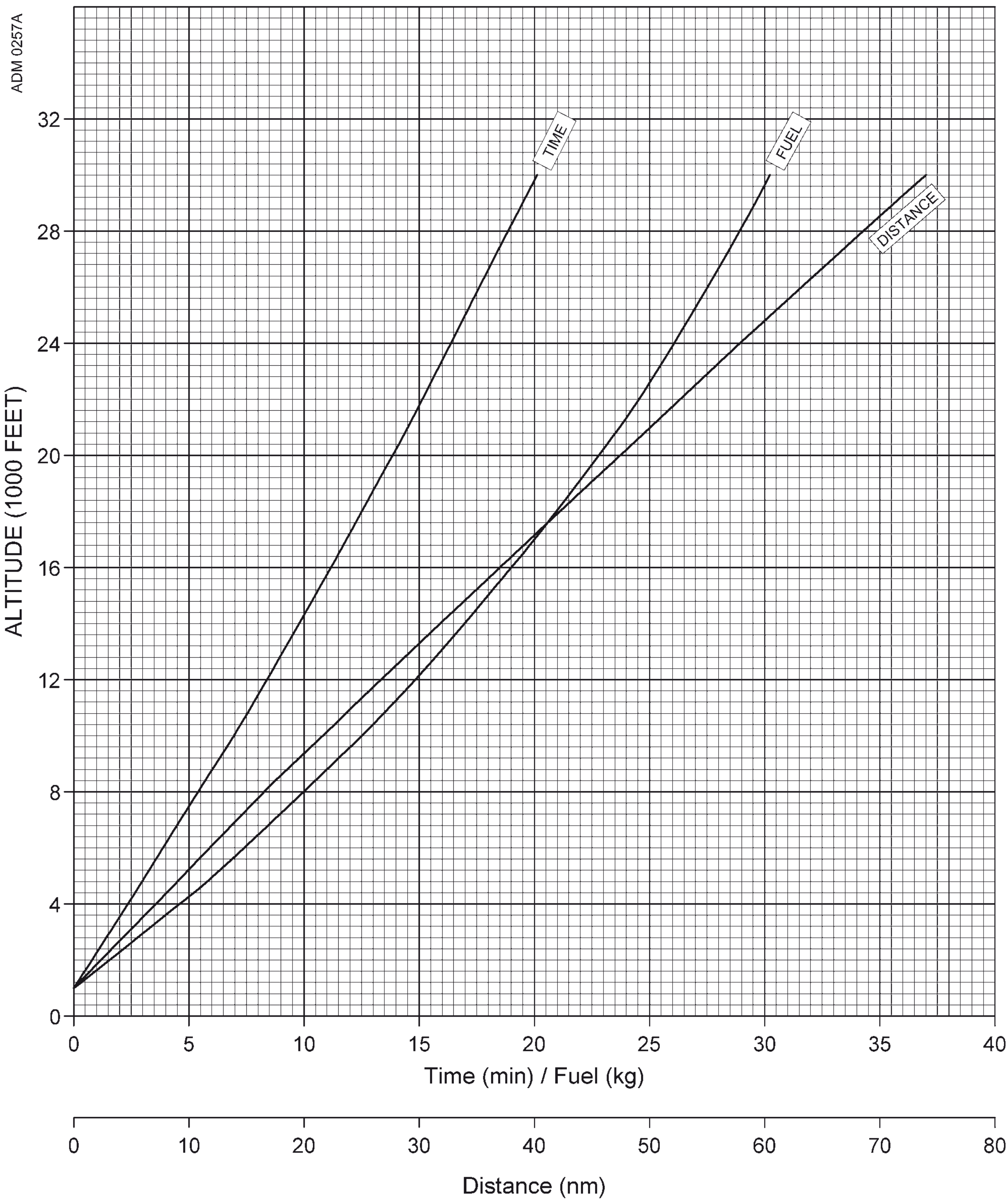

Figure 6.4

SECTION 7

LANDING

CONTENTS

LIST OF FIGURES

Introduction

1. This Section gives the landing distances to be expected when carrying out a powered approach with full flap and selecting reverse thrust after touchdown, using the technique described in Part 3, Chapter 3 of AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual. The effects of airfield altitude, surface wind, OAT and runway slope are considered for a range of aircraft landing mass and for dry and wet runway conditions.

2. The effects of airframe icing on landing and the effects of runway surface conditions, other than dry and wet, are not considered. Advice on landing in such conditions, and without full flap, is provided in Part 3 of AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual.

3. Where the effect of wind component is presented, safety factors of 0.5 and 1.5 have been applied within the charts to the reported headwind and tailwind components respectively, thus allowing for a possible difference between reported and actual wind.

Landing Speeds

4. The data given in this Section assume a normal 3° powered approach and a target threshold speed (V_{AT}) of 85 knots at an aircraft mass of 2500 kg and below. Above 2500 kg and up to 2900 kg, a threshold speed of 90 knots is assumed. Above 2900 kg, the assumed threshold speed is 92 knots.

Note 1: Although the above threshold speeds are used for ODM calculations, the normal practical method for calculating threshold speeds is given in Part 3, Chapter 3 of the Tucano T Mk 1 Aircrew Manual.

Note 2: When using the threshold speeds from AP101B-4901-15, the Tucano T Mk 1 Aircrew Manual, the landing distances from Figure 7.1 to Figure 7.4 will be exceeded. In runway distance limiting conditions the V_{AT} speeds from paragraph 4 are to be used.

Landing Distances

5. **Normal Landing Distances.** Figure 7.1 to Figure 7.4 give average values of landing total distance from 50 feet and ground run for dry and wet runways. The distances are applicable to landings using a braking technique which just avoids skidding. The distance data presented are 'average achieved' in crosswind components of 0 to 5 knots, thus allowing for the effects of typical asymmetric braking. In crosswinds above 5 knots the average ground run is increased by 0.5% per knot above 5 knots.

6. **Emergency Landing Distances.** With the propeller feathered, the landing ground run distances are increased by 20% on a dry runway, and 30% on a wet runway and this must be corrected for in any calculation.

7. **Effect of Flight Idle.** With FLT IDLE selected instead of REVerse, the landing ground run distances are increased by approximately 100% and this must be corrected for in any calculation.

8. **Corrections to Landing Total Distance from 50 feet**. The corrections in paragraph 5 to paragraph 7 for cross wind, emergency landing distances and the effect of flight idle, are applicable to the landing ground run distance; when these factors are applied to the Landing Total Distance from 50 feet a safe but conservative distance will result. Where an optimised Landing Total Distance from 50 feet is required, use the following process.

a. Find the landing airborne distance (the distance from 50 feet to touchdown) by subtracting the landing ground run (uncorrected) from the Landing Total Distance from 50 feet.

b. Apply the relevant corrections from paragraph 5 to paragraph 7 to the landing ground run.

c. Now add the landing airborne distance (from paragraph 8a) to the corrected landing ground run (from paragraph 8b) to give the corrected Landing Total Distance from 50 feet.

Landing on a Contaminated Runway

CAUTION: The aircraft is not cleared for operation in snow or from surfaces covered with snow/slush. Unavoidable operations in snow/slush should be treated with caution.The reduced runway surface friction characteristics may significantly degrade the braking effort available such that the landing distance may exceed the calculated landing distance required.

Examples

9. **Question.** An aircraft with a mass of 2700 kg is to land from a 3° powered approach to an airfield at 1000 feet pressure altitude where the runway is dry and has a 1% uphill slope. The reported headwind component is 20 knots and the OAT is +10°C. What threshold speed should be used, what is the total distance from 50 feet, and what ground run is required?

10. **Solution.**

a. From paragraph 4 the threshold speed is 90 knots.

b. From Figure 7.1 the average total distance from 50 feet is 1600 feet, and from Figure 7.2 the ground run required is 950 feet.

c. The distances obtained in paragraph b above must be multiplied by 1.25 to allow for the variation of up to 25% in landing total distance from 50 feet and ground run. Therefore, the factored total distance from 50 feet is 1.25 x 1600 = 2000 feet, and the factored ground run is 1.25 x 950 = 1188 feet.

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LANDING TOTAL DISTANCE FROM 50 FEET, FULL FLAP, DRY RUNWAY

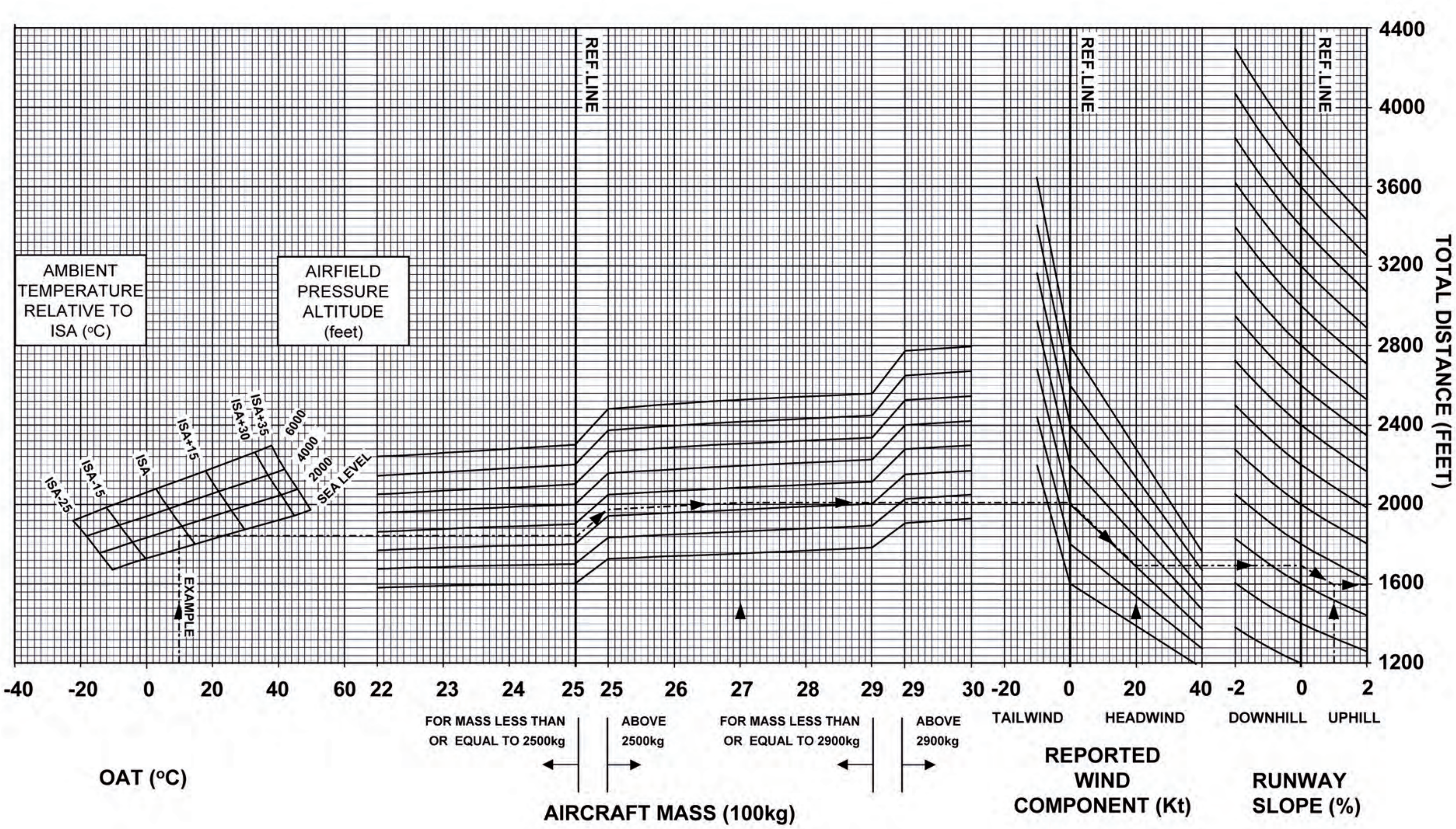

Figure 7.1

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LANDING GROUND RUN, FULL FLAP, DRY RUNWAY

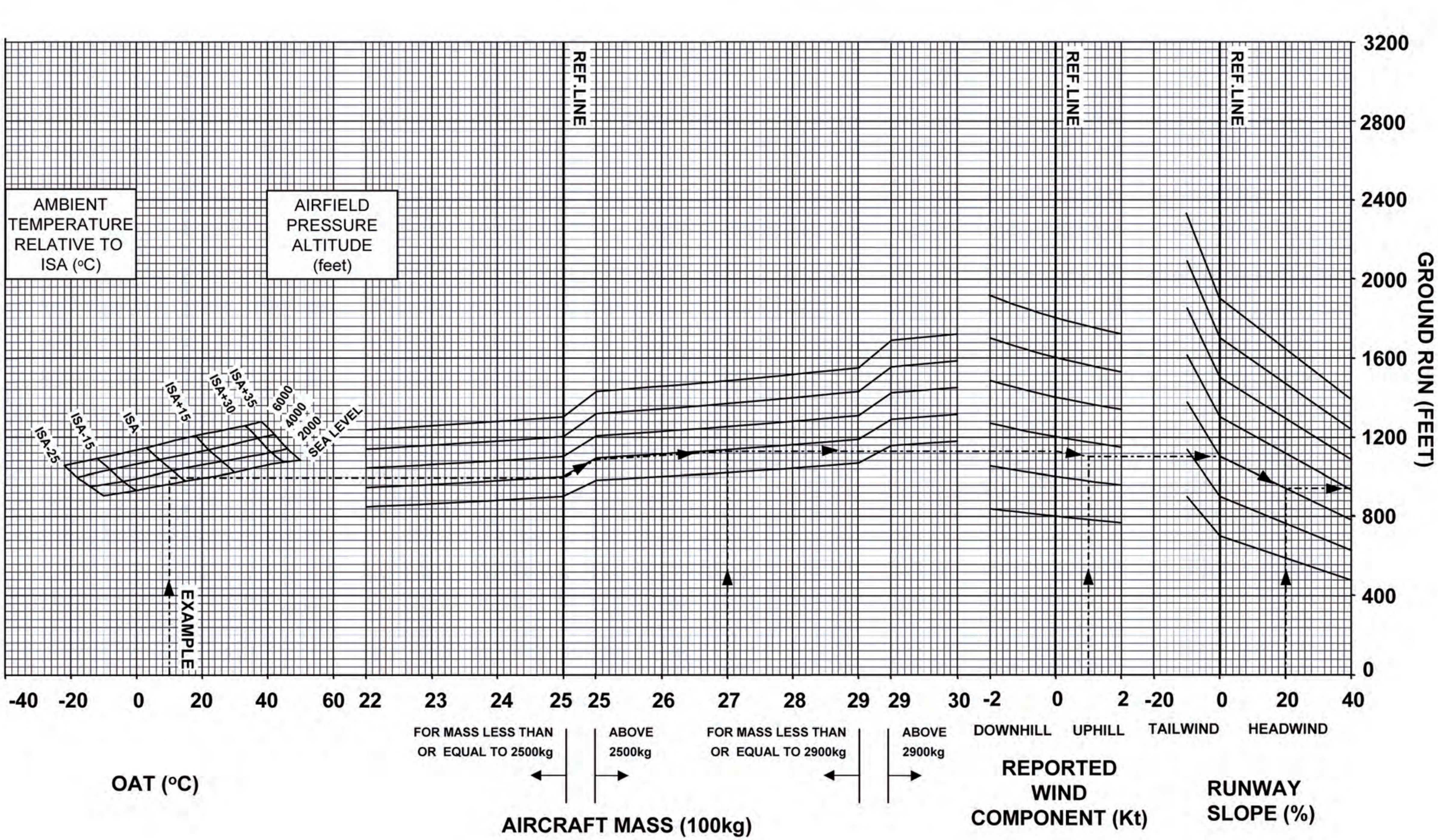

Figure 7.2

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LANDING TOTAL DISTANCE FROM 50 FEET, FULL FLAP, WET RUNWAY

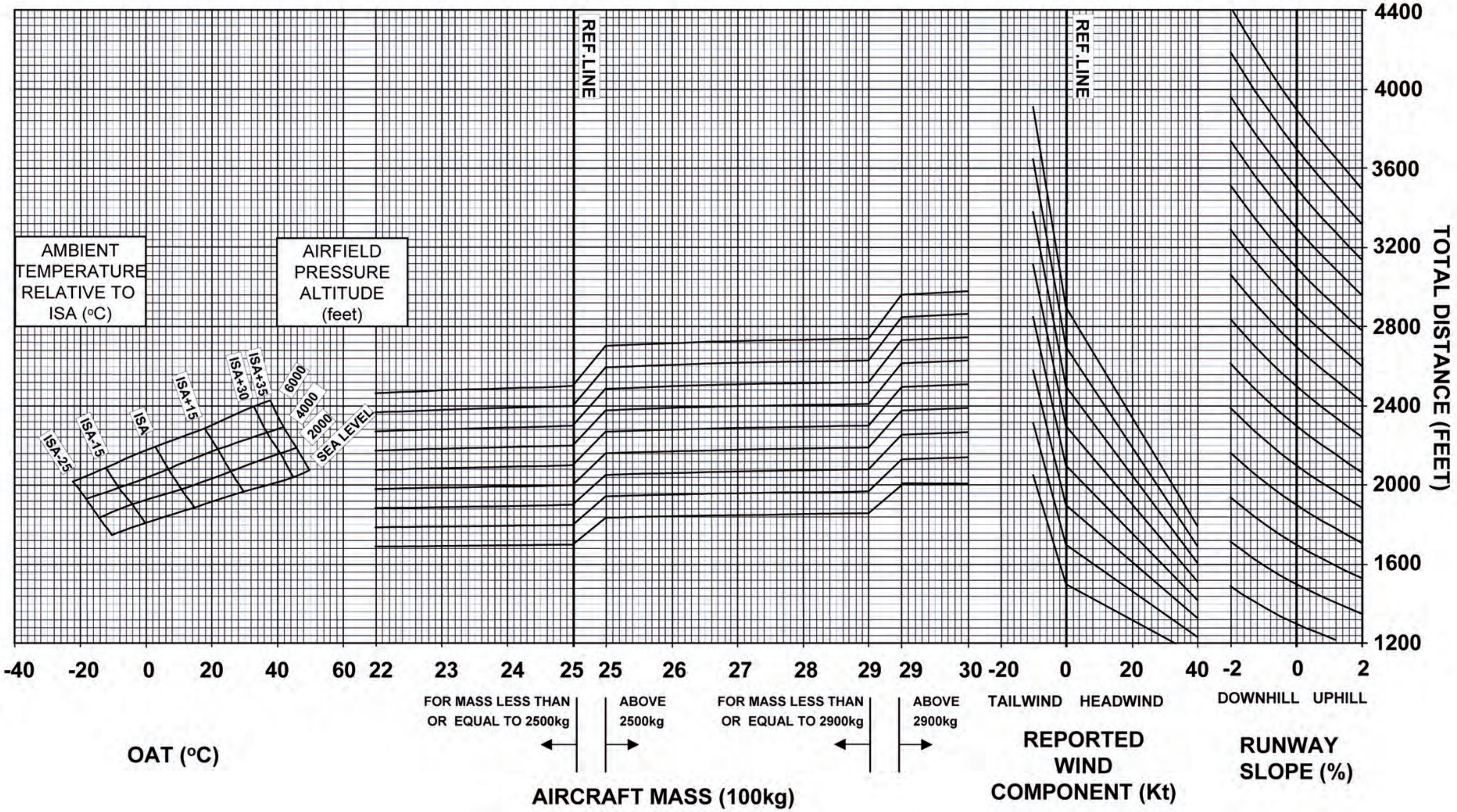

Figure 7.3

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LANDING GROUND RUN, FULL FLAP, WET RUNWAY

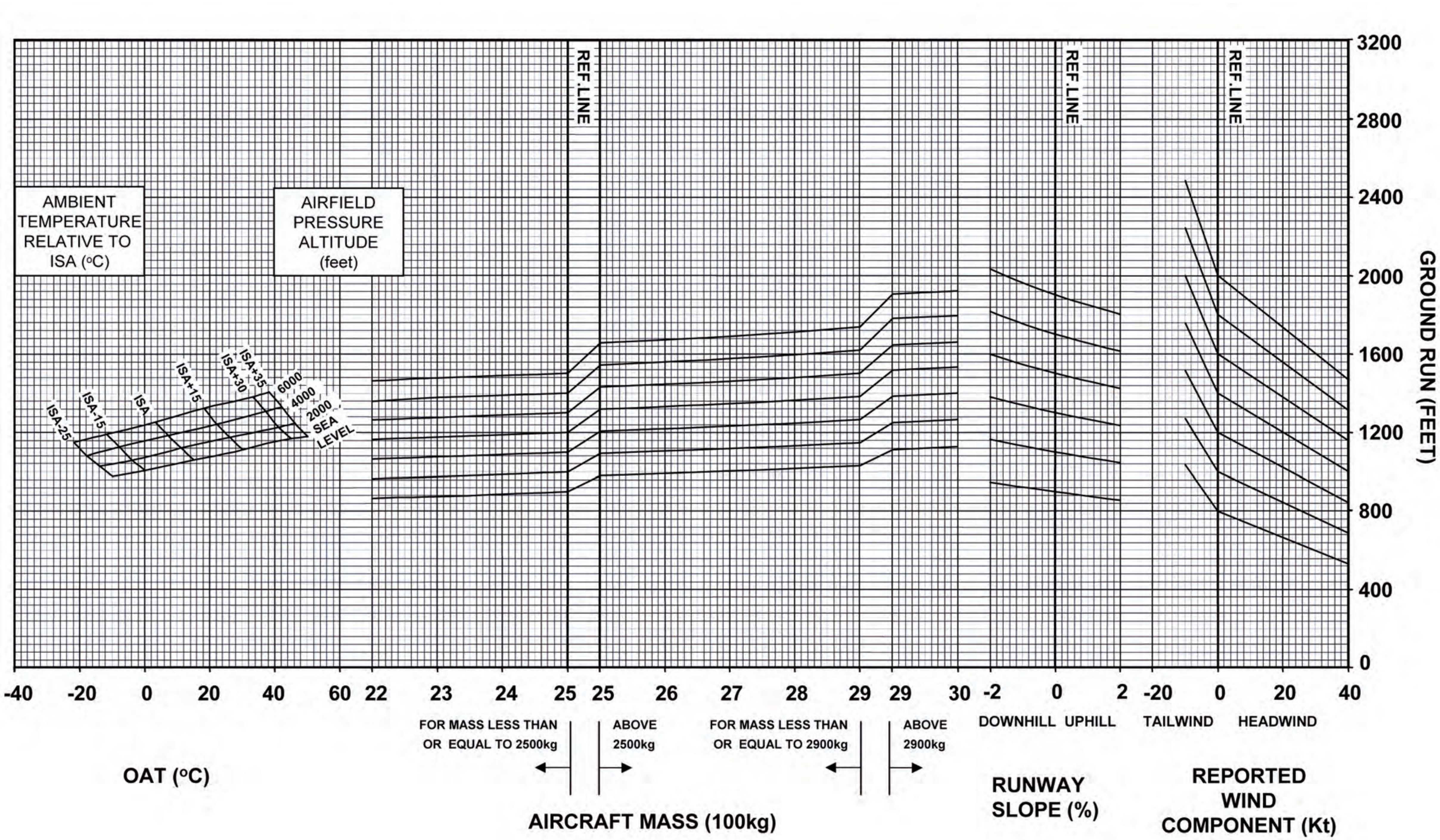

Figure 7.4

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