ICAO
CIRCULAR

1963

CIRCULAR 65-AN/59

PROVISIONAL
ACCEPTABLE MEANS OF COMPLIANCE

STANDARDIZATION
OF APPROVED AEROPLANE FLIGHT MANUALS

Prepared by the Airworthiness Committee

(Montreal, 21 May - 16 June 1962)

Published under the authority of the Secretary General

**INTERNATIONAL
CIVIL AVIATION
ORGANIZATION
MONTREAL • CANADA**

Published in separate English, French and Spanish editions by the International Civil Aviation Organization. All correspondence, except orders and subscriptions, should be addressed to the Secretary General of ICAO, International Aviation Building, 1080 University Street, Montreal 3, P.Q. (Canada).

Orders for this publication should be sent to one of the following addresses, together with the appropriate remittance (by bank draft or post office money order) in the currency of the country in which the order is placed or in a freely convertible currency:

Regional Offices

France: Représentant de l'OACI, Bureau Europe-Afrique, 60 bis, avenue d'Iéna, Paris, XVIe.

Peru: Representante de la OACI, Oficina Sudamérica, Apartado 4127, Lima.

Thailand: ICAO Representative, Far East and Pacific Office, P.O. Box 614, Bangkok.

United Arab Republic: ICAO Representative, Middle East Office, 16 Hassan Sabri, Zamalek, Cairo.

Sales Agencies

Argentina: Editorial Sudamericana S.A., Calle Alsina 500, Buenos Aires.

Australia: Robertson and Mullens, 107 Elizabeth Street, Melbourne, C. 1.

India: Oxford Book & Stationery Co., Scindia House, New Delhi *or* 17 Park Street, Calcutta.

Mexico: Editorial Hermes S.A., Ignacio Mariscal 41, México 4, D.F.

United Kingdom: Her Majesty's Stationery Office, P.O. Box 569, London, S.E. 1.

International Civil Aviation Organization (Attention: Distribution Officer), International Aviation Building, 1080 University Street, Montreal 3, P.Q. (Canada).

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

PROVISIONAL ACCEPTABLE MEANS OF COMPLIANCE

STANDARDIZATION OF APPROVED AEROPLANE FLIGHT MANUALS

FOREWORD

1. The Standards in Annex 8, Airworthiness of Aircraft, are of the nature of broad specifications stating objectives rather than methods of realizing those objectives. In order to indicate by example the level of airworthiness intended by the Standards of that Annex, some specifications of a more detailed and quantitative nature have been included in the same volume under the title "Acceptable Means of Compliance". The Foreword of Annex 8 indicates the obligation under the Convention, resulting from the introduction of Acceptable Means of Compliance.

2. When the Annex was adopted on 13 June 1957, the Standards on the subjects: Aeroplane Performance, Strength under Flight Loads, Reciprocating Engines, Turbine Engines, Propellers, and Navigation Lights were supplemented by Acceptable Means of Compliance. The absence of provisions of that type pertaining to other subjects was considered either as recognition by the Council that the Standards in themselves defined a sufficiently accurate level of airworthiness, or as recognition by the Council that due to the technical developments going on in a subject at the time of adoption of the Annex, it had not yet been possible to establish a more precise technical specification than that in the Standards themselves.

3. It is the essence of the Acceptable Means of Compliance that they permit variations in overall methods as well as in detailed application. Therefore, Contracting States, in establishing national codes that will ensure compliance with the Standards, will sometimes need guidance as to the departures from Acceptable Means of Compliance that are suitable for the certification of aircraft other than those specified in their Range of Validity, and also as to the use of methods developed too recently to have behind them the suitable background of experience deemed necessary for introduction of an Acceptable Means of Compliance.

4. The guidance material is established by ICAO as "Provisional Acceptable Means of Compliance", a class of specification that does not impose any obligation under the Convention. The Provisional Acceptable Means of Compliance are not, like the Standards or the full-fledged Acceptable Means of Compliance, established by agreement between Contracting States; instead, they reflect an agreement reached by an international body of experts to the effect that a specification is worthy of trial.

5. Trial application of Provisional Acceptable Means of Compliance in national regulations or practices is intended to build up the amount of experience that, eventually, could lead to the introduction of an Acceptable Means of Compliance on the same subject.

6. The Provisional Acceptable Means of Compliance presented in this Circular was prepared by the Airworthiness Committee, a body of experts authorized by the Council and functioning under the Air Navigation Commission. The Airworthiness Committee proposed this Provisional Acceptable Means of Compliance in its fifth report,

issued at the end of its Fifth Meeting which took place from 21 May to 16 June 1962. The Air Navigation Commission, after satisfying itself that this Provisional Acceptable Means of Compliance is properly coordinated with the Standards, the Acceptable Means of Compliance, and other Provisional Acceptable Means of Compliance, and that the policies of the Organization have been followed, authorized issue of this Provisional Acceptable Means of Compliance at the second meeting of its Forty-First Session, on 23 October 1962. It is to be noted that in so doing, the Air Navigation Commission did not pass judgment on, or endorse, the technical contents recommended by the Airworthiness Committee.

7. The issue of a PAMC relating to Aeroplane Performance made it possible to develop detailed specifications for the presentation of performance limitations and information. Previously, the achievement of international standardization had been impossible, due to the differences in performance specifications which then existed among the national codes of Contracting States.

8. The Airworthiness Committee recognized that standardization, particularly in the field of performance presentation, was an important task. Lack of standardization could cause confusion, and serious errors might be caused if the user was unfamiliar with the particular methods used. Standardization is particularly needed for operators who use aeroplanes of different types, especially if they are manufactured in different countries.

9. The Airworthiness Committee concluded that the Flight Manual should be written primarily for the convenience of the users, that is, operators and pilots, to enable them to discharge their responsibilities to comply with the national regulations. However, it was recognized that Flight Manuals were also used by government authorities. The Airworthiness Committee accepted that pilots having to comply with the limitations in such Manuals would be fully trained and qualified and that it was not the prime purpose of the Flight Manual to include any instructive material, except items such as procedures having an important bearing on safety.

10. The specifications in this PAMC are intended to standardize only the approved part of the Flight Manual (that is, that referred to in Annex 8). The Airworthiness Committee concluded that it was inadvisable to attempt to standardize the additional non-approved data sometimes included in the Flight Manual.

11. Because of the great importance of performance in relation to safety, the Committee devoted considerable time to the study of various methods of presenting performance data. The specifications contained in this PAMC, some of which are illustrated by sample graphs, have been included as being, in general, preferable to other methods. The Committee realized that, as types of aeroplanes differed considerably in their susceptibility to the various parameters, it would not always be practical to adopt the preferred methods of presentation. However, all concerned are urged to follow the prescribed methods to the greatest extent possible, in order to achieve standardization.

STANDARDIZATION OF APPROVED AEROPLANE FLIGHT MANUALS

INTRODUCTION

The specifications in this PAMC refer to the standardization of the essential contents of Approved Aeroplane Flight Manuals supplied with each aeroplane, in accordance with Annex 8 (4th Edition) Part II, paragraph 8, and Part III, paragraph 9.5.* These specifications have been prepared on the basis that the aeroplane manufacturer makes available additional information relevant to the aeroplane type for use by operators.

1.- General

1.1 Approval of data

The portions of the Manual listed in 3 to 8 should be approved. If the document is also to contain other data, these portions should be separated and clearly distinguished from portions which are approved.

1.2 Standard of technical and basic piloting knowledge to be assumed

In preparing the Manual, the pilot should be assumed to be qualified to operate the aeroplane, its systems, and its equipment, to the standard ensured by the technical examination for type endorsement required for operating crew licences.

2.-Administration

2.1 Size of paper

The Manual should be on paper of size as close as possible to quarto, 22 cm x 28 cm (8-1/2 in. x 11 in.), except that, where this size is found restrictive for graph presentation, the 22 cm (8-1/2 in.) dimension may be increased and the sheet folded so as to fit within the quarto size limits.

2.2 Reproduction

2.2.1 On pages containing text, both sides of the page should be used. All graphs should normally appear on right-hand pages but, exceptionally, a graph may be printed on a left-hand page opposite another graph, if the pair of graphs are to be used together. Texts associated with a graph should either appear on the left-hand page facing the graph or, where space permits, on the graph itself.

2.2.2 Reproduction methods should provide good quality text and graphs giving maximum clarity and minimum distortion and variability.

---

* These paragraphs appear unchanged in the Fifth Edition of Annex 8.

2.2.3 Graphs should be presented on paper having the main graticule spacing at 1 cm intervals. The spacing of the intermediate graticule lines should not exceed 2 mm. The lines at 1 cm spacing should be bolder than the others. If 1 mm spacing is chosen for the intermediate graticule, the 5 mm lines should be slightly bolder than the other lines. The presentation should provide maximum contrast between the graticule and the graph lines. Texts and graphs should be capable of reproduction by photographic or other normal reproduction practices without significantly impairing legibility or clarity.

2.3 Layout

2.3.1 The Manual should be divided into Sections as follows:

Section 1 - General
Section 2 - Limitations
Section 3 - Emergency Procedures
Section 4 - Normal Procedures
Section 5 - Performance
Appendices - (If necessary)

The Manual should contain the items stated in paragraphs 3 to 8, and each Section should be prefaced by a Table of Contents.

2.3.2 Sections can be sub-divided, as necessary, into Sub-sections which should be numbered using a decimal notation (e.g. Take-off WAT Curves would be numbered Sub-section 5.3).

2.3.3 For easy reference, Sections and Sub-sections should be separated by tabbed divider cards, the tab showing the number and title of the Section and the number of the Sub-section. The divider card and tab of the Emergency Procedures Section should be red in colour.

2.3.4 The first page within each Section should be numbered page 1, and subsequent pages should be numbered consecutively.

2.4 Amendment procedure

All amendments should be effected by means of the insertion of new pages and, where applicable, by the removal of existing pages. A detailed record of amendments should be provided, together with the appropriate date and a complete list of all the pages affected. Where practicable, a marginal notation should be used to indicate those parts of the contents of a page that have been amended. Each page should be marked, so that it can be identified as the current issue by reference to the logging sheet (see 3.1).

2.5 Units

The Manual should be written in terms of the following units:

Speeds - knots
Weights - kilogrammes; alternatively, pounds
Temperatures - degrees centigrade; alternatively, degrees Fahrenheit
Height and altitude - feet
Large horizontal distances - nautical miles
Small horizontal distances - metres; alternatively, feet

2.6 Weight and balance

If information on weight and balance, including the empty weight at the time of certification, is not provided, reference should be given to the other document from which this information can be obtained.

3. - Section 1 - General

This section should include the items listed in 3.1 to 3.6.

3.1 Amendment records

A description of the amendment system together with logging sheets (see 2.4).

3.2 General arrangement drawing

A line drawing showing the outline of the particular aeroplane. All main dimensions should be given, together with a key to the scale of the drawing.

3.3 Other dimensional data

A table of other dimensional data, including areas, chords, and the relationship of the standard mean chord (S. M. C.) or mean aerodynamic chord (M. A. C.) to the declared centre of gravity datum.

3.4 Registration particulars

Details to identify the aeroplane or aeroplanes to which the Manual applies, as given on the Certificate of Airworthiness, by nationality and registration marks, manufacturer, manufacturer's designation of aeroplane, and aeroplane serial number. If the material applies to several aeroplanes, the data particular to each aeroplane should be readily identifiable.

3.5 Conversion tables/graphs

3.5.1 The inter-relationship of temperature to altitude in the ICAO Standard Atmosphere (I. S. A.) shown in graphical form.

3.5.2 Such graphs or tables as are necessary to enable units of one kind to be readily converted into another.

3.6 Definitions

Definitions of all terms regarding which there may be some doubt as to their precise meaning (see 1.2). This should include a definition that "altitude" is to be taken as "pressure altitude".

4.- Section 2 - Limitations

This Section should contain those limitations given in 4.1 to 4.7, if applicable, in the order listed. Additional limitations should be provided when unusual design, operating, or handling characteristics warrant, if required to ensure safe operation. Where considered necessary because a limitation includes a new concept, information on the background to the limitations should be given clearly and concisely.

4.1 Weights

The maximum certificate weights, determined in accordance with the airworthiness requirements, should be provided. These will normally include the maximum taxying, take-off, landing, and zero fuel weights. If the scheduled performance data are based on more than one configuration or set of power conditions, the maximum take-off (or landing) weight appropriate to each such configuration or power conditions should be stated. In the case of maximum zero fuel weight, a precise definition of which fuel may be included in this weight should be given if there is risk of ambiguity.

4.2 Performance limitations

The limitations should be expressed in such language that it is obvious that they are limitations on the operation of the aeroplane. If a limitation can be stated briefly, it should be so stated. If, on the other hand, a limitation involves reference to performance data contained in Section 5, it should refer directly to the appropriate graph or page. The limitations should be listed with respect to:

- Take-off weight
- Landing weight
- Accelerate-stop distance
- Take-off distance
- Take-off run, if applicable
- Altitude
- Atmospheric temperatures
- Wind speed and direction
- Runway slope
- Any other subject for which a limitation is needed to ensure compliance with the performance requirements

4.3 Floor loading

The maximum loads which may be placed on the floor of the compartments and the structural limitations on their distribution should be stated.

4.4 Centre of gravity

The centre of gravity limits should be included together with a definition of the datum to which the limits are referred. Any variations of these limits with parameters such as weight, flight regime, wing flaps should be shown graphically.

4.5 Powerplant

The limitations to ensure the safe operation of the engines, propellers, and power plant accessories as installed in the aeroplane should be given.

4.6 Airspeed and Mach number

4.6.1 All airspeed limitations should be stated in terms of indicated airspeed (I. A. S.) and/or indicated Mach number of values so chosen that, in no case, assuming each instrument is within its accepted tolerance, will the design equivalent airspeed (E. A. S.) or true Mach number be exceeded.

4.6.2 Airspeed and/or Mach number limitations (other than those included under 4.2) established in accordance with the airworthiness requirements should be stated. In addition, the following amplification should be given:

i) The never exceed speeds. An explanation of the factor which determines these speeds should be given.

ii) The limiting operating speeds. The text should indicate the nature of the limitation associated with these speeds.

iii) Limiting speeds for extendable devices. The text should indicate the limiting speeds for flight with the device extended, if this is different from that for extension or retraction. If these speeds are the same, this should be stated.

4.7 Miscellaneous

4.7.1 Certification status. The Category or Categories in which the aeroplane is certificated should be stated.

4.7.2 Type of operation. The types of operations for which the aeroplane is approved, subject to the carriage of certain equipment, should be listed.

4.7.3 Manoeuvres. The flight manoeuvres which are prohibited should be stated together with the values of the limit manoeuvre load factors which the aeroplane has been designed to withstand and which can be safely applied at any altitude up to the maximum permissible altitude (see 4.7.6).

4.7.4 Minimum crew. The number and composition of minimum flight crew should be stated. In addition, any associated instruction as to where these crew members should be seated - for example to ensure adequate look-out standards - should be stated.

4.7.5 Maximum number of occupants. The maximum permissible number of occupants which may be carried, as determined by the design requirements, should be stated. Seats or seat stations, not approved for take-off or landing, should be stated.

4.7.6 Maximum altitude. The maximum permissible altitude should be stated. If performance is critical, this should be indicated by referring to the data in Section 5 of the Manual.

4.7.7 Smoking. The compartments in which smoking is not permitted should be listed.

4.7.8 Electrical system limitations. The basic limitations affecting the safety of the aeroplane which are associated with the electrical system should be stated.

4.7.9 Automatic pilot limitations. Any limitation which has been established on the use of the equipment should be stated.

4.7.10 Markings and placards. When certain limitations in the Manual are required to be emphasized by means of placards, these should be suitably indicated in the Manual. If any essential instrument is marked by a colour code system, the explanation of the code used should be given in the Manual.

4.7.11 Additional limitations. Any additional limitations necessary, as may be associated with such matters as control of cabin pressurization or windshield heating, should be stated. Limitations covering ground operations which are under the control of the flight crew and which, if not observed, could adversely affect airworthiness should be included.

5. - Section 3 - Emergency Procedures

5.1 This Section should contain essential operating procedures for emergency conditions. An emerergency, in this context, is defined as a foreseeable, but unusual, situation in which immediate and precise action will substantially reduce the risk of a disaster. If alternative sequences of the steps in the procedures are permissible, this should be stated.

5.2 These procedures should be presented as briefly as possible and with maximum clarity.

5.3 Those steps in these procedures in which immediate action is essential to safety should be distinguished from the steps which are taken subsequently.

5.4 The presentation used should be in a form suitable for the preparation of check lists.

6. - Section 4 - Normal Procedures

This section should contain normal procedures and those procedures in the event of malfunctioning which are not included in Section 3. At least those items given in 6.3 should be considered, but no procedure which is accepted as being part of basic airmanship need be included. Additional procedures and information should be provided when unusual design, operating, or handling characteristics warrant, if required to ensure safe operation. (For procedures associated with the performance of the aeroplane, see 7 which deals with Section 5 of the Manual).

6.1 Use of capitals

Capital letters should be employed throughout the text of the procedures to indicate the control marking and the marked position. Thus: - "engine HP FUEL cock: move to OFF" which means that the control marked "HP FUEL" has been moved to a position marked as "OFF".

6.2 Classification

The procedures should be classified as recommended procedures except those which are of great significance to the safety of the aeroplane, which should be regarded as essential procedures.

An essential procedure is defined as an action, sequence of actions, or a prohibition of incorrect actions which, if not observed, would result in a significant adverse effect on airworthiness. These procedures or portions of procedures should be qualified by the words "shall" or "must".

6.3 Items to be considered

- Engines and propellers
- Fuel system
- Engine lubrication system
- Fire extinguisher system
- Electrical systems
- Hydraulic systems
- Pneumatic systems
- Ice protection systems
- Flight direction system
- Flying control system
- Automatic pilot
- Procedure for severe turbulence
- Pressurization system and air conditioning
- Oxygen system

7.- Section 5 - Performance

7.1 Layout

7.1.1 Order of sub-sections. The order of presentation in this Section should be as follows:

1 - General
2 - Take-off procedures and speeds
3 - Take-off WAT curves
4 - Take-off climb gradients
5 - Take-off field lengths
6 - Net take-off flight path data
7 - En route data
8 - Landing procedures and speeds
9 - Landing WAT curves
10 - Landing climb gradients
11 - Landing field lengths
12 - Additional special performance data

7.1.2 Alternative powers and configurations. Data appropriate to different approved power conditions and configurations should appear clearly as alternative data within each Sub-section.

7.2 Limitations

Any performance condition which may be required to be enforced as a limitation applicable to all flights should be indicated by suitable wording and a cross reference given to the appropriate part of the Limitation Section.

7.3 Presentation of graphs

7.3.1 Definitions. Terms which are used in the detailed specifications for performance graphs are defined in 7.3.1. It is not intended that these definitions should be included in the Manual. The terms are also illustrated in Figure 1.

> Grid: A system of closely spaced curves or guide lines with or without a reference line which form one stage in a graphical presentation. There are two types of grids, a basic grid and a correction grid.
>
> Reference line: A line on a correction grid corresponding to the arbitrarily chosen reference value of the parameter for which the correction is being made.
>
> Guide lines: A family of curves in a correction grid which intersect a reference line and which indicate a shift in the value of the variable being projected from either the ordinate or abscissa of the basic grid.

7.3.2 Form of graphs. The form of presentation of some of the graphs in this Section is given in 7.8. In cases where the characteristics of the aeroplane type are such that compliance with the specification would be impractical, deviations therefrom would be acceptable.

7.3.3 Readability of graphs

7.3.3.1 The number and spacing of the guide lines in the correction grids should be such as to facilitate accurate reading of the graphs without unduly obscuring the graticule lines (see also 2.2.3).

7.3.3.2 The scales used in the graphs should be as large as possible compatible with the size of paper (see 2.1), especially those connected with weight and runway distances. Where a series of graphs are frequently likely to be used successively, the scales of a parameter which occurs in more than one graph should be the same in each. The scales should not be smaller than the following:

Weight Scale:

1 cm = not more than 2 000 kg or 5 000 lb

Field Length Scale:

1 cm = not more than 200 metres or 500 feet

Altitude Scale:

(i) For En Route Flight Paths and En Route Climb data:
1 cm = not more than 2 000 feet

(ii) for other data:
1 cm = not more than 1 000 feet

Temperature Scale (if used linearly):

1 cm = not more than 10° centigrade or 20° Fahrenheit

Speed Scale:

1 cm = not more than 10 knots

Runway Slope Scale:

1 cm = not more than 1 per cent

Horizontal Distances:

(i) For Net Take-off Flight Path up to a height of 400 feet:
1 cm = not more than 200 metres or 500 feet

(ii) For Net Take-off Flight Path up to a height of 1 500 feet:
1 cm = not more than 0.5 nautical mile

(iii) For En-Route Net Flight Paths:
1 cm = not more than 20 nautical miles

Obstacle Heights:

(i) For Net Take-off Flight Path up to a height of 400 feet:
1 cm = not more than 20 feet

(ii) For Net Take-off Flight Path up to a height of 1 500 feet:
1 cm = not more than 100 feet

Climb Gradient:

1 cm = not more than 1 per cent

7.4 Method of use of graphs

The methods by which each graph is intended to be used should be shown clearly by means of a well chosen example, followed through by an arrowed broken line. Where further explanation is necessary (e.g. use of two or more graphs used in conjunction), this should be included in the text, with an example. Where a graph is likely to be read in a direction which differs from that illustrated by the example line, suitable explanation should be included.

7.5 Conditions associated with graphs

The configurations and conditions associated with the measurement of the various performance cases should be stated and all relevant details should be given (see also 2.2.1). Speed should be stated in terms of I. A. S.

7.6 Identification of graphs

Where two or more graphs which are similar in appearance are used to cover the variation of items such as alternative take-off wing flap settings, the graphs themselves should be prominently marked to ensure the immediate recognition of the particular case.

7.7 Performance procedures

Performance procedures which are required in order that the level of safety, implicit in the scheduled performance, can regularly be achieved under normal and emergency conditions, should be included in the procedures related to performance (see 7.1.1). Speed should be stated in terms of I. A. S. Normally, the only cases required to be covered by such procedures, are take-off and landing.

7.8 Form of presentation of performance graphs

7.8.1 Airspeed indicator and altimeter error correction curves

These curves should be provided in a form in which the correction to be applied (ΔV or ΔH) is plotted as the ordinate with indicated airspeed as the abscissa for lines of constant weight or altitude. Each static source should be considered. This is illustrated by Figure 2.

7.8.2 Weight-Altitude-Temperature (WAT) curves - Take-off

7.8.2.1 WAT curves should be provided which limit the weight to an extent necessary to ensure compliance with the airworthiness climb requirements appropriate to take-off.

7.8.2.2 The curves should be titled as follows: "Maximum Take-off Weight for Altitude and Temperature".

7.8.2.3 The curves should be drawn having the altitude at the aerodrome as the ordinate and aeroplane weight as abscissa, with lines of constant temperature. Lines showing operational and structural limits should be marked on the graph and identified to show the limit they represent. The curves should not extend beyond these limits except for weight where the curves should be extended a small amount beyond the maximum structural weight limit using broken lines.

7.8.2.4 Should account have to be taken of additional parameters (e.g. use of anti-icing equipment, variation of V_2/V_2 min), these should be dealt with by additional correction grids associated with the weight axis.

7.8.2.5 To assist the user, any point of discontinuity or change of criticality from one requirement to another should be indicated. When a serious discontinuity occurs (such as a reversal of the normal effect of temperature due to a particular engine characteristic) more than one graph should be given.

7.8.2.6 The value of the climb requirement or requirements which determine the curves should be stated.

7.8.2.7 Figure 3 illustrates the requirements to be met in 7.8.2.

7.8.3 Take-off climb gradients

The basic take-off climb gradient data should be in a form which gives the gross gradient (%) of climb for varying altitudes, temperatures above and below standard, and for varying weights. The climb gradient data should consist of two grids. The basic grid should have climb gradient as the ordinate, with air temperature as the abscissa, having lines of constant altitude intersected by lines of constant atmosphere to form a carpet. The second part of the graph should be a correction grid for weight, with a reference line at a convenient position. An example is given by Figure 4.

7.8.4 Take-off field lengths

7.8.4.1 A graph should be provided to enable the IAS value (on the ground) of speed V_1, appropriate to the V_1/V_R ratio, the weight and, if applicable, the altitude and temperature, to be obtained. This is illustrated in Figure 5.

7.8.4.2 Take-off field lengths should be presented either in the form described in 7.8.4.3 or in the form described in 7.8.4.4.

7.8.4.3 First alternative

7.8.4.3.1 The graphs should be in a form which allows the user to proceed from the field lengths available to obtain the weight. The basic grid should be drawn having field length as the ordinate and weight as the abcissa for lines of constant altitude. Correction grids for the ordinate should be provided for temperature, wind and slope. The parameters will be given in the following order: field length, slope, wind, temperature, altitude, and weight. Figure 6 is an example.

7.8.4.3.2 A take-off field length required graph should be given to facilitate the take-off calculation for aerodromes at which balanced field length operations are used. This curve should cover all the required take-off distances (with all engines operating and with one engine inoperative); the distance scheduled can thus be equated directly to the length of the runway. An additional curve showing the value of V_1/V_R ratio associated with the balanced field length should be provided.

7.8.4.3.3 When it is desired by the applicant to provide information to enable credit to be taken for stopways and clearways, graphs for the following additional cases should be provided: the accelerate-stop distance and, for both the one-engine-inoperative and all-engines operating conditions, the take-off run required and the take-off distance required. Except when determined entirely by the all-engines operating requirements, the graphs should include one additional correction grid for V_1/V_R, interposed between the correction grids for temperature and wind.

7.8.4.4 Second alternative. Graphs for two cases should be used, one graph being entered with take-off run available and accelerate-stop distance available as variables and the other chart with take-off distance available and accelerate-stop distance available as variables, each chart giving an answer in the form of maximum weight appropriate to the particular aerodrome conditions together with the V_1/V_R ratio to be associated with this weight. Comparison of the two answers gives the limiting weight and its associated V_1/V_R ratio. Figures 7 to 10 inclusive are examples.

> Note.- This method, which is more complex and laborious to prepare but simpler to use than the method described in 7.8.4.3, avoids the need for separate cross plotting of V_1/V_R in order to obtain the optimum weight for a particular set of aerodrome conditions.

7.8.5 Net take-off flight path

7.8.5.1 Data necessary for the construction of the net take-off flight path should be presented so that the positions of the ends of each sector, in terms of co-ordinates from a defined datum, can be determined; the assumed flight path then being completed by joining these points by straight lines. Such parameters as weight, altitude, temperature, and wind, should be plotted in terms of distance. Figures 12 to 20 inclusive are examples.

7.8.5.2 An example of a plot of a typical net flight path profile should be provided, together with a complete fully calculated example and text, to explain exactly how the data are to be used. This is illustrated by Figure 11.

7.8.5.3 In addition, a graph should be provided so that any limitation on weight due to obstacles which occur in the flight path in at least the first 400 feet of height, can be determined directly without the necessity for further calculation or plotting. Distances to obstacles should be related to the start of take-off point. Variables additional to those listed in 7.8.5.1 should be covered by additional grids or other corrections on, or adjacent to, the graph, in preference to additional graphs. An example is given in Figure 21.

7.8.6 En route data

7.8.6.1 The basic en route net climb gradient data should be in a form which gives the net gradient of climb or descent for varying altitudes, weights, and for temperatures above and below standard. The basic grid should consist of lines of constant atmosphere drawn with altitude as the abscissa and net gradient as the ordinate. A correction grid for the ordinate should be given for weight, having a reference line at a suitable value of weight. The effect of the operation of anti-icing or other auxiliary systems should be shown by means of additional correction grids. An example of this graph is given by Figure 22.

7.8.6.2 In the case of the one-engine-inoperative en route configuration, additional graphs showing the net flight paths should be provided except for aircraft where the one-engine-inoperative performance is sufficient to ensure that drift down procedure will not have to be used for compliance with the performance operating limitations. These graphs should be drawn for varying weights and altitudes. The effect of temperature and wind component, as well as the effect of the operation of anti-icing or other auxiliary systems, should be shown by means of additional correction grids. In calculating flight paths, consideration may be given to consumption of fuel and oil. Figure 23 illustrates one method of meeting the specification. An alternative method is illustrated by Figures 24 and 25.

7.8.7 Weight-Altitude-Temperature (WAT) Curves - Landing

7.8.7.1 The curves should be drawn to the same specification as for the take-off WAT curves (see Figure 3), except that the temperature curves should be extended by broken lines beyond the maximum structural landing weight as far as the maximum take-off weight.

7.8.7.2 The title of the curves should be: "Maximum Landing Weight for Altitude and Temperature"

7.8.8 Landing climb gradients

The basic landing climb gradient data should be in accordance with the same specification as for take-off climb gradients. Figure 4 is an example.

7.8.9 Landing field lengths

These graphs should be in accordance with the same basic specification as for the first alternative method of take-off field length presentation (see 7.8.4.3.1 and Figure 6).

8.- Appendices

8.1 This part of the Manual should include data at the discretion of the applicant.

FIGURE 1

The graph in Figure 1 illustrates the definitions of 7. 3. 1.

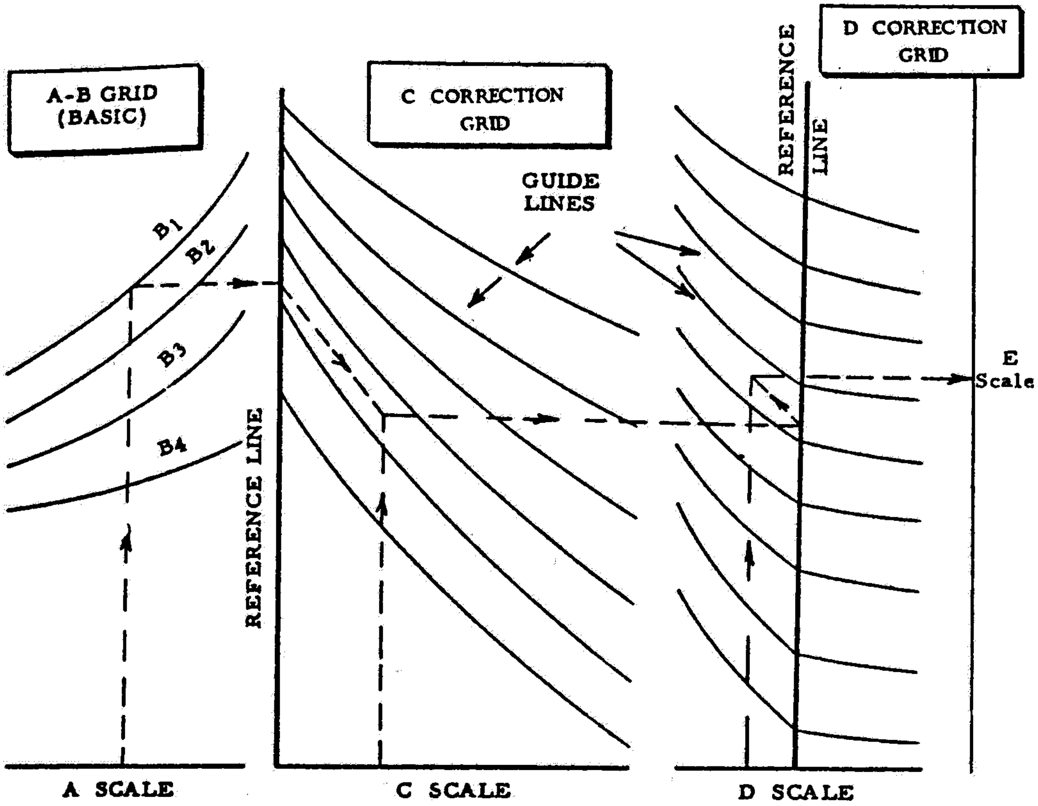

A-B GRID
(BASIC)
C CORRECTION
GRID
D CORRECTION
GRID
GUIDE
LINES
B1
B2
B3
B4
REFERENCE LINE
REFERENCE
LINE
E
Scale
A SCALE
C SCALE
D SCALE

Figure 1

FIGURE 2

The graph in Figure 2 illustrates a presentation of airspeed indicator error correction curves in accordance with 7.8.1. A second graph would usually be provided in the case of an alternative static source. A similar type of presentation would be followed to present the altimeter error correction.

POSITION AND COMPRESSIBILITY ERROR CORRECTION TO AIRSPEED INDICATOR

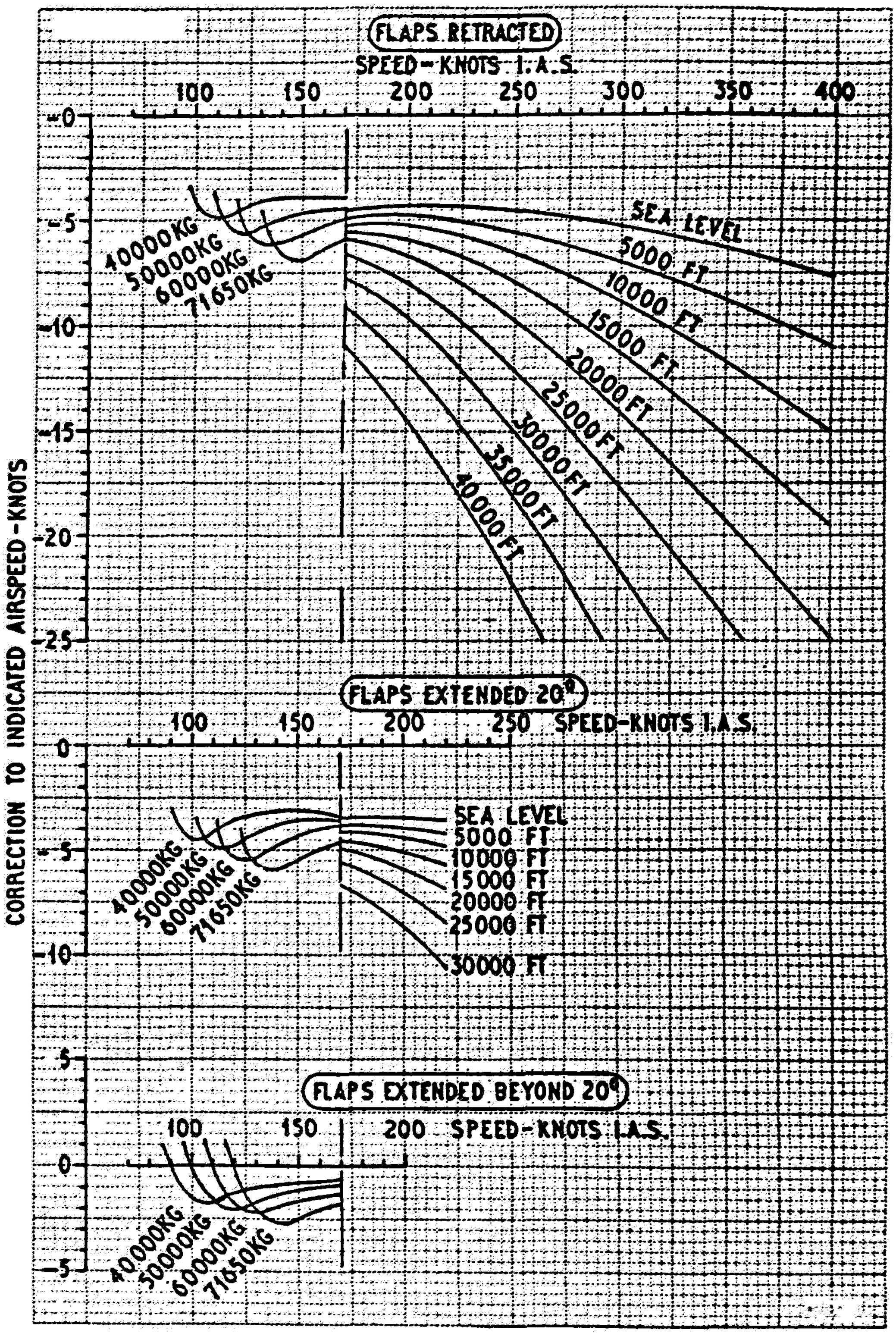


Figure 2

FIGURE 3

The graph in Figure 3 illustrates the presentation of the maximum take-off weight for altitude and temperature which is specified in 7.8.2. A similar type of presentation is also required by 7.8.7.

MAXIMUM TAKE-OFF WEIGHT FOR ALTITUDE AND TEMPERATURE

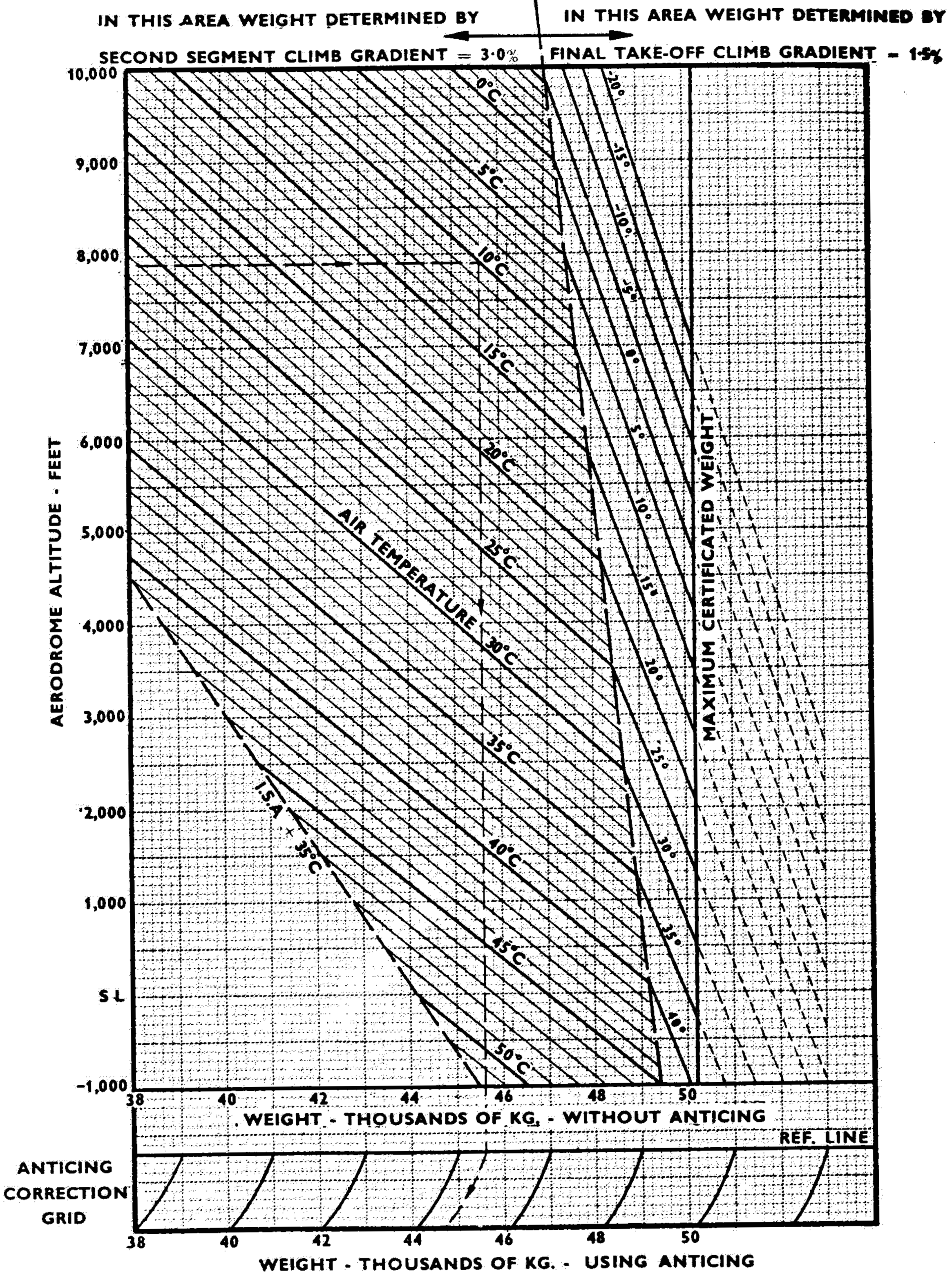


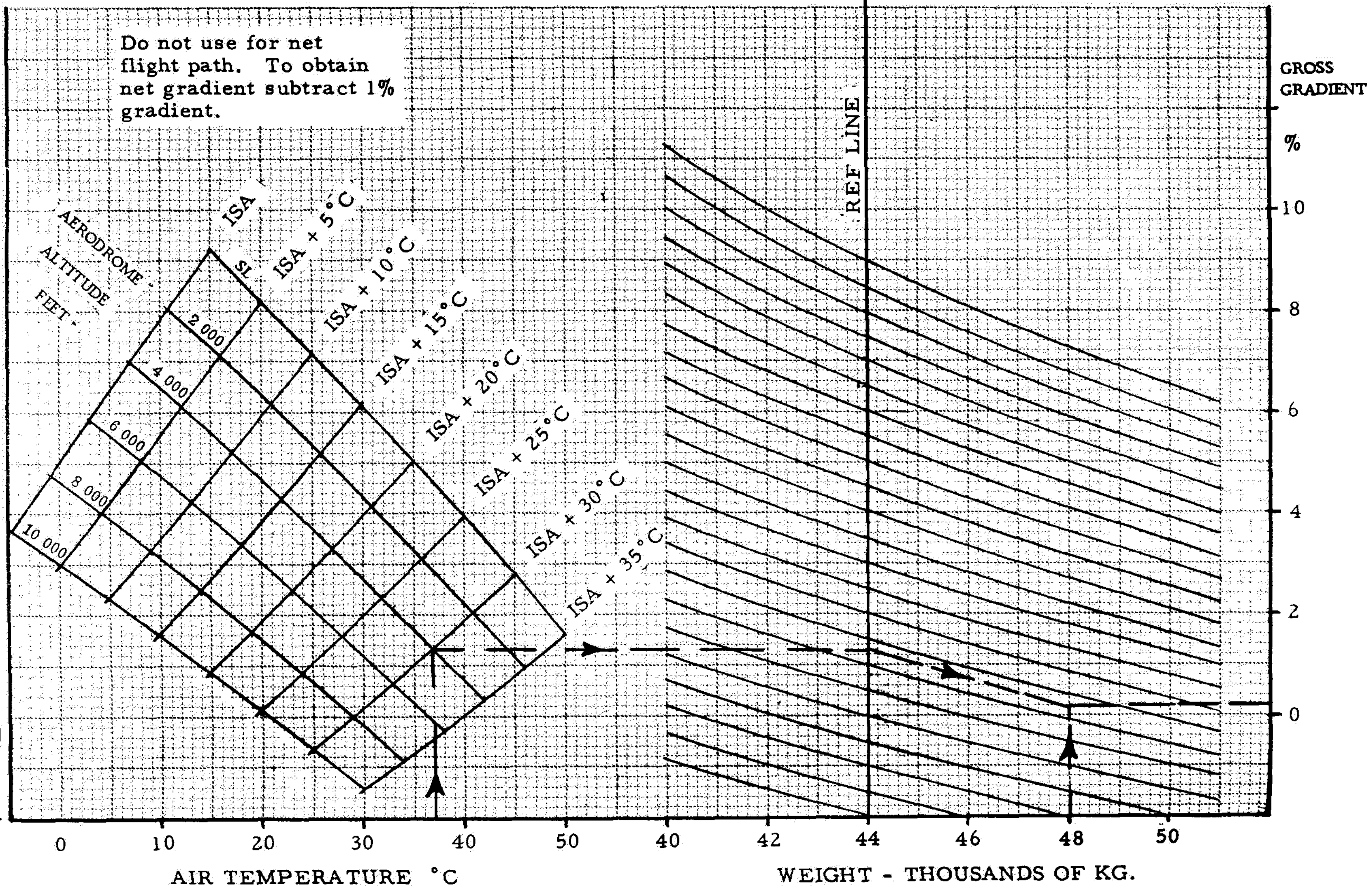
Figure 3

FIGURE 4

The graph in Figure 4 illustrates a presentation of a climb gradient in accordance with 7.8.3. A similar type of presentation is also required by 7.8.8.

GROSS GRADIENT OF CLIMB

TAKE-OFF SECOND SEGMENT



Do not use for net flight path. To obtain net gradient subtract 1% gradient.

Figure 4

FIGURE 5

The graph in Figure 5 illustrates a presentation which enables V_1/V_R to be converted into V_1 in accordance with 7.8.4.1.

CONVERSION OF $\frac{V_1}{V_R}$ INTO V_1 KNOTS I.A.S.

NOTE :-
USE FIG.A. OR FIG.B , WHICHEVER
GIVES THE GREATER SPEED

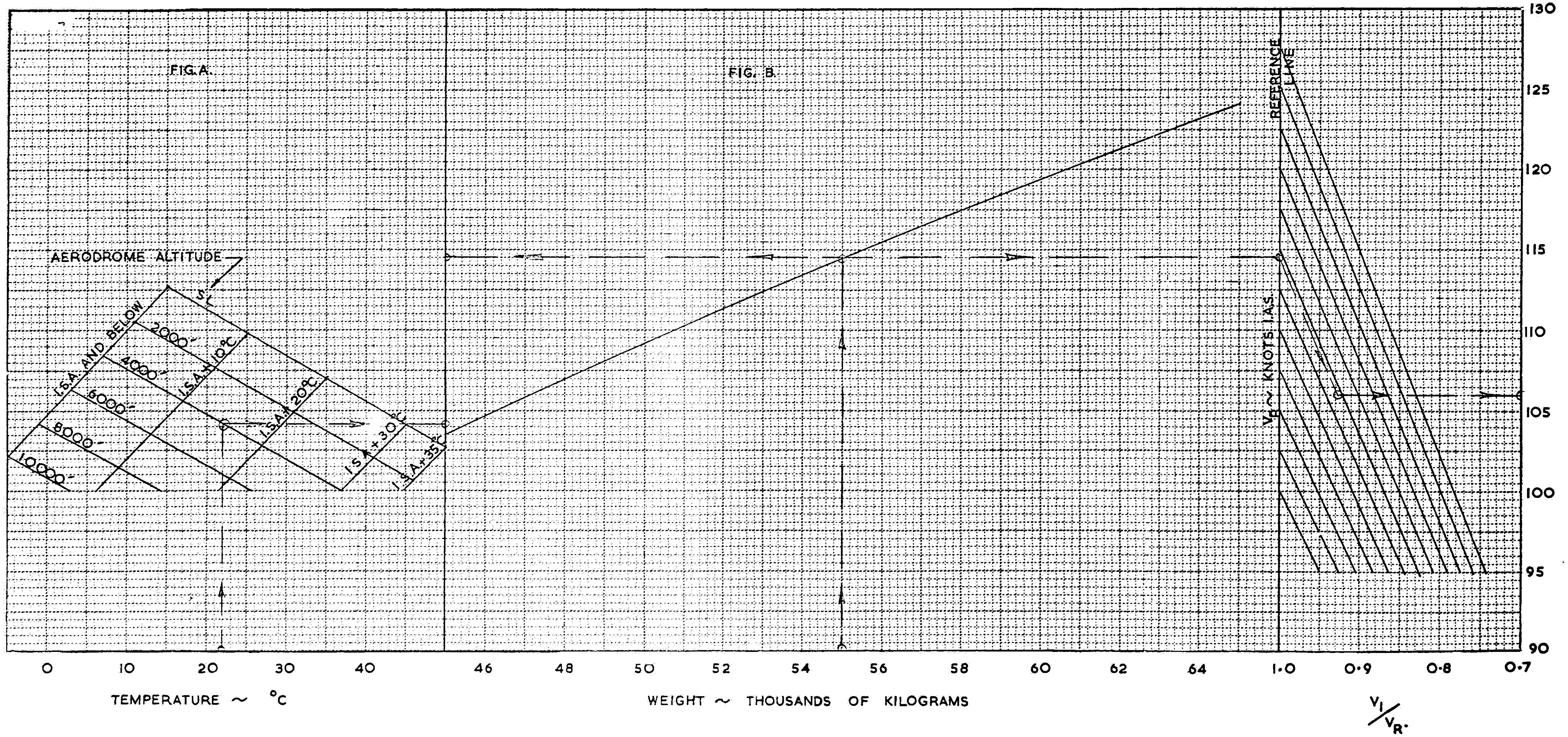


Figure 5

FIGURE 6

The graph in this Figure illustrates 7.8.4.3.2. The value of the weight which is obtained from the graph is the maximum weight at which the aeroplane may take off or accelerate and stop in a given distance. If the distance used includes stopway, it will be necessary to ascertain, by reference to one of the graphs which are provided in accordance with 7.8.4.3.3, that the take-off run does not exceed the length of the runway.

A type of presentation similar to Figure 6 is specified by 7.8.4.3.3 with the addition of a correction grid for V_1/V_R interposed between the correction grid for temperature and wind.

The graph may also be read in the reverse direction to the arrows, to obtain the field length for a given weight.

BALANCED TAKE-OFF FIELD LENGTH - MAXIMUM WEIGHT

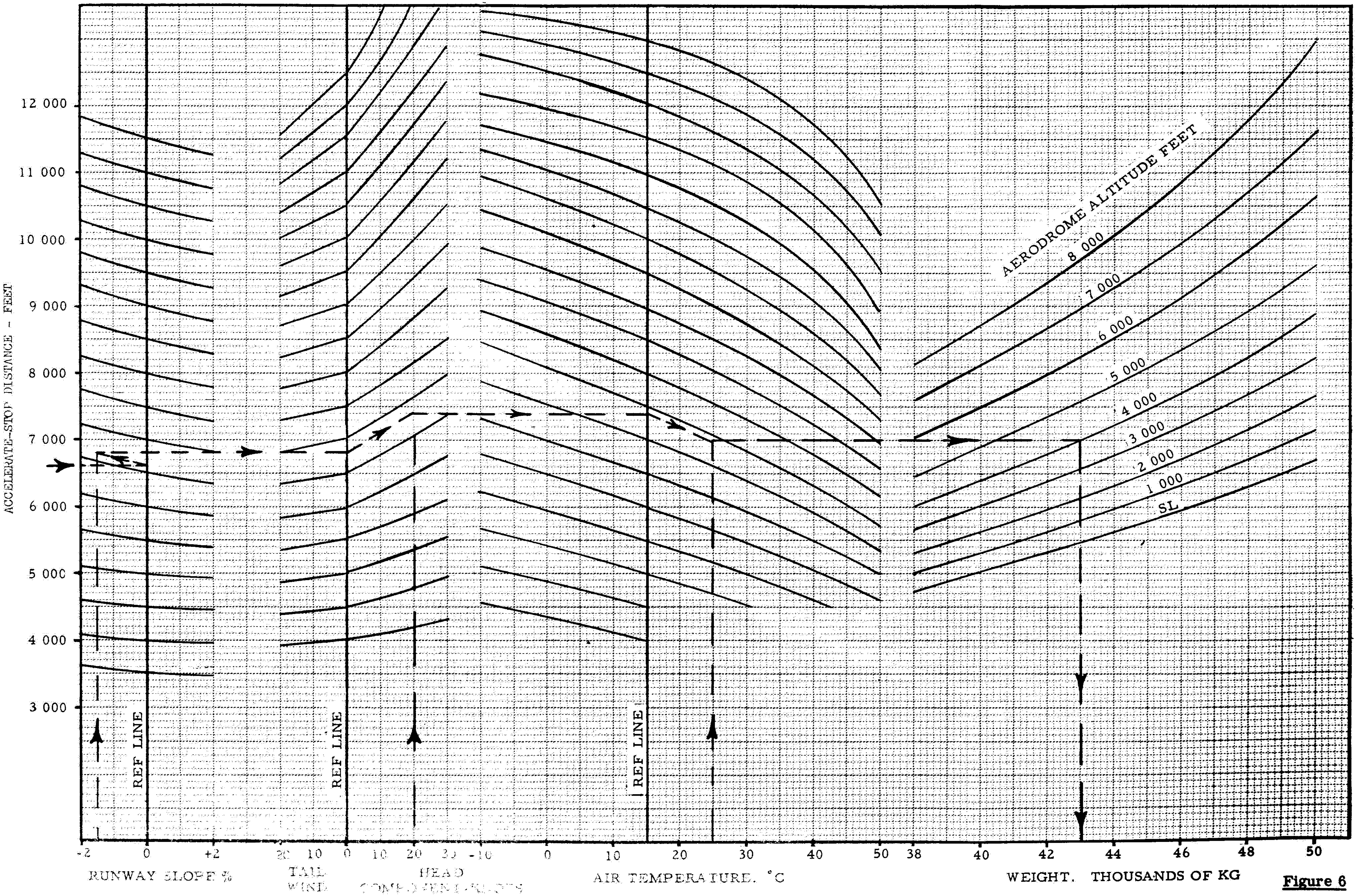


Figure 6

FIGURES 7 to 10 inclusive

The graphs in Figures 7 to 10 inclusive illustrate the method of presentation of the take-off field lengths which is specified by 7. 8.-4. 4. Because the way in which this series of graphs is to be used is not readily apparent, some instructions are necessary and a typical example is given below.

Introduction

The data in Figures 7 to 10 inclusive enable the weight to be calculated at which the take-off field length limitations can be met. At the weight thus obtained, the take-off run required, accelerate-stop distance required, and the take-off distance required will, respectively, not exceed the take-off run available, accelerate-stop distance available, and the take-off distance available.

Method of use

Two calculations are required:

(i) to find the greatest weight permitted by take-off distance and accelerate-stop distance available at the aerodrome,

and

(ii) to find the greatest weight permitted by take-off run and accelerate-stop distance available at the aerodrome.

Then whichever is the smaller of these two weights will be the maximum take-off weight permitted by field length considerations only.

Note.- In cases where the take-off run available is equal to the take-off distance available then calculation (i) only need be considered.

For calculation (i) , Figure 7 gives a distance D and the associated V_1/V_R for the given conditions of take-off and accelerate-stop distances available, runway slope and wind. The distance D thus obtained is then used in Figure 8 to give the take-off weight for the appropriate aerodrome altitude and temperature.

For calculation (ii), Figure 9 gives a distance R and the associated V_1/V_R for the given conditions of take-off run and accelerate-stop distance available, runway slope and wind. The distance R thus obtained, is then used in Figure 10 to give the take-off weight for the appropriate aerodrome altitude and temperature.

As explained previously, the maximum weight will be whichever is the lesser of these two weights. Then use Figure 5 to correct the associated V_1/V_R to an I. A. S. value of V_1. It should be noted that Figure 5 has a cut-off such that V_1 values less than 95 knots I. A. S. cannot be obtained. This is the minimum permissible value of V_1 and in cases where the values of V_1 would apparently be less tan 95 knots I. A. S. the procedure given in the next paragraph is necessary.

Reduce "D" (or "R", whichever case limits the take-off weight from runway considerations) at constant accelerate-stop distance available and obtain a higher value of V_1/V_R. The lower value of "D" (or "R") will result in a lower take-off weight. Use this lower weight and higher value of V_1/V_R to obtain V_1 and repeat if necessary.

Example Calculation

A fully worked example is provided to illustrate how to use the various take-off field length graphs. The aerodrome conditions are:

- Take-off run available	: 5 100 feet
- Take-off distance available	: 6 100 feet
- Accelerate-stop distance available	: 5 350 feet
- Altitude	: 4 000 feet
- Temperature	: 22°C (I.S.A. + 15°C)
- Runway slope	: 0.5% downhill
- Wind component	: 10 knots reported headwind

To determine the highest take-off weight permitted by take-off field length limitations, proceed as follows:

(i) Using Figure 7, start on left of the chart from the given take-off distance available (6 100 ft); proceed across to the runway slope (0.5% downhill), then down the guide lines to the reference line, then across again to the wind component (10 knots headwind) and then to the reference line. Similarly, starting from the accelerate-stop distance available (5 350 ft) proceed upwards through the slope grid to the wind component, then to the reference line. Where the two lines finally intersect, fixes the value of D and V_1/V_R; in this case the intersection is at:

$$D = 6\,800$$
$$V_1/V_R = 0.914$$

(ii) Using Figure 8, start on the right with the value of D (obtained from Figure 7) and proceed to the appropriate altitude (4 000 feet). Then follow the guide lines to the reference line, and proceed to the left to the appropriate temperature curve (I.S.A. + 15°C). At this intersection read off on the scale below the maximum weight (55 000 kg).

(iii) Using Figure 9 in the same way as described previously for Figure 7, it is found that for a take-off run available of 5 100 feet and an accelerate-stop distance available of 5 350 feet, with a downhill runway slope of 0.5% and with a headwind of 10 knots, the value of R is 5 850 which is associated with a V_1/V_R of 0.92.

(iv) Using Figure 10, and with value of R previously obtained, the maximum weight is found to be 55 350 kg.

Conclusion

By using these four graphs, it has been found that, for the example conditions given, from (i) and (ii) the weight and V_1/V_R are respectively 55 000 kg and 0.914; from (iii) and (iv) they are respectively 55 350 kg and 0.92. By comparing these two weights, it is seen that the lower is 55 000 kg. This, therefore, is the maximum permitted weight; the associated V_1/V_R is 0.914 and this can be converted into the V_1 for the take-off by using Figure 5. With this graph it should also be checked that the V_1 required is not less than the minimum permissible values.

VALUE OF "D" AND $\frac{V}{V_R}$ RATIO FOR TAKE-OFF DISTANCE AVAILABLE AND ACCELERATE - STOP DISTANCE AVAILABLE

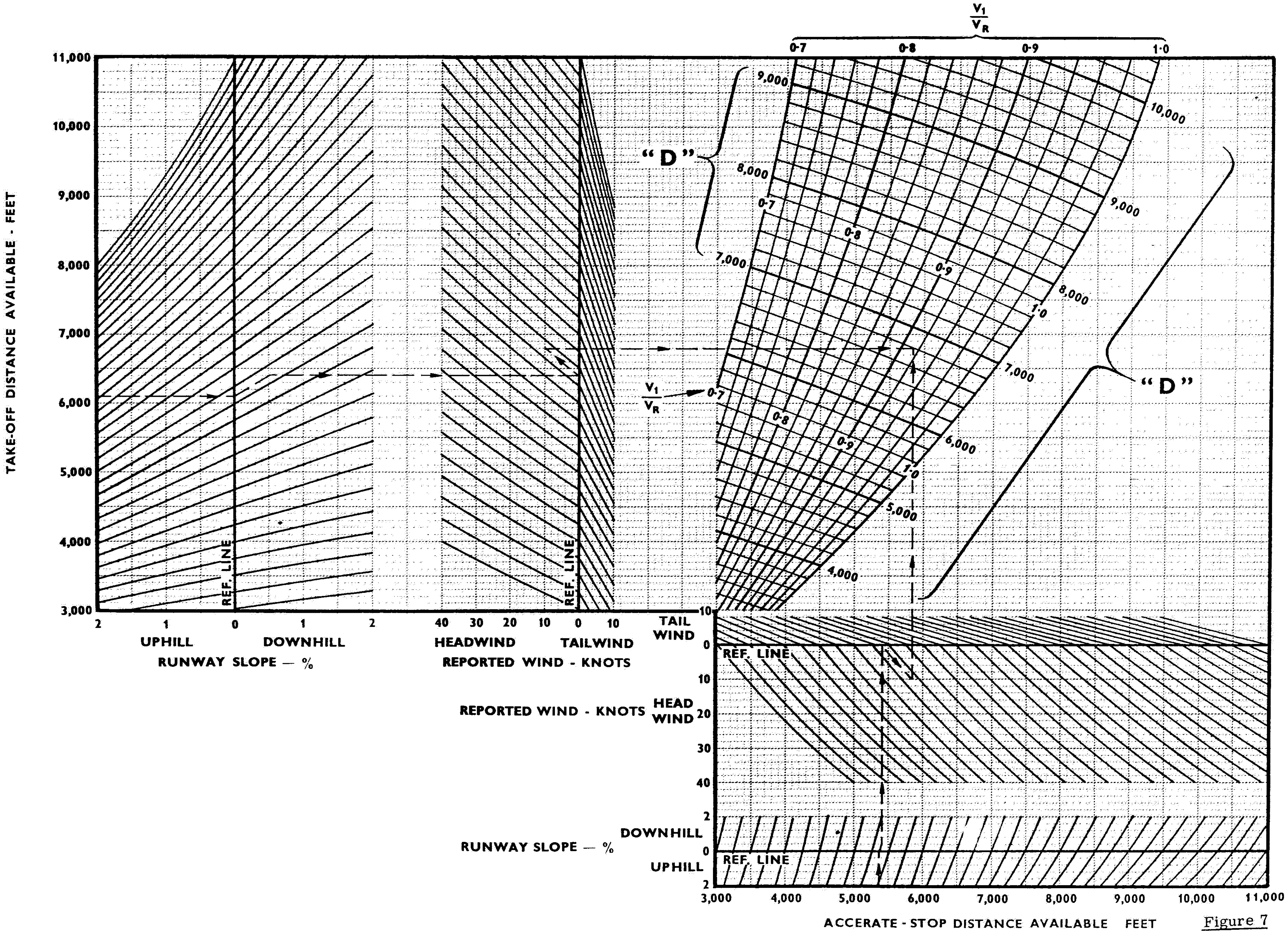


Figure 7

FIGURE 8

An explanation of Figure 8 is given in the text associated with Figures 7 to 10 inclusive.

MAXIMUM TAKE-OFF WEIGHT FOR TAKE-OFF DISTANCE AVAILABLE AND ACCELERATE - STOP DISTANCE AVAILABLE

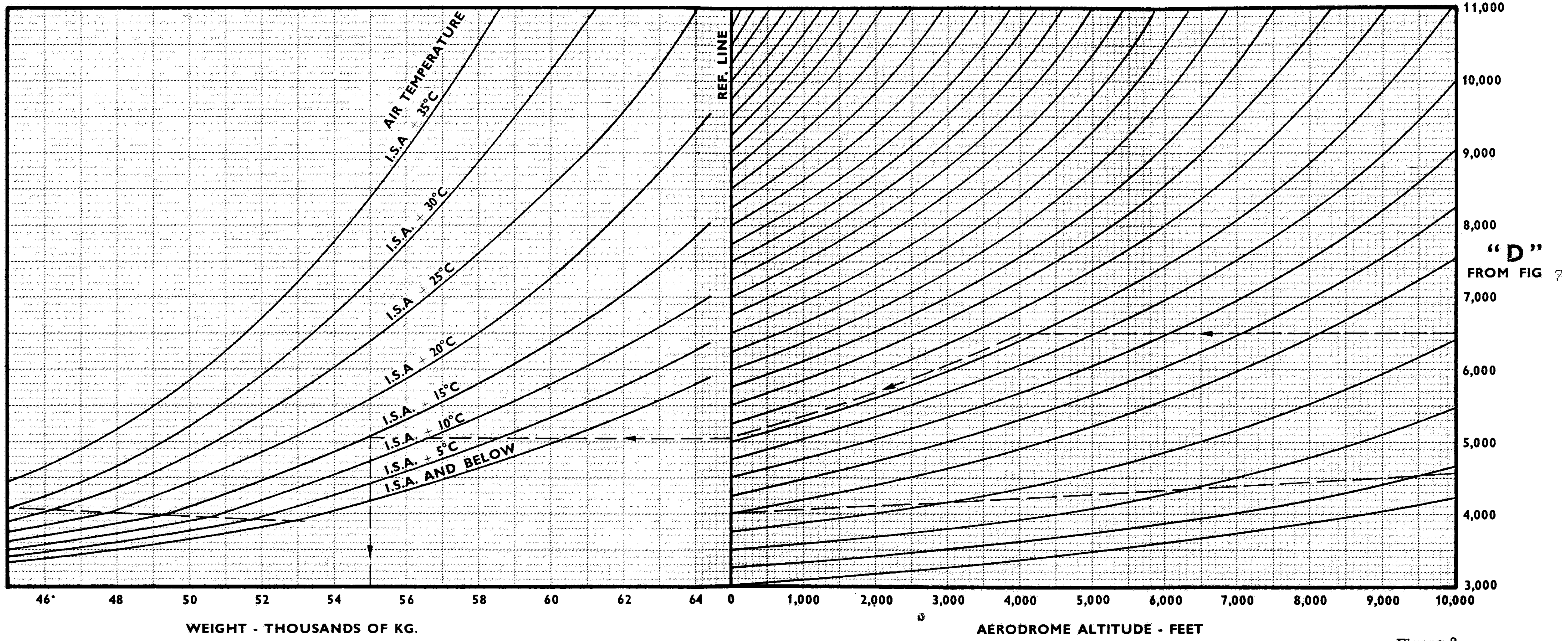


Figure 8

FIGURE 9

An explanation of Figure 9 is given in the text associated with Figures 7 to 10 inclusive.

VALUE OF "R" AND $\frac{V_1}{V_R}$ RATIO FOR TAKE-OFF RUN AVAILABLE AND ACCELERATE - STOP DISTANCE AVAILABLE

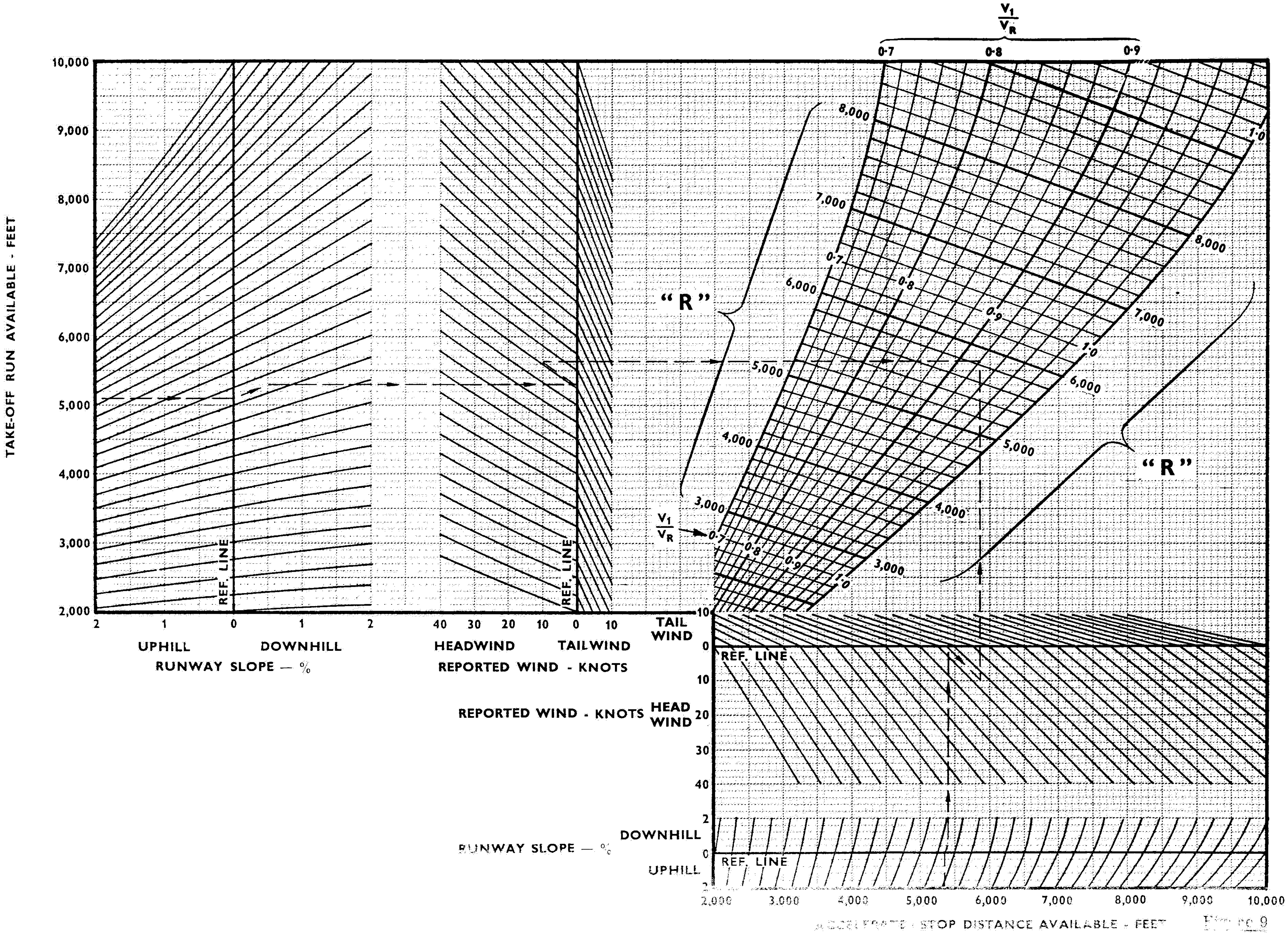


Figure 9

FIGURE 10

An explanation of Figure 10 is given in the text associated with Figures 7 to 10 inclusive.

MAXIMUM TAKE-OFF WEIGHT FOR TAKE-OFF RUN AVAILABLE AND ACCELERATE - STOP DISTANCE AVAILABLE

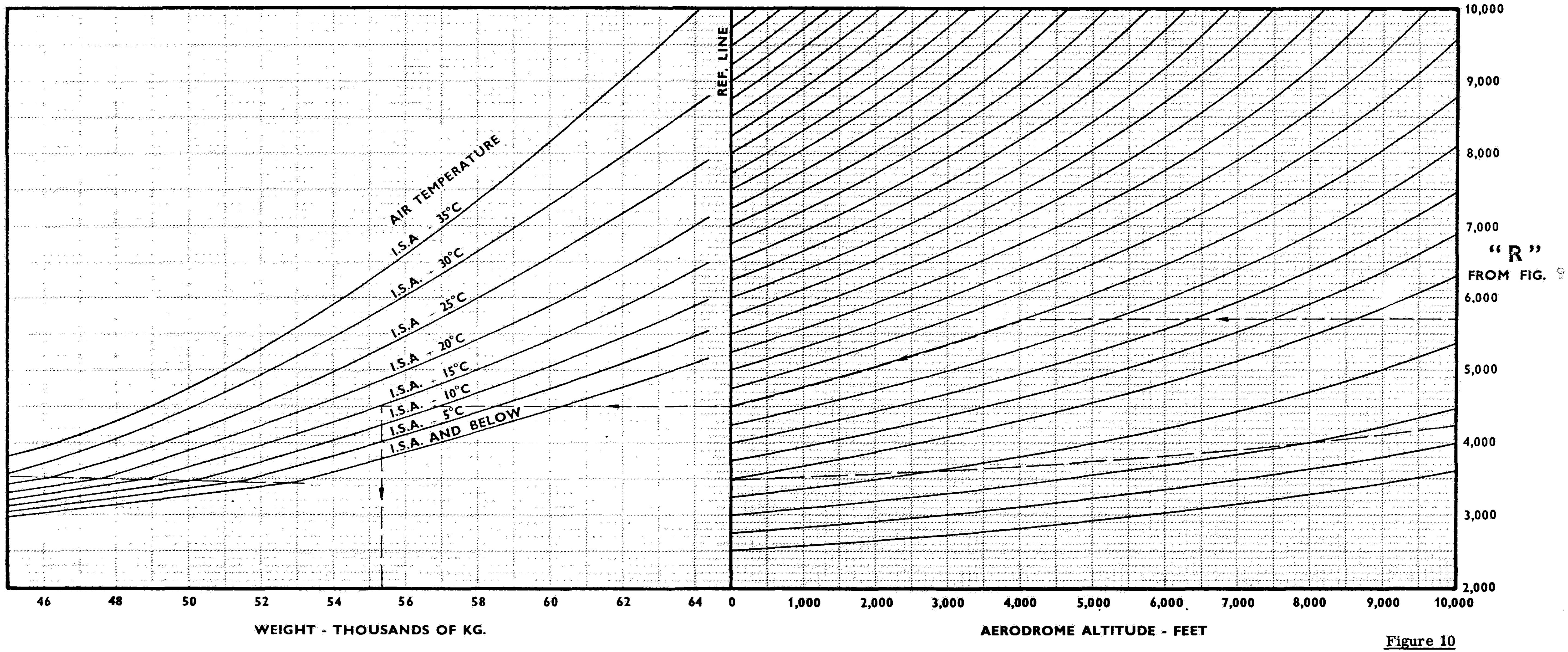


Figure 10

FIGURES 11 to 20 inclusive

The graphs in Figures 11 to 20 inclusive illustrate the construction of the net take-off flight path in accordance with 7. 8. 5. 1 and 7. 8. 5. 2. An example of the explanatory text and a sample calculation in accordance with 7. 8. 5. 2 is provided below.

Introduction

Figures 11 to 20 inclusive are provided to enable a complete net take-off flight path to be constructed, should it be necessary to establish that any obstacles along the intended line of flight will be cleared by the safety margin required by the relevant operating regulations. Once it has been established beyond all doubt that the obstacles will be cleared, there is no need to proceed further with the calculation.

Figures 11 to 17 are for constructing a "straight climb out" flight path - that is to say, one in which any change of heading is less than 15°. To make allowance for the effect of a steady turn with a change in heading greater than 15°, the information in Figures 18, 19 and 20 is to be used.

Definitions

The following definitions of some of the terms used in the net take-off flight path data, are given:

Reference zero: The zero to which the co-ordinates of the various points in the flight path are referred. This zero contains a vertical datum which passes through the 35 feet height point, (i. e. at the end of the take-off distance required) and a horizontal datum which is 35 feet below this point.

Five minute power point: The point at which a time of 5 minutes has elapsed after start of take-off. The power of the operative engines must then be reduced to maximum continuous.

First segment: From the 35 feet height point to the point at which the landing gear is fully retracted, retraction of the landing gear having been initiated 3 seconds after lift-off.

Second segment: From the landing gear retraction complete point to a height of 400 feet. (NOTE: For this aeroplane, no change in power or configuration is made at this point).

Third segment: From the point at a height of 400 feet to the point reached when the time elapsed from the start of take-off is that given in Figure 17.

Fourth segment: From the end of the third segment to the point reached by following the procedure described hereafter. When the specified time has elapsed (see Figure 17), the aeroplane is accelerated in level flight using maximum take-off power. When speed has reached the Flap Retraction Initiation Speed the flaps are selected to UP. The acceleration in level flight is continued until the flaps are fully retracted and the speed has increased to the appropriate flaps up climb speed (one engine inoperative) at which point power is reduced to maximum continuous.

Fifth segment: From the end of the fourth segment to the point defined hereafter. The aircraft is in the en route configuration. The segment normally ends at 1 500 feet, but may be continued to a greater height should obstacle clearance make this necessary (see Figure 15 and 16).

Method of Use

Figure 11 illustrates a plotting sheet on which is shown a typical flight path. The details of this calculation are given on a later page.

From Figure 12 obtain the basic reference flight path slope. This parameter is used in the subsequent graphs to obtain the gradients in the 1st, 2nd, 3rd and 5th segments, the horizontal distance covered during the 4th (acceleration) segment, and the height above the reference zero at the end of each segment.

Figure 17 is provided so that the time at the start of the acceleration segment can be ascertained. Provided that this time is accurately observed the flaps up climbing speed will be attained at the five minute power point.

Example calculation

To demonstrate the use of all the graphs, it is assumed that the fourth segment occurs below 1 500 feet and terrain makes it necessary to continue the construction of the flight path up to 1 500 feet, although in many cases this would not be required. It is also assumed that there is no change in heading during the climb. The following aerodrome conditions are assumed:

- Weight : 55 000 kg
- Aerodrome Altitude : 4 000 feet
- Temperature : 22°C (I. S. A. + 15°C)
- Wind Component : 10 knots reported headwind

In all graphs it is permissible to use the altitude appropriate to the aerodrome and, therefore, no allowance need be made for reduction in performance above aerodrome altitude except above 1 500 feet.

The position of the 35 ft point (at the end of the take-of distance required) will previously have been ascertained from the take-off field length calculations, and thus the position of the "reference zero" - to which all the various points in the flight path are referred - can be fixed in relation to the known obstacle profile in the direction of take-off.

(a) Obtain the reference flight path gradient. From Figure 11, for the given conditions of temperature, altitude, weight, and wind component, this is found to be 3.5%. This parameter is used in the subsequent graphs to obtain the complete flight path.

(b) First segment. Using the basic reference flight path gradient previously obtained, the gradient in the first segment (from Figure 13) is 1.6% and the height above reference zero at the end of the segment (from Figure 15) is 46 feet. The height increment is 46-35 + 11 feet and the distance increment is $\frac{11 \times 100}{1.6}$ = 690 feet. The end of the first segment is now fixed.

(c) Second segment. From Figure 13, the gradient in this segment is 3.4% and the height at the end of the segment is (always) 400 feet. The height increment is therefore 400-46 = 354 feet and the horizontal distance increment = $\frac{354 \times 100}{3.4}$ = 10 410 feet.

(d) Third segment. The segment ends when the fourth segment commences which is 244 seconds after the start of take-off as shown in Figure 17. The height at the end of this segment is 1 290 feet, obtained from Figure 15, because the fourth segment will occur below 1 500 feet and the height increment is therefore 1 290 - 400 = 890 feet. The gradient is 3.16% and the horizontal distance increment is therefore 28 160 feet.

(e) Fourth segment. This is the acceleration segment and therefore there is no gain of height. The horizontal distance covered in the segment is, from Figure 14, 13 150 feet.

(f) Fifth segment. This segment ends at 1 500 feet or above and the mean gradient between its start and 1 500 feet in this example is 3.28% from Figure 13. The height increment in this example is 1 500 - 1 290 = 210 feet and the horizontal distance 6 400 feet.

All these points on the flight path are plotted in Figure 11, which also gives a table summarising this example. The figures in the last column (total horizontal distance covered) are obtained by adding the distance increments of the segments.

NET TAKE-OFF FLIGHT PATH I

EXAMPLE

AERODROME ALTITUDE	4,000 FT.
AERODROME TEMPERATURE	22°C. (I.S.A + 15°C)
REPORTED WIND	10 KT. (HEADWIND.)
TAKE OFF WEIGHT	55,000 KG.

EXAMPLE REFERENCE GRADIENT 3·5 %

SEGMENT	HEIGHT — FEET			NET GRADIENT	HORIZONTAL DISTANCE.	
	AT START OF SEGMENT	AT END OF SEGMENT	INCREMENT DURING SEGMENT		INCREMENT DURING SEGMENT	TOTAL FROM REFERENCE
FIRST	35	46	11	1·60	690	690
SECOND	46	400	354	3·40	10,410	11,100
THIRD	400	1290	890	3·16	28,160	39,260
FOURTH	1290	1290	0	—	13,150	52,410
FIFTH.	1290	1500	210	3·28	6,400	58,810

NOTE: HEIGHTS UNDERLINED ARE FIXED.

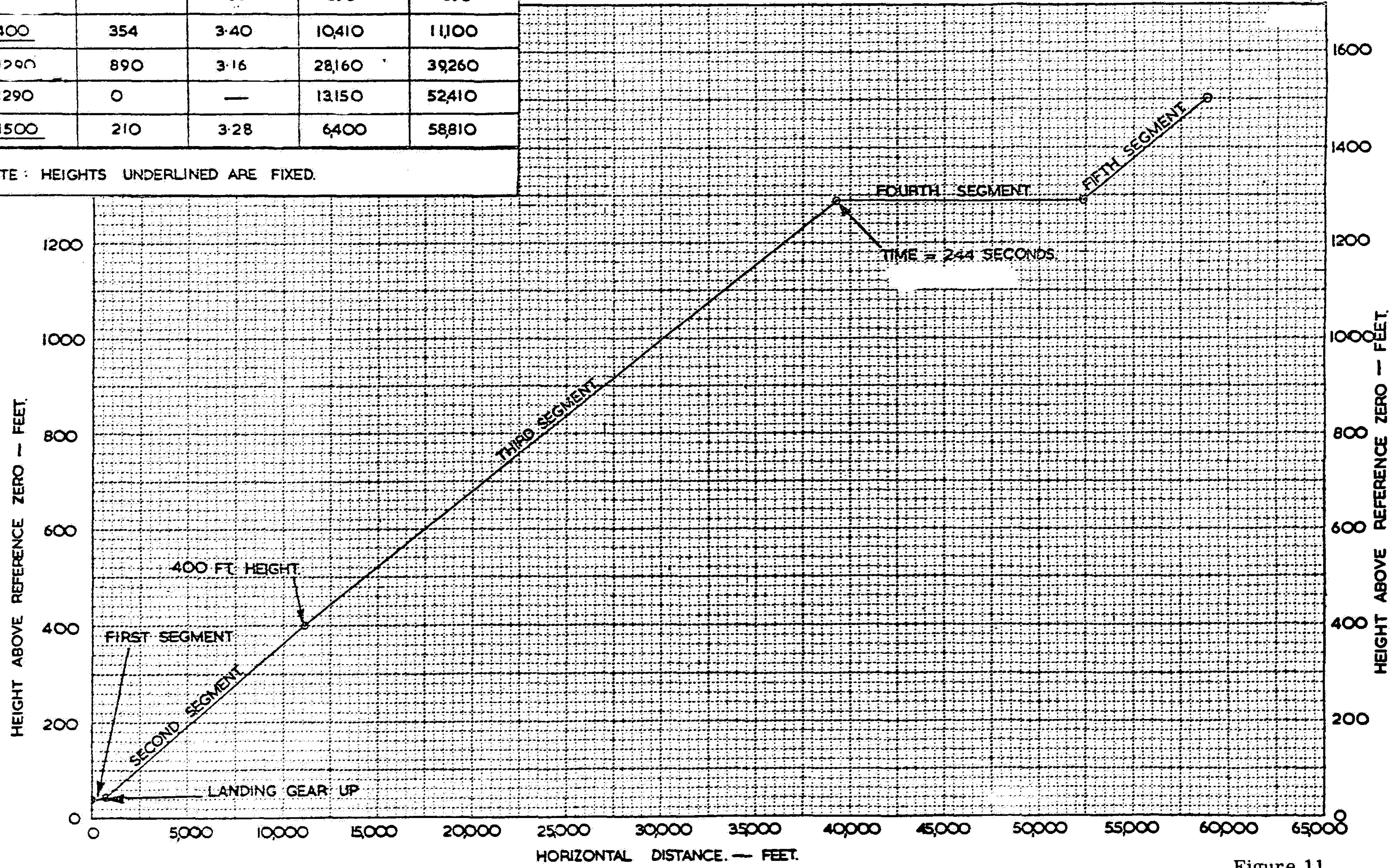


Figure 11

FIGURE 12

The use of Figure 12 is explained in the text associated with Figures 11 to 20 inclusive.

NET TAKE-OFF FLIGHT PATH II

REFERENCE FLIGHT PATH GRADIENT

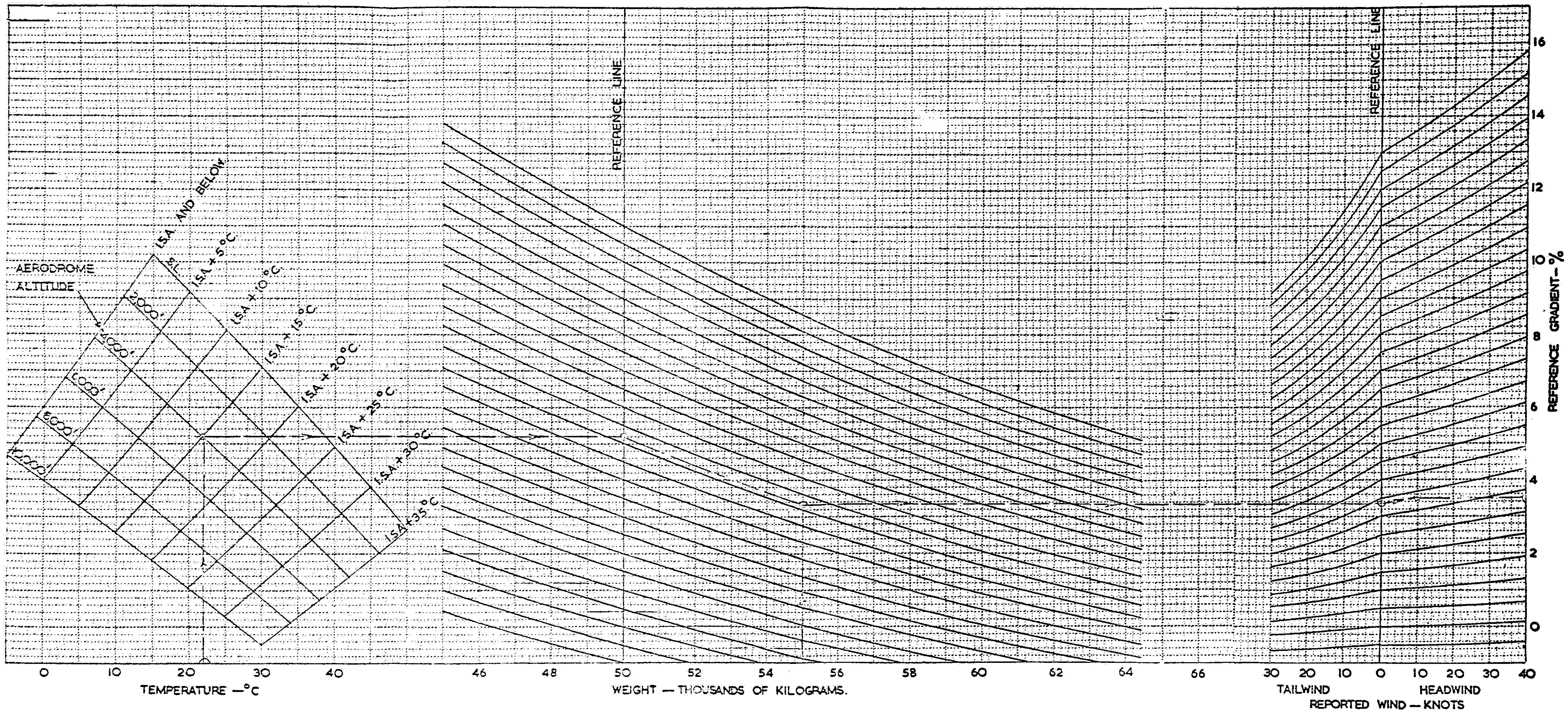


Figure 12

FIGURE 13

The use of Figure 13 is explained in the text associated with Figures 11 to 20 inclusive.

NET TAKE-OFF FLIGHT PATH 111

CONVERSION OF REFERENCE GRADIENT INTO ACTUAL GRADIENTS FOR FIRST, SECOND, THIRD AND FIFTH SEGMENTS

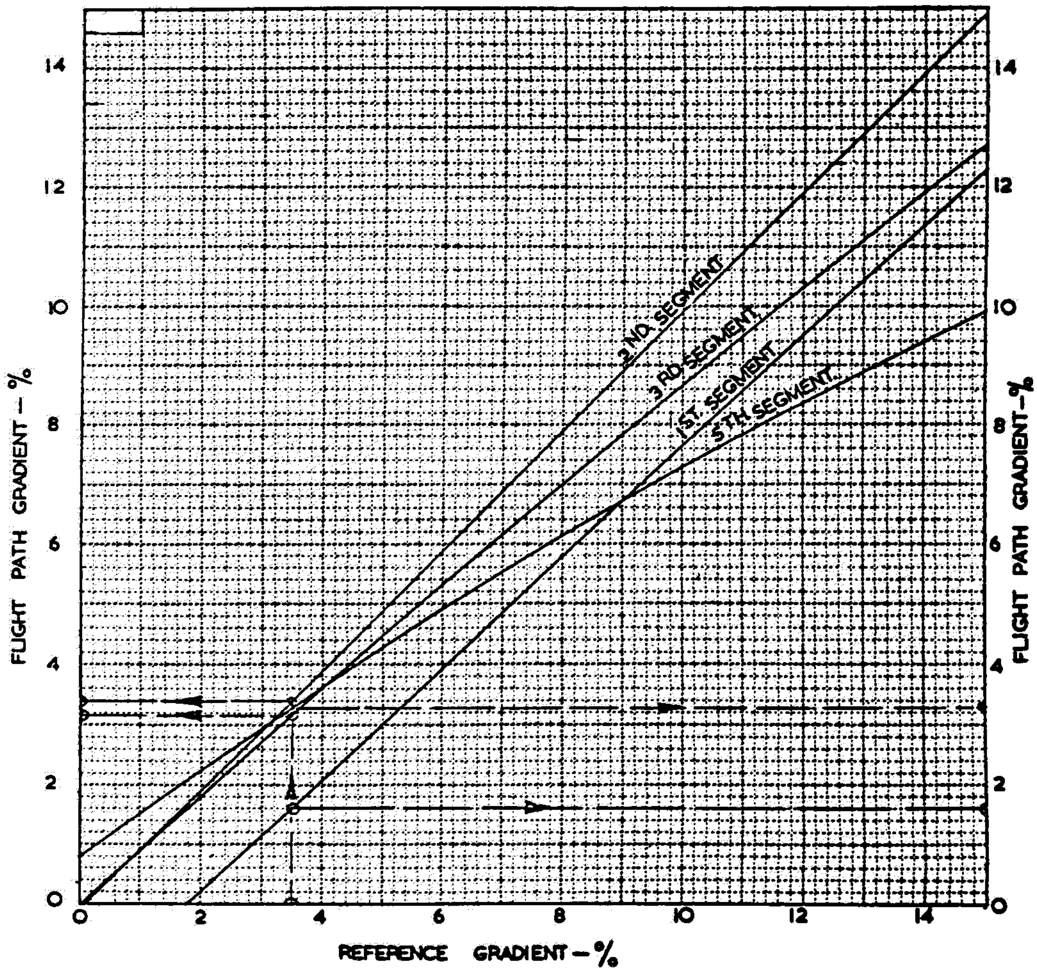


Figure 13

FIGURE 14

The use of Figure 14 is explained in the text associated with Figures 11 to 20 inclusive.

NET TAKE-OFF FLIGHT PATH IV

FOURTH (i.e. ACCELERATION) SEGMENT

HORIZONTAL DISTANCE

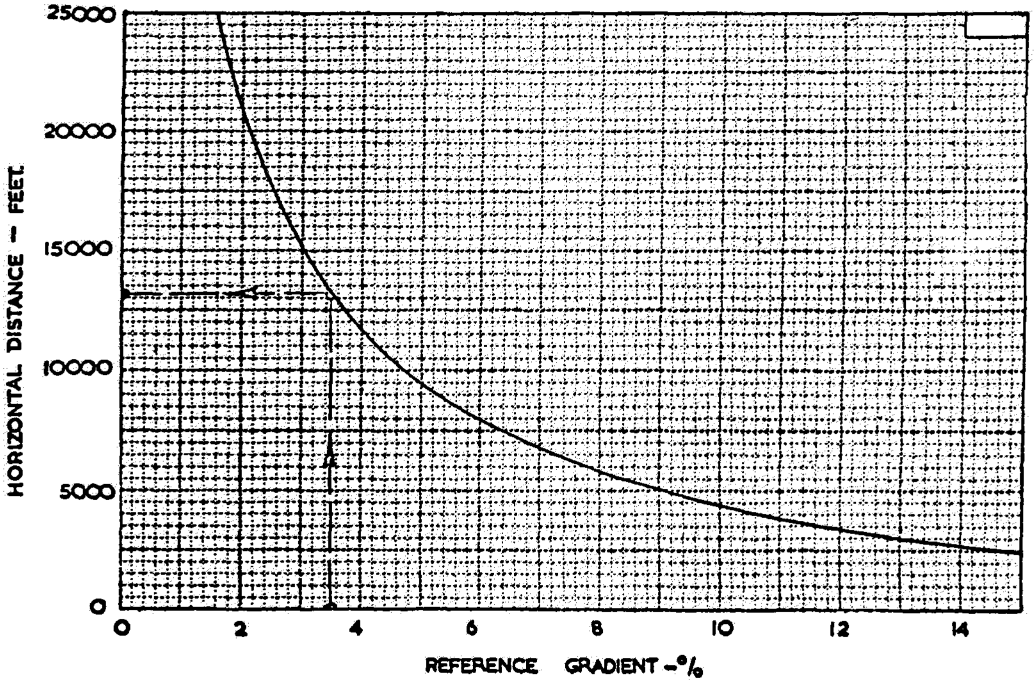


Figure 14

FIGURE 15

The use of Figure 15 is explained in the text associated with Figures 11 to 20 inclusive.

NET TAKE-OFF FLIGHT PATH Va

HEIGHT ABOVE REFERENCE ZERO AT END OF EACH SEGMENT

FOURTH SEGMENT BELOW 1500 FT.

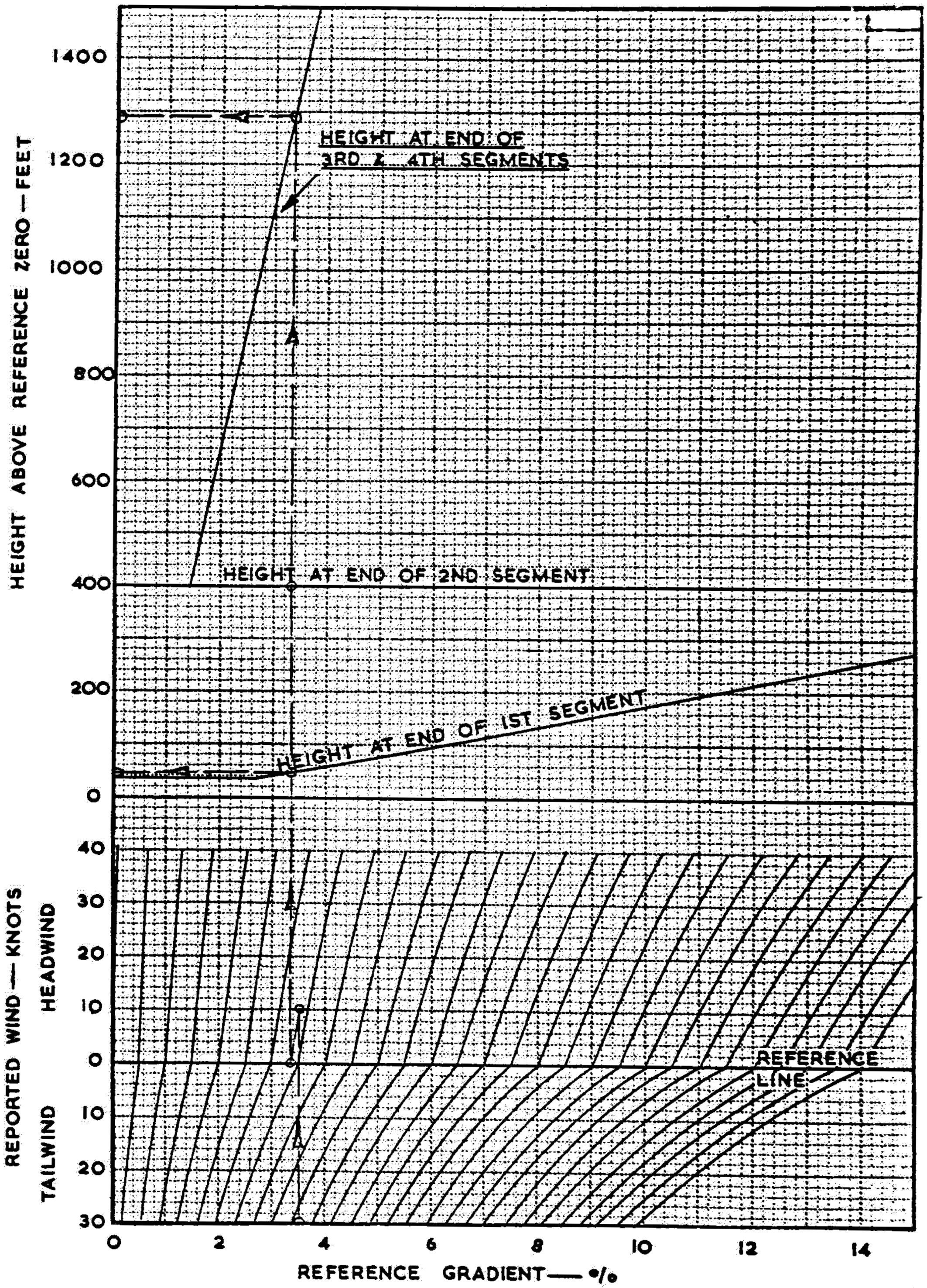


Figure 15

FIGURE 16

The use of Figure 16 is explained in the text associated with Figures 11 to 20 inclusive.

NET TAKE-OFF FLIGHT PATH Vb

HEIGHT ABOVE REFERENCE ZERO AT END OF EACH SEGMENT

FOURTH SEGMENT ABOVE 1500 FT.

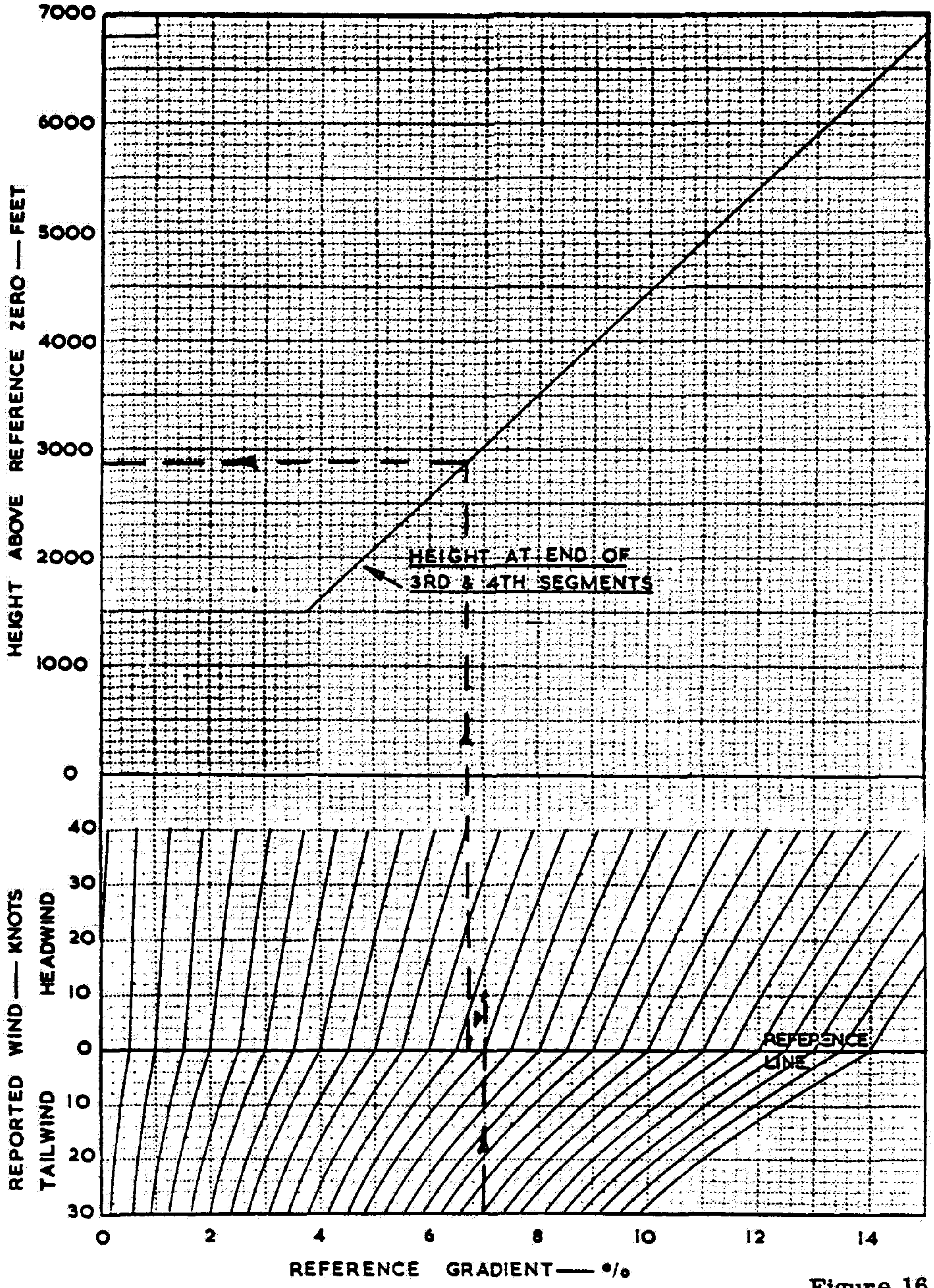


Figure 16

FIGURE 17

The use of Figure 17 is explained in the text associated with Figures 11 to 20 inclusive.

NET TAKE-OFF FLIGHT PATH VI

TIME AT START OF ACCELERATION SEGMENT

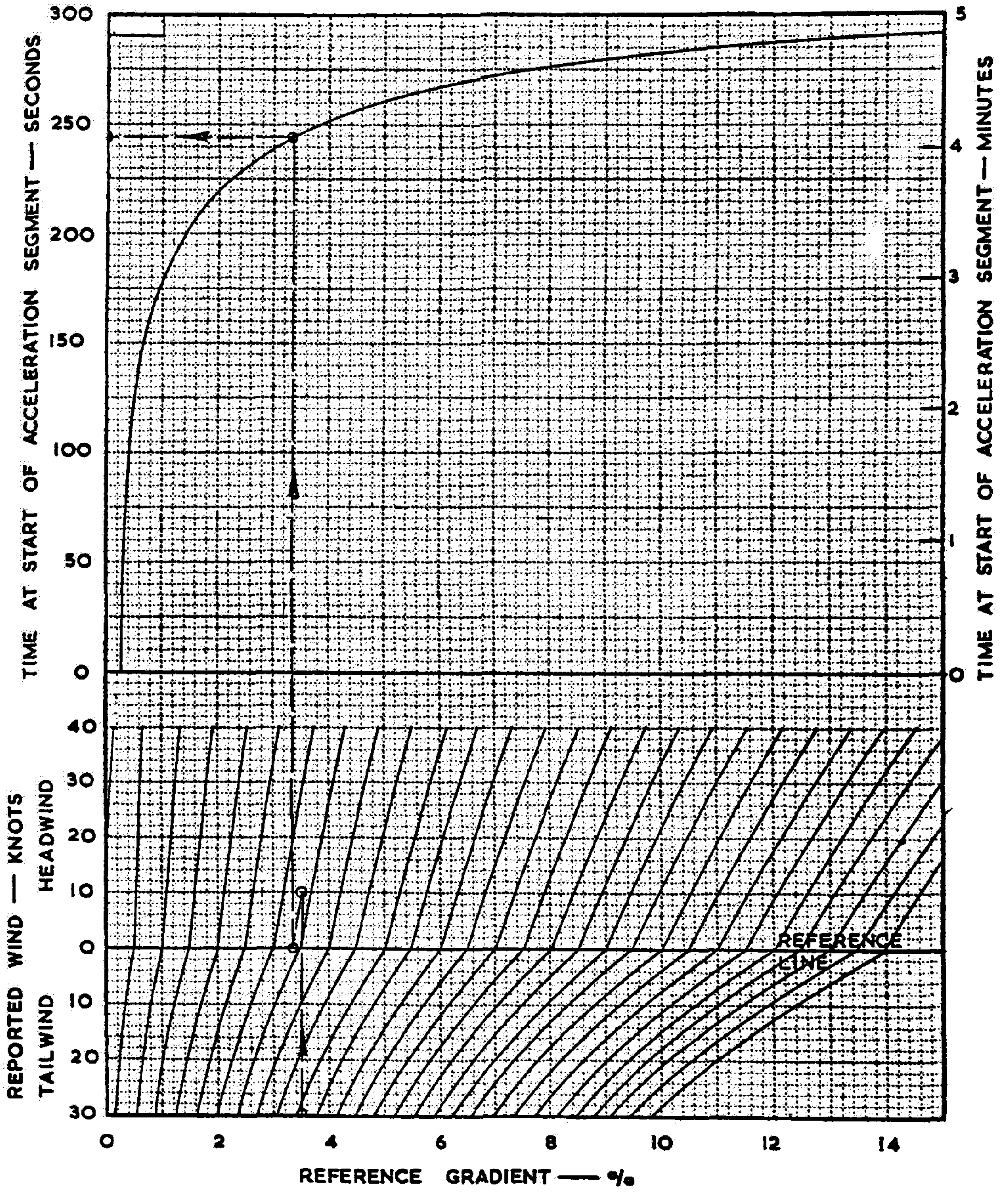


Figure 17

FIGURES 18 to 20 inclusive

Figure 18 and the graphs in Figures 19 and 20 illustrate the method of taking account of the effect of turns in the net take-off flight path, the construction of which is described in the earlier text associated with Figure 11 to 20 inclusive.

An explanation of the use of Figures 18, 19 and 20 is given below.

Effect of turns

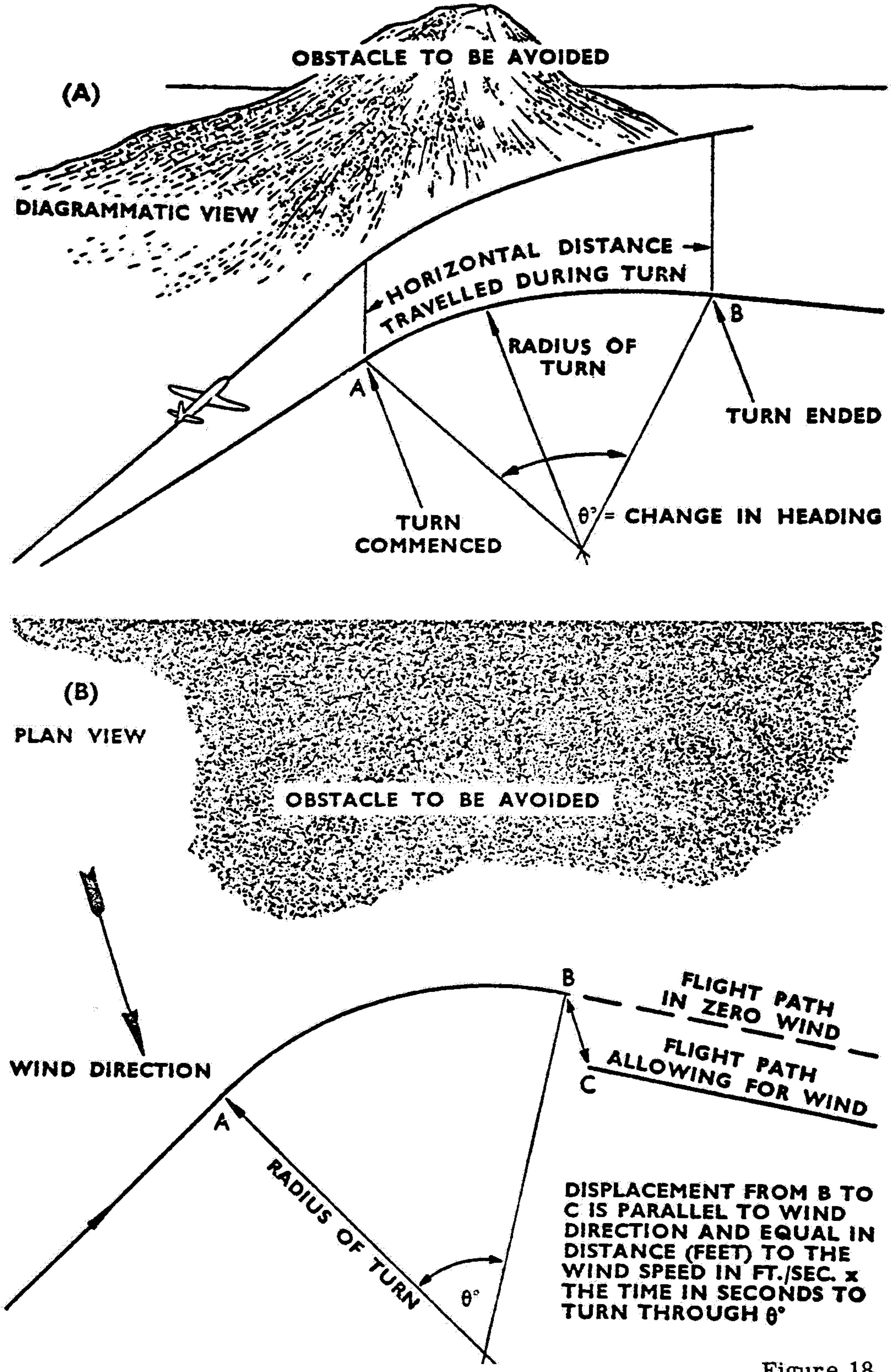
The minimum radius of turn which may be assumed in the appropriate segment is shown in Figure 19 for two wing flap positions. This is calculated for steady 15° banked turns. Having obtained the radius of turn, the total change in heading required is assessed from the aerodrome obstruction chart. Using Figure 20, the horizontal distance travelled during the turn is established and this distance is used to locate the point from which the segment continues. The procedure is illustrated in Figure 18 and a method of accounting for the effect of wind is also shown. If the change of heading is less than 15°, no account of the effect of the turn need be taken.

When calculating the net take-off flight path, turns can only be accurately accounted for in the first, second, third and fifth segments. The data cannot be used for turns which are assumed to occur in the fourth (acceleration) segment.

The charts are based on a steady 15° banked turn at speed V_2 in the first, second and third segments and the one engine inoperative flaps up climbing speed in the fifth segment.

After the turn is completed, the construction of the flight path may be continued as necessary by using the existing data, but it should be noted that if the wind component is unchanged, the resulting flight path will, at all places be situated below the flight path obtained had no turn been assumed. If the wind component has changed appreciably due to the turn, use the new wind component in the subsequent charts. It is not necessary to take into account the effect of wind, during the trim.

ASSESSMENT OF A STEADY TURN



DISPLACEMENT FROM B TO C IS PARALLEL TO WIND DIRECTION AND EQUAL IN DISTANCE (FEET) TO THE WIND SPEED IN FT./SEC. x THE TIME IN SECONDS TO TURN THROUGH θ°

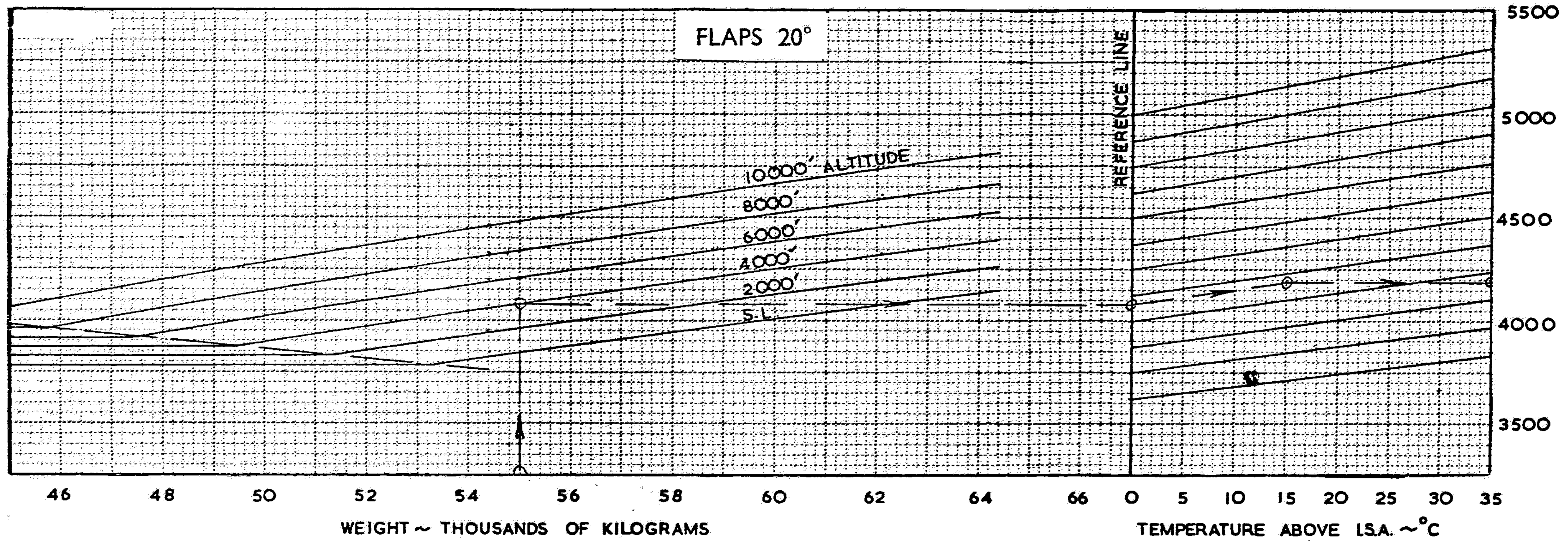
Figure 18

FIGURE 19

The use of Figure 19 is explained in the text associated with Figures 18 to 20 inclusive.

NET TAKE-OFF FLIGHT PATH

RADIUS OF STEADY TURN



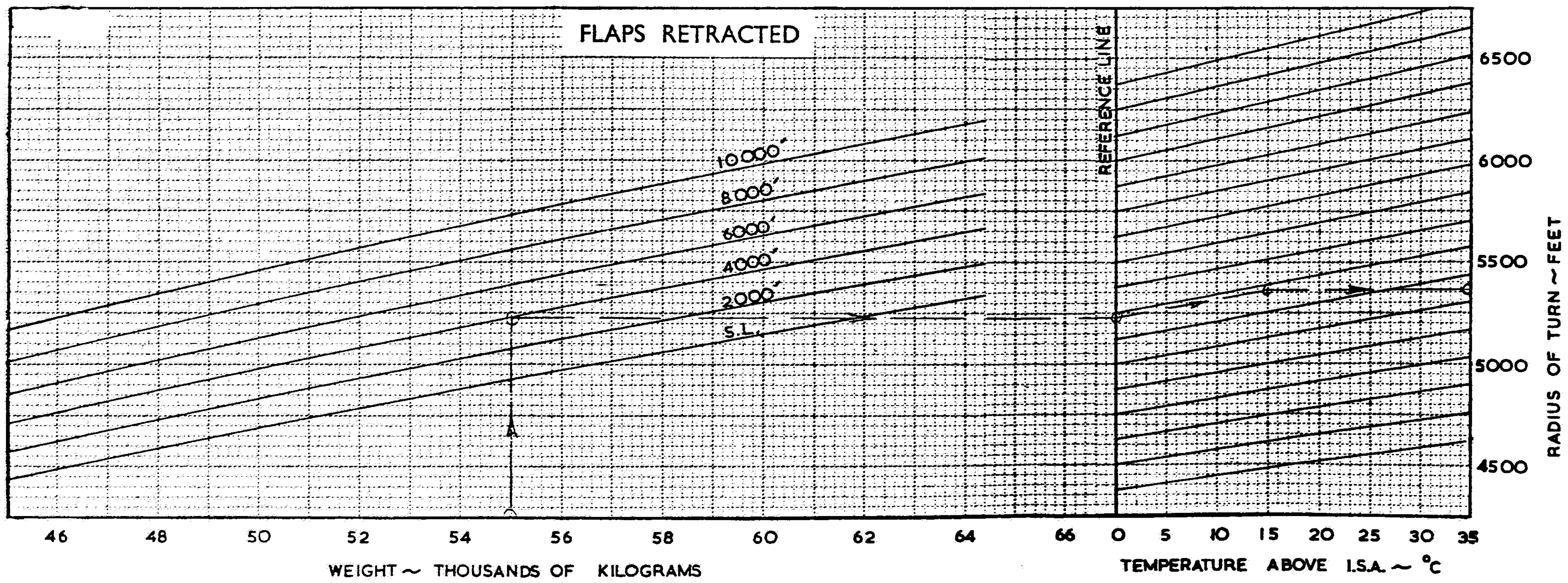


Figure 19

FIGURE 20

The use of Figure 20 is explained in the text associated with Figures 18 to 20 inclusive.

NET TAKE-OFF FLIGHT PATH

HORIZONTAL DISTANCE COVERED DURING TURN

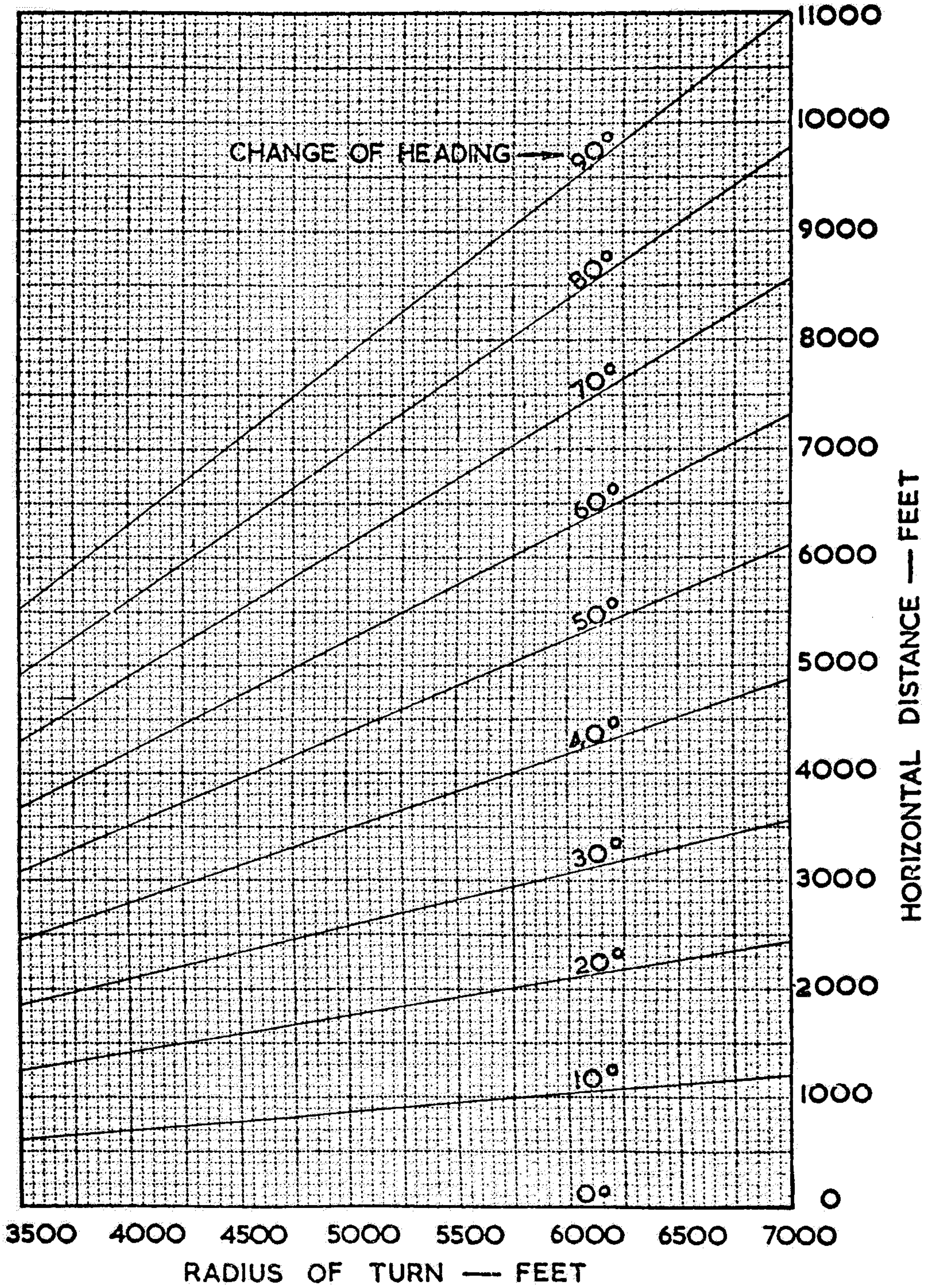


Figure 20

FIGURE 21

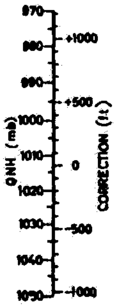
The graph in Figure 21 illustrates the specification in 7. 8. 5. 3 relating to the clearance of obstacles below 400 feet. The graph is based on balanced take-off field length and provides a quick indication of the maximum weight which would be permitted by obstacle clearance considerations. If this weight be found to be too restrictive, the more accurate, but more complicated, method of constructing the flight path explained in the text associated with Figures 11 to 20 inclusive would be used. Text of the kind that would be associated with such a graph is given below.

Net take-off flight path to 400 feet

The graph is based on balanced take-off field length, standard atmosphere temperature (I. S. A), sea-level altitude, and all the anti-icing systems being off. Additional corrections are to be made for the variation of these parameters, in accordance with the table below. A conservative allowance has been made for the effect of runway slope by relating the height of obstacles to the lowest point on the runway.

An example of the use of the graph is given by the arrowed broken line. This shows that for an obstacle which is 125 feet above the lowest point of the runway and situated 3 680 m from start of the take-off run, with a reported headwind of 24 knots and at a temperature +7°C above I. S. A. the maximum weight is 134 000 kg.

Summary of Additional Corrections

Altitude:	Decrease max. weight given by graph by 4 kg per foot above S. L. Altitude may be obtained from aerodrome elevation by making the correction appropriate to the QNH (mb) obtained from Figure A.	Add below correction (with sign) to aerodrome elevation to obtain pressure altitude.  FIGURE A
Engine anti-icing only:	Use graph with a temperature increased by 10°C.	
Engine and air frame anti-icing:	Use graph with a temperature increased by 14°C.	

NET TAKE-OFF FLIGHT PATH TO 400 FT.

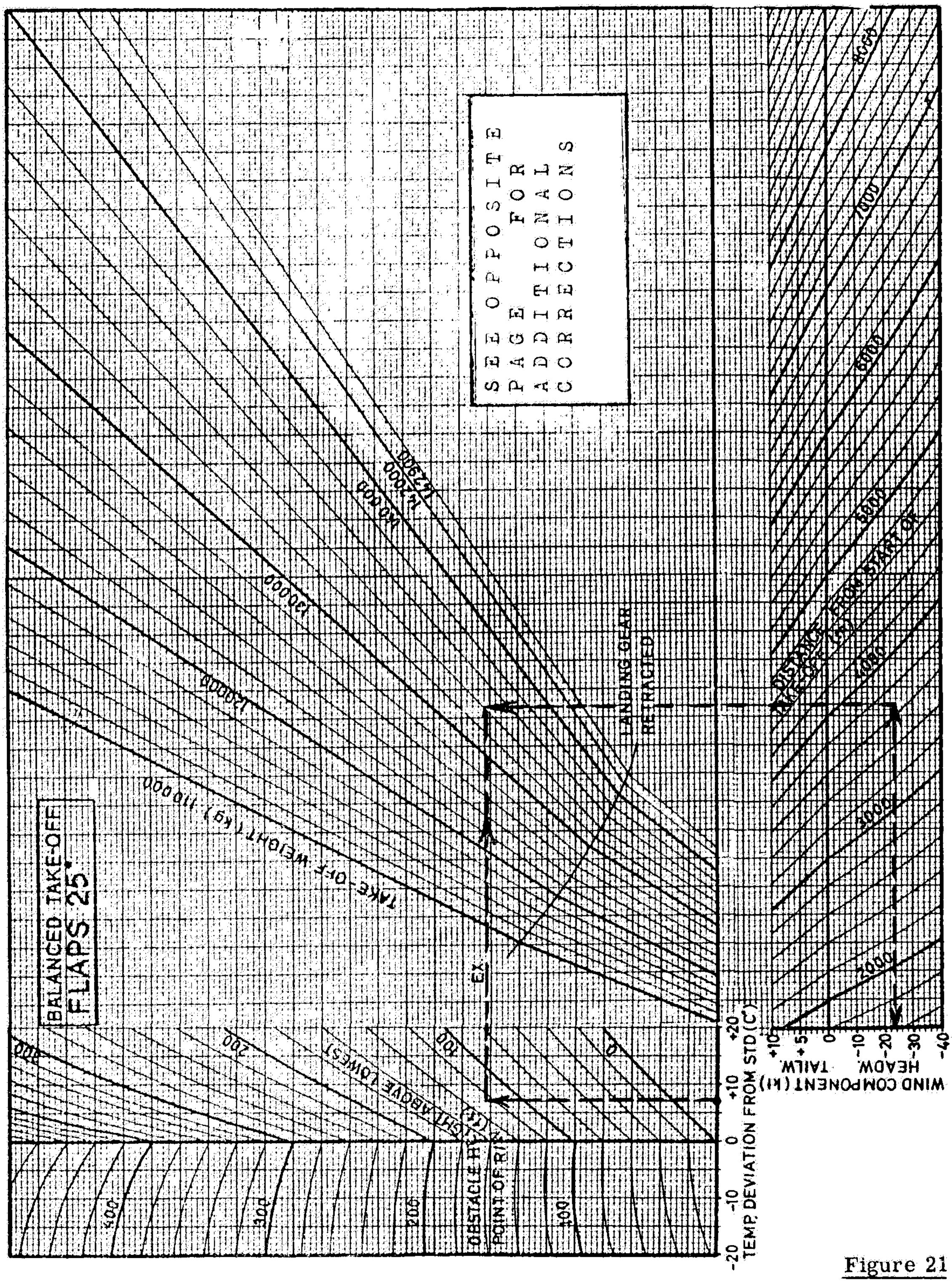


Figure 21

FIGURE 22

The graph in Figure 22 illustrates the presentation of the en route climb data which is specified in 7.8.6.1.

EN ROUTE NET GRADIENT OF CLIMB ONE ENGINE INOPERATIVE

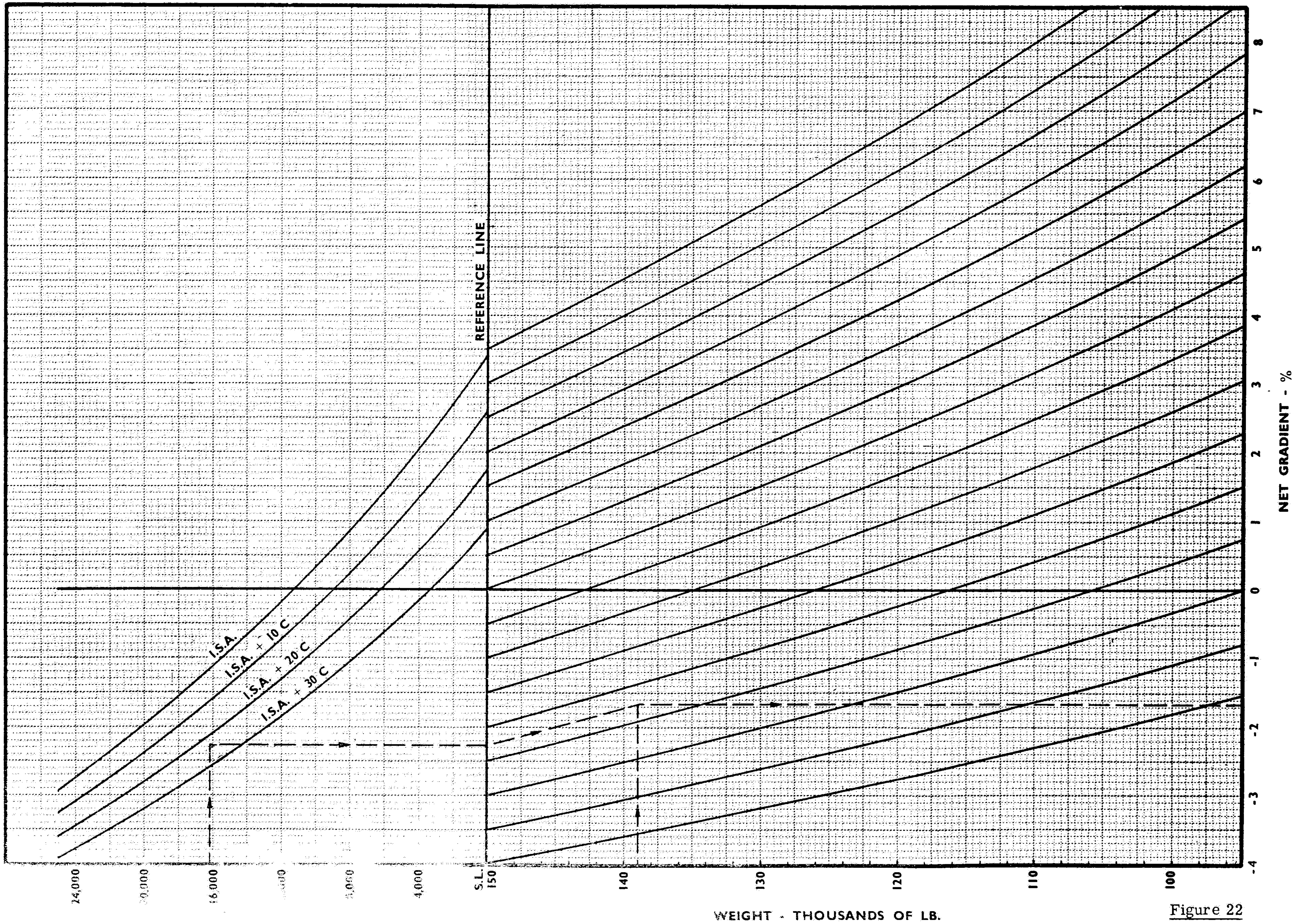


Figure 22

FIGURE 23

The graph in Figure 23 illustrates one method of presenting en route drift down flight path in accordance with 7. 8. 6. 2. An example of the explanatory text which would be associated with such a graph is given below.

En route net flight path

The net flight path following engine failure can be obtained from the chart opposite for a range of temperatures, unfactored uniform wind components, and weight at the moment of power failure. Elapsed time from the power failure point and the amount of fuel burnt can also be obtained from the chart. The data is presented for an initial cruising altitude of 23 000 feet, but the flight paths from lower initial cruising altitudes can also be obtained from the chart. The use of the chart is illustrated by the broken line for the following conditions.

- Weight at engine failure : 37 000 lb
- Altitude at engine failure : 23 000 feet
- Temperature : I. S. A. + 18°C
- Headwind component (unfactored) : 28 knots

It is required to find the eventual altitude at which level flight can be maintained, and the distance from power failure at which an altitude of say 9 000 feet (height of obstacle + margin) can be cleared. Enter the carpet in the top right hand corner with the initial weight and temperature condition. This gives the eventual level flight altitude as 8 200 feet. Follow the arrowed line to the reference line and along the guide lines to 9 000 feet. The elapsed time from power failure to 9 000 feet is 62 minutes.

Follow the arrowed line down to the reference line and along the guide lines of the temperature correction grid. This gives the distance to 9 000 feet in still air as 152 nautical miles. Continuing down the chart, the fuel used along the flight path to 9 000 feet is 1 070 lb. The final grid corrects the still air distance for headwind component and gives the distance as 120 nautical miles.

The above example assumes an initial cruising altitude of 23 000 feet. It is possible to obtain drift down paths from other altitudes by using only that part of the path between cruising altitude and the obstacle clearance altitude. However, the weight at power failure point will not correspond exactly with the weight quoted on the carpet, but will differ by the amount of fuel which would be used drifting down from 23 000 feet to the assumed cruising altitude.

Had the above example considered drift down from an initial altitude of 18 000 feet, the following information would have been obtained.

- Eventual level flight altitude	8 200 ft
- Elapsed time	62 - 9 = 53 minutes
- Still air distance	152 - 23 = 129 nautical miles
- Fuel used	1 070 - 130 = 940 lb
- Distance corrected for wind	120 - 18 = 102 nautical miles

The initial weight would be 37 000 - 130 = 36 870 lb. If an answer corresponding exactly to an initial weight of 37 000 lb were required, a second approximation, entering the carpet at a weight of 37 000 + 130 = 37 130 lb could be made.

The chart may also be used to obtain a maximum permissible weight at the critical point for any combination of obstacle clearance height, distance from critical power failure point to obstacle, temperature, wind and cruising altitude.

EN ROUTE NET FLIGHT PATH ONE ENGINE INOPERATIVE

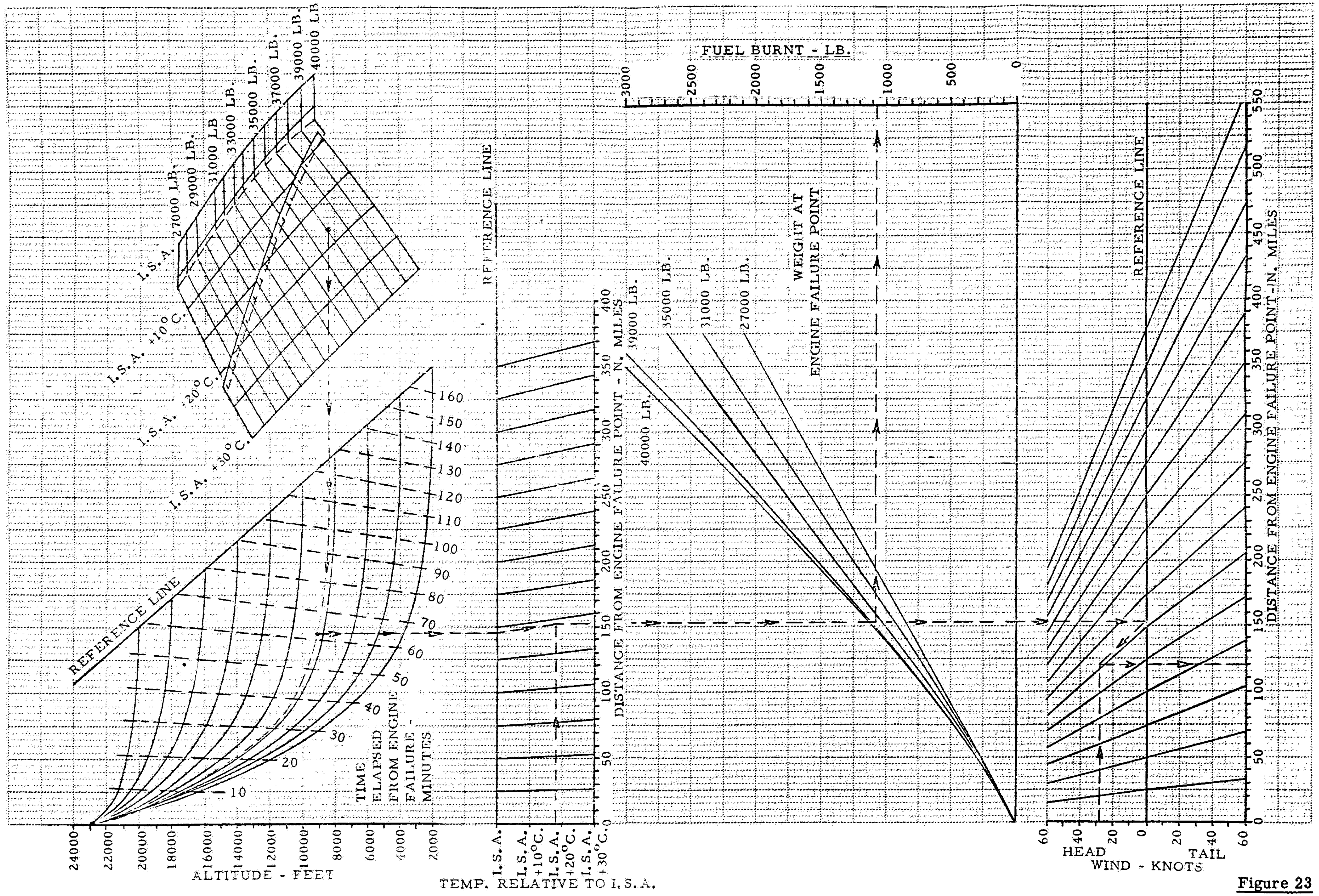


Figure 23

FIGURES 24 and 25

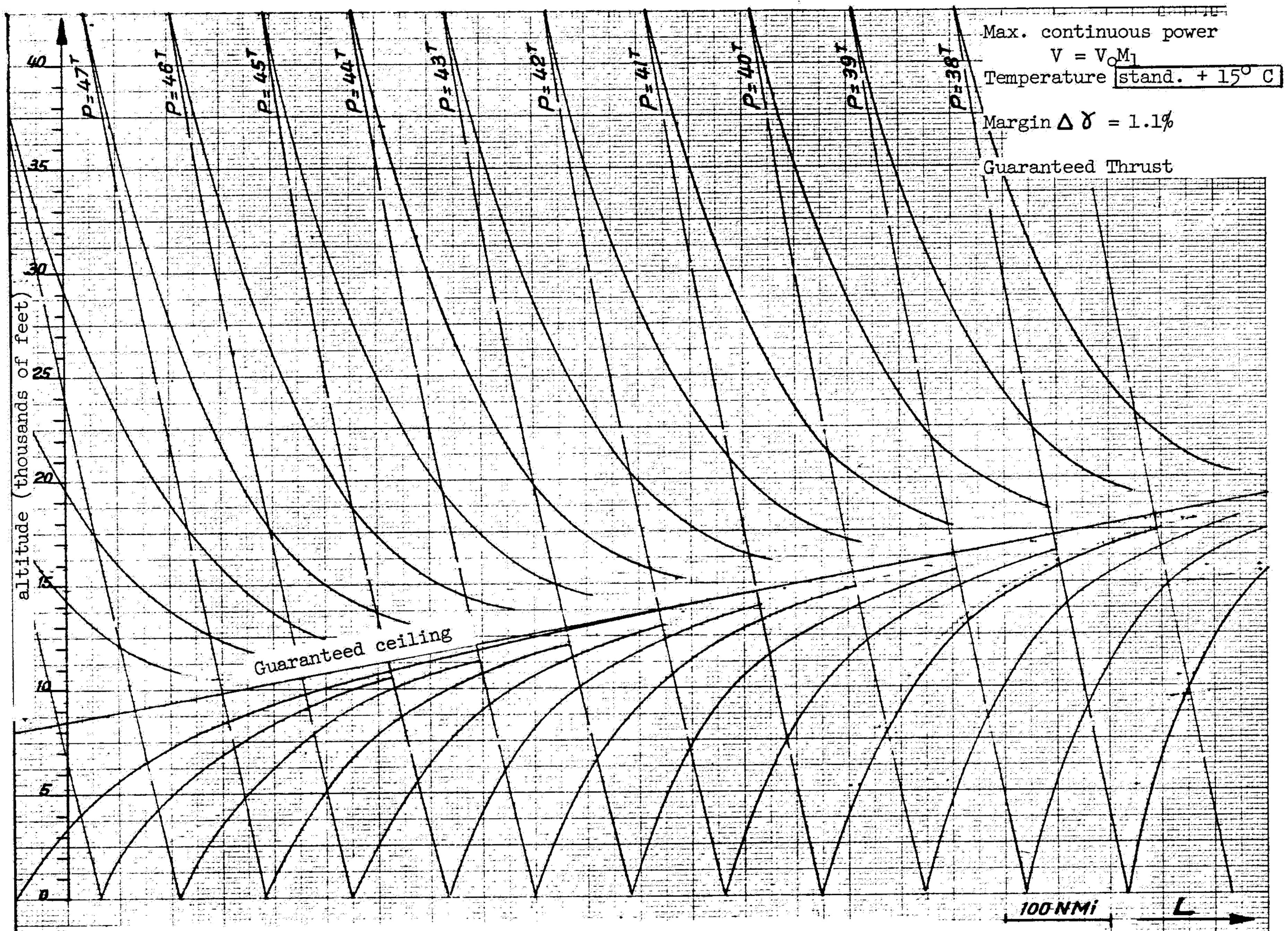
Figure 24 illustrates another method of meeting the specification of 7.8.6.2 for en route drift down paths. Figure 25 shows the presentation of true airspeeds which are required in some cases, to complete the whole calculation. Figure 24 is based on a temperature of 15°C above standard (I. S. A.), therefore similar graphs for other temperatures (e.g. I. S. A. and I. S. A. +30°C) would additionally be provided in a Flight Manual. An example of some text which explains how the graph is to be used is given below.

En route net flight path (one engine inoperative)

The curves are based on a temperature of I. S. A. +15°C on zero wind and on use of maximum continuous power, being derived by deducting 1.4% from the gross gradients.

Performance operating limitations specify that the net path must clear obstructions by 1 000 feet in the ascending part of the path and 2 000 feet in the descending part. The effect of winds will have to be calculated separately and to assist this calculation the true airspeed is shown in Figure 25 drawn for varying altitude indicated airspeed, Mach number, weight and air temperature. Figure 24 is based on I. S. A. +15°C; for intermediate temperatures interpolation may be made on the basis of 400 kg per °C difference from I. S. A. +15°C - i.e. the flight path for I. S. A. +20°C would be that appropriate to a weight which is (5 x 400) = 2 000 kg greater than the actual weight.

A convenient method of relating the flight path to the obstacles is to plot on a transparent sheet the terrain profile, with the same scales for distance and altitude as are used in Figure 24. This sheet is put over the graph so that altitudes correspond and the curve corresponding to the anticipated weight (corrected for temperature) at the obstacles, clears the obstacles with the margins specified by the performance operating limitations. This curve is transferred to the transparent sheet; the sheet is then reversed and the return flight path is plotted in the same way.

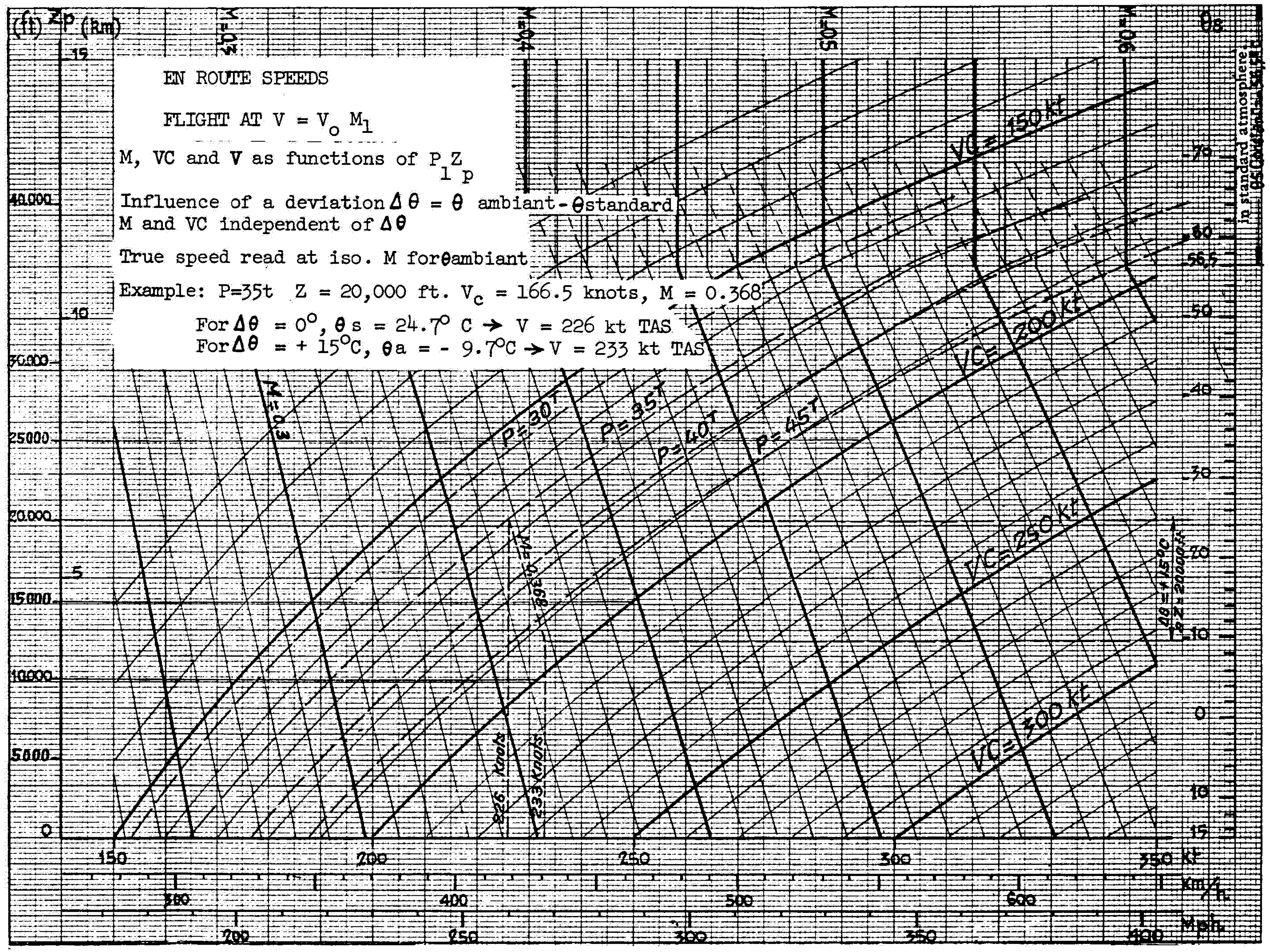


ONE ENGINE INOPERATIVE NET EN ROUTE FLIGHT PATHS

Figure 24

FIGURE 25

The use of this graph is explained in the text associated with Figures 24 and 25.



EN ROUTE SPEEDS

FLIGHT AT $V = V_o M_1$

M, VC and V as functions of $P_1 Z_p$

Influence of a deviation $\Delta\theta = \theta$ ambiant - θstandard

M and VC independent of $\Delta\theta$

True speed read at iso. M for θambiant

Example: P=35t Z = 20,000 ft. V_c = 166.5 knots, M = 0.368

For $\Delta\theta = 0°$, $\theta s = 24.7°$ C → V = 226 kt TAS
For $\Delta\theta = +15°C$, $\theta a = -9.7°C$ → V = 233 kt TAS

Figure 25

- END -

ICAO TECHNICAL PUBLICATIONS

The following summary gives the status, and also describes in general terms the contents of the various series of technical publications issued by the International Civil Aviation Organization. It does not include specialized publications that do not fall specifically within one of the series, such as the ICAO Aeronautical Chart Catalogue *or the* Meteorological Tables for International Air Navigation.

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES are adopted by the Council in accordance with Articles 54, 37 and 90 of the Convention on International Civil Aviation and are designated, for convenience, as Annexes to the Convention. The uniform application by Contracting States of the specifications comprised in the International Standards is recognized as necessary for the safety or regularity of international air navigation while the uniform application of the specifications in the Recommended Practices is regarded as desirable in the interest of safety, regularity or efficiency of international air navigation. Knowledge of any differences between the national regulations or practices of a State and those established by an International Standard is essential to the safety or regularity of international air navigation. In the event of non-compliance with an International Standard, a State has, in fact, an obligation, under Article 38 of the Convention, to notify the Council of any differences. Knowledge of differences from Recommended Practices may also be important for the safety of air navigation and, although the Convention does not impose any obligation with regard thereto, the Council has invited Contracting States to notify such differences in addition to those relating to International Standards.

PROCEDURES FOR AIR NAVIGATION SERVICES (PANS) are approved by the Council for world-wide application. They comprise, for the most part, operating procedures regarded as not yet having attained a sufficient degree of maturity for adoption as International Standards and Recommended Practices, as well as material of a more permanent character which is considered too detailed for incorporation in an Annex, or is susceptible to frequent amendment, for which the processes of the Convention would be too cumbersome. As in the case of Recommended Practices, the Council has invited Contracting States to notify any differences between their national practices and the PANS when the knowledge of such differences is important for the safety of air navigation.

REGIONAL SUPPLEMENTARY PROCEDURES (SUPPS) have a status similar to that of PANS in that they are approved by the Council, but only for application in the respective regions. They are prepared in consolidated form, since certain of the procedures apply to overlapping regions or are common to two or more regions.

The following publications are prepared by authority of the Secretary General in accordance with the principles and policies approved by the Council.

ICAO FIELD MANUALS derive their status from the International Standards, Recommended Practices and PANS from which they are compiled. They are prepared primarily for the use of personnel engaged in operations in the field, as a service to those Contracting States who do not find it practicable, for various reasons, to prepare them for their own use.

TECHNICAL MANUALS provide guidance and information in amplification of the International Standards, Recommended Practices and PANS, the implementation of which they are designed to facilitate.

AIR NAVIGATION PLANS detail requirements for facilities and services for international air navigation in the respective ICAO Air Navigation Regions. They are prepared on the authority of the Secretary General on the basis of recommendations of regional air navigation meetings and of the Council action thereon. The plans are amended periodically to reflect changes in requirements and in the status of implementation of the recommended facilities and services.

ICAO CIRCULARS make available specialized information of interest to Contracting States. This includes studies on technical subjects as well as texts of Provisional Acceptable Means of Compliance.

EXTRACT FROM THE CATALOGUE

ICAO SALABLE PUBLICATIONS

Airworthiness Committee — Second Meeting. Montreal, 3-29 July 1958. (Doc 7926-AN/866). 72 pp.	$0.75
Airworthiness Committee — Third Meeting. Stockholm, 14 July - 10 August 1959. (Doc 8024-AN/870). 158 pp.	$1.75
Airworthiness Committee — Fourth Meeting. Montreal, 18 October - 15 November 1960. (Doc 8149-AN/875). 155 pp.	$1.75
Airworthiness Committee — Fifth Meeting. Montreal, 21 May - 16 June 1962. (Doc 8283-AN/878). 272 pp.	$6.25

ANNEXES TO THE CONVENTION

Annex 6 — Operation of aircraft — International commercial air transport. 5th edition, October 1957. 32 pp.	$0.75
Annex 8 — Airworthiness of aircraft. 5th edition, April 1962. 62 pp.	$1.00

PROCEDURES FOR AIR NAVIGATION SERVICES

OPS — Aircraft Operations. (Doc 8168-OPS/611). 1st edition, 1961. 92 pp.	$1.50

CIRCULARS

51-AN/46 — Provisional Acceptable Means of Compliance — Turbine engines - Type tests. 1957. 10 pp.	$0.25
53-AN/48 — Provisional Acceptable Means of Compliance — Testing of pressure-sensitive altimeters. 1957. 32 pp.	$0.50
55-AN/50 — Provisional Acceptable Means of Compliance — Emergency evacuation provisions. 1958. 9 pp.	$0.25
58-AN/53 — Provisional Acceptable Means of Compliance — Aeroplane performance. 1959. 24 pp.	$0.50
60-AN/55 — Operational Measures for Dealing with the Problem of Taking Off from Slush - or Water-Covered Runways. 1961. 9 pp.	$0.25
61-AN/56 — Provisional Acceptable Means of Compliance — Fatigue Strength of Aeroplane Structures. 1961. 7 pp.	$0.25

NB.—*Cash remittance should accompany each order.*
Catalogue sent free on request.

PRICE: $1.25 (Canadian) (Montreal)
Equivalents at date of publication:

Bangkok:	25.00 bahts	Buenos Aires:	100.00 pesos
Cairo:	L.E. 0.500	Melbourne:	11s. 3d.
Lima:	31.25 soles	Mexico City:	15.00 pesos
London:	8s. 8d.	New Delhi:	Rs. 6.25
Paris:	6.25 francs		

3/63, E/P1/1500