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MILITARY SPECIFICATION

MANUALS, NATOPS FLIGHT: REQUIREMENTS FOR PREPARATION OF

* This specification is approved for use by the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense

1. SCOPE

* 1.1 Purpose. This specification covers general style, format, and technical content requirements for preparation of NATOPS Flight Manuals.

1.2 Types of Manuals.

1.2.1 NATOPS Flight Manual.

1.2.1.1 Preliminary NATOPS Flight Manual. A Preliminary NATOPS Flight Manual makes technical information and operational procedures available for test, verification, or training purposes in advance of the final NATOPS Flight Manual. This manual will not contain a letter of promulgation.

1.2.1.2 NATOPS Flight Manual. A manual for a specific model piloted aircraft which contains standardized ground and flight operating procedures, training requirements, limitations and technical data necessary for the safe and effective operation of the aircraft. This manual shall contain a letter of promulgation.

1.2.2 NATOPS Flight Manual Supplements.

1.2.2.1 Weapon Systems and/or Aircrew Operators' Supplements. A weapon systems supplement is published when weapon systems differ from one aircraft to another and other instructions are necessary. An aircraft operators' supplement is published when aircraft systems instructions are added that only concern one crew member.

1.2.2.2 Special Mission Supplement. A special mission supplement is a publication that provides general information and checklists for special flight missions not included in the basic mission profiles given in the NATOPS Flight Manual.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to the Commanding Officer, Naval Air Engineering Center Engineering Specifications and Standards Department (ESSD) Code 93, Lakehurst, NJ 08733 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter

1.2.2.3 Classified Supplement. A classified supplement is a publication that contains classified information which augments the NATOPS Flight Manual. The NATOPS Flight Manual does not normally contain classified material. Classified material shall be presented in accordance with OPNAV Instruction 5510.1D.

* 1.2.3 NATOPS Partial Flight Manual. A partial flight manual is one that includes instructions for a small number of aircraft that differ by model or through modification. The format and method of reproduction shall be the same as specified for the formal flight manual. Content shall be only the additional information necessary to cover the differences between models or the differences created through modification. The difference data shall be presented under a comparable appropriate paragraph heading contained in the formal flight manual. If the data is not related to a specific system or paragraph heading, new headings may be established. Each section shall contain an introductory statement, as appropriate, to state that "Except for the following, all other limitations are covered in NAVAIR ________." If the normal or emergency procedures are changed from the formal flight manual, it shall be necessary to present the entire procedures section in the partial flight manual.

2. APPLICABLE DOCUMENTS

* 2.1 Issues of Documents. The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

* MIL-D-8706	Data and Tests, Engineering: Contract Requirements for Aircraft Weapons Systems
MIL-P-38790	Printing Production of Technical Manuals; General Requirements for
MIL-A-81573	Aircrew Escape System Descriptive and Performance Data Presentations, Requirement and Formats for, General Specification for

STANDARDS

Military

MIL-STD-12	Abbreviations for Use on Drawings, Specifications, Standards, and in Technical Type Documents

PUBLICATIONS

Department of Defense

DOD 5200.1-R	Information Security Program Regulation

Navy

OPNAVINST 3710.7	NATOPS General Flight and Operating Instructions
OPNAVINST 4790.2	Naval Aviation Maintenance Program (NAMP)
OPNAVINST 5510.1	Department of the Navy Supplement to the DOD Information Security Program Regulation
NAVAIR 01-1B-40	Weight and Balance Data
Military Bulletin 544	List of Specifications and Standards (Book Form)

Library of Congress Catalog

No. Z253,U58	U.S. Government Printing Office Style Manual

*(Copies of specifications, standards, drawings and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

* 2.2 Other Publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Y14.15	Electrical and Electronics Diagrams

(Application for copies should be addressed to the American National Standards Institute, Incorporated, 1430 Broadway, New York, New York, 10018.)

3. REQUIREMENTS

3.1 Function. The NATOPS Flight Manual shall describe the aircraft, its systems, flight operation, limitations, and performance data, so that a qualified aircrew of minimum experience can accomplish flights and missions. Description of training for aircrew personnel and the NATOPS evaluation program shall be included in the manual. The aircrew affected by the manual shall consist primarily of pilot personnel. It will also include all crewmembers who work directly with pilot personnel in the accomplishment of flight and mission. The manual shall not contain instructions in basic skills and knowledges, that are assumed to be already known. The manual shall, however, instruct in any variations in basic duties that may exist due to unique aircraft model characteristics.

* 3.2 Conflict Between Specifications. In case of any conflict between other NATOPS Flight Manual Specifications, this specification shall take precedence.

* 3.3 Copyrights and Advertising. Copyrighted material shall not be included in any publication prepared in accordance with this specification without written permission of the copyright owner. Proprietary legends shall not be shown. The manual shall not contain advertising matter. All material prepared in accordance with this specification shall be Government property.

3.4 General Format.

* 3.4.1 Form. Material for manuals shall be prepared in the form (manual plan, manual outline, manuscript copy only, manuscript copy for review, original artwork, reproducible copy, negatives, printed copies) specified in the technical manual contract requirement.

* 3.4.1.2 Data. Requirements for flight operations data established by this specification shall be prepared in accordance with the Data Item Description and the applicable Technical Manual Contract Requirement.

* 3.4.2 Reproducible (Camera-Ready) Copy. Reproducible copy shall consist of pages ready for the intermediate photographic step leading to the production of a printing plate. The reproducible copy shall be completely satisfactory for use in making a 16mm negative of each page. Full page illustrations, including those for foldout pages, that have been prepared in exact printing size (or in the same size as text pages), shall have the marginal copy mounted on them. Full page illustrations that are oversize shall either have the marginal copy separate, or have the marginal copy also prepared proportionately oversize and mounted on the page frame. Reproduction pages shall be mounted and covered. Text may be separately prepared in single-column galleys and then attached to the appropriate layout page. Prescreened photographs are acceptable as reproducible copy provided they are proper quality, size, and mounted on the reproducible copy of the text page or marginal copy, as applicable.

3.4.3 Page Size. The page size for NATOPS Flight Manuals is 8-1/2 x 11 inches after trim.

* 3.4.4 Image Area. The actual overall area utilized for each sheet shall be 42 picas (7 inches) in width and 54 picas (9 inches) in depth, excluding marginal copy. The overall area including marginal copy shall be 42 picas (7 inches) in width and 60 picas (10 inches) in depth.

* 3.4.4.1 Column Width. Single column width shall be 20 picas wide. Each page shall normally be double-columned with a 2 pica gutter between columns.

3.4.5 Marginal Copy. Marginal copy generally consists of the publication number, page number, and section and part locators. When applicable, it may also consist of the security classification and change number.

3.4.5.1 Publication Number. The publication number assigned by the procuring activity shall be a running head placed at the top center of each page approximately 1/4 inch above the top of the text matter.

3.4.5.2 Section and Part Number. The section number shall appear in the upper-outer corner of each page, on the same line as the publication number. The part number shall be immediately below the section number.

* 3.4.5.3 Page Number. The page number shall appear in the lower right corner of odd-numbered pages, and the lower-left corner of even-numbered pages.

3.4.6 Text Preparation.

3.4.6.1 Headings.

a. Table of Contents, Sections, Parts, Alphabetical Index. Numbers and titles for table of contents, sections, parts and alphabetical index shall be centered at the top of the first page of text for each. Sections and the alphabetical index shall always begin on a right-hand page. Parts may begin on either right or left-hand pages.

b. Paragraph Headings. Paragraphs are referred to as primary, secondary, tertiary, and quaternary sideheads.

* (1) Primary sideheads are normally used to divide the text into primary subjects. There should be at least one primary sidehead in each section. Primary sideheads stand alone (are not run in with the text) and shall appear in capital letters (ALL CAPS). They shall be prepared in 12 point Futura Demi-Bold or IBM Composer UN-11B or equivalent. (See Figure 1.)

* (2) Secondary sideheads are used to divide text where there are two or more subjects to be covered under one primary sidehead. Secondary sideheads shall stand alone and the first letter of each word shall appear in capital letters (Initial Caps). They shall be prepared in 11 point Futura Demi-Bold or IBM Composer UN-11B or equivalent. (See Figure 1.)

* (3) Tertiary sideheads are used to include additional breakdown. They shall stand alone and shall appear in capital letters (ALL CAPS). They shall be prepared in 10 point Modern or IBM Composer C-10M or equivalent. (See Figure 1.)

* (4) Quaternary sideheads shall be run in with the text and appear in capital letters (ALL CAPS). The type shall be 10 point Modern or IBM Composer C-10M or equivalent. (See Figure 1.) The type sizes and faces specified may be varied when improved definition or clarity can be achieved by use of alternates.

These variations are subject to the approval of Navy Tactical Doctrine Activity (NTDA).

3.4.6.2 Indentation. Runover lines of paragraphs shall not be indented. The indexing numeral for procedural steps shall be indented one pica and all runover lines two picas. The indexing letter for sub-steps shall be indented two picas and all runover lines four picas.

3.4.6.3 Type Size, Leading, and Spacing. Type size for text shall be a minimum of 10 point. Type size for illustrations shall be a minimum of 8 point. Layout shall conserve space without lessening usability or clarity of material. Blank pages and spaces shall be avoided, wherever possible. Leading and spacing shall be used for best readability and conservation of space. Double spacing of text within a paragraph, or similar wastefulness, is prohibited. Slight variations are permitted, however, in order to avoid layout practices that would result in:

a. The first line of a paragraph being at the bottom of a page or column, or the last line beginning a new page. (A minimum of two lines is desirable.)

b. A subhead falling on the last line of a page or column.

c. Warnings, cautions, and notes being divided so that first line appears on one page and remaining lines on another. (For notes only, first lines may appear in the left column, and remaining lines in the right column on the same page.) Warnings and cautions should not be separated from their applicable steps by appearing on a backup page.

3.4.6.4 Procedural Steps. Procedural steps are listed numerically and may be divided into sub-steps that are listed alphanumerically. Procedural steps shall be in text form; however, emergency procedures and/or commonly used procedures may be presented in checklist form.

3.4.6.5 Figure Titles. Illustrations shall be assigned figure titles (see 3.12.5.4 for foldouts). The title shall follow the figure number and normally be placed below the applicable illustration. Normally, figure titles should begin with an identifying name: example, "Fuel Control--Exploded View".

* 3.4.6.6 Section Table of Contents. (See Figure 2.) Tables of contents in individual sections shall list numbers and titles of parts and primary headings within the sections with their initial page numbers. Each section shall contain its own table of contents for that section. The table of contents shall always appear on the first right-hand page of each section.

* 3.4.7 Thumb Indexing. Thumb or edge indexing tabs shall appear on the outer edge of the first five right hand pages of each section. Tabs are to be aligned with the appropriate tabs shown in figures 3 and 4. Sections, appendixes, foldout pages, and alphabetical index shall have edge indexing tabs. Edge indexing shall be superimposed over emergency page markings.

* 3.4.8 Emergency Page Markings. Pages containing emergency information shall have a border of black diagonal strips at the top, bottom and unbound edges as shown in figure 5.

3.5 Front Matter. The front matter of a NATOPS Manual shall consist of the following.

a. Cover

b. Title page

c. List of Effective Pages

d. Interim Change Summary

e. Summary of Applicable Technical Directives

f. Promulgation Page

g. Table of Contents

h. Foreword

i. Glossary (if required)

j. Three-View Illustration of Aircraft

* 3.5.1 Cover. The reproducible copy for the front cover shall be in accordance with figure 3. The publication number and authority notice on the cover page will be prepared by the procuring activity. The cover shall contain a three-quarter view line drawing of the latest configuration of the aircraft and the initial issue date or revision date.

* 3.5.2 Title Page. Reproducible copy for the title page shall be in accordance with figure 4. In revisions, a new illustration portraying the most current configurations of the aircraft shall be presented. The publication number, authority notice, and publication date will be prepared by the procuring activity. Initial issue or revision date and change number and date shall be included. The supersedure notice shall only appear in basic manuals and manual revisions. It shall be deleted at the first change to the manual.

* 3.5.3 List of Effective Pages ("A" Page). A list of effective pages shall be prepared. (See Figure 6.) This page shall back up the title page and shall be identified by the letter "A" in the lower left corner. When additional space is required, pages shall be added and identified by "B", "C", etc. All pages of the manual shall be listed and identified as original or change. The List of Effective Pages shall be a complete list of all manual pages including title, "A", blank, deleted, added, and foldout pages. The List of Effective Pages shall be updated for each manual change. The listing shall be held to a minimum by grouping numbers, where applicable. Blank pages shall be listed exactly as they appear on the printed side of the sheet for example, 5-1/(5-2 blank). A list of change numbers and corresponding dates of change shall be included. The appropriate change number shall be shown in the "Change Number" column. The words "Deleted" or "Blank" shall be placed alongside the page number of pages so affected.

3.5.4 Interim Change Summary. An interim change summary in accordance with figure 7 shall be included in each separate volume. The Interim Change Summary shall be the first right-hand page following the List of Effective Pages.

* 3.5.5 Summary of Applicable Technical Directives. A summary of applicable technical directives as shown in figure 8 will be included in each separate volume. The Summary of Applicable Technical Directives will be a left-hand page backing up the Interim Change Summary.

* 3.5.6 Promulgation Page. (See Figure 9.) Reproducible copy for the promulgation page will be prepared by the procuring activity. The promulgation page shall be the first right-hand page following the Summary of Applicable Technical Directives. The date appearing on the letter of promulgation must agree with the copy freeze/publication date of the basic or revised manual.

* 3.5.7 Table of Contents. The table of contents shall list numbers and titles of sections and parts with their initial page number. Layout shall conform to figure 10. Each volume in a set of manuals shall contain its own table of contents. The table of contents shall be the first right-hand page following the promulgation page.

* 3.5.8 Foreword. A foreword prepared by the procuring activity shall back up the table of contents page. If applicable, an effectivity code may be added as the last item of the foreword. (See Figure 11.)

* 3.5.9 Glossary. (See Figure 12.) Glossaries are not desirable; however, if approved in advance by the procuring activity, a glossary of terms and abbreviations unique to the aircraft may be prepared. The glossary shall follow the foreword, and shall be a right-hand page.

* 3.5.10 Frontispiece. A three-dimensional, three-quarter view halftone illustration that depicts the most distinctive aspect of the aircraft on the ground shall be prepared. On the same page shall appear the following line drawings of the aircraft: top view, side view, and front view. The aircraft shall be shown with wings or rotors spread, and flaps, droops, speedbrakes, radome, MAD boom, etc., retracted. The frontispiece shall appear on the left-hand page preceding the first page of section I. The frontispiece may back up the foreword, and shall be designated figure 1-0. (See Figure 13.)

* 3.6 Alphabetical Index. An alphabetical index in accordance with figure 14 shall be prepared as the last portion of the manual; exception: any foldout pages that fall at the end of the manual, regardless of the section to which they apply, will follow the alphabetical index. The index shall contain a reference to every major, secondary, and any other headings deemed important enough for listing, i.e., each system description, each procedural entry, and each performance chart. Subjects and illustrations shall be referenced to page numbers. The section locater term for the alphabetical index shall be the word,"Index". The first and last entry of each page shall be shown under the section locater term. Each manual and supplement shall contain its own alphabetical index. The security classification, if any, of any title appearing in the alphabetical index shall be indicated.

3.7 Security Classification.

3.7.1 Cover and Title Page Classification. The overall classification for a NATOPS Flight Manual (each volume in a multi-volume set shall be considered independently) shall agree with the highest classification assigned to any material therein. It shall be placed at the top and bottom of the title page and on the front and back covers. (Refer to DOD 5200.1-R.)

3.7.2 Page Classification. Each page shall be marked at the top and bottom according to its highest classification, except that when the classification of two back-to-back pages differ, then the higher classification shall be placed on both pages. A blank page, backing up a classified page, shall not show any classification marking. Unclassified sheets (both pages unclassified) shall be so marked. When any page is marked with a higher classification than that assigned to its contents, an explanation shall be made on that page beneath the bottom classification marking; for example:

CONFIDENTIAL
(This page is UNCLASSIFIED)

or

SECRET
(This page is CONFIDENTIAL)

3.7.3 Paragraph Classification. Each paragraph or subparagraph, when there are differences in their classifications, shall be marked to show the level of classification, if any, or that such paragraph or subparagraph is unclassified. For example, when the text of the lead-in (basic) portion of a paragraph is unclassified but subsequent paragraphs are classified, the lead-in paragraph shall be marked as Unclassified (U) and each subparagraph shall be marked with its respective classification status (C) or (S) as appropriate. In this instance, the symbol denoting the overall classification of the paragraph would be shown immediately following the paragraph number or letter, as appropriate. (Refer to DOD 5200.1-R.)

3.7.4 Downgrading/Declassification. When required, downgrading/declassification shall be accomplished in accordance with DOD 5200.1-R.

3.8 Abbreviations and Symbols. Abbreviations and symbols different than those contained in MIL-STD-12, if used, must be explained in the illustration on which they appear or in a glossary, if appropriate.

3.8.1 Abbreviations. Use of abbreviations shall be avoided unless established as customary, or unless repetitious references within a description justify the usage. Always spell out the words when there is any chance of misunderstanding a procedure or confusing the meaning of one abbreviation for that of another. Avoid use of periods between letters of abbreviations such as "fpm," "psi," "rpm," etc.

3.9 References.

3.9.1 References to Models or Types Covered By The Manual. References should be held to a minimum to facilitate coverage of additional models at a later date.

* 3.9.2 References to Government Specifications and Standards. Refer to the basic number of Government specifications and standards. If it is essential

to reference a specific issue of a specification or standard, assure that copies of that issue may be requisitioned and that the document is listed in the Department of Defense Index of Specifications and Standards or Military Bulletin 544.

3.9.3 References to Materials Such as Fuel, Lubricants, Hydraulic Fluids, etc.. When the contractor does not know the Government specification, he shall request this information from the procuring activity, furnishing complete information concerning the material's composition, properties, characteristics, applications, manufacturer's specification number, etc. Where design considerations require use of a proprietary specification, a Government specification shall be listed as an emergency substitute, if such a substitute exists.

3.9.4 References to Temperature Readings. Temperature readings shall be referred to as Celsius, Fahrenheit, or Kelvin to correspond to the same units as those of the instruments. General temperature references, such as ambient temperatures, shall normally be given in degrees Fahrenheit followed by a corresponding Centigrade temperature in parentheses.

3.9.5 References to Speed and Distance Readings. Speed and distance readings as calibrated on the equipment, with conversion to U.S. standards, shall follow in parentheses if the metric system was used.

* 3.9.6 References to Measures. Measures shall be referring to U.S. standard units except in instances where metric measurements are required.

3.9.7 References to Illustrations. Illustrations shall be referred to by figure number, including sheet number for multi-sheet illustrations.

3.9.8 References to Index Numbers. Index numbers that appear on illustrations shall not be referred to in the text or procedural steps.

3.9.9 References to Other Supporting Paragraphs. Other paragraphs in the same manual shall be referred to by paragraph heading and the section within which it is contained. Duplication of material in two or more parts of a manual shall be avoided except when required for clarity or emphasis.

3.9.10 References to Other Technical Manuals. Reference to other publications shall be minimized so that the manual shall be as self-sufficient as possible and, when necessary, the reference shall be to publication numbers. Reference shall only be made to manuals in the publication system(s) of the service(s) that will use the manuals, and shall only be those that will be available to the organization that will be using the manual. References shall not be made to publications of a temporary nature or those that are limited in distribution.

3.9.11 References to Switch Positions and Panel Markings. Switch positions and panel markings should be referred to as marked on the equipment, if possible without confusion. When unusual decal positions or markings are encountered, the approved nomenclature shall be defined.

3.9.12 References to Steps and Substeps. Steps and substeps shall be referred to by paragraph heading, step and substep numbers; example: "Refer to Takeoff Procedure, step 1.c."

3.9.13 References to Footnotes. Footnotes can be identified by numbers or symbols and shall be used sparingly. If footnote numbers are used, consecutive numerals beginning with 1 shall be used in text. The numbering system, as long as it is consistent, may be per page, per section or chapter, or per manual. Per volume shall be used for multi-volume sets. In illustrations, footnote references shall be in accordance with the U.S. Government Printing Office Style Manual. Footnotes to the text shall be placed at the bottom of the page; footnotes to illustrations shall be placed below each illustration.

3.9.14 References to Tabular Pages, Charts and Graphs. Reference data presented in tabular pages, charts, or graphs shall be designed to be easily understood. Tabular type information of small quantity that will not be referenced may be included within the paragraph without identification by title. Other tabular pages, charts, and graphs shall be considered illustrations, and shall be assigned figure numbers.

* 3.10 Arrrangement and Titles. The arrangement of the NATOPS Flight Manual into sections shall include the following:

a. Front Matter

b. Section I. The Aircraft

c. Section II. Indoctrination

d. Section III. Normal Procedures

e. Section IV. Flight Characteristics and Special Procedures

f. Section V. Emergency Procedures

g. Section VI. All Weather Operations

h. Section VII. Communications

i. Section VIII. Weapons Systems

j. Section IX. Flight Crew Coordination

k. Section X. NATOPS Evaluation

l. Section XI. Performance Data

m. Alphabetical Index

n. Foldout Illustrations

* 3.10.1 Section, Use Statement. Sections not applicable to a specific manual or for which information is to be supplied at a later date shall have a statement to that effect on the first page of the section.

* 3.10.2 Partial Manuals. NATOPS Partial Flight Manuals shall follow the arrangement of the NATOPS Flight Manual, but shall include only those sections specified in the technical manual contract requirement.

* 3.10.3 Supplements. NATOPS Flight Manual Supplements shall follow the general arrangement of 3.10.1, but shall include only those sections specified in the technical manual contract requirement.

* 3.11 Warnings, Cautions, and Notes. Refer to foreword (figure 11) for definitions, appearances and uses of warnings, cautions, and notes. Warnings, cautions, and notes shall always follow the text to which each applies. Warnings, cautions, and notes shall not contain procedural steps nor be numbered. When a warning, caution, or note consists of two or more paragraphs, the heading WARNING, CAUTION, or NOTE, shall not be repeated above each paragraph; a bold (1/16 inch) dot identifier shall be used. When a warning, caution or note follow each other, they shall appear in the sequence as noted: warnings, cautions, notes. Such inserts in the text shall be short and concise and used to emphasize important and critical instructions.

3.12 Numbering.

3.12.1 Covers, Title Pages, and Letters of Promulgation. Covers, title pages and letters of promulgation shall be unnumbered. The reverse side of the letter of promulgation page shall be blank.

3.12.2 List of Effective Pages, Interim Change Summary, and Summary of Applicable Technical Directives. These pages shall be identified by capital letters starting with "A" for the List of Effective Pages. The "A" page shall back up the title page.

3.12.3 Manual Table of Contents, Foreword, Glossary, and Illustration of Aircraft. These pages, as applicable, shall be assigned lower case Roman numerals in sequence. The table of contents shall always be a right-hand page.

3.12.4 Section, Part, and Appendix Titles. Section titles shall be numbered in Roman numerals, part titles in Arabic numerals, and Appendix titles with capital letters (Appendix A, Appendix B, etc.).

3.12.5 Pages and Illustrations.

3.12.5.1 Sections. Pages and illustrations for sections shall be numbered consecutively within each section, in Arabic numerals. All assignments shall be a two-part number, each separated by a hyphen. The first number shall designate the section number, such as Section II (2), and the second number shall designate the page within that section; example: 2-17, Section II, seventeenth page. Figure 2-17 shall be the seventeenth illustration in Section II. A manual may contain a page 2-17 and a figure 2-17. Manuals divided into sections, and, in turn, into parts, shall contain consecutively numbered pages and illustrations for the entire section.

3.12.5.2 Appendixes. Appendixes are not desirable; however, if they must be used they shall be numbered in Arabic numerals, preceded by the capital letters of the appendix; for example: A-17 shall be the seventeenth page, or paragraph, in Appendix A; figure B-17 shall be the seventeenth illustration in Appendix B.

3.12.5.3 Alphabetical Indexes. Page numbers for alphabetical indexes shall be consecutively numbered in Arabic numerals with the word "Index" preceding the page number; for example: Index-4.

* 3.12.5.4 Foldout Pages. When there are foldout pages, regardless to which section they apply, they will follow the last page of the alphabetical index. A table of contents shall be made for foldout pages and be numbered FO-0; this page and all foldouts are blank on the reverse side. Foldouts will carry no figure numbers, only the illustration title below the illustrations and will be page numbered sequentially in margin of lower right corner; for example: FO-1, FO-2, FO-3, etc. All foldout pages will have the reverse blank; therefore, immediately under the page number place the words "(Reverse blank)." All foldout pages shall be printed as right hand pages with a full page apron. These pages shall not be assigned a section or appendix number.

3.12.5.5 Procedural Steps - Numbering. Steps of a procedure shall be identified consecutively with Arabic numerals. Substeps shall be identified consecutively with lower case letters.

* 3.13 Multi-Volume Manuals. Multi-volume manuals shall be assigned individual publication numbers. If a volume, because of its bulk, warrants being further divided, the procuring activity will decide how these divisions shall be identified. When a set of divided manuals is prepared, the general, or first volume, shall contain complete general introductory information. Each of the other volumes shall contain introductory information applicable to it.

3.14 Changes. A change shall be prepared when a limited proportion of the total pages of the manual are affected, as determined by the procuring activity. A change must incorporate all previously issued interim changes to the existing manual. When pages are added to the end of a section, or to the back of a publication, not affecting pages already in the manual, a change shall be prepared A change shall be so prepared that its pages can be substituted for existing pages of the manual, or added to the manual. Changes shall approximate the type style and size used in the basic manual. If a manual has justified right margins, changes may be made with unjustified right margins. Manuals consisting of sixteen or fewer pages shall be revised, not changed.

3.14.1 Change Numbers. Each page containing changed or added material shall bear the words "Change (number)" placed at the bottom of the page in the same corner and on the same line, as the page number. The change number will begin about 1/2 inch to the right of the page number for an even numbered page, and end about 1/2 inch to the left of the page number for an odd numbered page. This requirement is also applicable to all added pages, including those placed at the back of the manual.

3.14.2 Numbering Changed Pages.

* 3.14.2.1 Illustrations and Pages. Illustrations added between existing pages shall be assigned the preceding number plus consecutive capital letter suffixes. For example, 2-3A, 2-3B, and 2-3C (suffix letter I and O shall not be used) would be assigned to the first three illustrations added between figures 2-3 and 2-4. The same applies to added pages except that such pages shall not be added between a right-hand (odd) and left-hand (even) numbered page. Pages added between existing pages shall always be assigned even numbers, such as 2-4A, 2-4B, and 2-4C. Additional added pages to previously added pages shall be numbered 2-4A-1, 2-4A-2, etc.

3.14.2.2 Additional Copy. If additional copy is to be added to a right-hand page, and there is adequate space on the preceding left-hand page, rearrangement of the two pages is permitted to avoid the need for a letter-suffix page. For example, if material is to be added to page 3-3 and there is some blank space on page 3-2, material at the top of page 3-3 should be moved back to the bottom of page 3-2. The added material would then fit on page 3-3. There would thus be no need to create page 3-4A.

3.14.2.3 Deleted Figures. Where a change deletes a figure without substituting another, space formerly occupied by the figure can be used for text or other material if needed. A sentence such as "Figure 4-3 deleted" shall be placed at the bottom of the page. When this results in a blank page, paragraph 3.14.2.4 applies. The delete statement shall appear on the page until the first revision. The table of contents, and alphabetical index, etc., shall be changed as necessary.

3.14.2.4 Deleted Pages. When page number continuity is broken by deletion of a page and a blank page results, a statement indicating the deletion shall be placed in the bottom margin of the preceding page, or top margin of the following page; for example, "Page 2-17, including figure 2-17, deleted." This also applies when two consecutive pages are deleted.

3.14.2.5 Added Procedural Steps. Procedural steps and substeps added between existing steps shall normally mean renumbering the steps. If this would mean printing additional pages, the added steps shall be numbered thus: an addition between 1. and 2. shall be 1A., 1B., 1C., etc.; an addition between a. and b. shall be a1., a2., a3., etc.

3.14.2.6 Change at End of Sections. Figures and pages added at the end of a section shall be numbered consecutively, starting with the next number after the last number used. These pages shall not contain page numbers with alphabetical suffixes.

3.14.3 Change Symbols. Changes to the text and figures (including new material on added pages) shall be indicated by a 3/32 inch (final printed size) black vertical line, with the word "NEW" spaced at approximately 3/16 inch intervals, in the nearest margin, and defining the entire material affected. Previous change symbols on a page shall be deleted when a page is subsequently changed; symbols shall show current changes only. This does not apply for a back-up page (negative) to a changed page. Change symbols are not required for:

a. Front matter, table of contents, and alphabetical index.

b. Blank space resulting from the deletion of text or a figure.

c. Correction of minor inaccuracies, such as spelling, punctuation, relocation of material, etc., unless such correction changes the meaning of instructive information and procedures.

3.14.3.1 Changes to Figures. Instructions specified in 3.14.3 shall apply. Changes confined to the same general area shall be indicated only once on the illustration.

* 3.15 Revisions. A revision must incorporate all previously issued changes and interim changes to the existing manual. Preparation of a revision must be approved by the procuring activity. The following information should be considered by the contractor before requesting the procuring activity to approve a revision.

a. Percentage of change, and whether updated/new material will affect significant portions of the manual, or be located mainly in one or two sections.

* b. Reason for revision, such as, change in equipment configuration, new specification to be complied with, etc. This information shall be considered sufficiently in advance to permit the procuring activity to take adequate time to reach a decision, yet not delay submittal of data. The procuring activity will decide whether a change or revision shall be prepared. (See 6.2.1)

* 3.15.1 Supersedure Notice. When a manual supersedes an existing manual(s), (including changes and supplements), or a portion of a manual(s), a notice shall be incorporated to include the publication number(s) and date(s) of each superseded manual. This notice shall appear on the cover and title page of the superseding manual. If the manual being superseded showed both a new and a former publication number, the supersedure notice shall also show both numbers. The supersedure notice shall be removed from the title page at the first change and replaced at the next revision.

3.15.2 Revision Change Symbols. All change symbols shall be removed from the revised manual, and new change symbols shall be inserted to identify only those changes in text and figures that differ in revision from those contained in the latest previous edition of the manual.

3.16 Writing Style.

3.16.1 Grammatical Person and Mood. The second person imperative mood shall be used for all operation procedures, ("Check tip tank fuel level.") and the third person indicative mood shall be used for description and discussion ("When the No. 1 inverter fails, the caution light illuminates.") Pronouns may be
* used when they will not cause confusion.

3.16.2 Use of "Shall", "Will", "Should", and "May." The words "shall", "will", "should", and "may" are to be used as indicated in the foreword shown in figure 11.

3.16.3 Nomenclature Consistency. Nomenclature shall be consistent within a NATOPS Flight Manual and any supplements. Occasionally, names may be shortened, provided this does not result in confusion.

3.16.3.1 Nomenclature Appearing on Placards and Decalcomanias. The nomenclature used in the manual to identify controls and equipment shall contain the identical wording which appears on the applicable placards and decalcomanias. The only exception to this shall be when the decaled nomenclature has been definitely established as unsatisfactory to the procuring activity. In such cases, the approved nomenclature shall be used throughout the manual. However, the decaled nomenclature shall appear at least once in the manual in parentheses and immediately following the first reference to that item.

3.16.3.2 Nomenclature for Controls and Control Positions. All controls shall be identified by titles that are descriptive of their configuration, i.e.: "fuel selector handle" not "fuel selector control"; "flap lever" not "flap control"; etc. Exceptions will be infrequent, and then only on extremely common items such as the throttle. Whenever reference is made to a specific control position (whether that position is decaled or not), it shall be shown in capitals--quotes shall not be used.

3.16.4 Development of Text. The text shall contain only essential information of interest to the flight crew. It shall be developed in a factual, specific, concise, and clearly worded manner to assure ready understanding. It shall not resort to theoretical discussion. Specifically descriptive and unique paragraph headings and illustration titles shall be used, avoiding such words as "general," "chart," "performance," "description," "operation," unless accompanied by some content identifying term. Superfluous words and phrases shall be avoided. Emphasis symbols such as bold capital letters, quotation marks and underlining shall not be used. Use of italics or bold lower case letters should be used sparingly when phraseology reinforcement is considered necessary. The U.S. Government Printing Office Style Manual shall be used as a general guide for capitalization, punctuation, and word compounding.

* 3.16.5 System Description. Any system description shall briefly state system purpose, identify major system components, and state the contribution each component makes toward fulfilling the system purpose. The system description shall include a description of the major components. The identification of a component and its contribution to system purpose should be combined within one discussion. Emphasis shall be placed on brevity.

a. System Purpose. A statement of system purpose shall be specific but not an inflated version of the system name. It shall build upon the implications of the system name as in "the engine start system uses externally supplied air and electrical power to: impart turbine rotation, to establish fuel flow, to energize start ignition, and to transition automatically to a self-sustaining condition." A restatement of the obvious is not satisfactory, as in "the engine start system provides the power and controls to start the engine."

b. Major Components. The requirement to identify only major components is intended to eliminate parts such as solenoids, relays, controls, and indicators. The components identified in a system shall be of approximately the same magnitude and mutually exclusive such as "oil cooler, scavenge pump," and not "butterfly valve, carburetor." Identification shall use official terminology. However, adjectives shall be avoided, e.g., "208/120 volt, 3 phase, 400 cycle, a-c generator."

c. Component Contribution to System Purpose. All components have a purpose or an output. This output may be transformed or refined by another component prior to finding its ultimate use regarding the system purpose. Thus, the outputs of the major components shall be identified or related to each other or to system purpose. These outputs and their relationships to each other convey an understanding of "how the system works." An example is: "oil system--the pressure pump (major component) establishes a flow of oil from the supply tank (major component) to the frictional surfaces of the engine and reduction gearing."

d. Component Description. The major components of a system shall be described in terms of static characteristics and operating characteristics.

(1) Static characteristics include information concerning the physical attributes of a component which are normally important during preflight and post-flight activities. These activities include briefing and flight planning as well as the preflight and postflight inspection conducted by the crew.

(2) Operating characteristics describe the dynamic attributes of a component during its normal operation. This information expands and details the outputs of components and their interrelationships which were introduced briefly in the beginning of the system description. The reason for providing this information is to tell how a component or series of components operate so that appropriate procedures can be applied effectively.

3.16.5.1 Depth of Detail. Extent of coverage of any system shall be determined by:

a. Criticality of System. Systems contributing to the safety of flight are more critical than systems that are primarily for crew convenience. The more critical the system is, the more detailed should be its coverage.

b. Complexity of System. A system is considered complex and warrants detailed description when one or more of the following characteristics are present: multiple components, multiple modes of operation, associated factors, effect on other systems.

c. Uniqueness of System. Two types of uniqueness shall warrant detailed description of the system: design innovation of the system and/or limited occurrence of the system.

3.16.5.2 Readability of Systems Descriptions. Writing style is most important in readability. Grouping and sequence are also important. Complimentary artwork may be used, consisting of controls figures and schematic designs. The following guidelines are emphasized:

a. Directness. Begin new subjects with a positive statement expressed in the active voice.

b. Wordiness. Avoid repetition, surplus words, and unnecessary engineering detail.

c. Inferences. Do not require the reader to infer from the text to get the important points of the discussion.

d. Lengthy Sentences. All sentences should be concise.

e. Parallel Structure. Use parallel grammatical structure for sentence elements that are logically parallel.

f. Continuity. Maintain a logical continuity of thought, especially in describing time-oriented events.

g. Balance. The amount of coverage for a subject should be based on the subject's criticality, complexity, and uniqueness, and should not be influenced by writer interest or availability of reference material.

* h. Grouping. Cover the description of a system in its entirety under a major heading. Group related systems so that they appear successively. Strict adherence to these rules may be difficult, because of the high degree of system interaction within an aircraft. The following rules include assistance in determining appropriate grouping for system description materials.

(1) Grouping by Function. Descriptions of systems of hardware which are functionally related shall be grouped together. The functional grouping must be meaningful in terms of pilot and crewmember activities. Mechanical relationships should not be interpreted as functional.

* (2) Grouping by Flow. Descriptions of hardware devices which process energy, fluid, or gas shall be grouped under a common heading or series of related headings. The scope of the common heading or series of related headings is defined by tracing the process from its source to its consumption and return to its source. Exceptions to this rule occur when functional differences are present within the flow as in the fuel system and the hydraulic system. In the case of the fuel system, devices for the fueling, transfer, dumping and filtering of fuel are functionally related to "fuel management" activities. The descriptions of the devices which control the metering and consumption of fuel are functionally related to "engine operation" activities. An accepted convention is to describe the former devices under the heading of "engine fuel supply system." The latter devices are to be described under the heading of "engine fuel control system" and within the description of the engine. Similarly, hydraulic systems typically include normal and emergency power for utility systems (landing gear, wing fold, bomb-bay) and flight control systems. Each powered system often has separate reservoirs, pumps, and distribution networks, and, in terms of crewmember activities, can be operated independently. Accordingly, each such system warrants a separate "source-to-use and return-to-source" description. Each system may appear as a separate writeup under the common heading of "Hydraulic Systems." The rules for grouping by function and flow have been applied to typical aircraft systems within the specification.

(3) Grouping of Emergency-Use Items. The description of emergency-type hardware which forms a part of a system shall be included within the description of its system. Examples are emergency fuel pump with "Fuel Supply System," and ram air turbine within "Electrical System" (or "Hydraulic System"). Emergency equipment which in itself is a system shall be treated as a separate system status.

i. Sequence. Descriptive materials shall be presented in the sequence that is meaningful to the user. Sequence refers to materials within a major system. Three rules for establishing sequence are:

(1) Usage. Where possible, the sequence of equipment descriptions shall be the same as the operational usage of the equipment.

(2) Criticality. The sequence of descriptive materials shall be based on relative importance. The principle applies to components within a system.

(3) Flow. Many systems, particularly those which process fluids, possess a natural sequence of events. Adherence to this sequence in presenting descriptive materials will increase meaningfulness.

3.16.5.3 Style and Format - Procedural Steps. Procedural steps may be presented in text form or in challenge-response checklist form. The former shall be presented in the third person indicative mood, and the latter shall be presented in the second person imperative mood. (See 3.16.1).

3.17 Artwork.

3.17.1 Style and Technique. Style and technique shall be of a quality which will produce artwork that will clearly, adequately, and economically portray the needed information. Illustrative material shall be used: to describe an item or idea more effectively through graphic presentation; to clarify text; to present phases or sequences difficult to understand through the use of text alone; to call attention to details; and to furnish graphic identification of displays and controls. The minimum number essential for such purposes shall be used. Multiple sheet illustrations may be used. Illustrations shall be located as near as possible to and following related text except where this would require unnecessary duplication of illustrations. Full page illustrations requiring sidewise placement on a page are discouraged. When used, sidewise illustrations shall be turned 90 degrees counterclockwise with the figure title beneath the illustration at the bottom of the page. Masthead and/or fill-in illustrations shall not be used. Cartoons may not be used without the advance permission of the procuring activity. All illustrations must be functional and used to clarify text. Art used solely for the purpose of decoration is expressly forbidden. Color shall not be used in illustrations except where absolutely necessary to depict some function of a system, such as flow, or to set off system components or areas.

3.17.2 Photographs/Halftones. Use of photographs shall be determined by the practical considerations of their purpose and suitability in the manual, and economy of preparation and reproduction, as compared with a line drawing of the same item. Photographs shall be used where they are of acceptable quality and are less expensive than line drawings of the same equipment. All photographic artwork shall be of continuous tone. Prescreened halftones may be used on reproducible pages and shall be clear in detail and sharp in contrast of tones. Prescreened photographs are acceptable as reproducible copy provided they are of proper quality, size, and mounted on the reproducible copy of the text page or marginal copy. They are not acceptable as original or final artwork in place of continuous tone photographs.

* 3.17.3 Line Drawings. Selection of line drawings shall be the same as specified for photographs in 3.17.2. Line drawings shall be of high quality. India ink, or other suitable permanent medium of consistent high intensity tonal

values shall be used for preparing the line drawing. Line drawings include schematics, wiring diagrams, block diagrams, etc. Drawings shall be to as small a scale as possible with all essential detail legible, be the same size as areas they will occupy on the manual page, or such oversize as to permit uniform reduction to this size. (See Figure 15.) Refer to 3.18 regarding foldout pages.

* 3.17.4 Schematic Diagrams. Schematic diagrams shall be used where it is necessary to show "flow" such as the hydraulic, fuel, and electrical systems. The function of a schematic diagram is to illustrate the operation of the system in as straightforward a manner as possible. To accomplish this, the components of the schematic diagrams are to be presented in the following order of importance:

a. Flow of the System. This shall receive primary importance by being presented conspicuously, by having a minimum of turns in the lines, and by starting at one of the outer edges of the page and continuing as straight as possible until the other side of the page is reached. It should be noted that the flow includes tanks or reservoirs which are considered to be the starting point of most schematic diagrams. The equipment may not assume the same relative position as it does in the aircraft; it is more important that the diagram be arranged so that the "flow" of the system can be traced with minimum effort. Crossovers should be avoided or eliminated whenever possible. Return lines need not be shown in entirety unless necessary to understand the system. To avoid resemblance to electrical wiring diagrams, all electrical flow lines on electrical schematics shall be wide bands as opposed to thin lines, except for electrical actuation lines which must be shown as thin black lines. Perspective shall not be used unless it improves the diagram and the system still can be easily traced. In the interest of standardization, the following coding shall be used:

Solid line. . . . . Electrical actuation
Dashed line . . . . Mechanical actuation
Black . . . . Main portion of system
Black diagonal stripes. . . . Emergency

The following codings are recommended for use in those cases where an additional coding is warranted because of complexity of the system:

Blue. . . . . Secondary power, cold air
Green . . . . Supply
Green diagonal stripes. . . . Return
Blue diagonal stripes . . . . Static fluid
White . . . . Vent

These color codings, once assigned, shall be consistent throughout the manual. All symbology shall be listed in a legend on the schematic for easy interpretation of the schematic.

b. Controls and Indicators Used by Flight Crew. These items shall be second in importance only to the flow of the system. They shall be presented in accordance with the appropriate military standards or commercial standards. Controls and indicators shall be set off slightly to the side of fluid flow lines. On electrical diagrams, controls may be placed directly on flow lines. Valves shall be presented schematically in the shape of a "T", "L", etc.

c. Flow Control Devices. These include all flow control devices within the system, such as check valves, fuel pumps, fuses, relays, restrictors, etc. They shall be presented in a simple, stylized version to show the function of the device. Solenoid valves shall be indicated as such and shall include a note indicating whether the valve is spring-loaded to the open or closed position.

* 3.17.4.1 Schematic Design. In designing most schematics, it will be necessary to compromise between completeness, simplicity, and making the diagram self-explanatory, in order to facilitate reading and understanding. To prevent over-complexity because of automatic features, these characteristics should be covered by text in the diagram. Lists of large numbers of items shall be in alphabetical order. The major systems described above shall be arranged in alphabetical order. (See Figure 16). Refer to ANSI Y14.15 for preparation.

* 3.17.5 Graphs. The three types of acceptable graphs are illustrated in figure 17. When multiple plots appear on a graph, they shall be separated by a space in the grid structure. This space should not exceed one inch. Shift graphs conserve space and are frequently used for correction functions on charts. However, their use should be kept to a minimum. When they are used, the baseline shall be labeled BASELINE and the shift lines labeled GUIDELINES.

* 3.17.5.1 Sample Graphs. The graphs in this specification are samples to be used as guides in preparation of the manuals. Use of better presentations is encouraged; however, the graphs shall be approved by the procuring activity to assure that the presentation includes the desired information. (See 6.2.1)

3.17.5.2 Nomographs. Nomographs shall not be used.

3.17.5.3 Back-to-Back Scales. For certain functions such as simple value conversion, the use of back-to-back scales is recommended.

* 3.17.5.4 Grid Constructions. Grids shall appear on graphical and profile type charts. Grid structure is included to facilitate the tracing process which is different from the scale reading process. The following rules shall apply to preparing grid structure:

a. Grid Interval. The distance between adjacent grid lines shall not be less than 0.1 inch and not greater than 0.3 inch. The larger grid intervals (0.2 to 0.3 inch) are preferred.

b. Grid Structure. Grid lines shall be composed of major and minor grid lines. There shall be four minor grid lines between each major grid line. Major grid lines shall be 0.017 inch thick (No. 0 pen); minor grid lines shall be 0.013 inch thick (No. 00 pen).

c. Contrast. Grid structure shall appear less bold than the scales, parametric lines, labels and numbers. One acceptable process is to prepare the grid structure in solid line form and then photographically screen the grid (approximately 50 percent) before adding scales, parametric lines, and labels which shall not be screened.

* 3.17.5.5 Scale Construction. To include optimum legibility and consistency, the following rules shall apply to scale construction:

a. Axes Selection. Graph axes shall be selected in terms of spatial orientation. Thus, altitude shall be located on the vertical axis (ordinate), and distance or range on horizontal axis (abscissa). In addition, values should increase in the upward, left-to-right, and clockwise directions and decrease in downward, right-to-left, and counterclockwise directions.

b. Scale Breakdown. Recommended scale breakdown patterns are shown in figure 17. Scale breakdown selection shall take into account aircraft instrumentation. Minimum scale breakdown shall be established in accordance with actual instrument scales. Scale interval shall not be less than 0.1 inch. The number of graduation marks between numbered points shall not exceed nine. The height of major, intermediate, and minor graduation marks shall be approximately 0.22, 0.16, and 0.09 inch, respectively. The stroke width of major, intermediate and minor graduation marks shall be approximately 0.0175, 0.015, and 0.0125 inch, respectively.

3.17.5.6 Parametric Lines. The maximum thickness of parametric lines shall be approximately 0.015 inch. The minimum thickness shall be approximately 0.005 inch. The minimum thickness shall be used only when adjacent curves are close and require increased separation distance. Distance between adjacent parametric lines shall not be less than 0.1 inch. No hard-and-fast rule can be applied to the number of parametric lines that should appear. Chart designers must first determine the degree of accuracy required and then the number of parametric lines necessary to gain this accuracy without clutter.

* 3.17.5.7 How-to-Use Description. A short pictorial guide of how the chart is to be used shall appear on or with each chart. (See Figure 17.)

* 3.17.5.8 Progression Line. A progression line example shall appear on each chart. (See Figure 17.) At the beginning of the progression line, the word "EXAMPLE" shall appear, followed by a worked example which traces the problem through all segments of the chart, and defines results obtained at each point.

* 3.17.5.9 Limitations and Marginal Performance. Limitations and marginal performance areas shall be identified on graphs. Where possible, the grid structure shall be deleted for regions which exceed limitations of the particular aircraft. Areas in which aircraft performance is marginal shall be identified and, where applicable, annotated with a warning note or reference to an additional chart which will include more detailed information concerning the marginal performance.

3.17.5.10 Size and Style of Type. Futura demibold (or a similar style) type shall be used for all letters on performance charts. Type size shall not be less than 6 point (after any necessary reduction). Labels and short descriptions shall be entirely in capital letters.

3.17.6 Use of Color. Color may be used in artwork (other than schematics which are defined in 3.17.4a) only where absolutely necessary to clarify functional operations. The number of colors shall be kept to a minimum by the use of tints, cross-hatching, dots, etc. When color is required the primary colors (red, yellow, blue) shall be used first. For each use of color in the manual, specific approval by the procuring activity is required. When color is used, a legend shall be included in the illustration containing an exact duplicate of the color or pattern used. Use of color should be consistent, where possible. See also 3.17.1.

3.17.7 General Preparation Requirements for Artwork (Board Art).

* 3.17.7.1 Crop and Size Marks. Illustrations shall be included separately (drop-in artwork). Each illustration shall have the reproduction area defined by crop marks appearing on each of the four corners marking the horizontal and vertical dimensions. The lines shall extend no closer than 1/4 inch to the outside of the area, and the exact reproduction size shall be indicated in black pencil between the crop marks. Ink or grease crayon shall not be used. These size marks shall be approximately 3/8 inch long and shall not cross or touch. (See Figure 18.)

* 3.17.7.2 Identifying Artwork. All artwork shall bear the art control number, publication number, figure number, and page number outside the area of reproduction. Applicable security classifications shall appear at the top and bottom center, also outside of the reproduction area. To avoid layout mistakes, the "TOP" of the artwork shall also be identified. (See Figure 18.)

3.17.7.3 Text on Artwork. Nomenclature, index numbers, and legends (or Keys) shall be used, when necessary, for identification of significant features. This use of text shall be placed on the background area, close to, but free of the illustration. Index numbers (callouts) shall be placed directly on line drawings (no overlays). Callouts shall not be freehand lettering, except on engineering drawings. Lettering shall be all capitals in eight- to 10-point type when printed. (Diagram callouts, as stated in 3.17.5.10, may reduce to 6 point.)

a. Nomenclature. Nomenclature of more than one line should have justified left margins. All lines of copy shall parallel the horizontal edges of the illustration.

b. Index Numbers. Index numbers for each separate illustration shall always start with Arabic numeral 1 and continue consecutively. Exception: all multiple sheet illustrations shall be considered one figure. Sequence of numbering shall be from top to bottom or clockwise starting from the upper left corner. Capital alphabetical suffixes shall be added to any new callout numbers inserted between existing callout items when an illustration is changed, such as 17A, 17B, etc. (Suffix letters I and O shall not be used.) Suffixed index numbers need not be removed for a revision unless the illustration is changed.

c. Legend (or Keys). When index numbers are used, a legend consisting of their numerical listing and their identification shall be included on, or adjacent to, the illustration. If a callout is deleted from an illustration, the word "Deleted" shall be placed after the appropriate number in the legend.

3.17.7.4 Leader Lines. Leader lines should touch the object to which they apply. Lines shall be uniform, short, and straight as possible; however, doglegs are permitted. Lines shall not cross or come in contact with other callout lines, and they shall not hide essential details. A line shall be highlighted for clarity. Arrowheads shall be used.

* 3.17.7.5 Covering Artwork. All final (board mounted) artwork (artwork not directly attached to reproducible copy) shall be protected by an inner flap of non-oil tissue or vellum, and an outer flap of heavy paper. The art control number, publication number, figure number, and page number shall appear conspicuously on the outer flap. An applicable security classification shall appear at the top and bottom center of the outer flap. (See Figure 18.)

3.17.7.6 Unacceptable Artwork.

a. Continuous tone or screened film negatives, and screened prints (See 3.17.2).

b. Film positives (except for color overlay preparation, or for the black key drawing of a color illustration).

c. Brown line prints, photostats, bromides, and prints made by similar reproduction processes.

d. Bleed illustrations.

e. Line illustrations containing weak or broken lines.

f. Illustrations containing illegible lettering.

3.18 Foldouts. Foldout pages shall be used to facilitate location of information while reading text. Candidate illustrations for foldout application include cockpit arrangement illustration, electrical system, fuel system, hydraulic system, and pneumatic system schematics. See also 3.12.5.4.

* 3.18.1 Page Size and Reproduction Area. Maximum printable area for a foldout page shall not exceed 47-1/8 inches in width and 10 inches in height. Foldout pages shall not be printed on their reverse side; the back shall be blank. A full page blank apron shall be used, and an additional 3/8 inch margin shall be included outside the apron fold to insure that illustrations can be seen when preceding pages cover the apron.

3.18.2 Figure Numbers and Titles. Marginal copy and figure numbers and titles shall be visible when the page is folded.

3.18.3 Numbering Foldouts. Refer to 3.12.5.4 for numbering instructions for foldout pages.

3.19 Technical Content.

3.19.1 Formal NATOPS Flight Manuals. The formal manual shall consist of Sections I through XI for NATOPS Flight Manuals. Material shall be included in the order and manner specified herein. Headings that are not applicable shall be ignored.

3.19.1.1 Section I. Section I shall consist of Part 1, Aircraft and Engine; Part 2, Systems (and equipment); Part 3, Servicing (and handling); Part 4, Operating Limitations.

* 3.19.1.1.1 Part 1. Aircraft and Engine. Part 1 shall describe the aircraft, its arrangement and its engine(s). A brief description of noteworthy features of the aircraft shall be presented. These shall include:

a. Aircraft type, class, model, and manufacturer.

b. Engine type, thrust or horsepower, and manufacturer.

c. Speed ranges for typical configurations.

d. Missions.

e. Typical takeoff gross weight.

f. Aircraft arrangement. The exterior and interior arrangement shall be discussed, including illustrations displaying exterior, interior, cockpit layout, and aircraft dimensions. Refer to figure 19. The overall dimensions of fixed wing aircraft shall be covered: maximum overall length; width with wings folded and extended, incidence at aerodynamic chord, sweepback of 1/4 chord line, dihedral, aspect ratio, and main landing gear tread; maximum height, static height, with wings extended, folded, and during folding. Rotary wing aircraft shall include: maximum length, with rotary wing blades extended and folded, and main landing gear to tail wheel distance; width, with rotary wing blades extended and folded, minimum rotary wind ground clearance and ground clearance when folding, minimum rotary rudder ground clearance, and main landing gear tread; maximum height, static height, and minimum height.

3.19.1.1.2 Part 2. Systems. Each system or item of equipment shall be described in accordance with 3.16.5. Systems or equipment for a particular aircraft which do not fit under a specific heading shall be included at the end of the general group with which they are most closely associated. Include minimum cooling requirements for heat-sensitive equipment.

3.19.1.1.2.1 Powerplant Systems.

a. Engines. Include a general discussion of the development of thrust and horsepower. Discuss reversed/directed thrust systems with controls, indicators, and inflight operation, and variable intake and variable exhaust area with sensors, controls, and indicators used, malfunction symptoms, and resulting engine operating characteristics.

b. Engine Fuel Control System. Discuss metering systems, computing systems, and power management systems. Outline the functions of the system in brief form. Include modes of operation, system limitations, controls and indicators, and indications of system malfunction.

c. Carburetor System. Include a complete description of all carburetor controls and indicators, including carburetor heat control, air temperature indicator, throttle control, manifold pressure indicator, and mixture control. Optimum range of carburetor air temperature, symptoms of carburetor icing, and the preventive and corrective actions shall also be discussed.

d. Supercharger System, Describe type of supercharger, the supercharger control, and use of supercharger in cabin pressurization. Discuss the operation of the supercharger covering altitude and power requirements for blower shifting and the effect of automatic shift on engine operation.

e. Manifold Pressure Regulation System. Discuss the purpose of the system. Outline consequences of system malfunction, including throttle movement precautions, limitation of available power, and back-up system operation.

f. Water Injection System. Discuss quantity, duration of supply, use, and control.

g. Alternate Air System. Describe function of system, including source of protected air, controls and indicators, and method of testing system operation.

h. Start System. Describe components, controls and indicators used in CSD(/S) and external power required. Discuss indications of start system malfunction, and system capabilities and limitations.

i. Ignition System. Include controls and methods of ground checking.

j. Torque Sensing System. Describe function of system and components, and indications of system malfunction.

k. Overspeed Protection System. Describe function of system and components, and indications of and response to system malfunctions.

l. Afterburner System. Describe system functions, controls, and indicators. Include a brief discussion of safety precautions, effect of system on operating characteristics, and indications of afterburner malfunction.

m. Engine Oil System. Discuss oil supply, oil pressure, oil cooling, oil-to-oil/oil-to-fuel heat exchange, oil dilution, and chip detector systems.

(1) Oil Supply System. Describe oil quantity indicator, emergency oil shutoff control, and oil-quantity-low warning indicator. Where appropriate, discuss inflight replenishment of oil supply, oil consumption for extended flights, and emergency shutoff control use. Limitations of the oil supply system under aerobatic flight and maximum time indications should also be mentioned when it is an oil supply factor.

(2) Oil Pressure System. Identify the types of oil pressure and scavenging pumps and their source of power; describe the oil pressure indicator and normal indicator readings; discuss oil pressure as the governing factor for the selection of low-cruise engine RPM. Also include abnormal oil pressure and the need for cross-checks, remedial action to extend flight, and expected time to engine seizure.

(3) Oil Cooling System. Describe the oil cooler bypass control, oil cooler shutter control, oil cooler door/flap control, oil temperature gauge and normal oil temperature range, and oil cooler door/flap position indicator. discuss warmup sequence, ground and inflight operation, and normal and bypass oil cooler operation.

(4) Oil-to-Oil Heat Exchange System. Discuss the purpose of the system. Emphasize the effect of improper engine oil temperature management on the second oil system and the equipment which it lubricates. Describe action to relieve high oil temperature condition. Identify systems which should be shut down as a precaution when oil temperature is high.

(5) Oil-to-Fuel Heat Exchange System. Discuss the purpose of the system. Emphasize the effect of high oil temperature on fuel system and engine operation, the limitations imposed on maximum permissible engine RPM, and means of detecting heat exchanger malfunction from engine performance.

(6) Oil Dilution System. Describe the oil dilution switch, and note the point where fuel is injected into the oil system. Show in tabular form the relationship of ambient temperature, percentage of dilution required, and time from actuation of control to achieve percentage oil dilution required, for each type of oil specified. Describe engine warmup techniques required after oil has been diluted to insure proper lubrication during takeoff.

(7) Chip Detector System. Discuss the purpose of the chip detector system including the location of the detector plugs. Describe the chip detector warning light with press-to-test feature, and its source of power. Indicate inability of magnetic plug to attract aluminum or other nonferrous metal chips. Describe the action recommended when warning light illuminates, such as cross-checking of other engine instruments and feathering when possible to guard against additional engine damage.

n. Engine Controls and Instruments. All engine controls and instruments that indicate engine condition and operation, such as tachometer, manifold pressure gauge, torquemeter, engine analyzer, engine oil pressure, engine oil temperature, engine fuel pressure, and fuel flowmeter shall be discussed.

o. Engine Overheat System. Describe indicators, sensors, and function of the system.

3.19.1.1.2.2 Propeller Systems.

a. Transmission/Reduction Gear. Describe the function of each gear box, transmission oil systems, oil coolers, source of cooling air and accessory drive systems. Discuss capabilities and limitations.

b. Propeller RPM Control System. Describe the propeller pitch control, source of power, propeller governor, tachometer, and RPM range limit indicators. Indicate the normal propeller governing range. Discuss the relationship of oil pressure and RPM, and minimum oil pressure as the determining factor in selecting low RPM for cruise. Discuss oil temperature management and its effect on governor operation.

c. Propeller Synchronization System. Describe the propeller synchronization and synchrophaser system. Include synchronizer control, power source, master engine synchronization selector, manual synchronization override, and synchronization reset switch. Discuss automatic synchronization limits, when reset should be actuated, and implications of securing (feathering) engine selected as "master."

d. Propeller Reverse Pitch Control System. Describe the reversing control, control lock, power source for reversing propeller, auxiliary pump and propeller-in-reverse indicator. Emphasize throttle manipulation required to achieve and control reverse pitch power. Discuss safety features incorporated to prevent use of system while airborne, the setup of air conditioning system during operation of reverse pitch, implication of system malfunction on landing roll distance, and possibility of asymmetric reverse thrust and its control. Describe propeller unreversing cycle if different from the opposite of the reversing cycle.

e. Automatic/Manual Feathering System. Describe system purpose, method of sensing power loss, and the throttle or power lever position in relation to system operation, for automatic feathering. Also describe auto-feather arming control, and system-armed light. Discuss time delay as a safety feature and the automatic deactivation of the automatic system when one propeller has been feathered, and the caution involved. Mention test switch and test indicators. For the manual system, briefly describe the feathering pump or motor and its source of power. Describe the feathering control, feathering indicators, and warning indicators. Discuss the effect of feathering on other systems operating from each respective engine, such as air conditioning, pressurization, and a-c generator.

3.19.1.1.2.3 Rotor Systems.

a. Rotary Wing System. Briefly describe the characteristics of the rotors, rotary wing head, wing blades, operation of antiflap restrainers, droop stops with respect to rotary wing speed, and function of dampers. The rotary wing system includes rotor mechanism, automatic blade fold system, and rotor brake system.

b. Rotary Rudder System. Describe the tail rotor assembly, hub, and blades. Indicate the source of tail rotor drive power, and the type of power transmission used. Discuss pilot directional controls including pedal feel and position as affected by the negative force gradient system, or inoperative auxiliary servo. Include any interaction between tail rotor movement and movement of the collective pitch control.

c. Transmission System. Include transmission oil system and accessory drive system. Describe the transmission oil system covering the supply tank (capacity and fill point), quantity indicator, oil pressure pump, scavenge pump, and oil cooler. Discuss the purpose of the accessory drive system. List the accessories which can be operated without turning the rotary wing. Describe accessory drive/rotary wing control, accessory drive warning indicator, and test features. Indicate limitations for system operation such as engine speed, throttle/power lever position, rotor brake control position and interlock features.

3.19.1.1.2.4 Aircraft Fuel System.

* a. Fuel Supply System. Fuel grades, specifications, and capacities shall be covered. Recommended and emergency fuels shall also be covered. Discuss drop tank release controls, fuel tanks, tank venting, boost pumps, gravity feed, jettisoning, controls, and indicators. Include procedures for fuel system management and fuel heater. Discuss single-point ground refueling.

b. Fuel Pressure System. Discuss engine-driven and electrical pressure and boost pumps and their interrelationship. Describe boost pump control, fuel pressure indicator and normal range of fuel pressure, low-fuel-pressure warning indicator, and fuel flowmeter.

c. Air Refueling System. Discuss air refueling system in detail and include all aircraft-peculiar refueling procedures and techniques. Include tanker and receiver systems. Refer to NATOPS Air Refueling Manual for standard air refueling procedures.

d. Aircraft Fuel System Schematic. Schematic shall include tanks and up to the engine-driven fuel pump.

3.19.1.1.2.5 Assist Takeoff (ATO) System. Indicate conditions under which the system is to be used. Briefly describe the system covering nomenclature and number of units or mounts. Describe arming switches, system armed indicator light, electrical power source, firing switch, and safety interlocks. Indicate capability of replacing units from within the aircraft. Discuss jettisoning of ATO units, precautions to be observed, and sequence of jettisoning.

3.19.1.1.2.6 Auxiliary Power Unit (APU). Discuss the APU system, compressor assembly, power turbine assembly, accessory assembly, oil system, fuel system, starting system, special control, fire detection and warning system, fire extinguisher system, controls, indicators, and operational procedures.

3.19.1.1.2.7 Electrical Power Supply System.

a. Electrical Power Distribution System. Discuss AC power supply, DC power supply, circuit breakers. Include schematic diagram.

b. Air Turbine Motor/Ram Air Turbine. Discuss air turbine motor/ram air turbine components, cooling, speed controls, controls and indicators, and operation.

* c. Lighting Systems. Discuss exterior and interior lighting. Include diagram to show areas illuminated by exterior lighting.

3.19.1.1.2.8 Hydraulic Power Supply System. Identify the aircraft hydraulic systems and controls and indicators. The primary and secondary systems are generally those which serve aircraft flight systems. The auxiliary system serves only non-flight related systems (e.g., cargo doors, radomes, etc.).

a. Primary System (PC-1, Flight Booster, etc.). Describe major components and identify aircraft systems served by primary system. Outline degradation or loss of aircraft systems for primary system malfunction.

b. Secondary System (PC-2, Combined, Utility, etc.). Describe major components and identify aircraft systems served by secondary system. Outline degradation or loss of aircraft systems for secondary system malfunction.

c. Auxiliary System. Describe major components and identify aircraft systems served by auxiliary system.

d. Back-Up System. Describe the major components, controls, and indicators. Indicate the capabilities and limitations of the system, and include system tests.

e. Hydraulic Power Distribution. Summarize the flight controls and aircraft systems served by each hydraulic system.

f. Hydraulic Power Supply System Schematic. Include all flight controls, hydraulically-operated aircraft systems, major system components and controls and indicators.

3.19.1.1.2.9 Flight Controls. Describe effectiveness and possible unusual reactions encountered in operations and use of flight controls. Consider all types listed below; state their function, power source, capabilities, and limitations.

a. Pilot's/Copilot's (Cockpit) Controls

b. Ailerons/Flaperons

c. Horizontal Stabilizer

d. Rudder

e. Flaps, Slats, and Boundary Layer Control

f. Collective Pitch

g. Cyclic Controls

h. Trim Controls

i. Speed Brakes/Spoilers

3.19.1.1.2.10 Automatic Flight Controls. Describe major components and capabilities of automatic flight control systems, automatic stabilization equipment, approach power compensation systems, and similar equipment.

3.19.1.1.2.11 Pneumatic Power Supply System. Describe major components, aircraft systems served by pneumatic power system, indications of system malfunction, and back-up modes of operation for pneumatically-powered systems.

3.19.1.1.2.12 Landing Gear Systems. The landing gear systems listed below shall be discussed, including their controls and indicators, limitations, and emergency extension and retraction provisions.

a. Attachments (skis, floats, etc.)

b. Ground Steering System

c. Wheel Brake System. Include normal and auxiliary braking, and anti-skid system.

d. Catapult System

e. Arresting Hook System

f. Drag Chute. Include safety release features.

3.19.1.1.2.13 Wing Fold System. Describe the wing fold including power requirements and safety precautions.

3.19.1.1.2.14 Pylon Fold System. Describe the pylon fold system.

3.19.1.1.2.15 Flight Instruments.

a. Angle-of-Attack System. Describe function of the system, interaction between angle-of-attack indicator, approach indexer, approach lights, and head-up display.

b. Pitot-Static System. Cover location of probes and static ports, alternate static source, instruments served by the system, and pitot heat.

c. Vertical Gyro System. Include power sources.

d. Horizontal Situation Systems

e. Compass System

f. Acceleration Indication Systems

g. Radar Altimeter

h. Miscellaneous Flight Instruments. Include all controls and indicators not specifically described under another heading.

* 3.19.1.1.2.16 Warning, Caution, and Advisory Lights. Include a summary table that is organized by flight station. For each light provide name, location, meaning when illuminated, and action to be taken.

3.19.1.1.2.17 Fire Detection System. Describe function, components, and test procedures for the aircraft fire detection system.

* 3.19.1.1.2.18 Ingress/Egress Systems.

a. Canopy. Discuss all canopy controls, both external and internal.

b. Doors/Hatches. Discuss operation and operating procedures.

c. Ladders. Discuss operation and operating procedures.

d. Ejection Seats. Cover in detail ejection seat (module) and controls, emphasizing how they are affected by other systems, such as canopy. Discuss applicable hardware and list attached survival equipment.

e. Parachutes. Discuss operation and operating procedures, including location when not in use.

3.19.1.1.2.19 Environmental Control Systems.

a. Cockpit (Cabin Air Conditioning and Pressurization Systems). Discuss air source, air conditioning units, distribution, temperature regulation, air flow regulation, controls and indicators, and normal and alternate operation. Discuss the source of pressurized air and method of controlling it. Cover any effect that the pressurization system has on any other systems or vice versa.

* b. Avionic Equipment Cooling System. Discuss any system or method included for cooling avionic or electronic equipment.

c. Heating and Ventilating. Discuss heating and ventilating systems as specified for air-conditioning and pressurization systems, as applicable.

d. Oxygen System. Discuss crew and passenger oxygen systems, in that order. Include the effects of temperature on pressure reading, and oxygen duration chart, showing manhours of oxygen available for various combinations of oxygen pressure versus altitude. Show duration for normal and for 100 percent use of oxygen. Establish location of all portable oxygen bottles and all recharger points in the aircraft. Include items such as the types of regulators, types of masks, and procedures for checking and operating the oxygen system.

3.19.1.1.2.20 Defogging System. Include controls and indicators and system operation.

3.19.1.1.2.21 Windshield Washing System. Include controls and system operation.

3.19.1.1.2.22 Rain Removal/Anti-Ice Systems.

a. Windshield/Canopy. Include controls, indicators and system operation.

b. Engine. Include engine pressure ratio (EPR) probes, and engine intake. Cover controls and indicators.

c. Propeller/Rotor. Describe function, controls and indicators. Outline system capabilities and limitations.

3.19.1.1.2.23 Personnel Equipment.

a. Pilot's and Copilot's Seats (if not ejection seats), Crew Seats, and Passenger Seats. Describe seats, adjustments, and positions.

b. Seat Belts/Harnesses. Discuss completely the automatic safety belt controls. Include appropriate illustrations of belt and parachute controls to show proper attachment of parachute harness and safety belt.

3.19.1.1.2.24 Rescue Equipment. Describe function and location of all rescue equipment, rescue hoists, life rafts, etc., including capabilities and limitations.

3.19.1.1.2.25 Cargo Provisions.

* a. Cargo Deck. Discuss access and space included for cargo loading, tie-down points and protective devices. Reference the applicable cargo-handling manual.

b. Cargo Sling. Describe cargo sling and tiedown provisions; include precautions to observe, capabilities, and limitations.

c. Winches/Hoists. Describe and include lifting capacity, hoisting speeds, and emergency jettison and braking provisions.

* d. Aerial Delivery Equipment. Include references to applicable cargo-handling manual. Describe aircraft-unique equipment.

3.19.1.1.2.26 Emergency Equipment.

a. Survival Equipment. Identify name, purpose and location. Include first aid kits.

b. Fire Extinguishing Systems. Discuss operation and procedures, identify location of hand-held fire extinguishers.

c. Flotation Systems. Discuss purpose of the system including stability on water with rotor stopped. Describe the emergency flotation units or bags and the emergency air supply. Cover the pressure gauge, emergency flotation control panel including off/armed switch, system armed indicator, activation switch or button, source of system power, and test switches and indicators. Indicate normal inflation time and if the bags should be inflated for other than water landing, such as, as energy absorbers for rough terrain. Discuss asymmetric inflation and if bags can or should be deflated to provide symmetrical flotation.

d. Emergency Signalling Equipment. Discuss names and purposes of all emergency signalling equipment.

3.19.1.1.2.27 Miscellaneous Equipment. Include description and location of all equipment listed below, and any additional equipment of a general nature.

a. Armor Plate

b. Flak Curtains

c. Radiation Shields

d. Stowage/Storage Compartments

e. Relief Tubes

f. Rear View Mirrors

g. Equipment Destruct Systems

h. Tool Kits

i. Checklists Mounted to Airframe

* 3.19.1.1.2.28 Loose Gear. Include instructions for securing all loose gear carried inside the aircraft.

* 3.19.1.1.3 Part 3. Service and Handling. Part 3 includes all information required for handling and servicing the aircraft at a Naval installation unfamiliar with the aircraft, or at an Air Force, Army, NATO, (reference to the "Cross Servicing Manual" should be made when available,) or commercial installation.

3.19.1.1.3.1 Servicing Data. Servicing data includes the following information on fuels, oils, hydraulic fluid, lubricants, and other servicing items. The information shall be presented in tabular form.

a. Item. Fuel, oil, oxygen, electrical starting unit, windshield wash fluid, etc. Alternate use items shall be indicated in order of preference.

* b. Navy Designation. The Navy designation or military designation of the item; for example: "MIL-L-7808", "NC-5", "JP-4", shall be included. The color code of fuel and hydraulic fluid shall be included.

c. NATO Equivalent

d. Commercial Equivalent

e. En Route Supplement Code. This is the code for the item as indicated in the En Route Supplement, Flight Information Publication, such as"A+", "ADI", or "W".

f. Remarks. Include whether an item is an alternate or emergency replacement for the standard item.

3.19.1.1.3.2 Fueling. Describe the following fueling procedures, including safety precautions to be observed.

a. Pressure Fueling. Discuss the requirement for external power during pressure fueling, and the aircraft attitude required to allow maximum amount of fuel to enter tanks. Describe the pressure fueling procedure, and include an illustration of pressure fueling receptacles and fueling panel switch setup during refueling.

b. Pressure Fueling Top-Off Method. Describe procedures for pressure fueling when only a small quantity of fuel is required. Emphasize the limit below which this method is to be used and the requirement for strict adherence to this procedure to prevent tank damage or rupture.

c. Pressure Fueling Alternate Method. Where appropriate, describe the pressure fueling procedure when external electrical power is not available.

* d. Gravity Fueling. Describe the gravity fueling procedure. Include an illustration of the gravity fueling setup. Emphasize position of fueling nozzle and location of grounding jack. Discuss nozzle length or diameter restrictions to prevent tank or filler port damage. Discuss precautions which must be observed in routing filler hose to prevent damage to wing slots, vortex generators, and wing fences. If the gravity fueling procedure differs from one integral tank to another, or for external tanks, include separate procedures and illustrations.

* e. Fuel Control/Fuel Selector. Describe the procedure for setting the fuel selector adjustment for alternate grades of fuel. Include illustrations suitable for use by maintenance personnel totally unfamiliar with the aircraft. Insert warning note indicating that the adjustment should be noted on the aircraft yellow sheet upon return to home base to preclude operation with an improper fuel control fuel selector setting.

f. Hot Refueling. Describe switch settings, safety precautions, crew manning level, and ground crew requirements. Include emergency shut-down procedures.

* 3.19.1.1.3.3 Oil System Servicing. Describe the procedure for checking oil system level and for filling. For reciprocating aircraft, indicate the servicing level for engine "hot" and engine "cold". Where available, identify the maximum oil consumption figure (the rate of consumption which when reached or exceeded requires maintenance action). Cover the use of special continuity-type oil-level check equipment and the procedures to be used when using pressure oiling units. Illustrate the pressure oiling setup. For helicopters, discuss transmission gear box oil system servicing procedures. Include a table listing grade of oil versus ambient temperature.

* 3.19.1.1.3.4 Hydraulic System Servicing. Describe servicing procedures for each hydraulic system, if separately serviced. Indicate maximum filler port (inlet) pressure for each system. If utility hydraulic system quantity indication varies with aircraft configuration, such as wings folded versus spread, indicate the normal servicing level for each configuration. Include an illustration to depict features such as the portable hydraulic test stand, and fill and bleed lines.

* 3.19.1.1.3.5 Pneumatic System Servicing. Describe servicing procedures. Indicate location of servicing points, system pre-loads, and gases to be used. Specify safety precautions.

* 3.19.1.1.3.6 Oxygen Servicing. Describe the servicing procedure for the oxygen system to include the specific tasks required, precautions to be observed, and the use of portable servicing units. Include an illustration of the system being serviced. (For liquid oxygen systems show the danger areas.) In tabular and chart form, describe the process of determining how much oxygen is required for various aircraft missions; for example: a chart showing oxygen duration by altitude and the conversion of liters to pounds. Include, where appropriate, a discussion of emergency (bailout) and portable oxygen system servicing.

3.19.1.1.3.7 Battery Servicing. Indicate the location of and the steps of gaining access to aircraft battery. Describe filling procedure, normal servicing level, minimum specific gravity per cell and minimum acceptable battery voltage (no load).

3.19.1.1.3.8 Anti-Icing/De-Icing Systems Servicing (Fluid Systems Only). Indicate the location of filler point and normal servicing level.

3.19.1.1.3.9 Water Injection System Servicing. Indicate the location of filler point and normal servicing level. Include the percentage of water and alcohol/methanol, for those systems requiring a particular mix.

3.19.1.1.3.10 Windshield Wash System Servicing. Treat this in the same manner as anti-icing system.

3.19.1.1.3.11 Fire Extinguishing System Servicing. Indicate the location of the fire extinguishing system filler points. Describe the servicing procedure for both extinguishing agent and propellant. Indicate the relationship of ambient temperature and normal fill pressure.

3.19.1.1.3.12 Auxiliary Powerplant (APP) Servicing. Describe the fueling and oil system servicing procedures for the APP.

3.19.1.1.3.13 Constant Speed Drive (CSD(/S)) Servicing. Describe the procedure for gaining access to the constant speed drive. Discuss inspection, filling procedure, and normal servicing level. Discuss the consequences of using other than approved fluid.

3.19.1.1.3.14 Assist Takeoff (ATO) Servicing. Describe the installation procedure for JATO bottles. Indicate the checks which the pilot can perform to insure that the system is in a "ready" condition.

* 3.19.1.1.3.15 Drag Chute System Servicing. Discuss the procedure for removing, repacking, and installing the drag chute assembly. Emphasize items which the pilot can check visually to insure proper deployment and attachment. Include illustrations which will permit the system to be serviced by a parachute rigger who has never seen the system.

* 3.19.1.1.3.16 Aircraft Jacking Points. Describe location and type of jack fitting to be used for each jacking point. Specify capacity required of each jack.

3.19.1.1.3.17 Tire Servicing. Specify minimum acceptability requirements for tire, tread, cuts, and abnormal wear. Include inflation pressures, and tire sizes and types.

3.19.1.1.3.18 External Power Requirements.

a. Electrical. Describe the external a-c and d-c electrical power requirements. Indicate voltages, current, phases, and the location of the electrical power recepticle. Indicate whether service power requirements are identical to starting unit requirements.

b. Starting Unit Requirements. Indicate the starting unit requirements for both air and electrical power and combinations thereof. State minimum and maximum air pressure flow. Identify voltages, current rating, and phases for electrical power. List approved starting units. Indicate modification or change to unacceptable units to make them acceptable under emergency conditions.

* 3.19.1.1.3.19 Danger Areas. Include an illustration showing the hazard areas which exist during ground operation with engines at idle power and military power. Show both induction and exhaust hazard areas, show length and width of exhaust pattern indicating both temperature and velocity relative to distance from exhaust nozzle or tailpipe and distance from either exhaust centerline or aircraft longitudinal axis. Indicate ear protection zones, type of ear protection required in zones, and maximum exposure time, as applicable.

* 3.19.1.1.3.20 Turning Radii/Ground Clearance. Include an illustration showing turning radii, ground clearances, and overall aircraft height in different configurations. Refer to figure 20.

3.19.1.1.3.21 Towing Aircraft. Discuss special towing procedures, including towbar, tractor, maximum velocity, and safety requirements.

* 3.19.1.1.3.22 Tiedown/Securing Aircraft. Describe the tiedown fittings, jury struts, and methods of securing aircraft. Include illustrations of tiedown arrangements for normal and heavy weather tiedown.

3.19.1.1.4 Part 4. Operating Limitations. Part 4 shall present a summary of the operating characteristics of the aircraft. Coverage shall include both aerodynamic limitations and system limitations. Aerodynamic limitations are associated with flight of the aircraft and include factors such as maneuvering limits, weight and balance considerations, and minimum/maximum speeds under various aerodynamic configurations. System operating limitations concern the normal and abnormal ranges of system variables, i.e., pressures, temperatures, voltage loading, and revolutions per minute.

3.19.1.1.4.1 Engine and Transmission Operating Limits. This section shall cover points such as engine starting limits (hot starts, time sequence for unsuccessful starts, etc.), engine operating limits (gas generator speeds, exhaust gas temperature, power turbine speed, oil temperature and pressure, etc.), and transmission operating limits (input torque as read on the torquemeter, oil temperature and pressure, etc.). Include an exhaust gas temperature limit chart.

3.19.1.1.4.2 Aerodynamic Limitations. Cover limiting factors, descriptions of the limitations, flight phase, and result of exceeding limit for the following.

a. Airspeeds. Include maximum level flight airspeed, maximum diving airspeed, maximum airspeed for landing gear and various degrees of flap extensions, for bomb door opening, and for various conditions of weight and configuration. Include multiple limitations such as when landing gear is in transit and when it is fully extended, whenever these limits vary. Also cover limitations for jettisoning external stores and maximum airspeed for helicopters when carrying external cargo.

b. Acceleration. Include points such as maximum acceleration with tip tanks and maximum bank at high weights. Discuss maximum permissible accelerations under various flight conditions at specific gross weights and fuel versus load distributions. Cover purpose of the operating flight strength diagram.

c. Altitude. Indicate the absolute and service ceilings. For helicopters, describe the reasons for establishing minimum altitudes and airspeeds for autorotation, or, where appropriate, for single-engine landing. Include a chart for minimum height for safe landing after engine failure. For conventional single-engine aircraft indicate the no-thrust glide distance under clean and "dirty" configurations. Make reference to Section V, Emergency Procedures, for complete descriptions.

d. Weight and Balance. Discuss limitations involved for aircraft in which weight and balance distribution is a problem. Include a tabulation of normal, emergency, and overload takeoff gross weights and design zero fuel weight for the applicable aircraft. Also include a tabulation of normal and emergency weight distribution. Refer to NAVAIR 01-1B-40 for detailed weight and balance information.

e. External Stores. Discuss any limitations imposed by external stores.

3.19.1.1.4.3 Instrument Markings. Illustrate each instrument that indicates an operating limit. For each instrument marking illustration that contains an engine power instrument, include a notation of the fuel grade on which the limits are based. The notation should be conspicuously located and printed in large boldface type.

3.19.1.1.4.4 Maneuvers. Discuss flight maneuvering limitations, including aerobatic flight. Include restrictions on control movements and bank angle limits, and limits for slipping or skidding during asymmetric power condition or landing approaches.

3.19.1.1.4.5 Weight Limitations. List gross weight limitations for field and carrier catapult and non-catapult launches, touch and go, FCLP, landing, and arresting hook and barricade engagements.

3.19.1.2 Section II. Indoctrination.

* 3.19.1.2.1 Ground Training Syllabus. Include a brief and general outline of the material that should be included in the ground training syllabus. The syllabus outline should be in tabular form. For each training entry, include crewmember applicability and the number of hours to be devoted to the training item. Include the following:

a. Familiarization

b. Safety and Survival Training

c. Weapon System Training

d. Weapon Delivery Training

3.19.1.2.2 Flight Training Syllabus. Outline the flight syllabus by identifying the topics to be treated during each training flight. Include the following:

a. Takeoffs

b. Landings

c. Navigation/Instruments

d. Shipboard Procedures

3.19.1.2.3 Personal Flying Equipment. List only aviation and survival equipment to be worn or carried by crewmembers on all flights that is peculiar to the aircraft being covered by the manual. Refer to OPNAVINST 3710.7 for all standard equipment.

3.19.1.2.4 Flight Crew Designations. Define the designations and basic duties of each crew member.

3.19.1.2.5 Flight Crew Qualifications and Currency Requirements. List the initial qualification requirements for each crew member for various flight phases, and the requirements for maintaining current qualification.

3.19.1.2.6 Waivers. Include a statement stating that unit commanders are authorized to waive, in writing, minimum flight and/or training requirements in accordance with OPNAVINST 3710.7 (series).

3.19.1.3 Section III. Normal Procedures.

3.19.1.3.1 Part 1. Flight Preparation. Flight preparation specifies procedures to be followed prior to manning the aircraft.

* 3.19.1.3.1.1 Mission Planning. Mission planning specifies procedures and includes aircraft-unique information on the following mission aspects unless a separate Tactical Manual is to be prepared. Information may be in tabular or graphic form where convenient.

a. Mission Capabilities

b. Fuel (range and endurance capabilities)

c. Navigation Capabilities

d. Tactics

e. Communication Capabilities

f. Conventional Weapons

g. Special Weapons

3.19.1.3.1.2 Briefing/Debriefing. Specify briefing/debriefing responsibilities for briefing officer and pilot-in-command. Reference applicable briefing/debriefing publications, if any. Specify the general areas which should be covered during briefing/debriefing, including the following:

a. Target or Destination. Cover location, characteristics, mission purpose, alternates, and interaction with other participating units.

b. Navigation and Flight Planning. Cover launch and recovery points, local operating procedures, and divert and emergency fields.

c. Communication. Cover frequencies, controlling agencies, and identification procedures.

d. Weapons or Cargo. Cover special routing or loading, tactics, emergencies, and safety precautions.

e. Weather. Cover local, en route, destination, alternate and divert field weather conditions, and winds aloft.

f. Emergency Procedures. Generally cover aborted missions to include communication, navigation, and search and rescue.

g. Intelligence Information. Identify friendly and enemy dispositions, targets of opportunity, reports and authentications, escape and evasion, and NOTAMS.

* 3.19.1.3.2 Part 2. Shore-Based Procedures. Include general information and detailed procedures from which crewmember checklists will be formulated. The crewmember checklist to be provided shall be in a challenge-response format for normal shore-based ground and flight procedures. Information and procedures to be included are:

a. Line Operations. Cover general information on operating from a flight line.

b. Preflight Check. Specify in checklist format the checks which must be made on the exterior of the aircraft prior to boarding, and the interior of the aircraft immediately after boarding; include diagrams as required.

c. Ejection Seat Check. Specify checks to be made prior to strapping in, including removal of safety pins.

* d. Starting Engines. Include checklists for prestart, start, and post-start engine procedures. Include indications of and procedures for abnormal starts (hot starts, wet starts, etc.).

e. Ordnance Checks. Include cockpit, pylon, and stores checks for ordnance and related equipment.

f. Wing/Rotor Spread. Describe procedures, including flight and ground crew duties during spread, cycling procedures, and locked/unlocked indication.

g. Control Checks. Describe procedures for checking all flight controls for free and correct movement.

h. Before-Taxi Checks. Include all checks to be accomplished before taxiing such as hatches and doors, IFF/SIF standby control locks, hydraulic pressure, chocks, taxi clearance, crew readiness, safety lock pins, steering, and brakes.

i. Taxiing. Include all information useful to the pilot while taxiing such as differential power, braking, precautions to help avoid ground accidents during day and night, engine operation, engine taxi power settings, flight instruments, and crosswinds.

j. Engine Run-Up. Include complete instructions for checking items such as engine and propeller operation including power and ignition. Cover the means of assuring that the propeller is not in reverse pitch. Describe the proper use of brakes during run-up.

k. Takeoff. Include a discussion of the takeoff, covering the technique and procedures necessary to complete a normal takeoff. The normal takeoff is one upon which the takeoff data, in the performance data, is predicated. Include a statement of this fact. Also consider the following items in the discussion of takeoff:

(1) Use of controls to overcome engine torque if applicable.

(2) Force required to lift nose wheel or tail wheel.

(3) Conditions that may affect takeoff such as runway surface covering, runway condition reading crosswind, runway length, and obstacle clearance.

(4) Takeoff configuration such as external stores, center of gravity (cg) location, gross weight, and flap position.

(5) Effect of trim changes that may be required after breaking ground.

(6) Recommended techniques such as the use of brakes, anti-skid, flaps, and trim and effect of deviations from the recommended techniques.

(7) Peculiarities and unfavorable tendencies of the particular type or model of aircraft.

(8) High altitude takeoffs and runway requirements.

(9) Means of determining when a takeoff should be aborted.

(10) Any other items requiring consideration.

l. Transition to Forward Flight (Helicopter/VTOL). Describe procedures for normal transition, including altitude, airspeed, crosswind limitations, and post-takeoff cleanup procedures.

m. Climb. Discuss the normal climb procedures and techniques that will be required to produce the results stated in the performance data climb charts. Include post-takeoff cleanup procedures for fixed wing, conventional aircraft. Describe blower shift procedures, positioning of engine cooling flaps, trim settings, and power settings for normal, cruise, and military type climb.

n. Cruise. Cover action that must be taken when the transition from climb to cruise is made. Include any particular matters that must be considered during cruise flight such as manual leaning, depressurizing the hydraulic system, depurging superchargers, defouling spark plugs, periodic crewmember checks, oxygen system check, and any peculiarities during instrument flight. Refer to the applicable series of performance charts in Section XI for each aircraft cruise configuration for specific speeds, power settings, and fuel consumption.

* o. Descent. Include the procedural steps and a discussion of the descent phase of operation. The checklist should include all checks which must be made immediately before and during descent to land. Cover in detail the normal procedures that will be required to produce the results stated in the descent charts in the performance data. As applicable, include special instructions regarding various types of descent such as en route, tear drop, rapid (with spoiler), and rapid (clean) penetration. Add any special devices that may be included to facilitate descent.

p. Approach to Landing. Describe all activities performed prior to traffic-pattern entry and during traffic-pattern flight, including procedures for the following:

* (1) Instrument Approaches. Include text descriptions and checklists for

instrument approach patterns with a discussion of aircraft configuration, and techniques for all instrument approaches within aircraft capability. Include complete coverage on any special precautions or restrictions peculiar to the aircraft. Refer to applicable instrument flight procedure manual.

(2) Automatic Approach. Cover the preparation and procedure to be followed during automatic approach and special precautions and techniques. Discuss unsatisfactory approach indications and procedures for discontinuing such an approach.

q. Transition to Hover (Helicopter). Indicate all airspeed, altitude, power, and crosswind requirements for transition from forward flight to hover. Reference the applicable performance charts in Section XI.

r. Transition to Vertical Flight (VTOL). Indicate all airspeed, power, and crosswind requirements for transition from forward to vertical flight. Reference the applicable performance charts in Section XI.

s. Landing (Fixed-Wing). Discuss the problems that may be encountered during the landing phase. Cover the normal landing technique that will be required to produce the results stated in the landing charts of the performance data in Section XI. Discuss techniques such as use of brakes, nose wheel on or off the runway, reverse thrust, transition from aerodynamic to mechanical directional control, and drag chute deployment. Include procedures for each type of landing that can be made. Include procedures for touch-and-go, over-weight, crosswind, minimum run, and adverse weather landings.

t. Landing (Helicopter). Cover special landing problems such as mountain top, confined areas, snow and dust, run-on landing, landing from hover, and crosswind landing.

u. Waveoff. Discuss any special procedures required for waveoffs from a normal landing approach.

v. After Landing. Include all checks and operations to be accomplished after turnoff from runway and before the parking area is reached.

w. Post-Landing Procedures. List all actions necessary to accomplish after the parking area is reached.

x. Wing/Rotor Fold. List procedures for unlocking and folding wings or rotors.

* y. Engine Shutdown. Include a checklist covering the proper procedures for engine shutdown, including all precautions to be observed in accomplishing this procedure. Make reference to the appropriate section for oil dilution procedures. Include instructions for any other required operations such as supercharger desludging and proper positioning of throttle after engine stops.

z. Postflight Procedures. List all actions necessary to accomplish the postflight check or inspection.

* 3.19.1.3.3 Part 3. Ship-Based Procedures. Include general information and detailed procedures from which crewmember checklists are formulated for shipboard

procedures which differ from shore-based procedures and which are unique to the aircraft.

a. Flight/Hangar Deck Procedures. Include flap settings, turn-up limitations, recommended trim control settings for various loading configurations, and control manipulation. For helicopters, emphasize moving of aircraft, blade folding and spreading.

b. Preflight Procedures. Describe any actions which are unique to ship-based operations.

c. Post-Start Procedures. List any special turn-on, checkout or alignment procedures which are unique to ship-based operation.

d. Taxi. Briefly describe normal ship-based taxi procedures.

e. Launch Procedures. Include control settings, gross weight limits, and ranges of launching airspeed for STOL/VTOL launches.

f. Catapult Launch. Include flap settings, trim, control settings, ranges of launching airspeeds, power setting for tensioning catapult, and acceleration characteristics after launch.

g. Recovery. Include procedures for helicopter/VTOL recovery.

h. Pattern. Include pattern entry, and night, VFR, and IFR patterns.

i. Approach. Cover positions required during the approach (abeam, ninety, and final), optimum angle-of-attack and airspeeds, and aircraft-unique procedures for fresnel lens, angle-of-attack index, and APCS approaches.

j. Wave-off/Bolter Patterns. Emphasize wave-off/clearing turn procedures.

k. Arrested Landing/Recovery. Specify special procedures for arresting hook malfunction.

l. Exit from Landing Area. Describe procedures for clearing landing area, including procedures for arresting hook, steering, or brake malfunction.

m. Carrier Controlled Approach. Describe aircraft-unique procedures for carrier controlled or ACLS approaches, including manual override of ACLS system.

n. Aviation Facility Ships. Specify any procedures for helicopters or VTOL aircraft operating from non-aviation ships which differ from standard carrier-based procedures.

o. Field Carrier Landing Practice. Describe procedures which differ from standard ship-based procedures.

* 3.19.1.3.4 Part 4. Special Procedures. Include general information and checklists for special flight evolutions not involved in the basic mission profile of the aircraft, and for abnormal but non-emergency procedures. Refer to applicable manuals for standard procedures.

a. Formation Flying Procedures

b. Air Refueling

c. Aerobatics

d. Para-Drops

e. Cargo Drops

f. Vertical Replenishment

g. Helicopter In-Flight Refueling

h. Ferry Procedures

i. Three-Engine Takeoff Procedures (Multi-Engine Aircraft)

j. Search and Rescue Procedures

k. Autorotation

l. Windmilling Starts

* 3.19.1.3.5 Part 5. Functional Checkflight Procedures. Include general information and procedures for use on checkflights resulting from post-maintenance functions as defined in OPNAVINST 4790.2, or from other functional/operational requirements. Refer to applicable NATOPS supplement or checklist for detailed procedures.

a. Preflight Checks

b. Pre-Start Checks

c. Taxi Checks

d. Pre-Takeoff Checks

e. Takeoff Checks

f. Hover Checks

g. Climb Checks

h. Level Flight Checks

i. Descent Checks

j. Landing Checks

k. Postflight Checks

* 3.19.1.4 Section IV. Flight Characteristics and Special Procedures. Describe all pilot-significant flight characteristics and special procedures which are unique to the aircraft.

3.19.1.4.1 Fixed-Wing Aircraft.

* 3.19.1.4.1.1 General Characteristics. Include a description of how the aircraft is controlled.

a. Flight Controls. Include a complete discussion of the effectiveness and unusual reactions that may be encountered in the operation and use of flight controls. Cover all types of controls such as ailerons, elevators, rudders, trim tabs, speed brakes, slats, and directional thrust valves. State when and how the controls are used to achieve maximum benefits and what precaution must be observed. Cover the capabilities and limitations of power boosted systems and when power boost is inoperative.

b. AFCS and APCS. Describe the sensing, coupling, and control features. Cover each mode of operation and emergency disconnect.

3.19.1.4.1.2 Climb Characteristics. Describe aircraft characteristics at various climb configurations, including indications of approaching stalls.

3.19.1.4.1.3 Level Flight Characteristics. Discuss the characteristics of the aircraft through the entire speed range. Include characteristics in level flight in the transonic and supersonic regimes, and with external stores.

3.19.1.4.1.4 Maneuvering Flight. Describe the aircraft's characteristics in accelerating and constant speed maneuvers. Include stick forces, emphasizing conditions that may result in control reversal. Include recovery from unusual attitudes, if procedures are unique to the aircraft.

* 3.19.1.4.1.5 Stall Characteristics (Fixed-Wing Aircraft). Describe the aircraft's characteristics in various conditions, and include procedures for practice stalls. Discuss power-off and power-on stall characteristics of the aircraft in takeoff, landing, and "clean" configurations. Include stall characteristics for the approach configuration if sufficiently different from landing. Include a definition of power-on as used in the discussion. Include information on stall warning, emphasizing stall recovery procedures, and complete instructions regarding the method of accomplishing practice stalls. Apply the above specifications to normal stalls, stall penetration, accelerated stalls, and post-stall gyrations.

3.19.1.4.1.6 Spin Characteristics. Describe characteristics of the aircraft in spin conditions and procedures for spin recovery. Include an explanation of how spin characteristics of each type of spin differ from adverse-yaw induced spirals. Discussion shall cover the following spin conditions.

a. Erect Spins and Recovery

b. Inverted Spins and Recovery

c. Spin Recovery on Instruments

3.19.1.4.1.7 Compressor Stall. Describe characteristics of aircraft in compressor stall, indications of approaching stall, and any unique characteristics associated with compressor stalls in the aircraft.

* 3.19.1.4.2 Helicopters (Characteristics).

* 3.19.1.4.2.1 General Characteristics - Helicopters. Describe how the helicopter is controlled as follows:

a. Flight Controls. Include a complete discussion of the effectiveness and unusual reactions that may be encountered in the operation and use of flight controls. Cover all types of flight controls such as rudders, trim tabs, cyclic stick, and collective pitch.

b. ASE/AFCS, Stabilization Systems. Describe relationship with sensing systems, doppler, radar altimeter; and system test features. Cover control features and each mode of operation and emergency disconnect.

3.19.1.4.2.2 Flight Characteristics - Helicopters. Describe characteristics of the aircraft for operation both in and out of ground effect, over the entire speed range. Describe dynamic roll over.

3.19.1.4.2.3 Stall Characteristics - Helicopters. Emphasize corrective action in the event of severe blade stall and provide an incipient blade stall chart. Include complete instructions for accomplishing practice stalls.

3.19.1.4.2.4 Maneuvering Flight - Helicopters. Cover characteristics during accelerating and constant speed maneuvers.

3.19.1.4.2.5 Vibrations. Describe characteristic vibrations encountered during normal flight conditions, and unusual vibrations which may be indicative of a particular problem.

3.19.1.4.2.6 Autorotation. Describe aircraft characteristics and maneuvering limitations for autorotation over the entire altitude and speed range of the autorotation envelope.

* 3.19.1.5 Section V. Emergency Procedures. Describe all emergency procedures, including the use of emergency features of primary systems as well as use of back-up systems. All pages in this section shall contain emergency page markings (figure 5).

* 3.19.1.5.1 Part 1. Ground Emergencies. Include general information and challenge-response checklists for ground emergencies. Describe and illustrate as necessary emergency entrance and exit procedures. Include procedures to be followed in the event of engine starting malfunctions, emergency engine shutdown, and engine fire on the ground.

* 3.19.1.5.2 Part 2. Takeoff Emergencies. Include general information and challenge-response checklists for takeoff emergencies. Describe as necessary abort procedures. Include procedures to be followed in the event of engine failure or fire with takeoff aborted, engine failure with takeoff continued, fire warning with takeoff continued, and tire failure during takeoff roll.

* 3.19.1.5.3 Part 3. In-Flight Emergencies. Cover general information and checklists for in-flight emergencies, to include the following:

a. Engine Failure and Air Restart. Include critical and non-critical steps. Include procedures to be followed in case of afterburner overheat for jet aircraft, and recovery procedures for compressor stall.

* b. In-Flight Fire. Include instructions and procedures for fuselage fire, electrical fire, and wing fire. Include smoke and fumes elimination, crew protection, and use and limitations of onboard extinguishing agents.

c. Emergency Stores and Equipment Jettison. Cover the jettisoning of external stores, and semipermanent or loose gear carried inside the aircraft.

d. Emergency Fuel Dumping.

e. Refueling Hose Jettison.

f. Oil System Failure. Discuss all aspects of engine operation with partial or complete loss of oil and oil pressure.

g. Fuel System Failure. Discuss symptoms of known possible causes of failure such as fuel inlet pressure, pump, excessive fuel consumption, or likely combinations of these symptoms. Present procedures for meeting these emergencies.

h. Electrical System Failure. Describe procedures for controlling aircraft and operating critical aircraft systems in case of electrical system failure. Include procedures for operating back-up electrical power sources.

i. Hydraulic System Failure. Describe procedures for controlling aircraft in case of failure of one or more aircraft hydraulic systems.

j. Propeller/Rotor Failure.

k. Rotary Rudder Failure (Helicopter).

l. Torque Sensing System Failure.

m. Transmission Failure.

n. Aileron/Flaperon Failure.

o. In-Flight Refueling Emergency. Include procedures for both tanker and receiver.

p. Hung Ordnance. Procedures to be taken when ordnance has failed to leave aircraft after triggering shall be included.

* 3.19.1.5.4 Part 4. Landing Emergencies. Include general information and checklists for landing emergencies, to include the following:

a. Landing with Engine(s) Inoperative. Include the changes in configuration and procedures, and the recommended precautions required for a forced or engine(s)-

out landing. In the event of complete loss of power, emphasize that ejection or abandonment of the aircraft may be preferable to forced landing. Include procedures for single-engine and twin-engine jet aircraft for landing without thrust, discussion of missed approach with inoperative engine(s), and procedures for ejection or abandonment from aircraft. For helicopters, describe procedures for autorotation.

b. Flaps/Slats Failure. All procedures for leading edge and trailing edge flap/slat failures shall be included. Any unusual conditions which may develop, such as chatter, failure to close, and asymmetrical (split flaps) condition shall be discussed.

c. Landing Gear Failure. Procedures for emergency extension of the landing gear shall be included. Describe procedures for combinations such as main gear down nose gear up, one main gear up, nose wheel cocked, and all gear up.

d. Forced Landing. Include procedures and warnings and cautions, as applicable. Consider altitude, aircraft configurations, pattern airspeeds, and engine speed.

e. Field Arresting Gear.

f. Barricade Arrestment.

g. Blown Tire. A discussion of the procedures required in the event of tire failure during landing roll shall be included.

h. Wheel-Brake System Failure. Procedures for accomplishing a landing when brakes are inoperative shall be discussed. If failure of these systems affect any other areas, mention the area(s) affected. Note that emergency brakes (if applicable to the aircraft) are limited to a certain number of applications.

i. Ditching. Complete instructions regarding the method and the best configuration for ditching the aircraft shall be included. Capabilities of the aircraft after ditching and the advantage of ditching versus bailout shall be discussed. The discussion shall include night ditching, partial power ditching, power-off ditching, preparation for ditching, after ditching, and crew member duties.

* j. Emergency Exits. Include illustrations showing emergency exits and entrance points.

* 3.19.1.5.5 Part 5. Ejection/Bailout. Include general information including ejection envelope, and checklist for ejection and/or bailout in accordance with MIL-A-81573. Describe the techniques, precautions, and warning signals for leaving the aircraft in flight. Include complete coverage for bailout from aircraft not equipped with ejection systems, and a brief explanation of parachute characteristics such as deployment speeds. Cover ejection seat procedures and bailout procedures in the event of ejection seat failure. Indicate the proper procedure for preparing the aircraft for bailout and the method of jettisoning cockpit enclosures and doors. Provide a pictorial sequence of operation for ejection and/or bailout.

3.19.1.6 Section VI. All Weather Operation.

* 3.19.1.6.1 Part 1. Instrument Procedures. Include general information

and checklists for procedures unique to instrument flight. Reference applicable manual for standard instrument flight procedures.

* 3.19.1.6.1.1 Simulated Instrument Procedures. Include procedures for flight under simulated instrument conditions. Include procedures for deactivating these instrument systems and equipment. Describe safety precautions, chase plane requirements, instrument hood, radio checks, simulated instrument maneuvers, confidence maneuvers, and instrument patterns.

* 3.19.1.6.1.2 Instrument Flight Procedures. Include procedures for flight under actual IFR conditions to include the following:

a. Instrument Takeoff. Cover engine anti-icing, setting of directional indicators, activation of automatic tracking or computer equipment, and maneuvering limitations while cleaning up and transitioning to climb.

b. Instrument Climb. Describe the speed and attitude parameters for normal instrument climbout, and best fuel power settings.

c. Instrument Cruising Flight. Discuss best economy or maximum endurance power settings, configurations, and airspeeds, referring to Performance Data, Section XI where necessary.

d. Holding. Discuss power settings, airspeeds, and configurations for optimum fuel conservation and maneuverability.

e. Instrument Descent. Discuss the procedures to employ for normal instrument descent, dirty and clean penetration procedures, and operating limitations to be observed.

f. Instrument Approaches. Describe instrument approach patterns and discuss aircraft configuration, procedures, and techniques for all instrument approaches within aircraft capability. Complete coverage on any special precautions or restrictions shall be included.

g. GCA/CCA Approaches. The preparation and procedure to be followed during GCA/CCA approach and special precautions and techniques shall be covered. Unsatisfactory approach indications and procedures for discontinuing such an approach shall be discussed.

h. Formation-Unique Procedures. Discuss section penetration and rendezvous.

i. Carrier-Unique Procedures. Discuss special holding patterns, loiter configurations, bingo fuel, etc.

j. Aviation Facility Ships-Unique Procedures.

* 3.19.1.6.2 Part 2. Extreme Weather Operation. Include general information and checklists for operation under the following extreme weather conditions.

a. Ice, Rain, and Snow. Discuss the precautions and remedial actions appropriate for flight in ice, snow, rain, and hail, covering each phase of flight. Include preflight removal of ice and snow from aircraft surfaces and taxiing on ice or snow. For inflight, cover use of pitot heat, alternate air and defogging equipment, propeller and rotor de-icing provisions, and special empennage or radome de-icing equipment. Cover the freezing of moving parts and flight procedures and characteristics which result. Include the precautions to be observed in applying ice removal and defogging compounds and fluids.

b. Thunderstorms and Turbulence. Briefly describe performance of the aircraft under moderate and severe turbulence conditions. Describe the counteracting procedures to be used including preparation for unavoidable thunderstorm penetration. Cover penetration airspeed, use of autopilot, and control restrictions to be observed.

c. Cold Weather. Discuss the operating requirements which are unique to extreme low temperatures and cold environments by phase of flight. Discuss the use of carrier-type approach for wet, slush-covered, or frozen runways. Discuss the use of ground-effect techniques to counteract adverse runway conditions.

d. Hot Weather. Discuss the operating requirements which are unique to extreme high temperatures and hot environments by phase of flight. Discuss inspection for overinflation of tires in hot weather, and discuss the use of high temperature portions of the Performance Data Charts.

e. Desert Operations. Discuss the operating requirements which are unique to desert environment by phase of flight. Emphasize removal and installation of dust, and sand protective devices.

f. Arctic Operations. Discuss the operating requirements which are unique to arctic environment by phase of flight.

* 3.19.1.7 Section VII. Communications-Navigation Equipment and Procedures. This section shall consist of descriptions of the communications-navigation-identification systems, controls and indicators, and operating procedures for communications equipment.

3.19.1.7.1 Communications-Navigation-Identification System. Description of the systems and equipment shall include (1) type of equipment; (2) A/N nomenclature or applicable Navy designation; (3) function; (4) horizontal range of equipment in miles; (5) location of controls used to operate equipment; (6) identification of the crew member(s) responsible for control of the equipment, and any notes or warnings important to operation or effects on other systems in the aircraft. Fol- [illegible] unless complexity or uniqueness warrants added detail. Include the following systems and equipment.

a. Radios: UHF, VHF, HF, etc.

b. Speech Security System

c. Identification Radar (IFF/SIF)

d. Intercommunications System

3.19.1.7.2 TACAN, LORAN, Marker Beacon Receiver, RDF. Present as specified in 3.19.1.7.1.

3.19.1.7.3 VOR/ILS. Present as specified in 3.19.1.7.1.

3.19.1.7.4 Non-Integral Part of the Weapon System. The following systems shall be described in this section if not an integral part of the weapon system:

a. Terrain Avoidance System

b. Weather Radar

c. Doppler Radar

d. Inertial Navigation System

3.19.1.7.5 Visual Communications. Include illustrations and explanatory text, as necessary, for the following:

a. In-Flight Visual Communication (unique to the aircraft)

b. Ground Handling Signals (unique to the aircraft).

3.19.1.8 Section VIII. Weapons Systems. This section shall include system descriptions, controls and indicators, and operating procedures for weapon systems and associated equipment. Typical coverage includes a brief discussion of the function of the system, location of equipment, source of power, functional description and illustration of each control and display panel, normal turn-on procedures, modes of system operation, and shutdown procedures. Detailed information is required for those mission systems which are highly specialized and unique to the aircraft.

3.19.1.8.1 Part 1. Armament Systems. Part 1 describes all hardware associated with weapons delivery (other than avionics included in Part 2), including the following:

a. Gunnery Equipment

b. Bombing Equipment

c. Rocket and Missile Equipment

d. Special Weapons Equipment

e. Torpedo and Mine Equipment

f. Chemical and Tank Equipment

3.19.1.8.2 Part 2. Avionics. Include all weapons system avionics hardware.

3.19.1.8.2.1 Fire Control Systems. Include computer function and operation, peripheral equipment, and inputs received from other avionics systems.

3.19.1.8.2.2 Radar Systems. Include search, attack, and navigation systems. Include the following if part of a weapons system; if aircraft is not equipped with a weapon system, include the following in Section VII, Communications-Navigation Equipment and Procedures.

a. Terrain Avoidance System

b. Weather Radar

c. Doppler Radar

3.19.1.8.2.3 Inertial Navigation System. If the aircraft is not equipped with a weapon system, include the INS in Section VII, Communications-Navigation Equipment and Procedures.

3.19.1.8.2.4 Target Detection Systems. Include TV, infra-red, laser, and other devices for detection of airborne and surface targets.

3.19.1.8.2.5 Anti-Submarine Warfare Systems. Include all systems for detection of underwater targets.

3.19.1.8.2.6 Tactical Situation Display Systems. Include scope presentations, heads-up displays, and any associated equipment used to present the attack or intercept situation.

3.19.1.8.2.7 Electronic Countermeasures Systems. Include electronic countermeasures and electronic intelligence systems.

3.19.1.8.2.8 Photographic Equipment. Include photo-reconnaissance and radar recorder systems.

3.19.1.8.3 Part 3. Special Missions Systems. Include the following systems not associated with the basic attack/intercept/reconnaissance mission.

a. In-Flight Refueling System (Tanker)

b. Glider Tow Equipment

c. Tow Target System

d. Target Drone Control System

e. Searchlight System

3.19.1.8.4 Part 4. Software. Include computer software functions for computerized, airborne-programmable weapon systems.

3.19.1.8.5 Part 5. Degraded Modes of Operation. Include capabilities and limitations of weapon system and its components when individual systems or parts of systems are down.

3.19.1.8.6 Part 6. Troubleshooting Techniques and Procedures. Include charts, diagrams, and text for airborne troubleshooting of weapon systems.

* 3.19.1.9 Section IX. Flight Crew Coordination. This section shall contain information regarding flight crew coordination, responsibilities, duties, and procedures.

* 3.19.1.9.1 Responsibilities. Define crewmember responsibilities.

* 3.19.1.9.2 Duties. Specify duties of each crewmember for each basic mission of the aircraft.

* 3.19.1.9.3 Procedures. Specify procedures which involve coordination of two or more crewmembers and define interrelationship of individual crewmembers' checklists.

3.19.1.10 Section X. NATOPS Evaluation. This section shall explain the concept and implementation of the NATOPS Evaluation Program and define specific meanings of terms as they are used in the NATOPS program.

3.19.1.10.1 Ground Evaluation. Describe the requirements of ground evaluation: open book examination, closed book examination, oral examination, OFT/WST procedures examination, and question format and grading instructions for each of these types of NATOPS examinations.

* 3.19.1.10.2 Flight Evaluation. Include a description of the flight evaluation phase of NATOPS Evaluation, including the objective and format of flight evaluations. The description should follow the chronology of flight beginning with mission planning/briefing phase and ending with postflight procedures and debriefing. List communications and emergency procedures, and include the procedure for determining the flight evaluation grade.

3.19.1.10.3 Final Grade Determination. Describe the method of determining the final grade.

3.19.1.10.4 Records and Reports. Specify records and reports which must be used and include an illustration of each form. Show entries to be made in the Flight Log Book.

* 3.19.1.10.5 NATOPS Evaluation Question Bank. Include a list of questions concerning standard normal and emergency procedures which form a basis for preparation of ground examinations. Questions may be discussion, completion, true or false, multiple choice, or a combination of these.

3.19.1.11 Section XI. Performance Data.

* 3.19.1.11.1 General.

* 3.19.1.11.1.1 Types of Aircraft. Performance charts required for each type of aircraft are specified in 3.19.1.11.3 through 3.19.1.11.7.

a. 3.19.1.11.3 Fixed Wing Turbojet and Low Bypass Ratio Turbofan Aircraft

b. 3.19.1.11.4 Fixed-Wing Turboprop and High Bypass Ratio Turbofan Aircraft

c. 3.19.1.11.5 Fixed-Wing Reciprocating Engine Aircraft

d. 3.19.1.11.6 Fixed-Wing V/STOL Aircraft

e. 3.19.1.11.7 Helicopters

* 3.19.1.11.1.2 Arrangement of Data. Flight manual performance data for all types of aircraft shall be arranged as follows:

First Page. Section Table of Contents

Part 1. Standard Data

Part 2. Takeoff

Part 3. Climb

Part 4. Range

Part 5. Endurance

Part 6. Inflight Refueling

Part 7. Descent

Part 8. Landing

Part 9. Mission Planning

Part 10. Emergency Operation

Each Part shall contain the following:

a. List of Performance Charts

b. Explanatory Text

c. Sample Problems

d. Performance Charts

The explanatory text shall contain a brief dissertation on the charts which shall describe chart function, method of use, and chart limitations. This dissertation shall avoid duplication of information contained in other sections of the flight manual.

* 3.19.1.11.1.3 Identification. Each page shall be identified by section number and part number given on the upper outer corner. Each chart giving performance data shall contain positive and concise means of identification in a title block at the top of the page. The following information shall be given in the title block:

a. Aircraft model number:

b. Engine model number:

c. Propeller model number:

d. A title descriptive of the data (time to climb, etc.).

e. Configuration (take-off flaps, etc.).

f. Power (two engines, maximum power, etc.).

g. Pressure altitude, if applicable.

h. Atmosphere (standard day, if applicable).

i. Data as of: date.

j. Data basis: estimated or flight test.

k. Fuel grade:

l. Fuel density:

Notes giving information that is required in the interpretation of the charts shall be placed at the bottom of the charts, and shall be numbered. Charts giving data with an engine inoperative shall be marked with a cross hatched border.

* 3.19.1.11.1.4 Guidelines. Each chart giving data as a function of several variables shall have guidelines drawn on the chart which pictorially explain the use of the chart.

* 3.19.1.11.1.5 Operating Procedures. Information contained on performance charts shall be based on, and consistent with, the recommended operating procedures set forth in Sections III, IV and V of the flight manual. If special piloting techniques are required to achieve performance, and these techniques are described in sections III, IV or V, then footnotes should be given on the performance charts referring the reader to the appropriate description elsewhere in the manual.

* 3.19.1.11.1.6 Data Basis

* a. Source of Data. The engine power, fuel flow, and aerodynamic drag used in preparing the charts shall be derived from flight tests whenever available; otherwise, the data presented in the Performance Data Substantiation Reports described in paragraph 3.19.1.11.1.7 of this specification shall be used. Flight test data obtained in tests conducted at Navy testing facilities shall be used in preference to data obtained during contractor flight tests; however, the procuring agency, as a result of a review of the contractor's methods of flight tests, instrumentation, and data reduction techniques, may grant approval for the contractor to use his flight test results as the basis for performance. (See 6.2.1)

* b. Propulsion Data. If engine performance has been verified by flight tests, performance data calculated using engine manufacturer's thrust and fuel flow data, with appropriate corrections for installation losses, shall be labeled flight test data. If engine performance has not been verified by flight tests, then engine manufacturer's fuel flows shall be increased 5 percent, and performance charts shall be labeled "estimated data". In all cases, the status computer deck, with appropriate corrections for installation losses, shall be used as the source of engine manufacturer's data.

c. Drag Data. Performance data calculated using flight verified drag shall be labeled flight test data. Drag may be changed as much as 5 percent for configuration differences between the flight test aircraft and flight manual aircraft, using estimated drag increments to make the change, and the data may still be labeled flight test data.

d. Propeller Efficiency. Propeller efficiency data used in deriving flight test drag polars, and propeller efficiency data used in calculating performance must be consistent.

* 3.19.1.11.1.7 Performance Data Substantiating Reports. The Basic Aerodynamic Data Report and the Substantiating Performance Data Report, required by Specification MIL-D-8706, shall serve to substantiate flight manual performance data. These reports shall present the derivation of drag data for all configurations for which performance data is given in the flight manual, and shall also describe assumptions and techniques used to calculate flight manual performance data.

* 3.19.1.11.1.8 Airspeed. Unless specifically called for otherwise, all airspeeds shall be given as CAS or true Mach Number (or TAS, if applicable); except that IAS shall be given for minimum control speeds, stall speeds, and for takeoff and landing data. IAS shall be based on the primary airspeed system calibration.

* 3.19.1.11.1.9 Atmosphere. ICAO standard atmosphere shall be used unless otherwise specified. Performance data given as a function of temperature shall be given in terms of ambient air temperature, and not in terms of deviation from standard atmosphere temperature, if at all possible.

* 3.19.1.11.1.10 Drag Count. Performance data should be presented in chart form with a chart input variable for drag count of external stores. A drag count of one corresponds to a drag coefficient of 0.0001. In cases where an input variable of drag count cannot be used, and hence charts are applicable to one drag count only, or where the use of drag count is not desirable due to a small number of external store configurations being used, a complete set of charts shall be included for each alternate configuration when a variation in performance between alternate configurations exceeds 5 percent.

* 3.19.1.11.1.11. Power Setting. For takeoff performance and climb performance with flaps extended, Intermediate (Military) Thrust for turbojet and turbofan engines is synonymous with Takeoff Power for turboprop engines. For climb performance with flaps retracted, Intermediate (military) Thrust for turbojet and turbofan engines is synonymous with Maximum Continuous Power For turboprop engines.

* 3.19.1.11.2 Definitions

* 3.19.1.11.2.1 Minimum Control Speeds

a. Ground Minimum Control Speed, V_{MCG}, shall be the minimum airspeed at which directional control can be maintained on the ground using aerodynamic control only with the critical engine inoperative, and propeller feathered on the inoperative engine (if applicable).

b. Air Minimum Control Speed, V_{MCA}, shall be the minimum airspeed at which directional control can be maintained in the air with the critical engine inoperative, not more than five degrees bank away from the inoperative engine, and propeller feathered on the inoperative engine (if applicable).

* 3.19.1.11.2.2 Runway Coefficients of Friction

a. The rolling coefficient of friction used in the calculation of takeoff distance shall be determined by ground tests. When ground test data are not available, a rolling coefficient of friction of 0.025 shall be used for dry, hard surfaces.

b. The braking coefficient of friction used in the calculation of stopping distance shall be determined by ground tests. When ground test data are not available, a braking coefficient of friction of 0.3 shall be used for dry, hard surfaces.

c. Runway Condition Reading, RCR, corrections to the braking coeffieient of friction used in the calculation of stopping distance shall be based on the authorized coefficient of friction for dry hard surfaces at an RCR of 23, and a coefficient of friction of 0 at an RCR of 0, with a linear relationship in between.

* 3.19.1.11.2.3 Takeoff

a. Acceleration check distance or time is the distance or time from start of takeoff to the point at which a particular airspeed of interest is reached during the takeoff ground run.

b. Lift-off speed, V_{LOF}, shall be the speed at which the main landing gear leaves the ground. For conventional aircraft, V_{LOF} shall be at least 10 percent greater than the speed represented by 90 percent maximum lift coefficient, power on, including ground effect. If ground clearance limits the angle of attack at main gear lift-off, V_{LOF} shall be increased to coincide with at least the speed corresponding to maximum obtainable angle of attack as limited by ground clearance with shock absorbers in the static, no lift, position. See 3.19.1.11.2.8.a for lift-off speed criteria of fixed wing V/STOL aircraft.

c. Takeoff ground run distance shall be the ground run in feet to V_{LOF}, lift-off speed.

d. Minimum Go Speed, V_1, shall be the minimum airspeed at which the aircraft can experience an engine failure, and then continue to accelerate to V_{LOF}, lift-off speed, within the remaining runway length. The data is based on an engine failure occuring at the Minimum Go Speed. Engine failure is followed by a three second decision period with the remaining engines operating at the initial thrust setting. In the case of an Intermediate thrust takeoff, an additional time period shall be allowed for advancing the operating engine throttles to Maximum Thrust. The time period to be used shall be applicable to the airplane configuration and be approved by the procuring activity. V_1 shall not be less than V_{MCG}, Ground Minimum Control Speed.

e. Rotation Speed, V_{RO}, is the airspeed at which transition from ground run attitude to lift-off attitude is begun. V_{RO} shall not be less than 1.05 V_{MCA}, Air Minimum Control Speed, nor shall it be less than V_1, Minimum Go Speed.

f. The Speed at the 50 Foot Obstacle Height, V_2, for conventional aircraft, shall be the highest of the following three speeds, determined with takeoff flaps, landing gear retracted: (1) Speed for maximum climb gradient out of ground effect with the critical engine inoperative, takeoff thrust on the operative engines, and propeller feathered on the inoperative engine (if applicable); (2) 1.2 times power-off stall speed; (3) 1.1 times V_{MCA}, Air Minimum Control Speed. See 3.19.1.11.2.8.a for corresponding criteria of fixed wing V/STOL aircraft.

g. Maximum Abort Speed, $V_{MAX\ ABORT}$, shall be the maximum airspeed at which an abort may be started and the aircraft stopped within the remaining runway length. The data are based on a three second decision period after reaching maximum abort speed, with the engines operating at the initial thrust setting during this time. At the end of the three second decision period, a time period shall be allowed for wheel brake application, and a time delay allowed for movement of engine throttles to the idle position and activation of deceleration devices (if applicable). The time periods to be used shall be applicable to the airplane configuration and be approved by the procuring activity.

* h. A.T.O. ignition time or distance shall be the time or distance from start of takeoff at which rocket assist devices are ignited. Unless

otherwise directed by the procuring activity, A.T.O. ignition shall be timed to produce the minimum takeoff ground run distance with all engines operating. (See 6.2.1)

i. Minimum Afterburner Blowout Speed shall be the minimum airspeed at which the aircraft can experience an afterburner failure, and then continue to accelerate to V_{LOF}, Lift-off Speed, within the remaining runway length.

j. Maximum Braking Speed shall be the highest speed from which the aircraft can be brought to a stop without exceeding the maximum design energy absorption capability of the brakes. The data is based on engines producing idle thrust, and on the aircraft being brought to a stop with wheel brakes only.

* 3.19.1.11.2.4 Cruise and Endurance Speeds

a. Maximum Range Cruise Speed for turbojet, turbofan and turboprop powered airplanes shall be the cruise speed which results in attainment of 100 percent of the maximum miles per pound of fuel.

b. Long Range Cruise Speed for reciprocating engine powered airplanes shall be highest of the two cruise speeds which result in attainment of 99 percent of the maximum miles per pound of fuel.

c. Best Range Cruise Speed for helicopters shall be the cruise speed which results in attainment of 100 percent of the maximum miles per pound of fuel.

d. Maximum Endurance Speed shall be the speed which results in the lowest fuel flow rate. Maximum Endurance Speed shall not be less than V_{MCA}, Air Minimum Control Speed, nor shall it be less than airframe buffet speed.

* 3.19.1.11.2.5 Ceilings

a. Service Ceiling shall be the pressure altitude at which the maximum rate of climb is 100 feet per minute at the stated power.

b. Cruise Ceiling shall be the pressure altitude at which the maximum rate of climb is 300 feet per minute at Maximum Continuous Thrust, or the equivalent power setting.

c. Combat Ceiling shall be the pressure altitude at which the maximum rate of power is 500 feet per minute at the stated power (Maximum or Intermediate).

d. Optimum Cruise Altitude (not to exceed Cruise Ceiling) shall be the pressure altitude at which cruise at Maximum Range Cruise Speed, Long Range Cruise Speed, or Best Range Cruise Speed results in the highest possible miles per pound of fuel.

e. Optimum Endurance Altitude (not to exceed Cruise Ceiling) shall be the pressure altitude at which cruise at Maximum Endurance Speed results in the lowest possible fuel flow rate.

* 3.19.1.11.2.6 Wind Corrections. All wind correction plots shall be for 100 percent accountability; i.e., the full force of the reported wind shall be assumed to act on the aircraft.

* 3.19.1.11.2.7 Landing. See 3.19.1.11.2.8.c for landing performance criteria of fixed wing V/STOL aircraft.

* 3.19.1.11.2.7.1 Landing, Land Based Aircraft. Landing Distances for conventional fixed wing aircraft shall be based on the following speeds determined out of ground effect.

a. The speed at the 50 foot obstacle height shall not be less than 1.2 times power-off stall speed.

b. Touchdown speed shall not be less than 1.1 times power-off stall speed.

* 3.19.1.11.2.7.2 Landing, Carrier Based Aircraft. Preliminary NATOPS Flight Manual approach and touchdown speeds shall correspond to 1.05 times $V_{PA_{MIN}}$, using the definition of $V_{PA_{MIN}}$ given in the aircraft detail specification. Final NATOPS Flight Manual approach and touchdown speeds shall be based on flight test results.

* 3.19.1.11.2.8 Fixed Wing V/STOL Aircraft (Performance Criteria).

a. STO, short takeoff, performance shall be based on engines delivering 100 percent of rated power output up to the point at which aircraft configuration is changed from the acceleration configuration to the lift-off configuration. From lift-off to attainment of a height of 50 feet, engines shall be assumed to deliver 95 percent of rated power output. At lift-off, the lift coefficient for single engine aircraft shall not exceed 80 percent of maximum lift coefficient including thrust induced lift effects. For multi-engine aircraft V_{LOF}, Lift-off speed, shall be such that in the event of engine failure, 1.0g flight can be maintained at lift-off speed with one engine inoperative at a lift coefficient not to exceed 80 percent of maximum lift coefficient determined with one engine inoperative and including thrust induced lift effects, with no change in thrust vector angle. For multi-engine aircraft V_2, the speed at the 50 foot obstacle height shall be the speed for maximum climb gradient with one engine inoperative, landing gear retracted, and flaps in the takeoff position. For single engine aircraft, V_2 shall be the speed for maximum climb gradient with landing gear retracted, and flaps in the takeoff position.

b. VTO, vertical takeoff, performance shall be based on engines delivering 95 percent of rated power output.

c. SL, short landing, performance shall be based on engines delivering not more than 85 percent of rated power output from a height of 50 feet down to touchdown. Aerodynamic lift shall be based on no more than 60 percent of maximum lift coefficient at the 50 foot height point, and on no more than 80 percent of maximum lift coefficient at touchdown. Aerodynamic lift as defined above includes thrust induced lift forces.

d. VL, vertical landing, performance shall be based on engines delivering 95 percent of rated power output.

* 3.19.1.11.3 <u>Fixed-Wing Turbojet and Low Bypass Ratio Turbofan Aircraft</u>.

* 3.19.1.11.3.1 <u>Part 1. Standard Data (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan)</u>. Part one includes standard data which is independent of the aircraft, and aircraft performance data which are applicable to more than one flight regime.

* 3.19.1.11.3.1.1 <u>Explanatory Text (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan)</u>. The explanatory text shall include the following:

a. Glossary of Terms and Abbreviations. Include terms which explain the conversion of airspeed from indicated to calibrated to equivalent to true.

b. Weights. Include a Gross Weight Table giving the following weights: (1) Aircraft Empty. Note that aircraft empty weight includes fixed equipment, oil, and unusable fuel. (2) Crew. Note that crew weight includes crew equipment and disposables such as oxygen. (3) Internal Fuel. (4) External Fuel. (5) Gross Weight including internal fuel only but no payload. (6) Gross Weight including internal and external fuel but no payload.

* 3.19.1.11.3.1.2 <u>Performance Charts (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan Aircraft)</u>. The performance charts shall be arranged as follows:

* a. External Store Drag Count and Weight Table. (See Figure 21.) The drag count and weight for each externally carried store and its associated suspension equipment shall be given. If stores are intended to be carried asymmetrically, producing appreciable rolling moment and trim drag, methods of accounting for these effects shall be given.

* b. Standard Units Conversion Chart. (See Figure 22.)

* c. Fuel Density Chart. This shall be a plot of primary and alternate fuel specific weight versus temperature covering a temperature range of -50° to +50°C.

* d. Standard Atmosphere Table. (See Figure 23.)

* e. Temperature Deviation From Standard Chart. (See Figure 24.)

* f. Compressibility Correction to Calibrated Airspeed. (See Figure 25.)

* g. Airspeed Mach Number Conversion Chart. (See Figure 26.)

h. Outside Air Temperature Compressibility Correction Chart. This shall be a plot of indicated outside air temperature versus true ambient air temperature with parameters of Mach Number or true airspeed.

* i. Airspeed Position Error Correction Chart. (See Figure 27.) Charts shall be given covering flap deflection, landing gear extension, speed brakes and ground effect. Data shall be shown for sufficient conditions to provide a $\pm$ 2 knot accuracy.

* j. Altimeter Position Error Correction Chart. (See Figure 28.) Charts shall be given covering flap deflection, landing gear extension, speed brakes and ground effect. Data for subsonic aircraft shall be plotted versus indicated airspeed. For supersonic aircraft, data shall be plotted versus indicated Mach Number also. Data shall be shown for sufficient conditions to provide a $\pm$ 100 foot accuracy.

k. Machmeter Position Error Correction Chart. The correction shall be plotted versus indicated Mach Number with parameters of altitude.

* l. Takeoff/Landing Crosswind Chart. (See Figure 29.) Include minimum nosewheel liftoff (touchdown) speed as a function of runway crosswind component. At the minimum liftoff (touchdown) speed, the aircraft must be capable of ground steering with aerodynamic control only in a crosswind.

m. V_{MCG}, Ground Minimum Control Speed. This shall be a plot of ambient air temperature versus Ground Minimum Control Speed with lines shown on the plot for pressure altitudes of sea level, 4000, 8000 and 12,000 feet. Temperatures shall cover a range from -50° to +50°C. Data shall be given for the engine power settings, and the flap settings, that are normally used for takeoff.

n. V_{MCA}, Air Minimum Control Speed. This shall be a plot of ambient air temperature versus Air Minimum Control Speed with lines shown on the plot for pressure altitudes of sea level, 4000, 8000 and 12,000 feet. Temperatures shall cover a range from -50° to +50°C. Data Shall be given for the engine power settings that are normally used for takeoff. The effect of flap setting shall be shown if applicable.

* o. Stall Speed Chart. This shall be a plot of gross weight versus power-off stall speed, based on the pilot's airspeed system, for bank angles of 0, 30, 45 and 60 degrees. Separate plots shall be included for take-off, cruise, combat, approach and landing configurations. Data shall be labeled as being applicable to altitudes below 10,000 feet.

* p. Angle of Attack Chart. This shall be a plot of indicated airspeed versus indicated angle of attack units, based on the pilot's airspeed system, with lines shown on the plots for various gross weights. Separate plots at sea level shall be furnished for takeoff, cruise, approach and landing configurations. For supersonic aircraft, data shall also be included at an altitude of 35,000 feet plotted versus indicated Mach Number for cruise and combat configurations.

q. Center of Gravity Versus Gross Weight Chart. Forward and aft stability limits shall be shown, and effects of external store and other configuration changes shall be given if applicable. A note shall refer to NAVAIR 01-1B-40 for detailed weight and balance information.

r. Fuel Flow Chart. Graphical data shall be given for Maximum Continuous Power, or the equivalent power setting, with parameters of pressure altitude, ambient air temperature covering a temperature range of -50° to +50°C, and airspeed or Mach Number.

* 3.19.1.11.3.2 Part 2. Takeoff Data (Fixed Wing Turbojet and Low Bypass Ratio Turbofan). Include separate charts for Intermediate (Military) Thrust and for Maximum (Afterburner) Thrust where applicable. Data Shall cover a temperature range from -50° to +50°C, an altitude range from sea level to 12,000 feet, and winds from -40 to +40 knots.

* a. Graphical Illstration of Multi-engine Airplane Takeoff. (Figure 30.) For multi-engine airplanes, sketches similar to those shown on figure 30 shall be presented in the text depicting safe takeoff (Maximum Abort Speed greater than Minimum Go Speed) and unsafe takeoff (Maximum Abort Speed less than Minimum Go Speed) conditions. Explanatory text shall emphasize that takeoff is unsafe if Maximum Abort Speed is less than Minimum Go Speed, because if engine failure occurs at a speed higher than Maximum Abort Speed, insufficient runway remains to complete the takeoff.

* b. V_1, Minimum Go Speed. (See Figure 31.) Include parameters of runway length, ambient temperature, pressure altitude, wind velocity and gross weight.

* c. $V_{MAX\ ABORT}$, Maximum Abort Speed. (See Figure 32.) Include parameters of runway length, ambient temperature, pressure altitude, runway condition reading and gross weight.

* d. V_{LOF}, Lift-off Speed, and V_2, Speed at the 50 Foot Obstacle Height. (See Figure 33.) Parameters shall include ambient temperature, pressure altitude, and gross weight.

* e. Takeoff Distance. (See Figure 34.) Takeoff ground run to lift-off speed, and total distance to clear a 50 foot obstacle, reaching a speed of V_2 at that point, shall be shown with all engines operating. Parameters shall include ambient temperature, pressure altitude, gross weight and wind velocity.

f. A.T.O. Ignition Time or Distance. This shall be a plot of A.T.O. Ignition Time or Distance with parameters of ambient temperature, pressure altitude, runway length, gross weight, and wind velocity. Format shall be similar to the Minimum Go Speed Chart, figure 31.

* g. Takeoff Gross Weight Limit. (See Figure 35.) For multi-engine airplanes, the gross weight shall be shown which results in a rate of climb of 200 feet per minute at lift-off speed with one engine inoperative. Parameters shall include ambient temperature, pressure altitude, wing flap position, and landing gear position.

* h. Velocity During Takeoff Ground Run. (See Figure 36.) This shall be a plot which may be entered with takeoff ground run, and lift-off speed. Following a guide line to a lower speed will yield the ground roll distance at which this speed will be reached.

i. Minimum Afterburner Blowout Speed. Include parameters of runway length, ambient temperature, pressure altitude, wind velocity and gross weight. Format shall be similar to the Minimum Go Speed Chart, figure 31.

j. Maximum Braking Speed. This shall be a plot of maximum braking speed, KIAS, for aborted takeoff from a dry hard surfaced runway. Include parameters of ambient temperature, pressure altitude, and gross weight.

* 3.19.1.11.3.3 Part 3. Climb Data (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan).

* a. Climb Performance. (See Figure 37.) Include a climb speed schedule table (sheet 1) as a function of drag count with fuel allowances for take-off and acceleration to climb speed given as a note. Unless otherwise directed by the procuring activity, fuel allowance shall be fuel for four minutes Intermediate Thrust at sea level, static, standard day conditions. Include graphical data (sheets 2 through 4) for time, fuel and distance to climb with parameters for initial gross weight, pressure altitude, drag count, and temperature deviation from standard day. For fighter and attack aircraft, with all engines operating, include charts for Intermediate (Military) Thrust and for Maximum (Afterburner) Thrust. For all other types of aircraft, with all engines operating, include charts for Maximum Continuous Thrust and for Intermediate (Military) Thrust. For all types of aircraft, with one engine inoperative, include charts for Intermediate (Military) Thrust. Charts shall be given for the clean configuration (flaps up, landing gear retracted) only.

b. Instantaneous Rate of Climb. Parameters shall include air temperature, pressure altitude, gross weight, and drag count. The format shown in figure 39 shall be used. The altitude range shall extend from sea level to Service Ceiling. These charts shall be included for all conditions for which climb performance data, 3.19.1.11.3.3.a., are given.

* c. Service Ceiling. (See Figure 38.) Parameters shall include gross weight, drag count, and temperature deviation from standard day. These data shall be given for Maximum Continuous Thrust with all engines operating and with one engine inoperative.

* d. Combat Ceiling. (See Figure 38.) For fighter and attack aircraft only. Parameters shall include gross weight, drag count, and temperature deviation from standard day. Include charts for Intermediate (Military) Thrust and for Maximum (Afterburner) Thrust with all engines operating.

* e. One Engine Inoperative Climb Performance. (See Figure 39.) Parameters shall include air temperature, pressure altitude, gross weight, and drag count. Climb speed shall be called out on the gross weight lines. These data shall be given for the takeoff and landing configurations (flaps down, landing gear extended) for Intermediate (Military) Thrust.

* 3.19.1.11.3.4 Part 4. Range Data (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan). At the option of the procuring activity, range charts of the types specified for Fixed Wing Turboprop and High Bypass Ratio Turbofan Aircraft in 3.19.1.11.4.4 may be substituted for, or specified as additional charts for, Fixed-Wing Turbojet and Low Bypass Ratio Turbofan

Aircraft. The following types of charts shall be given for all engines operating and one engine inoperative conditions. (See 6.2.1)

a. Optimum Cruise Altitude. This shall be a plot of gross weight versus optimum cruise altitude with parameters of drag count and temperature deviation from standard. Format shall be the same as used in figure 38.

* b. Cruise Performance. (See Figure 40.) Design of charts is as follows: Phase I - Enter chart at aircraft average gross weight and proceed right to intersect pressure altitude line. Proceed up into the top block of data and intersect zero drag count line. From this point move parellel to guide lines to desired Mach number, and project right to read transfer scale. If it is desired to cruise at recommended Mach number for maximum range, move parellel to guide lines to intersect drag count line for appropriate drag count, and at this intersection read Mach number for maximum range and associated transfer scale reading. Phase II - Enter with Mach number, drag count and transfer scale reading, and read reference number. Phase III - Enter with Mach number, reference number and pressure altitude, and read pounds of fuel per nautical mile at zero wind. Phase IV - Enter with Mach number, temperature and pounds of fuel per nautical mile, and read fuel flow at zero wind.

* c. Maximum Range Cruise at Constant Altitude. (See Figure 41.) These charts provide cruise Mach number, true airspeed, ground speed, cruise time, pounds of fuel per nautical mile, fuel flow and fuel required for maximum range cruise at constant altitude as a function of average gross weight, pressure altitude, drag count, ambient temperature, wind velocity, and distance to be traveled.

* d. Speed, Time and Fuel to Cruise. (See Figure 42.) Include parameters of Mach number, ambient temperature, wind speed, distance to be traveled, and fuel flow.

* e. Low Altitude Cruise. (See Figure 43.) For fighter and attack aircraft only. These tables present total fuel flow values for various combinations of true airspeed and drag count at various selected low altitudes. Provide separate charts for several gross weights. Fuel flow values are tabulated for standard day; however, correction factors are given for non-standard temperatures.

* f. Rangewind Correction. (See Figure 44.) This chart includes a means of correcting specific or total range for existing wind effects.

* g. Bingo Chart. (See Figure 45.) These charts show time, fuel and airspeed required to travel a given distance using a combination of climb, maximum range cruise, and maximum range descent. Fuel required values include a fuel allowance for reserve. Unless otherwise directed by the procuring activity, the reserve fuel allowance shall be ten percent of maximum internal useable fuel. Give data for cruise at optimum cruise altitude, and for cruise at sea level. (See 6.2.1)

* 3.19.1.11.3.5 Part 5. Endurance Data (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan). At the option of the procuring activity, endurance charts of the types specified for Fixed-Wing Turboprop and High Bypass Ratio Turbofan Aircraft in 3.19.1.11.4.5 may be substituted

for, or specified as additional charts for, Fixed Wing Turbojet and Low Bypass Ratio Turbofan Aircraft. The following type of chart shall be given for all engines operating and one engine inoperative conditions: (See 6.2.1)

* a. Maximum Endurance. (See Figure 46.) Include parameters for average gross weight, bank angle, pressure altitude, drag count, and temperature deviation from standard.

* 3.19.1.11.3.6 Part 6. In-Flight Refueling Data (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan).

* 3.19.1.11.3.6.1 Tanker Aircraft (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan). Data shall be included for combat aircraft that are equipped to carry a refueling system as an external store.

a. Air Refueling Transfer Time. (See Figure 47.) Parameters shall include gross pounds of fuel transferred, fuel flow rate, and fuel density.

b. Fuel Consumption Rate During Air Refueling. (See Figure 48.) Parameters shall include Mach number or calibrated airspeed, gross weight, drag count, and pressure altitude.

* 3.19.1.11.3.6.2 Receiver Aircraft (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan). Charts shall be the same as described in 3.19.1.11.3.6.1 except that they are applicable to receiver aircraft rather than tanker aircraft.

* 3.19.1.11.3.7 Part 7. Descent Data (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan).

* a. Maximum Range Descent. (See Figure 49.) Include parameters for initial gross weight, pressure altitude, and drag count. Give data for all engines operative, and one engine inoperative conditions.

b. Normal Descent. Constant Calibrated Airspeed. The format of Figure 49 should be used except that sheet 1 may be omitted. Give data for the all engines operative at flight idle thrust, speed brakes retracted only condition. The airspeed to be used shall be applicable to the airplane configuration and be approved by the procuring activity.

c. Quick Descent at Limit Airspeed. The format of figure 49 should be used except that a simplified speed schedule may be given and sheet 1 may be omitted. Give data for all the engines operative at flight idle thrust, speed brakes extended only condition.

* 3.19.1.11.3.8 Part 8. Landing Data (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan). Data shall cover a temperature range from -50° to +50°C, an altitude range from sea level to 12,000 feet, winds from -20 to +40 knots, and slopes from -2° to +2°.

* a. Landing Speeds. (See Figure 50.) For carrier based aircraft include initial stall warning speed, and approach/touchdown speed as a function of gross weight for no flaps and normal landing flaps configurations. Recommended angle of attack setting should appear on the charts. For land based aircraft provide initial

stall warning speed, approach speed, and touchdown speed as a function of gross weight for no flaps and normal landing flaps configurations.

* b. Landing Performance - Ground Roll. (See Figure 51.) Include parameters for temperature, altitude, gross weight, wind velocity, runway condition reading, and runway slope. Include landing speed versus gross weight as a sub-graph. Include data with hard braking only for no flaps and normal landing flaps configurations.

* c. Landing Performance - Total Distance From 50 ft. Height. (See Figure 52.) Same conditions as 3.19.1.11.3.8.b.

* 3.19.1.11.3.9 <u>Part 9. Mission Planning (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan)</u>. Part 9 includesinformation regarding overall mission planning and presents special mission and tactical charts. Do not duplicate in this part charts contained in the aircraft Tactical Manual. External store loadings for charts shall be typical of the aircraft primary mission.

* a. Fuel transferred Versus Radius. (See Figure 53.) For tanker aircraft only. Include parameters for loiter time and refueling rate.

* b. Loiter Time Versus Radius. (See Figure 54.) For search and patrol aircraft only. Include parameters for loiter altitude.

* c. Level Flight Acceleration. (See Figure 55.) For fighter and attack aircraft only. Show time and distance to accelerate from cruise Mach number to combat Mach number. Fuel used can be obtained from initial and final readings of gross weights by following weight guide lines. Include separate charts for Intermediate Thrust and for Maximum Thrust. Include separate charts for individual altitudes covering the range of operating altitudes of the aircraft.

* d. Combat Allowance. (See Figure 56.) For fighter and attack aircraft only. Give combat time as a function of initial gross weight, pressure altitude, drag count, and fuel for combat under conditions of straight level stabilized flight. Include separate charts for Intermediate Thrust and for Maximum Thrust.

* e. Turn Rate Versus Airspeed. (See Figure 57.) For fighter and attack aircraft only. At a gross weight representative of combat weight, show turn rate that can be sustained in level flight with maximum thrust. Also show instantaneous turn rate at maximum useable angle of attack, as defined by maximum lift coefficient under static stall conditions, and at four units below maximum angle of attack. Include parameters for altitude. Include separate charts for Intermediate Thrust and for Maximum Thrust.

* f. Turn Radium Versus Airspeed. (See Figure 58.) For fighter and attack aircraft only. Include data for the same conditions as turn rate.

* g. Altitude Lost in Pullout (See Figure 59.) Parameters shall include altitude, speed, and dive angle at start of pullout. For fighter and attack aircraft, typically 4g and 6g charts are included for both low altitude and high altitude for Intermediate Thrust.

* h. Level Flight Envelope. (See Figure 60.) For fighter and attack aircraft only. Include an envelope of airspeed, or Mach number, versus altitude formed by the minimum and maximum straight level flight operating airspeeds of the aircraft. Include parameters for gross weight and for various configurations if applicable.

* i. Tanker Speed Envelope. For tanker aircraft only. (See Figure 61.) Include an envelope of Mach number or calibrated airspeed formed by the upper and lower speed limits. Show data for refueling drogue extended and retracted configurations.

* j. V-N Envelope. (See Figure 62.) For fighter and attack aircraft only. At a gross weight representative of combat weight, include an envelope of calibrated airspeed and/or Mach Number versus symmetrical limit load factor with lines drawn showing load factor at constant angle of attack. Include separate envelopes for individual altitudes covering the range of operating altitudes of the aircraft.

* 3.19.1.11.3.10. <u>Part 10. Emergency Operation (Fixed-Wing Turbojet and Low Bypass Ratio Turbofan)</u>.

* a. Glide Performance. (See Figure 63.) Give time, distance and speed for maximum range glide descent to sea level with all engines inoperative. Parameters shall include gross weight, drag count, and initial altitude.

* b. Air Start Envelope. (See Figure 64.) Include an envelope of airspeed, or Mach Number, versus altitude formed by the minimum and maximum speeds at which the engine can be airstarted.

* 3.19.1.11.4 <u>Fixed-Wing Turboprop and High Bypass Ratio Turbofan Aircraft</u>.

* 3.19.1.11.4.1 <u>Part 1. Standard Data (Fixed-Wing Turboprop and High Bypass Ratio Turbofan)</u>. Part one includes standard data which are independent of the aircraft, and aircraft performance data which are applicable to more than one flight regime.

* 3.19.1.11.4.1.1 <u>Explanatory Text (Fixed-Wing Turboprop and High Bypass Ratio Turbofan).</u> Same as 3.19.1.11.3.1.1.

* 3.19.1.11.4.1.2 <u>Performance Charts (Fixed-Wing Turboprop and High Bypass Ratio Turbofan Aircraft).</u> The performance charts shall be arranged as follows:

a. External Store Drag Count and Weight Table. Same as 3.19.1.11.3.1.2.a.

* b. Standard Units Conversion Chart. (See Figure 22.)

c. Fuel Density Chart. Same as 3.19.1.11.3.1.2.c.

* d. Standard Atmosphere Table. (See Figure 23.)

* e. Temperature Deviation From Standard Chart. (See Figure 24.)

* f. Compressibility Correction to Calibrated Airspeed. (See Figure 24.)

* g. Airspeed Mach Number Conversion Chart. (See Figure 26.)

h. Outside Air Temperature Compressibility Correction Chart. Same as 3.19.1.11.3.1.2.h.

i. Airspeed Position Error Correction Chart. Same as 3.19.1.11.3.1.2.i.

j. Altimeter Position Error Correction Chart. Same as 3.19.1.11.3.1.2.j.

k. Machmeter Position Error Correction Chart. Same as 3.19.1.11.3.1.2.k.

l. Takeoff/Landing Crosswind Chart. Same as 3.19.1.11.3.1.2.l.

m. V_{MCG}, Ground Minimum Control Speed. Same as 3.19.1.11.3.1.2.m.

n. V_{MCA}, Air Minimum Control Speed. Same as 3.19.1.11.3.1.2.n.

o. Stall Speed Chart. Same as 3.19.1.11.3.1.2.o.

p. Angle of Attack Chart. Same as 3.19.1.11.3.1.2.p.

q. Center of Gravity versus Gross Weight Chart. Same as 3.19.1.11.3.1.2.q.

r. Fuel Flow Chart. Same as 3.19.1.11.3.1.2.r.

* 3.19.1.11.4.2 Part 2. Takeoff Data (Fixed-Wing Turboprop and High Bypass Ratio Turbofan). Include charts for Intermediate (Military), Maximum (Afterburner) and any reduced power setting normally used for takeoff, when applicable.

a. Graphical Illustration of Multi-engine Airplane Takeoff. For multi-engine airplanes. Same as 3.19.1.11.3.2.a.

* b. Static Power Check for Takeoff. (See Figure 65.) For turboprop powered aircraft only. Include shaft horsepower or torque pressure available for takeoff with parameters for ambient temperature and pressure altitude.

c. V_1, Minimum Go Speed. Same as 3.19.1.11.3.2.b.

d. $V_{MAX\ ABORT}$, Maximum Abort Speed. Same as 3.19.1.11.3.2.c.

e. V_{LOF}, Lift-off Speed, and V_2, Speed at the 50 Foot Obstacle Height. Same as 3.19.1.11.3.2.d.

f. Takeoff Distance. Same as 3.19.1.11.3.2.e.

g. A.T.O. Ignition Time or Distance. Same as 3.19.1.11.3.2.f.

h. Takeoff Gross Weight Limit. For multi-engine airplanes. Same as 3.19.1.11.3.2.g. Propeller of inoperative engine is feathered.

i. Velocity During Takeoff Ground Run. Same as 3.19.1.11.3.2.h.

j. Maximum Braking Speed. Same as 3.19.1.11.3.2.j.

* k. Climb-Out Factor. (See Figure 66.) For turboprop powered aircraft only. The climb-out factor is a reference number utilized on climb-out flight path charts, 3.19.1.11.4.2.1, to simplify the determination of climb-out performance. Parameters shall include ambient termperature, pressure altitude, and gross weight. For multi-engine aircraft, include charts with all engines operating and with one engine inoperative.

* l. Climb-Out Flight Path. (See Figure 67.) For turboprop powered aircraft only. These shall be plots of vertical height above takeoff point versus horizontal distance from brake release with the parameter of climb-out factor. All engine operating charts shall be constructed to a minimum of either 8,000 foot vertical height or 20 nautical mile horizontal distance. One engine inoperative charts shall be constructed to a minimum of either 1,000 foot vertical height or 10 nautical mile horizontal distance. One engine inoperative charts shall be based on engine failure occurring during the takeoff run at a speed such that, under conditions of no wind with a dry runway, the runway lengths required for continued acceleration to liftoff speed, or braking to a stop are equal. Landing gear retraction shall be initiated 3 seconds after liftoff. The Speed at the 50 Foot Obstacle Height, V_2, shall not be exceeded during landing gear retraction. After gear retraction, the aircraft shall be accelerated to flap retraction speed, at which time flap retraction shall be initiated. After flaps are up, the aircraft shall be accelerated to the best climb speed. The final climb segment shall be performed with flaps up at best climb speed using Maximum Continuous power. Charts shall be based on maintaining takeoff power until the start of the final climb segment, or when engine time limit is reached, whichever occurs first.

* 3.19.1.11.4.3 Part 3. Climb Data (Fixed-Wing Turboprop and High Bypass Ratio Turbofan). All data with one engine inoperative for turboprop powered aircraft shall be given with propeller feathered on the inoperative engine.

a. Climb Performance. Same as 3.19.1.11.3.3.a.

b. Instantaneous Rate of Climb. Same as 3.19.1.11.3.3.b.

c. Service Ceiling. Same as 3.19.1.11.3.3.c.

d. Combat Ceiling. Same as 3.19.1.11.3.3.d.

e. One Engine Inoperative Climb Performance. Same as 3.19.1.11.3.3.e.

* 3.19.1.11.4.4 Part 4. Range Data (Fixed-Wing Turboprop and High Bypass Ratio Turbofan). The data presentation format given in 3.19.1.11.3.4 for Fixed Wing Turbojet and Low Bypass Ratio Turbofan Aircraft are not applicable to Fixed Wing Turboprop and High Bypass Ratio Aircraft. Therefore the following format must be used. The following types of charts shall be given for all engines operating and one engine inoperative conditions. Charts are required for alternate configurations when the variation in range exceeds five percent.

* a. Mission Profile - Maximum Range. (See Figure 68.) This chart includes a simplified method of flight planning at standard day conditions. The chart is

based on a sequence of Maximum Power takeoff, Intermediate Power climb, and Maximum Range cruise (zero wind). A fuel allowance is included for engine start, taxi, takeoff and acceleration to climb speed. Unless otherwise directed by the procuring activity, this allowance shall be fuel for four minutes at Intermediate Power, or the equivalent, at sea level, static, standard day conditions. No fuel allowance is included for descent, landing, or reserve. The Mission Profile chart can be used to determine directly the total fuel required to fly a given distance, or the total distance available for a given fuel load at any altitude. (See 6.2.1)

b. Mission Profile - Minimum Time. Same as 3.19.1.11.4.4.a, except that cruise is at Maximum Continuous Power, or the equivalent.

* c. Maximum Range Summary. (See Figure 69.) This chart includes nautical miles per 1000 pounds of fuel and calibrated airspeed for Maximum Range cruise at constant altitude at standard day conditions.

* d. Maximum Range Cruise. (See Figure 70.) This table presents torque per engine, fuel flow per engine, total fuel flow, and calibrated airspeed for Maximum Range Cruise Speed for Various combinations of altitude and gross weight. Include separate tables for temperature deviations from standard of -20, 0, 20 and 40 degrees centigrade.

e. Minimum Time Cruise. Same as 3.19.1.11.4.4.d. except that cruise is at Maximum Continuous Power, or the equivalent.

* f. Nautical Miles Per 1000 Pounds of Fuel. (See Figure 71.) This shall be a plot of nautical miles per 1000 pounds of fuel versus Mach Number, true airspeed and calibrated airspeed at standard day conditions extending from Maximum Endurance Speed to speed with Intermediate Power. Lines of constant total fuel flow [illegible] ed by increments of 5000 or 10,000 feet covering a range from sea level to approximately Cruise Celing for the lightest weight.

g. Rangewind Correction. Same as 3.19.1.11.3.4.f.

h. Bingo Chart. Same as 3.19.1.11.3.4.g.

* 3.19.1.11.4.5 <u>Part 5. Endurance Data (Fixed-Wing Turboprop and High Bypass Ratio Turbofan)</u>. The following types of charts shall be given for all engines operating and one engine inoperative conditions. Charts are required for alternate configurations when the variation in fuel flow exceeds five percent.

* a. Maximum Endurance Profile. (See Figure 72.) This chart shows maximum endurance that is available for any fuel remaining quantity at any altitude, and also what is available by climbing from sea level to Optimum Endurance Altitude. A climb speed schedule is also given. A fuel allowance is included for reserve. Unless otherwise directed by the procuring activity, the reserve fuel allowance shall be ten percent of maximum internal useable fuel. (See 6.2.1)

* b. Maximum Endurance Summary. (See Figure 73.) This chart includes total fuel flow rate and calibrated airspeed for Maximum Endurance Speed.

* 3.19.1.11.4.6 Part 6. In-Flight Refueling Data (Fixed-Wing Turboprop and High Bypass Ratio Turbofan).

* 3.19.1.11.4.6.1 Tanker Aircraft (Fixed-Wing Turboprop and High Bypass Ratio Turbofan). Data shall be included for combat aircraft that are equipped to carry a refueling system as an external store.

a. Air Refueling Transfer Time. Same as 3.19.1.11.3.6.1.a.

b. Fuel Consumption Rate During Air Refueling. Same as 3.19.1.11.3.6.1.b.

* 3.19.1.11.4.6.2 Receiver Aircraft (Fixed-Wing Turboprop and High Bypass Ratio Turbofan). Charts shall be the same as described in 3.19.1.11.4.6.1 except that they are applicable to receiver aircraft rather than tanker aircraft.

* 3.19.1.11.4.7 Part 7. Descent Data (Fixed-Wing Turboprop and High Bypass Ratio Turbofan).

a. Maximum Range Descent. Same as 3.19.1.11.3.7.a.

b. Normal Descent. Same as 3.19.1.11.3.7.b.

c. Quick Descent at Limit Airspeed. Same as 3.19.1.11.3.7.c.

* 3.19.1.11.4.8 Part 8. Landing Data (Fixed-Wing Turboprop and High Bypass Ratio Turbofan).

a. Landing Speeds. Same as 3.19.1.11.3.8.a.

b. Landing Performance - Ground Roll. Same as 3.19.1.11.3.8.b.

c. Landing Performance - Total Distance from 50 Ft. Height. Same as 3.19.1.11.3.8.c.

* 3.19.1.11.4.9 Part 9. Mission Planning (Fixed-Wing Turboprop and High Bypass Ratio Turbofan). Part 9 includes information regarding overall mission planning and presents special mission and tactical charts. Do not duplicate in this part charts contained in the aircraft Tactical Manual.

a. Fuel Transferred Versus Radius. For tanker aircraft only. Same as 3.19.1.11.3.9.a.

b. Loiter Time Versus Radius. For search and patrol aircraft only. Same as 3.19.1.11.3.9.b.

c. Level Flight Acceleration. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.c.

d. Combat Allowance. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.d.

e. Turn Rate Versus Airspeed. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.e.

f. Turn Radius Versus Airspeed. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.f.

g. Altitude Lost In Pullout. Same as 3.19.1.11.3.9.g.

h. Level Flight Envelope. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.h.

i. Tanker Speed Envelope. For tanker aircraft only. Same as 3.19.1.11.3.9.i.

j. V-N Envelope. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.j.

* 3.19.1.11.4.10 Part 10. Emergency Operation (Fixed-Wing Turboprop and High Bypass Ratio Turbofan).

a. Glide Performance. Same as 3.19.1.11.3.10.a.

b. Air Start Envelope. Same as 3.19.1.11.3.10.b.

* 3.19.1.11.5 Fixed-Wing Reciprocating Engine Aircraft

* 3.19.1.11.5.1 Part 1. Standard Data (Fixed-Wing Reciprocating Engine).

* 3.19.1.11.5.1.1 Explanatory Text (Fixed-Wing Reciprocating Engine). Same as 3.19.1.11.3.1.1.

* 3.19.1.11.5.1.2 Performance Charts (Fixed-Wing Reciprocating Engine Aircraft). The performance charts shall be arranged as follows:

a. External Store Drag Count and Weight Table. Same as 3.19.1.11.3.1.2.a.

* b. Standard Units Conversion Chart. (See Figure 22.)

c. Fuel Density Chart. Same as 3.19.1.11.3.1.2.c.

* d. Standard Atmosphere Table. (See Figure 23.)

* e. Temperature Deviation From Standard Chart. (See Figure 24.)

* f. Density Altitude Chart. (See Figure 74.)

* g. Psychrometric Chart. (See Figure 75.) This chart includes the determination of dew point temperature as a function of dry bulb temperature, wet bulb temperature, and pressure altitude.

* h. Compressibility Correction to Calibrated Airspeed. (See Figure 25.)

* i. Airspeed Mach Number Conversion Chart. (See Figure 26.)

j. Outside Air Temperature Compressibility Correction Chart. Same as 3.19.1.11.3.1.2.h.

k. Airspeed Position Error Correction Chart. Same as 3.19.1.11.3.1.2.i.

l. Altimeter Position Error Correction Chart. Same as 3.19.1.11.3.1.2.j.

m. Takeoff/Landing Crosswind Chart. Same as 3.19.1.11.3.1.2.1.

n. V_{MCG}, Ground Minimum Control Speed. Same as 3.19.1.11.3.1.2.m.

o. V_{MCA}, Air Minimum Control Speed. Same as 3.19.1.11.3.1.2.n.

p. Stall Speed Chart. Same as 3.19.1.11.3.1.2.o.

q. Angle of Attack Chart Same as 3.19.1.11.3.1.2.p.

r. Center of Gravity versus Gross Weight Chart. Same as 3.19.1.11.3.1.2.q.

s. Fuel Flow Chart. Same as 3.19.1.11.3.1.2.r.

* t. Engine Operating Limits Curve. (See Figure 76.) This shall be a plot of limit brake horsepower versus pressure altitude for conditions of standard atmosphere, no humidity, and no ram. Parameters shall include engine R.P.M. and manifold pressure.

* u. Maximum Power Available. (See Figure 77.) This chart includes maximum available brake horsepower and manifold pressure with parameters of pressure altitude, carburator air temperature, and dew point temperature. Charts are required for Takeoff, Military, and Maximum Continuous (METO or Normal) power ratings.

* 3.19.1.11.5.2 Part 2. Takeoff Data (Fixed-Wing Reciprocating Engine). Include charts for all power settings normally used for takeoff.

a. Graphical Illustration of Multi-engine Airplane Takeoff. For multi-engine airplanes. Same as 3.19.1.11.3.2.a.

b. V_1 Minimum Go Speed. This shall be a plot of V_1 with parameters for brake horsepower, density altitude, runway length, wind velocity, and gross weight. Format shall be similar to figure 31 except for the following changes to the first block of data: (1) Enter with brake horsepower rather than ambient temperature. (2) Proceed upward to density altitude rather than pressure altitude.

c. $V_{MAX\ ABORT}$, Maximum Abort Speed. This shall be a plot of $V_{MAX\ ABORT}$ with parameters for brake horsepower, density altitude, runway length, runway condition reading, and gross weight. Format shall be similar to Figure 32 except for the following changes to the first block of data: (1) Enter with brake horsepower rather than ambient temperature. (2) Proceed upward to density altitude rather than pressure altitude.

d. V_{LOF}, Lift-off Speed, and V_2, Speed at the 50 Foot Obstacle Height. Same as 3.19.1.11.3.2.d.

e. Takeoff Distance. Takeoff ground run to lift-off speed, and total distance to clear a 50 foot obstacle, reaching a speed of V_2 at that point, shall be shown with all engines operating. Parameters shall include brake horsepower, density altitude, gross weight, and wind velocity. Format shall be similar to that shown in figure 34 except for the following changes to the first block of data: (1) Enter with brake horsepower rather than ambient temperature. (2) Proceed upward to density altitude rather than pressure altitude.

f. A.T.O. Ignition Time or Distance. This shall be a plot of A.T.O. Ignition Time or Distance with parameters for brake horsepower, density altitude, runway length, wind velocity, and gross weight. Format shall be similar to that shown in figure 31 except for the following changes: First block of data - (1) Enter with brake horsepower rather than ambient temperature. (2) Proceed upward to density altitude rather than pressure altitude. Last block of data - Exit to A.T.O. Ignition Time or Distance rather than Minimum Go Speed.

g. Takeoff Gross Weights Limits. For multi-engine airplanes. This shall be a plot of the gross weight which results in a rate of climb of 200 feet per minute with one engine inoperative, with propeller feathered on the inoperative engine. Parameters shall include brake horsepower, density altitude, wing flap position, and landing gear position. Format shall be similar to that shown in figure 35 except for the following changes to the first block of data: (1) Enter with brake horsepower rather than ambient temperature. (2) Proceed upward to density altitude rather than pressure altitude.

h. Velocity During Takeoff Ground Run. Same as 3.19.1.11.3.2.h.

i. Maximum Braking Speed. Same as 3.19.1.11.3.2.j.

* 3.19.1.11.5.3 Part 3. Climb Data (Fixed-Wing Reciprocating Engine). All data with one engine inoperative shall be given with propeller feathered on the inoperative engine.

* a. Time to Climb. (See Figure 78.) This shall be a plot of time to climb versus gross weight with parameters of pressure altitude. Several guide lines indicating the monetary weights during climb also shall be shown to provide a measure of fuel consumption and weight reduction during climb. Service ceiling, cruise ceiling, climb speed, and fuel allowance for warm-up and takeoff shall be indicated on the chart. Unless otherwise directed by the procuring activity, fuel allowance shall be fuel for five minutes Maximum Continuous Power at sea level, static standard day conditions. Include charts for both all engine operating and one engine inoperative conditions for all power conditions normally used for climb. Charts are required only for standard day conditions in the clean configuration (flaps up, landing gear retracted). (See 6.2.1)

b. Distance To Climb. This shall be a plot of distance to climb in nautical miles versus gross weight with parameters of pressure altitude. Chart format and conditions are identical to Time to Climb, 3.19.1.11.5.3.a.

c. Instantaneous Rate of Climb. This shall be a plot of rate of climb and climb path gradient with parameters of brake horsepower, density altitude, gross weight and drag count. Format shall be similar to that shown in figure 39 except for the following changes to the first block of data: (1) Enter with brake horsepower rather than ambient temperature. (2) Proceed upward to density altitude rather than pressure altitude. These charts shall be included for all conditions for which time to climb charts, 3.19.1.11.5.3.a, are given. Charts shall be given also with one engine inoperative and with takeoff power on the other engines for the takeoff and landing configurations (flaps down, landing gear extended).

d. Service Ceiling. Same as 3.19.1.11.3.3.c.

* 3.19.1.11.5.4 Part 4. Range Data (Fixed-Wing Reciprocating Engine). Data are required for Standard Day conditions only. The following types of charts shall be given for all engines operative and one engine inoperative conditions.

a. Nautical Miles Per Pound of Fuel. (Similar to Figure 71.) This shall be a plot of specific range versus airspeed extending from Maximum Endurance Speed to High Speed with Maximum Continuous Power. Lines of constant engine power setting (manifold pressure and R.P.M.) shall be shown on the plots. The Long Range airspeed shall be shown on the plots. The effect of wind on long range cruise speed shall also be shown for 100 knot headwinds and tailwinds.

* b. Long Range Power Conditions. (See Figure 79.) This shall be a plot of gross weight versus specific range, fuel flow, engine manifold pressure, engine R.P.M., and calibrated airspeed with parameters of altitude for long range cruise conditions.

* c. Long Range Prediction - Distance. (See Figure 80.) This shall be a plot of gross weight versus air nautical miles at altitude with parameters of altitude. The charts are used to predict still air range available for a given expenditure of fuel. Cruise is at Long Range Cruise Speed.

d. Long Range Prediction - Time. This shall be a plot of gross weight versus time at altitude in hours with parameters of altitude. The chart is a companion to Long Range Prediction - Distance, 3.19.1.11.5.4.c.

e. Rangewind Correction. Same as 3.19.1.11.3.4.f.

f. Bingo Chart. Same as 3.19.1.11.3.4.g.

* 3.19.1.11.5.5 Part 5. Endurance Data (Fixed-Wing Reciprocating Engine). Data are required for Standard Day Conditions only. The following types of charts shall be given for all engines operative and one engine inoperative conditions.

a. Maximum Endurance Power Conditions. This shall be a plot of gross weight versus specific range, fuel flow, engine manifold pressure, engine R.P.M., and calibrated airspeed with parameters of altitude for maximum endurance conditions. Format shall be similar to that shown in figure 79.

b. Maximum Endurance Prediction - Time. This shall be a plot of gross weight versus time at altitude with parameters of altitude. The chart is used to predict flight time for a given expenditure of fuel at Maximum Endurance Speed. Format shall be similar to that shown in figure 80.

* 3.19.1.11.5.6 Part 6. Descent Data (Fixed-Wing Reciprocating Engine).

a. Maximum Range Descent. Same as 3.19.1.11.3.7.a.

b. Normal Descent. Same as 3.19.1.11.3.7.b.

c. Quick Descent at Limit Airspeed. Same as 3.19.1.11.3.7.c.

* 3.19.1.11.5.7 Part 7. Landing Data (Fixed-Wing Reciprocating Engine).

a. Landing Speeds. Same as 3.19.1.11.3.8.a.

b. Landing Performance - Ground Roll. Same as 3.19.1.11.3.8.b.

c. Landing Performance - Total Distance From 50 Ft. Height. Same as 3.19.1.11.3.8.c.

* 3.19.1.11.5.8 Part 8. Mission Planning (Fixed-Wing Reciprocating Engine). Part 8 includes information regarding overall mission planning and presents special mission and tactical charts. Do not duplicate in this part charts contained in the aircraft Tactical Manual.

a. Loiter Time Versus Radius. For search and patrol aircraft only. Same as 3.19.1.11.3.9.b.

b. Altitude Lost In Pullout. Same as 3.19.1.11.3.9.g.

* 3.19.1.11.5.9 Part 9. Emergency Operation (Fixed-Wing Reciprocating Engine).

a. Glide Performance. Same as 3.19.1.11.3.10.a.

* 3.19.1.11.6 Fixed-Wing V/STOL Aircraft.

* 3.19.1.11.6.1. Part 1. Standard Data (Fixed-Wing V/STOL). Part one includes standard data which are independent of the aircraft, and aircraft performance data which are applicable to more than one flight regime.

* 3.19.1.11.6.1.1 Explanatory Text (Fixed-Wing V/STOL). Same as 3.19.1.11.3.1.1.

* 3.19.1.11.6.1.2 Performance Charts (Fixed-Wing V/STOL). The performance charts shall be arranged as follows:

a. External Store Drag Count and Weight Table. Same as 3.19.1.11.3.1.2.a.

* b. Standard Units Conversion Chart. (See figure 22.)

c. Fuel Density Chart. Same as 3.19.1.11.3.1.2.c.

* d. Standard Atmosphere Table. (See Figure 23.)

* e. Temperature Deviation From Standard Chart. (See Figure 24.)

* f. Compressibility Correction to Calibrated Airspeed. (See Figure 25.)

* g. Airspeed Mach Number Conversion Chart. (See Figure 26.)

h. Outside Air Temperature Compressibility Correction Chart. Same as 3.19.1.11.3.1.2.h.

i. Airspeed Position Error Correction Chart. Same as 3.19.1.11.3.1.2.i.

j. Altimeter Position Error Correction Chart. Same as 3.19.1.11.3.1.2.j.

k. Machmeter Position Error Correction Chart. Same as 3.19.1.11.3.1.2.k.

l. Takeoff/Landing Crosswind Chart. Same as 3.19.1.11.3.1.2.l.

m. V_{MCG}, Ground Minimum Control Speed. Same as 3.19.1.11.3.1.2.m.

n. V_{MCA} Air Minimum Control Speed. Same as 3.19.1.11.3.1.2.n..

o. Stall Speed Chart. Same as 3.19.1.11.3.1.2.o.

p. Angle of Attack Chart. Same as 3.19.1.11.3.1.2.p.

q. Center of Gravity versus Gross Weight Chart. Same as 3.19.1.11.3.1.2.q.

r. Fuel Flow Chart. Same as 3.19.1.11.3.1.2.r.

* 3.19.1.11.6.2 <u>Part 2. Takeoff Data (Fixed-Wing V/STOL)</u>. Include charts for the power settings generally used for V/STOL. Charts are required for the following types of takeoff: (1) Conventional Takeoff: Data are required with all engines operative, and with engine failure considered to occur during the ground run. (2) Short Takeoff: Data are required with all engines operative, and with engine failure considered to occur only at lift-off speed. (3) Vertical takeoff: Data are required only with all engines operative. (4) Rolling Vertical Takeoff: Data are required only with all engines operative.

a. Static Power Check for Takeoff. Same as 3.19.1.11.4.2.b.

b. Conventional Takeoff, Graphical Illustration of Multi-engine Airplane Takeoff. For multi-engine airplanes. Same as 3.19.1.11.3.2.a.

c. Conventional Takeoff, V_1, Minimum Go Speed. Same as 3.19.1.11.3.2.b.

d. Conventional Takeoff, $V_{MAX\ ABORT}$, Maximum Abort Speed. Same as 3.19.1.11.3.2.c.

e. Conventional Takeoff, V_{LOF}, Lift-off Speed, and V_2, Speed at the 50 Foot Obstacle Height. Same as 3.19.1.11.3.2.d.

f. Conventional Takeoff, Takeoff Distance. Same as 3.19.1.11.3.2.e.

g. Conventional Takeoff, Gross Weight Limit. Same as 3.19.1.11.3.2.g. Data shall be given for the thrust vector angle (nozzle angle) used for conventional takeoff.

h. Conventional Takeoff, Velocity During Takeoff Ground Run. Same as 3.19.1.11.3.2.h.

i. Conventional Takeoff, Maximum Braking Speed. Same as 3.19.1.11.3.2.j.

* j. Short Takeoff, Nozzle Rotation Speed. (See Figure 81.) This chart gives the speed at which the thrust vector angle (nozzle angle) is changed from the ground run setting to the lift-off setting. Parameters shall include ambient temperature, pressure altitude, and gross weight.

* k. Short Takeoff, Nozzle Angle. (See Figure 82.) This chart gives the thrust vector angle (nozzle angle) at lift-off. Parameters shall include ambient temperature, pressure altitude, and gross weight. A note shall give the ground run nozzle angle.

l. Short Takeoff, V_{LOF}, Lift-off Speed, and V_2, Speed at the 50 Foot Obstacle Height. Same as 3.19.1.11.3.2.d.

m. Short Takeoff, Takeoff Distance. Same as 3.19.1.11.3.2.e.

n. Short Takeoff, Gross Weight Limit. Same as 3.19.1.11.3.2.g. Data shall be given for the thrust vector angle (nozzle angle) used at lift-off; and, a note shall be given at the bottom of the chart noting this fact.

* o. Vertical Takeoff, Gross Weight Limit. (See Figure 83.) This chart includes the vertical takeoff weight capability with parameters of ambient temperature, pressure altitude, and power setting.

* p. Rolling Vertical Takeoff Distance. (See Figure 84.) Include parameters of ambient temperature, pressure altitude, gross weight, and wind velocity. The takeoff technique; i.e., thrust vector angle (nozzle angle), and power setting shall be described in notes.

3.19.1.11.6.3 Part 3. Climb Data (Fixed-Wing V/STOL).

a. Climb Performance. Same as 3.19.1.11.3.3.a.

b. Instantaneous Rate of Climb. Same as 3.19.1.11.3.3.b.

c. Service Ceiling. Same as 3.19.1.11.3.3.c.

d. Combat Ceiling. Same as 3.19.1.11.3.3.d.

e. One Engine Inoperative Climb Performance. Same as 3.19.1.11.3.3.e. These data shall be given for the conventional takeoff and conventional landing flight modes only. For aircraft with manual control of the thrust vector angle (nozzle angle), data shall be given for the thrust vector angles used at lift-off and touchdown respectively; and, notes shall be given at the bottom of the chart noting this fact.

* 3.19.1.11.6.4 Part 4. Range Data (Fixed-Wing V/STOL). Charts are required for alternate configurations when the variation in range exceeds five percent. The following types of charts shall be given for all engines operating and one engine inoperative conditions:

a. Mission Profile - Maximum Range. Same as 3.19.1.11.4.4.a.

b. Mission Profile - Minimum Time. Same as 3.19.1.11.4.4.b.

c. Maximum Range Summary. Same as 3.19.1.11.4.4.c.

d. Maximum Range Cruise. Same as 3.19.1.11.4.4.d.

e. Minimum Time Cruise. Same as 3.19.1.11.4.4.e.

f. Nautical Miles Per 1000 Pounds of Fuel. Same as 3.19.1.11.4.4.f.

g. Rangewind Correction. Same as 3.19.1.11.3.4.f.

h. Bingo Chart. Same as 3.19.1.11.3.4.g.

* 3.19.1.11.6.5 Part 5. Endurance Data (Fixed-Wing V/STOL). Charts are required for alternate configurations when the variation in fuel flow exceeds five percent. The following types of charts shall be given for all engines operating and one engine inoperative conditions:

a. Maximum Endurance Profile. Same as 3.19.1.11.4.5.a.

b. Maximum Endurance Summary. Same as 3.19.1.11.4.5.b.

c. Hover Fuel Flow. This shall be a plot of total fuel flow in hover with parameters of ambient temperature, pressure altitude, and gross weight.

* 3.19.1.11.6.6 Part 6. In-Flight Refueling Data (Fixed-Wing V/STOL).

* 3.19.1.11.6.6.1 Tanker Aircraft (Fixed-Wing V/STOL). Data shall be included for combat aircraft that are equipped to carry a refueling system as an external store.

a. Air Refueling Transfer Time. Same as 3.19.1.11.3.6.1.a.

b. Fuel Consumption Rate During Air Refueling. Same as 3.19.1.11.3.6.1.b.

* 3.19.1.11.6.6.2 Receiver Aircraft (Fixed-Wing V/STOL). Charts shall be the same as described in 3.19.1.11.6.6.1 except that they are applicable to receiver

aircraft rather than tanker aircraft.

* 3.19.1.11.6.7 Part 7. Descent Data (Fixed-Wing V/STOL).

a. Maximum Range Descent. Same as 3.19.1.11.3.7.a.

b. Normal Descent. Same as 3.19.1.11.3.7.b.

c. Quick Descent at Limit Airspeed. Same as 3.19.1.11.3.7.c.

* 3.19.1.11.6.8 Part 8. Landing Data (Fixed-Wing V/STOL). Data shall be given with braking action supplied by means of wheel brakes only, and by means of wheel brakes plus thrust vector braking (nozzle angle), where applicable. Charts are required for the following types of landing: (1) Conventional Landing. (2) Short Landing. (3) Vertical Landing.

a. Conventional Landing, Landing Speeds. Same as 3.19.1.11.3.8.a.

b. Conventional Landing, Landing Performance - Ground Roll. Same as 3.19.1.11.3.8.b.

c. Conventional Landing, Landing Performance - Total Distance From 50 Ft. Height. Same as 3.19.1.11.3.8.c.

* d. Short Landing, Landing Distance. Include ground roll and total distance from a height of 50 feet with parameters of ambient temperature, pressure altitude, gross weight, and wind velocity. A format similar to that shown in figure 34 shall be used. The landing technique; i.e., thrust vector angle (nozzle angle), power settings, and angle of attack or airspeed, shall be described in footnotes or in separate charts if required. For multi-engine aircraft, charts shall be included for all engines operative and for one engine inoperative conditions.

* e. Vertical Landing, Gross Weight Limit. This chart includes the vertical landing weight capability with parameters of ambient temperature, pressure altitude, and power setting. A format similar to that shown in figure 83 shall be used. For multi-engine aircraft, charts shall be included for all engines operative and for one engine inoperative conditions.

* 3.19.1.11.6.9 Part 9. Mission Planning (Fixed-Wing V/STOL). Part 9 includes information regarding overall mission planning and presents special mission and tactical charts. Do not duplicate in this part charts contained in the aircraft Tactical Manual.

a. Fuel Transferred Versus Radius. For tanker aircraft only. Same as 3.19.1.11.3.9.a.

b. Loiter Time Versus Radius. For search and patrol aircraft only. Same as 3.19.1.11.3.9.b.

c. Level Flight Acceleration. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.c.

d. Combat Allowance. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.d.

e. Turn Rate Versus Airspeed. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.e.

f. Turn Radius Versus Airspeed. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.f.

g. Altitude Lost In Pullout. Same as 3.19.1.11.3.9.g.

h. Level Flight Envelope. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.h.

i. Tanker Speed Envelope. For tanker aircraft only. Same as 3.19.1.11.3.9.i.

j. V-N Envelope. For fighter and attack aircraft only. Same as 3.19.1.11.3.9.j.

* 3.19.1.11.6.10 Part 10. Emergency Operation (Fixed-Wing V/STOL).

a. Glide Performance. Same as 3.19.1.11.3.10.a.

b. Air Start Envelope. Same as 3.19.1.11.3.10.b.

* 3.19.1.11.7 Helicopters.

* 3.19.1.11.7.1 Part 1. Standard Data (Helicopter). Unless otherwise specified, charts in Part 1 are as described in 3.19.1.11.3.1.2. (See 6.2.1)

* a. Airspeed Calibration (See Figure 85.)

* b. Altitude Calibration (See Figure 86.)

* c. Density Altitude/Temperature Conversion. (See Figure 87.)

* d. Shaft Horsepower vs. Torque. Parameters shall include indicated torque, turbine speed/engine RPM, and horsepower. (See Figure 88.)

* e. Fuel Flow vs. Torque. Chart shall be a plot of fuel flow per engine versus torque pressure. (See Figure 89.)

* f. Engine Performance. (See Figure 90.)

g. Engine Operating Limits (Reciprocating Engines). Same as 3.19.1.11.5.1.2.t.

h. Maximum Power Available (Reciprocating Engines). Same as 3.19.1.11.5.1.2.u.

* 3.19.1.11.7.2 Part 2. Takeoff Data (Helicopter).

* a. Hover Gross Weight Limits. Provide maximum gross weight allowable for hover at military power when entered with pressure altitude, ambient air temperature, and wind velocity, for in and out of ground effect conditions. Altitude range should be from sea level to 20,000 feet and outside temperature range from -60°C to 60°C. Wind velocity should be from 0 to 30 knots. (See Figure 91.)

* b. Torque Required to Hover. Include charts for in and out of ground effect hovering. Charts should be plots of gross weight versus torque pressure with parameters of pressure altitude and correction plots of rotor RPM and outside air temperature. The rotor RPM correction is applicable only if the helicopter has an operational band of rotor RPM. This chart should be placed in the manual on the right-hand page opposite the chart for maximum gross weight to hover. (See Figure 92.)

* 3.19.1.11.7.3 Part 3. Climb Data (Helicopter).

* a. Climb Performance. This chart shall include necessary climb performance for all appropriate power settings. Parameters shall include gross weight, pressure altitude, climb time, distance, fuel, and a climb speed schedule. (See Figure 93.)

* b. Service Ceiling. Parameters shall include gross weight, temperature, pressure altitude, and indicated airspeed. (See Figure 94.)

* 3.19.1.11.7.4 Part 4. Range Data (Helicopter).

* a. Best Range. Parameters shall include gross weight, pressure altitude, unit range, IAS, CAS, fuel flow, and approximate torque at standard temperature and 100% rotor RPM. (See Figure 95.)

* b. Range at Maximum Continuous Power. Parameters shall include gross weight, pressure altitude, unit range, IAS, CAS, fuel flow, and approximate torque at standard temperature and 100% rotor RPM. (See Figure 96.)

* c. Time and Range vs. Fuel. Parameters shall include ranges of fuel quantity, fuel flow, time, TAS, and range in nautical miles (See Figure 97.)

* 3.19.1.11.7.5 Part 5. Endurance Data (Helicopter).

* a. Maximum Endurance. Parameters shall include gross weight, pressure altitude, IAS, CAS, fuel flow, time, and approximate torque at standard temperature and 100% rotor RPM. (See Figure 98.)

* b. Hovering Endurance. Include charts for out-of-ground effect hovering. Include parameters of gross weight, pressure altitude, ambient temperature, and fuel flow. (See Figure 99.)

* 3.19.1.11.7.6 Part 6. Emergency Operation (Helicopter).

* a. Single-Engine Range. Same as 3.19.1.11.7.4.a except for single-engine operation. (See Figure 100.)

* b. Single-Engine Endurance. Same as 3.19.1.11.7.5.a except for single-engine operation. (See Figure 101.)

* c. Single-Engine Service Ceiling. Parameters shall include pressure altitude, temperature, rotor speed, and gross weight. (See Figure 102.)

* d. Ability to Maintain Flight on One Engine. Parameters shall include altitude, IAS, temperature, and gross weight (in increments of 2000 pounds throughout operating range). Charts shall be provided for -20°C, 0°C, 20°C, and 40°C. (See Figure 103.)

* e. Minimum Airspeed for Flight with One Engine. Parameters shall include gross weight, temperature, and CAS based on 100% rotor RPM, military power, sea level, and out-of-ground effect conditions. (See Figure 104.)

* 3.19.1.11.7.7 Part 7. Special Charts (Helicopter).

a. Radius of Turn at Constant Airspeed. Parameters shall include TAS, turn radius (feet), and bank angle for standard (three degree per second) and double standard (six degree per second) turns. (See Figure 105.)

3.19.2 NATOPS Flight Manual Supplement.

* 3.19.2.1 Supplement Content. NATOPS Flight Manual Supplements are intended as supplements to a formal NATOPS Flight Manual. Technical content shall follow the same order of arrangement specified for formal manuals, with no requirement that all sections or parts of sections be present. All other requirements for format and content and arrangement of front matter and indices shall apply.

3.19.3 NATOPS Partial (Integratable) Flight Manuals.

* 3.19.3.1 Partial Manual Content. NATOPS Partial Manuals are intended for use with a NATOPS Flight Manual, some parts of which are replaced by the partial manual. Technical content of the partial manual will be the same as that of the applicable manual. Pages shall be arranged so as to allow replacement of pages in the manual with the pages of the partial manual.

4. QUALITY ASSURANCE PROVISIONS

* 4.1 Responsibility for Inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements. (See 6.2.1)

* 4.2 In-Process Review, Validation, and Verification. The review, validation, and verification of NATOPS publications will be the responsibility of the NATOPS Model Manager.

* 4.3 Rough Draft Review of Performance Data. Performance data shall not be incorporated into the NATOPS Flight Manual until the rough draft performance charts and accompanying text have been approved by the procuring activity.

5. PREPARATION FOR DELIVERY

* 5.1 Packaging. The material furnished according to this specification shall be packaged as directed in this specification.

5.1.1. Manuscript Review Copy. Manuscript review copy shall be packaged flat in the most appropriate containers. The review artwork and text material may be separated in one container or may be in separate containers. Review copies of large artwork may be folded. The containers shall protect the manuscript copy from damage that frequently occurs during shipping.

5.1.2 Reproducible Material. Reproducible copy shall be packaged flat and shall be double packaged. The interior packaging material shall be waterproof and free from chemicals that would destroy or discolor the reproducible copy. The exterior packaging shall be a standard commercial carton at least equal to Interstate Commerce Standards. It should be strong enough to protect the reproducible copy from damage that frequently occurs during shipping.

5.1.3 Negatives. Negatives will be collated in page sequence and shall be packaged the same as reproducible material. They will have slip sheets of white manifold onion skin, or other suitable paper between negatives. Foldout negatives should be collated separately in numerical sequence with appropriate sized slip sheets between each negative.

5.1.4 Classified Material. Classified material shall be packaged in accordance with DOD 5200.1-R.

* 5.1.5 Original Artwork. Artwork shall be packaged as specified in 5.1.2. Artwork shall not be folded or rolled. Original artwork is not to be confused with reproducible copy. Original artwork shall be prepared in accordance with 3.17 through 3.17.7.6, and furnished to the Government when specified by the procuring activity. Original artwork is an integral part of each manual unless otherwise specifically approved in advance as a contractural deviation by the procuring activity. (See 6.2.1)

5.1.6 Shipment Container Information. In addition to sender and addresses information, the outside of each container shall include:

a. Publication identifying number.

b. Contract or purchase order number.

c. "MANUSCRIPT COPY", when applicable.

d. "REPRODUCIBLE COPY", when applicable.

e. "NEGATIVES", when applicable.

f. "ORIGINAL ARTWORK", when applicable.

g. Number of containers in shipment.

5.1.7 Packing List. A copy of the letter of transmittal, and the packing list, shall be placed inside the container. When there are several containers in the shipment, the packing list shall be placed in the first container. The packing list shall identify the material enclosed in each container.

5.2 Printing Instructions. Manual pages shall be 8-1/2 x 11 inches after trimming. Pages of manuals shall be printed on JCP A-60 (or equivalent weight) white paper. The paper shall not exceed 100 pounds per 1000 sheets of 17 x 22 inch paper. Covers shall be printed on high-impact linear polyethylene plastic (Tenite). The following colors for Tenite covers will be used: Secret - Light red #50075, Confidential - Dark yellow #50116, Unclassified - Light blue #50345. Manuals shall be drilled for a three post or three ring binder in accordance with MIL-P-38790 and bound with hidden posts and screws.

6. NOTES

6.1 Intended Use. Flight manuals prepared in accordance with this specification are intended to augment the NATOPS program.

* 6.1.1 Figures Contained in This Specification. The figures contained in this specification are examples intended to illustrate style, format and sample content. The figures shall not be used for interpretation of specific technical content or exact scale requirements.

* 6.2 Ordering Data.

* 6.2.1 Procurement Requirements. Procurement documents for NATOPS Flight Manuals shall specify:

a. Title, number, and date of this specification.

* b. When to prepare a change or revision. (See 3.15)

* c. Approval of graph. (See 3.17.5.1)

* d. Flight test data requirements. (See 3.19.1.11.1.6)

* e. A.T.O. ignition time. (See 3.19.1.11.2.3.h)

* f. Type of range charts. (See 3.19.1.11.3.4)

* g. Reserve fuel allowance. (See 3.19.1.11.3.4.g and 3.19.1.11.4.5.a)

* h. Type of endurance charts. (See 3.19.1.11.3.5)

* i. Fuel allowance. (See 3.19.1.11.4.4.a and 3.19.1.11.5.3.a)

* j. Standard data charts for helicopters. (See 3.19.1.11.7.1)

* k. Quality assurance requirements. (See 4.1)

* l. When original artwork will be furnished. (See 5.1.5)

* 6.2.2 Data Requirements. When this specification is used in a procurement which incorporates a DD Form 1423 and invokes the provisions of 7-104.9(n) of the Defense Aquisition Regulations (DAR), the data requirements identified below will be developed as specified by an approved Data Item Description (DD Form 1664) and prepared in accordance with the approved Contract Data Requirements List (DD Form 1423) incorporated into the contract. When the provisions of DAR 7-104.9(n) are not invoked, the data specified below will be prepared by the contractor in accordance with the contract requirements. Data required by this specification is cited in the following paragraph:

Paragraph	Data Requirement	Applicable DID
3.4.1.2	Flight Operations Data	UDI-M-21368

(Copies of Data Item Description required by the contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

6.3 Definitions.

6.3.1 Change. A change means a modification of information in an existing flight manual.

6.3.2 Revision. A revision is a second or subsequent edition of a manual which supersedes the preceding edition.

6.3.3 Supplement. A supplement is a subsidiary document which complements information in a manual, usually for a special application.

6.3.4 Reprint. A reprint is a second or subsequent printing of a manual, including all changes. Normally, all changes are merged with the basic manual and a note to that effect is added to the title page.

6.3.5 Technical Work Directive. A technical work directive is an Airframe Change, Avionics Change, Single Action Maintenance Instruction, Continuing Action Maintenance Instruction, Technical Directive, or Service Bulletin.

6.3.6 Preliminary Issue. A preliminary flight manual is normally intended for interim use to make the information available for test, verification, or training purposes.

6.3.7 Copy Freeze Date. The copy freeze date is the date that the contractor or procuring activity decides that no more additions, deletions, and changes will be made to the publication material. Additions, deletions, and changes submitted after the copy freeze date will be accumulated for preparation of a subsequent change or revision of the manual. The copy freeze date shall be agreed upon at the appropriate NATOPS conference, unless otherwise directed by the procuring activity. The copy freeze date of a basic, revised, or changed manual must agree with the publication date.

6.3.8 Multi-Volume Publications. Multi-volume publications are assigned individual publication numbers. If a volume is further divided, the manner of division shall be decided by the procuring activity. (See 3.13.)

6.4 Update of Data. Refer to 3.14 through 3.15.2 for changes and revisions.

* 6.5 Changes From Previous Issue. The margins of this specification are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Preparing Activity:

NAVY-AS

(Project TMSS N123)

HYDRAULIC SUPPLY SYSTEM	*PRIMARY SIDEHEAD* *12 PT. FUTURA DEMI-BOLD, COMPOSER UN-11-B OR EQUIVALENT*
Utility System No. 1	*SECONDARY SIDEHEAD* *11 PT. FUTURA DEMI-BOLD, COMPOSER UN-11-B OR EQUIVALENT*
FAILURE OF UTILITY SYSTEM NO. 1	*TERTIARY SIDEHEAD* *10 PT. MODERN, COMPOSER C-10-M OR EQUIVALENT*
FAILURE IN FLIGHT. When the utility system fails in flight, switch to the power supply system.	*QUATERNARY SIDEHEAD* *10 PT. MODERN, COMPOSER C-10-M OR EQUIVALENT*

FIGURE 1. Example of type styles.

SECTION I - AIRCRAFT

TABLE OF CONTENTS

PART 1 - GENERAL DESCRIPITION

THE AIRCRAFT.

The Lockheed LC-130F/R is an all-metal, high-wing, long-range, land-based monoplane. It is especially adapted to operate on skis from snow and ice surfaces, as well as on more conventional type landing gear. The mission of the aircraft is to provide rapid transportation of personnel or cargo for delivery by parachute or landing. The aircraft can be used as a tactical transport, carrying 92 ground troops or 64 paratroops and equipment, and it can be readily converted for ambulance, aerial delivery, or bulk fuel transportation missions. When used as an ambulance, the aircraft can carry 74 litters. There are provisions for normal liferaft storage to accommodate 80 persons for overwater flights. The LC-130F/R can land and take-off on short runways, and it can be used on landing strips such as those usually found in advance base operations.

FIGURE 2. Example of section table of contents.

NAVAIR 01-40ABC-1

NATOPS FLIGHT MANUAL

NAVY MODEL

F-35B

AIRCRAFT

THIS MANUAL SUPERSEDES NAVAIR 01-40ABC-1 DATED 15 JULY 1970, CHANGED 15 MARCH 1972, WHICH SHOULD BE DESTROYED

Three-quarter view line drawing of aircraft in flight in clean configuration.

ISSUED BY AUTHORITY OF THE CHIEF OF NAVAL OPERATIONS AND UNDER THE DIRECTION OF THE COMMANDER, NAVAL AIR SYSTEMS COMMAND

1 JANUARY 1973

THE AIRCRAFT	1
INDOCTRI-NATION	2
NORMAL PROCEDURES	3
FLIGHT CHARAC	4
EMER PROCEDURES	5
ALL-WEA OPERATION	6
COMM PROCEDURES	7
WEAPONS SYSTEMS	8
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PERFORM DATA	11
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FIGURE 3. Example of cover - NATOPS flight manual.

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NAVAIR 01-40ABC-1A

CURRENT APPLICABLE
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(REFER TO DOD 5200.1-R)

SUPPLEMENTAL NATOPS FLIGHT MANUAL

NAVY MODEL

F-35B

AIRCRAFT (U)

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THIS PUBLICATION SUPPLEMENTS NAVAIR 01-40ABC-1 NATOPS FLIGHT MANUAL FOR MODEL F-35B AIRCRAFT

This publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of an unfriendly nation, unless specifically authorized by the "Operational Commander."

THIS DOCUMENT CONTAINS NATIONAL SECURITY INFORMATION. UNAUTHORIZED DISCLOSURE IS SUBJECT TO CRIMINAL SANCTION.

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1 JANUARY 1973

THIS PAGE IS UNCLASSIFIED

THE AIRCRAFT 1

COMM PROCEDURES 7

WEAPONS SYSTEMS 8

PERFORM DATA 11

FIGURE 3. Example of cover - classified supplement. - Continued

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SUPPLEMENTAL NATOPS FLIGHT MANUAL

NAVY MODEL

F-35B

AIRCRAFT (U)

WEAPONS SYSTEMS 8

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SECRET *1 JANUARY 1973*

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FIGURE 3. Example of cover - classified supplement. - Continued

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NAVAIR 01-40ABC-1

NATOPS FLIGHT MANUAL

NAVY MODEL

F-35B

AIRCRAFT

Manufacturer's Name

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Three-quarter view line drawing or halftone of aircraft in flight in clean configuration. Halftone should have light background and high contrast aircraft tones.

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1 JANUARY 1973

FIGURE 4. Example of title page - NATOPS flight manual.

THE AIRCRAFT 1

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NAVAIR 01-40ABC-1A

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SUPPLEMENTAL
NATOPS FLIGHT MANUAL

NAVY MODEL

F-35B

AIRCRAFT (U)

Manufacturer's Name

COMM PROCEDURES 7

WEAPONS SYSTEMS 8

In addition to security requirements which must be met, this document is subject to special export controls and each transmittal to foreign governments, foreign nationals or agents thereof may be made only with the prior approval of the NAVAIRSYSCOMHQ, Washington, D.C.

THIS MANUAL SUPERSEDES NAVAIR 01-40ABC-1A DATED 15 JULY 1970, CHANGED 15 MARCH 1972, WHICH SHOULD BE DESTROYED IN ACCORDANCE WITH APPLICABLE SECURITY REGULATIONS

THIS PUBLICATION SUPPLEMENTS NAVAIR 01-40ABC-1 NATOPS FLIGHT MANUAL FOR MODEL F-35B AIRCRAFT

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1 JANUARY 1973

FIGURE 4. Example of title page - classified supplement. - Continued

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SUPPLEMENTAL
NATOPS FLIGHT MANUAL

NAVY MODEL

F-35B
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SECRET *1 JANUARY 1973*

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FIGURE 4. Example of title page - classified supplement. - Continued

CHANGE NOTICE

THESE ARE SUPERSEDING OR SUPPLEMENTARY PAGES TO SAME PUBLICATION OF PREVIOUS DATE
Insert these pages into basic publication
Destroy superseded pages

NAVAIR 01-40ABC-1

NATOPS FLIGHT MANUAL

NAVY MODEL

F-35B

AIRCRAFT

Manufacturer's Name

THIS MANUAL SUPERSEDES NAVAIR 01-40ABC-1
DATED 1 OCTOBER 1967, CHANGED 1 JULY 1969

Three-quarter view line drawing or halftone of aircraft in flight in clean configuration. Halftone should have light background and high contrast aircraft tones.

ISSUED BY AUTHORITY OF THE CHIEF OF NAVAL OPERATIONS
AND UNDER THE DIRECTION OF THE COMMANDER,
NAVAL AIR SYSTEMS COMMAND

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1 JANUARY 1973

Change 1 — 1 January 1974

FIGURE 4. Example of title page - NATOPS flight manual change. - Continued

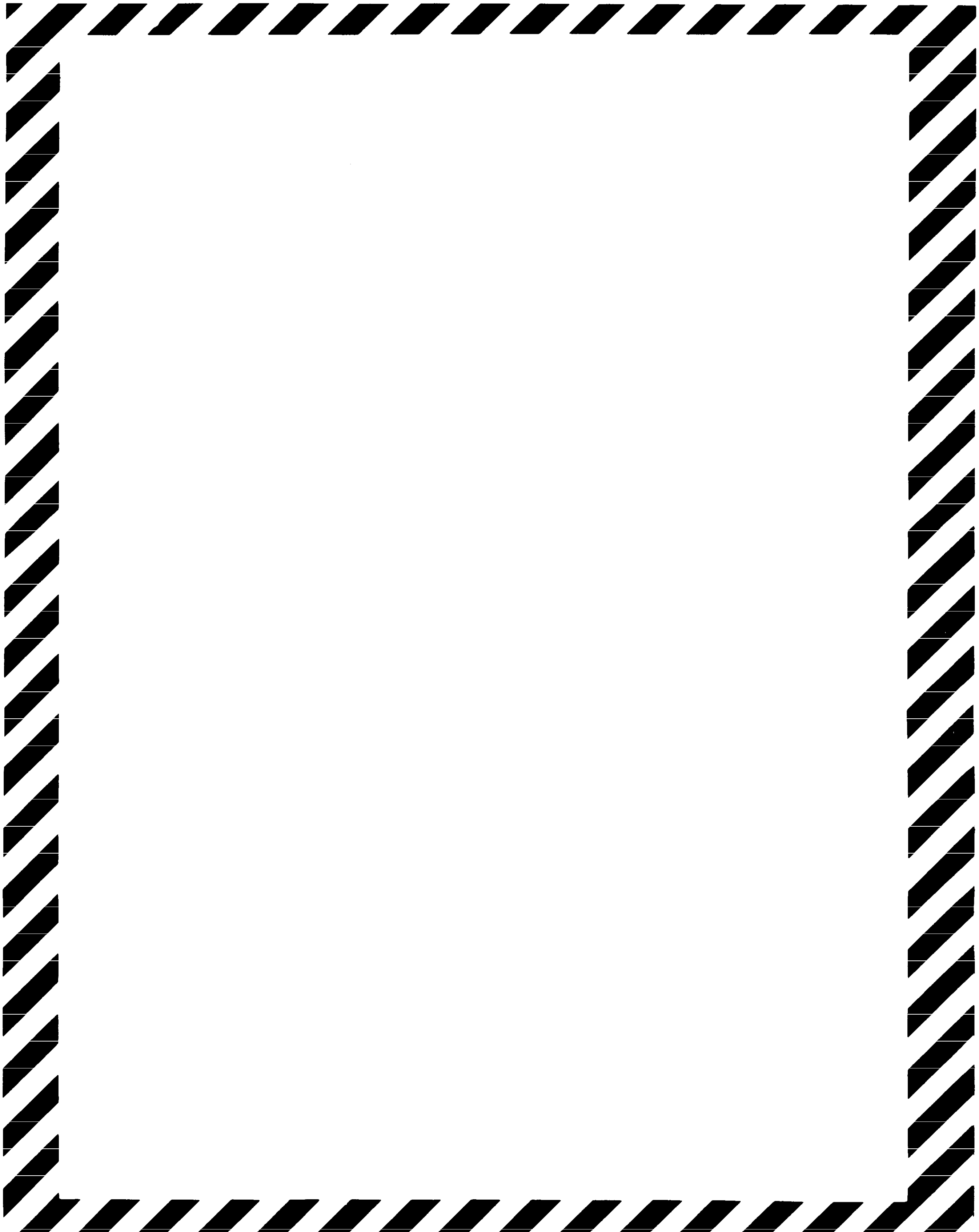

FIGURE 5. Example of emergency data page.

NAVAIR 01-40ABC-1

LIST OF EFFECTIVE PAGES

Dates of issue for original and change pages are:

Original (0) . . . . 1 Mar 69
Change 1 . . . . 27 Aug 69
Change 2 . . . . 4 May 71
Change 3 . . . . 27 Oct 71
Change 4 . . . . 19 Jun 72
Change 5 . . . . 15 Aug 72

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 931, CONSISTING OF THE FOLLOWING:

Page No	*Issue*	*Page No.*	*Issue*	*Page No.*	*Issue*	*Page No.*	*Issue*
*Title	5	1-61	4	1-180 — 1-181	2	1-256	2
*A — C	5	1-62	2	1-182	0	1-257 — 1-258	0
Letter of Promulgation		1-62A/(1-62B blank)	2	1-183	2	1-259 — 1-262	
(Reverse blank)	0	1-63	2	1-184 — 1-185	0	(Deleted)	2
i	2	1-64	4	1-186 — 1-187	2	1-263 — 1-267	2
*ii — iv	5	1-65	0	1-188	3	1-268	0
*(v blank)/vi	5	*1-66 — 1-68	5	1-189 — 1-191	2	1-269	2
1-1	2	1-69 — 1-70	0	1-192 — 1-195	0	1-270 — 1-272	0
1-2	0	1-71	4	1-196	1	1-273	2
1-3	2	1-72	0	1-197 — 1-199	0	1-274 — 1-278	0
1-4 — 1-7	0	1-73	4	*1-200	5	*1-279	5
1-8	2	1-74 — 1-75	0	1-201	0	1-280	0
1-9/(1-10 blank)	2	*1-76	5	1-202	2	*1-281	5
1-11	2	1-77 — 1-78	0	1-203 — 1-204	0	1-282 — 1-283	0
1-12	4	*1-79	5	*1-205	5	1-284	2
1-12A — 1-12B	2	1-80 — 1-93	0	1-206 — 1-207	0	1-285	0
1-13 — 1-19	0	1-94	4	1-208	2	1-286	2
1-20	2	1-95 — 1-98	0	1-209 — 1-212	0	1-287 — 1-299	0
1-21	0	1-98A/(1-98B blank)	0	1-213 — 1-214	2	1-300 — 1-301	2
1-22	2	1-99 — 1-119	0	1-215	0	1-302	0
1-23/(1-24 blank)	0	1-120 — 1-123	2	1-216	2	1-303/(1-304 blank)	0
1-25 — 1-28	0	1-124 — 1-125	0	*1-217/(1-218 blank)	5	1-305	2
1-29	2	1-126	1	*1-219	5	1-306 — 1-309	0
1-30 — 1-34	0	1-127	0	1-220	1	*1-310	5
1-35	1	*1-128	5	1-221	2	1-311	0
1-36 — 1-37	0	1-129	2	1-222 — 1-223	0	1-312 — 1-313	2
1-38	2	1-130 — 1-141	0	*1-224	5	1-314 — 1-316	0
1-39	0	*1-142	5	1-225 — 1-226	0	1-317 — 1-318	2
*1-40	5	1-143 — 1-146	0	1-227	2	1-319	4
1-41 — 1-42	0	1-147	2	*1-228	5	1-320	2
1-43	2	1-148	0	1-229	2	1-320A/(1-320B	
1-44 — 1-45	0	1-149	2	1-230	0	blank)	4
1-46	2	1-150	0	1-231	2	1-321	4
1-47 — 1-54	0	*1-151	5	1-232	0	1-322	0
1-55	4	1-152 — 1-153	0	1-233 — 1-239	2	1-323	2
1-56	0	*1-154	5	1-240 — 1-242	0	1-324	4
1-57	4	1-155 — 1-157	0	1-243	2	*1-325	5
1-58	0	1-158	2	1-244 — 1-249	0	1-326	2
1-59	4	*1-159 — 1-162	5	1-250 — 1-251	2	1-327	0
1-60	0	1-163 — 1-179	0	1-252 — 1-255	0	1-328	4

*The asterisk indicates pages changed, added, or deleted by the current change.

A

FIGURE 6. Example of list of effective pages.

NAVAIR 01-40ABC-1

INTERIM CHANGE SUMMARY

The following Interim Changes have been canceled or previously incorporated in this manual:

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE

The following Interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE

Interim Changes Outstanding - To be maintained by the custodian of this manual:

INTERIM CHANGE NUMBER	ORIGINATOR/DATE (or DATE/TIME GROUP)	PAGES AFFECTED	REMARKS/PURPOSE

B

FIGURE 7. Example of interim change summary.

NAVAIR 01-40ABC-1

SUMMARY OF APPLICABLE TECHNICAL DIRECTIVES

Information relating to the following recent technical directives has been incorporated in this manual

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION
AFC 575	Replaces the ARN-21D TACAN set with an ARN-52(V) TACAN set.	1 Oct. 71	By removal of TACAN DME feature from the Armament panel.
AFC 576	Changes ON/NORM placard on the Master Exterior Light switch to read OFF/ON.	15 Nov. 72	By reference to the Master Exterior Light switch on the left longeron switch panel.

Information relating to the following recent technical directives will be incorporated in a future change

CHANGE NUMBER	DESCRIPTION	VISUAL IDENTIFICATION
AFC 577	Modifies the 20mm gun system by installation of a gun charge switch.	By appearance of gun charge switch on gun select switch panel.

C

FIGURE 8. Example of summary of applicable technical directives.

NAVAIR 01-40ABC-1

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

1 January 1978

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization Program (NATOPS) is a positive approach toward improving combat readiness and achieving a substantial reduction in the aircraft accident rate. Standardization, based on professional knowledge and experience, provides the basis for development of an efficient and sound operational procedure. The standardization program is not planned to stifle individual initiative, but rather to aid the Commanding Officer in increasing his unit's combat potential without reducing his command prestige or responsibility.

2. This manual standardizes ground and flight procedures but does not include tactical doctrine. Compliance with the stipulated manual procedure is mandatory except as authorized herein. In order to remain effective, NATOPS must be dynamic and stimulate rather than suppress individual thinking. Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end, Commanding Officers of aviation units are authorized to modify procedures contained herein, in accordance with the waiver provisions established by OPNAVINST 3510.9 series, for the purpose of assessing new ideas prior to initiating recommendations for permanent changes. This manual is prepared and kept current by the users in order to achieve maximum readiness and safety in the most efficient and economical manner. Should conflict exist between the training and operating procedures found in this manual and those found in other publications, this manual will govern.

3. Checklists and other pertinent extracts from this publication necessary to normal operations and training should be made and may be carried in Naval Aircraft for use therein. It is forbidden to make copies of this entire publication or major portions thereof without specific authority of the Chief of Naval Operations.

W. D. Houser
W.D. HOUSER
Vice Admiral, USN
Deputy Chief of Naval Operations
(Air Warfare)

FIGURE 9. Example of promulgation page.

NAVAIR 01-40ABC-1 Contents

TABLE OF CONTENTS

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FIGURE 10. Example of table of contents.

Foreword NAVAIR 01-40ABC-1

FOREWORD

SCOPE

The NATOPS Flight Manual is issued by the authority of the Chief of Naval Operations and under the direction of Commander, Naval Air Systems Command in conjunction with the Naval Air Training and Operating Procedures Standardization (NATOPS) Program. This manual contains information on all aircraft systems, performance data, and operating procedures required for safe and effective operations. However, it is not a substitute for sound judgement. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein. Read this manual from cover to cover. It's your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

NAVAIR 01-40ABC-1A (Supplement)
NAVAIR 01-40ABC-1C (Emergency Card Checklist)
NAVAIR 01-40ABC-1.1C (Normal Card Checklist)
NAVAIR 01-40ABC-1.2C (ACS Card Checklist)
NAVAIR 01-40ABC-1F (Functional Checkflight Checklist)
NAVAIR 01-40ABC-1S (Scroll Checklist)

HOW TO GET COPIES

Automatic Distribution

To receive future changes and revisions to this manual or any other NAVAIR aeronautical publication automatically, a unit must be established on an automatic distribution list maintained by the Naval Air Technical Services Facility (NATSF). To become established on the list or to change existing NAVAIR publication requirements, a unit must submit a Mailing List Request for Aeronautic Technical Publications (NAVAIR Form 5605/3, Part II), to NATSF, 700 Robbins Ave., Philadelphia, Pa. 19111, listing requirements or changes thereto in accordance with the instructions contained on the request form. For additional information, refer to NAVAIRINST 5605.4 series and NAVSUP Publication 2002, Section VIII, Part C.

Additional Copies

Additional copies of this manual and changes thereto may be procured by submitting DD Form 1348 to Naval Publications and Forms Center, Philadelphia in accordance with NAVSUP Publication 2002, Section VIII, Part C.

UPDATING THE MANUAL

To ensure that the manual contains the latest procedures and information, NATOPS review conferences are held in accordance with OPNAVINST 3510.11 series.

CHANGE RECOMMENDATIONS

Recommended changes to this manual or other NATOPS publications may be submitted by anyone in accordance with OPNAVINST 3510.9 series.

Routine change recommendations are submitted directly to the Model Manager on OPNAV Form 3500-22 shown on the next page. The address of the Model Manager of this aircraft is

Commanding Officer
Fleet Air Reconnaissance Squadron Four
Naval Air Station
Patuxent River, Maryland 20670

Change recommendations of an URGENT nature (safety of flight, etc.) should be submitted directly to the NATOPS Advisory Group Member in the chain of command by priority message.

YOUR RESPONSIBILITY

NATOPS Flight Manuals are kept current through an active manual change program. Any corrections, additions, or constructive suggestions for improvement of its content should be submitted by routine or urgent change recommendation, as appropriate, at once.

NATOPS FLIGHT MANUAL INTERIM CHANGES

Flight Manual Interim Changes are changes or corrections to the NATOPS Flight Manuals promulgated by CNO or NAVAIRSYSCOM. Interim Changes are issued either as printed pages, or as a naval message. The Interim Change Summary page is provided as a record of all interim changes. Upon receipt of a change or revision, the custodian of the manual should check the updated Interim Change Summary to ascertain that all outstanding interim changes have been either incorporated or canceled; those not incorporated shall be recorded as outstanding in the section provided.

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FIGURE 11. Example of foreword.

NATOPS/TACTICAL CHANGE RECOMMENDATION
OPNAV FORM 3600/22 (5-89) 0107-722-2002

DATE

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

FROM (originator)	Unit
TO (Model Manager)	Unit

Complete Name of Manual/Checklist	Revision Date	Change Date	Section/Chapter	Page	Paragraph

Recommendation (be specific)

☐ CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title

Address of Unit or Command

TO BE FILLED IN BY MODEL MANAGER (*Return to Originator*)

FROM	DATE
TO	

REFERENCE
(a) Your Change Recommendation Dated ____________

☐ Your change recommendation dated ____________ is acknowledged. It will be held for action of the review conference planned for ____________ to be held at ____________

☐ Your change recommendation is reclassified URGENT and forwarded for approval to ____________ ____________ by my DTG ____________

/S ____________ MODEL MANAGER | ____________ AIRCRAFT

FIGURE 11. Example of foreword. - Continued

Foreword NAVAIR 01-40ABC-1

CHANGE SYMBOLS

NEW Revised text is indicated by a black vertical line in either margin of the page, adjacent to the affected text, like the one printed next to this paragraph. The change symbol identifies the addition of either new information, a changed procedure, the correction of an error, or a rephrasing of the previous material. NEW

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to "WARNINGS", "CAUTIONS", and "NOTES" found through the manual.

WARNING

An operating procedure, practice, or condition, etc., which may result in injury or death, if not carefully observed or followed.

CAUTION

An operating procedure, practice, or condition, etc., which may result in damage to equipment, if not carefully observed or followed.

Note

An operating procedure, practice, or condition, etc., which is essential to emphasize.

WORDING

The concept of word usage and intended meaning which has been adhered to in preparing this Manual is as follows:

"Shall" has been used only when application of a procedure is mandatory.

"Should" has been used only when application of a procedure is recommended.

"May" and "need not" have been used only when application of a procedure is optional.

"Will" has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.

EFFECTIVITY CODE

(Explanation of effectivity code when applicable)

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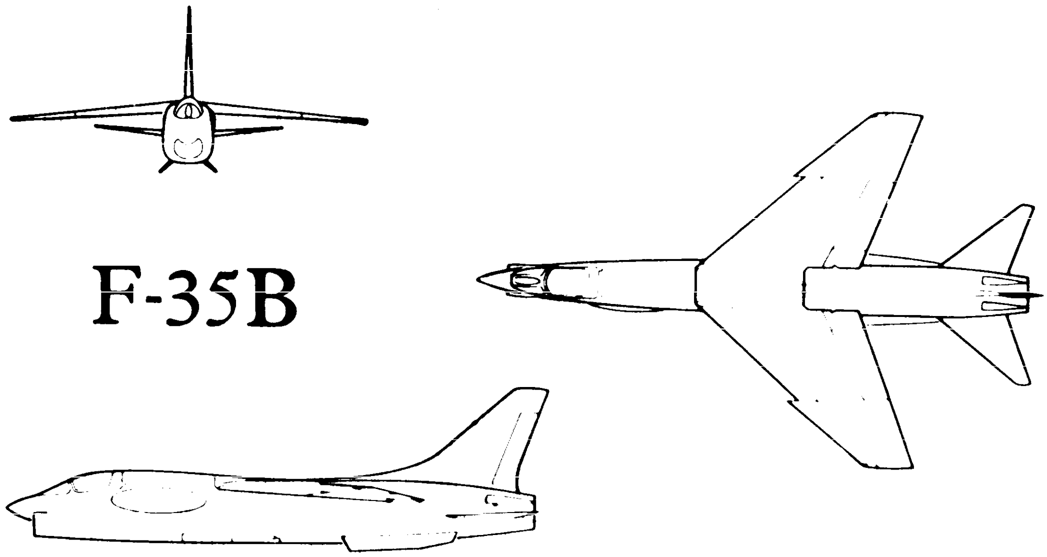
FIGURE 11. Example of foreword. - Continued

NAVAIR 01-40ABC-1 Glossary

GLOSSARY

FIGURE 12. Example of glossary.



Three-quarter halftone illustration
of aircraft on the ground in clean
configuration.

Figure 1-0

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FIGURE 13. Example of frontispiece.

INDEX

FIGURE 14. Example of alphabetical index.

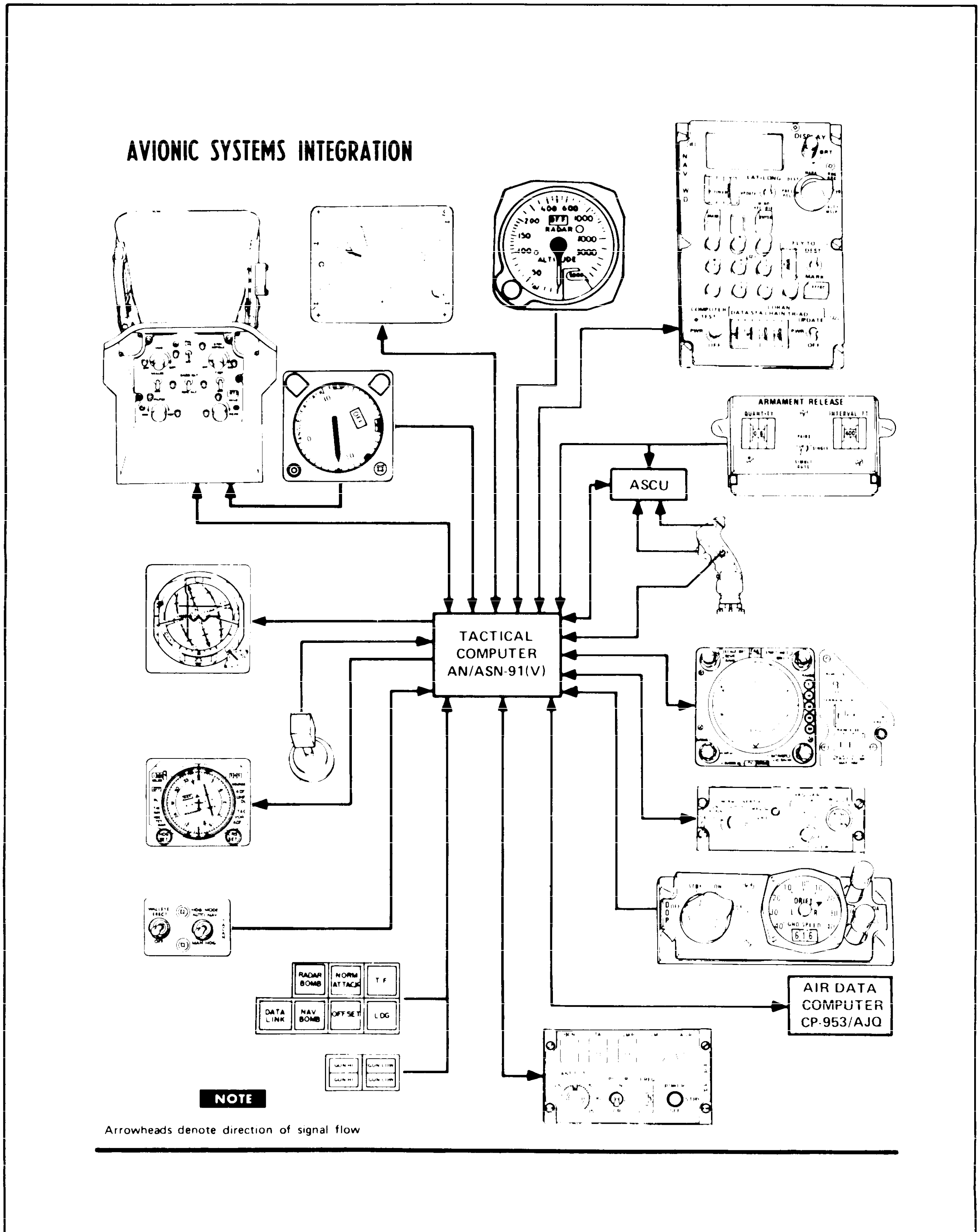


FIGURE 15. Example of line drawing.

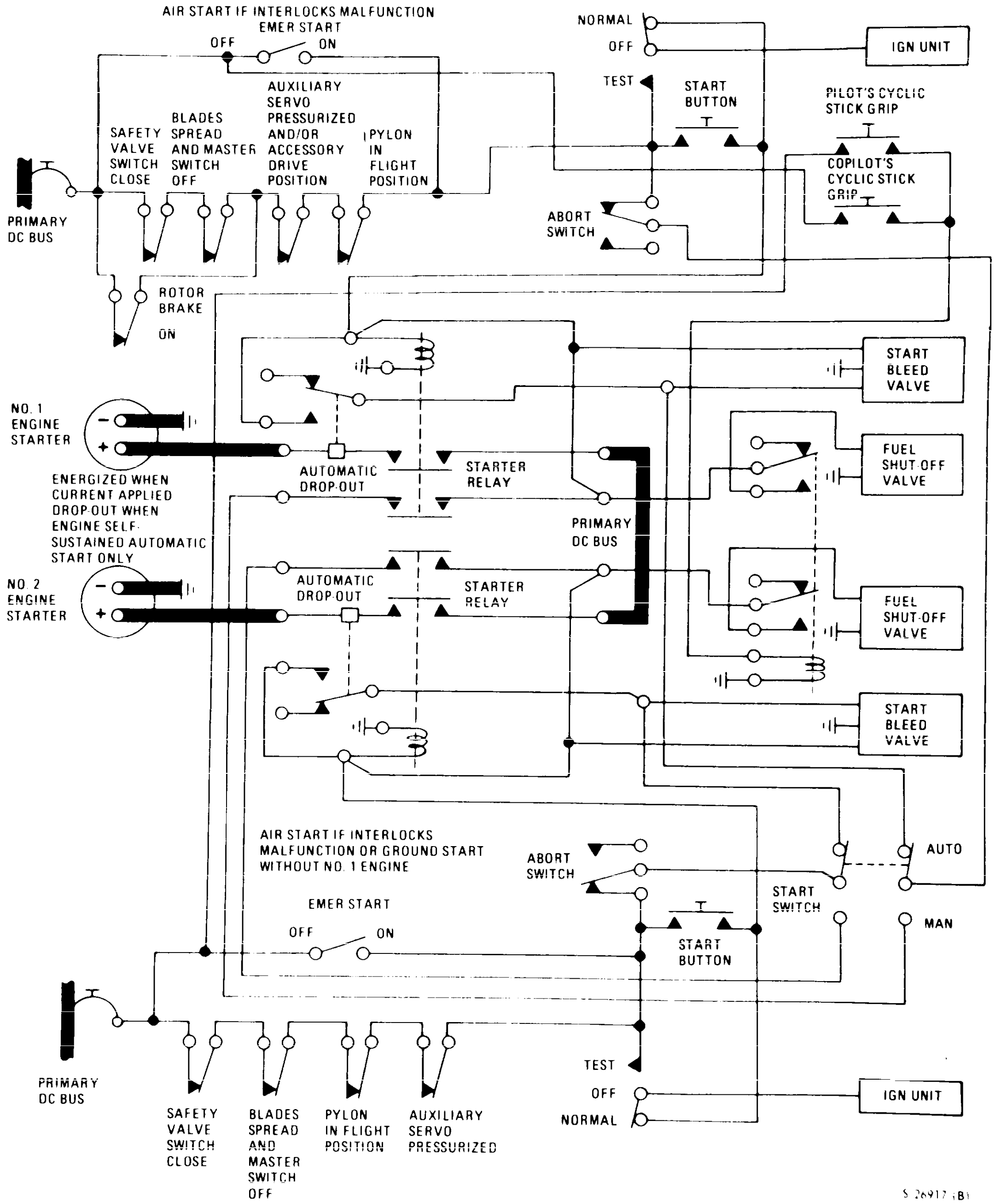
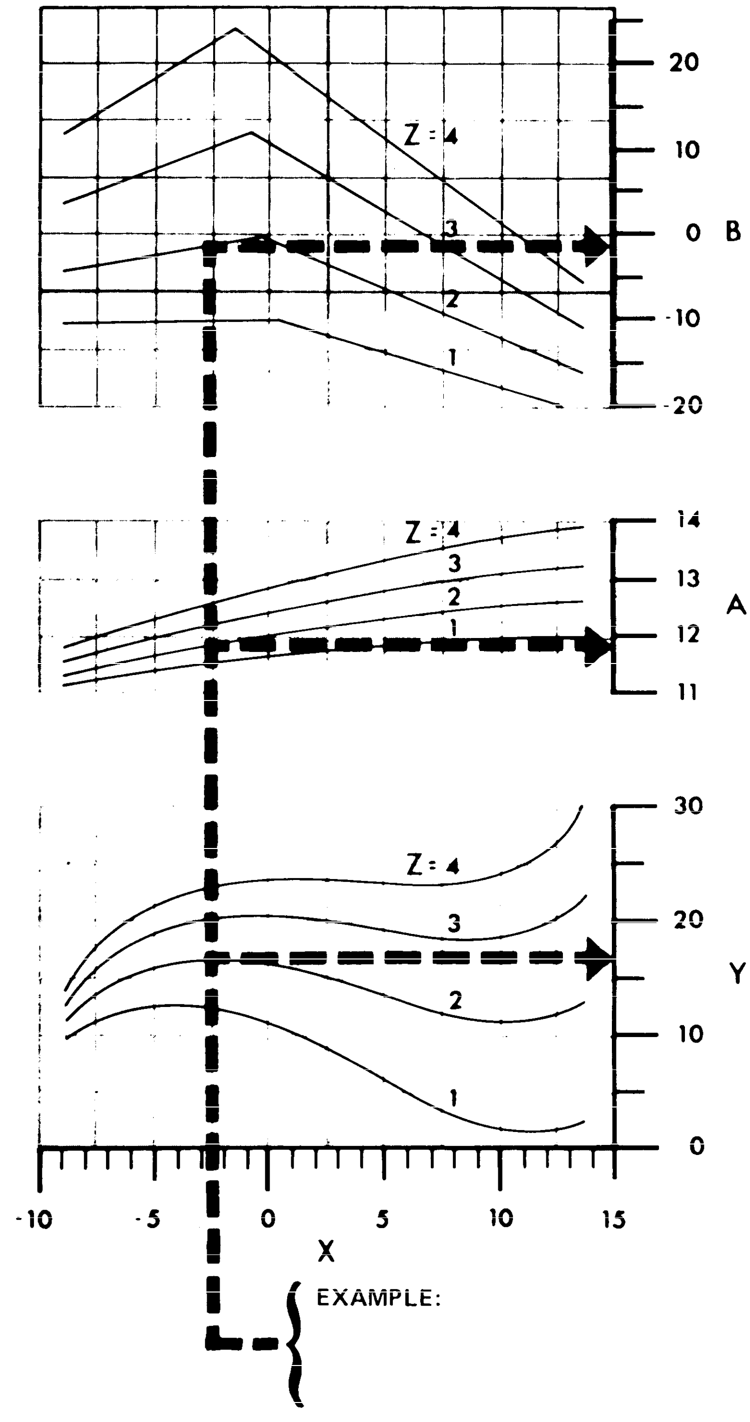


Figure 1-8. Starting System Diagram

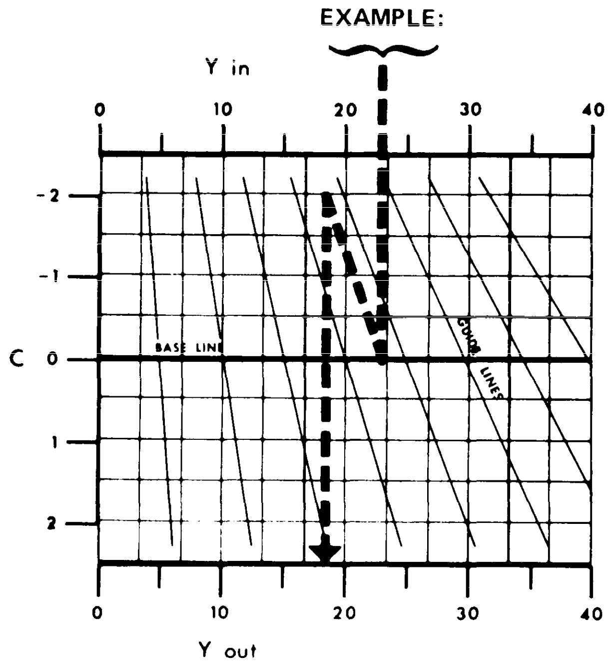
FIGURE 16. Example of schematic diagram.



SCATTER CHART

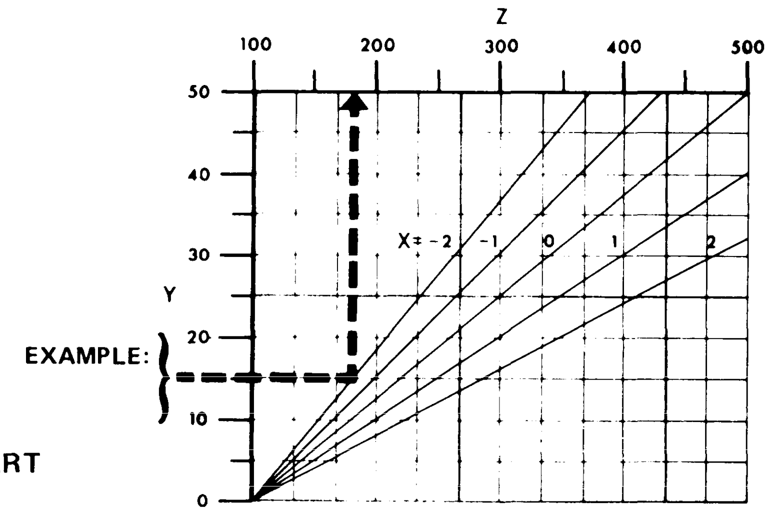
This chart type is sometimes called a "scatter" chart. In this chart, one input variable enters into the determination of more than one output. The progression line extending from the initial input axis intersects more than one function line or family of lines without changing direction. Each time a line is intersected, the progression line "scatters" to an output axis and another output is determined.

FIGURE 17. Example of graphs.



SHIFT CHART

This chart type is sometimes called a "shift" chart. The "shift" chart differs from other chart types because (1) the progression line lies on a curve or proportionately between two curves for some portion of its travel, and (2) by the presence of a set of curves which are not labeled as representing any variable. The unlabeled curves are called guidelines. In order to locate the correct interval point, the user must trace the initial progression line to the baseline and then parallel the guideline to the second input variable. The progression line is then traced in the same direction as the initial progression line to the output axis to determine the output value.



BOUNCE CHART

This chart type has sometimes been called a "bouncer" chart. In the simplest three-variable form, as shown above, there are two scaled axes and a set of parametric lines representing the interaction between two input variables in relation to an output variable. The user traces (or imagines) a progression line extending perpendicularly from an input axis to a parametric line. Each line is labeled with a value of the second input. The initial progression line is extended to the line representing the second input, or proportionately between two of the labeled lines. At the point of intersection, the progression line pivots 90° and proceeds to intersect the output axis or (when the number of input variables exceeds two) a second input curve.

FIGURE 17. Example of graphs. - Continued

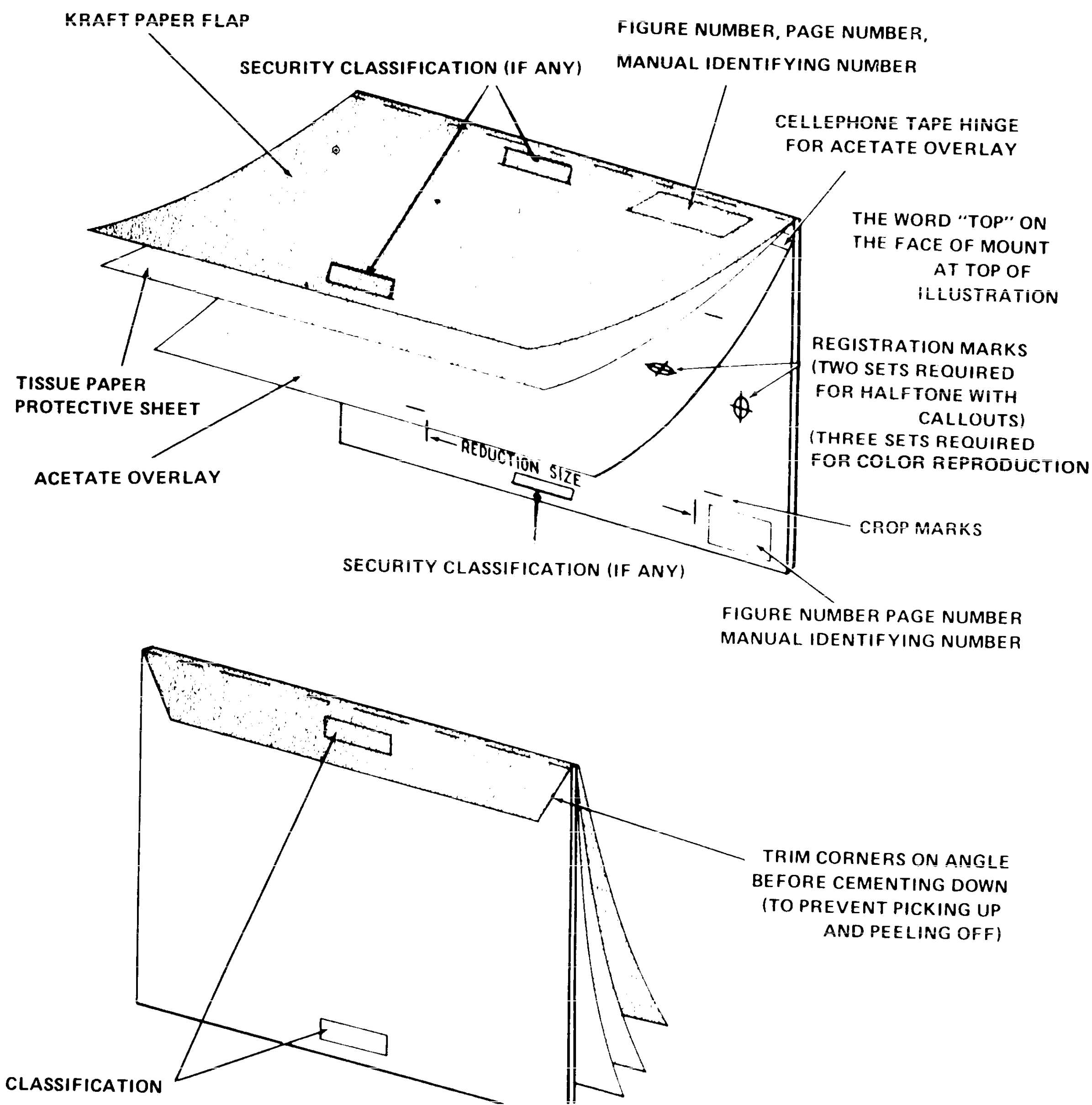


FIGURE 18. Example of identification, marking, and protective covering for artwork.

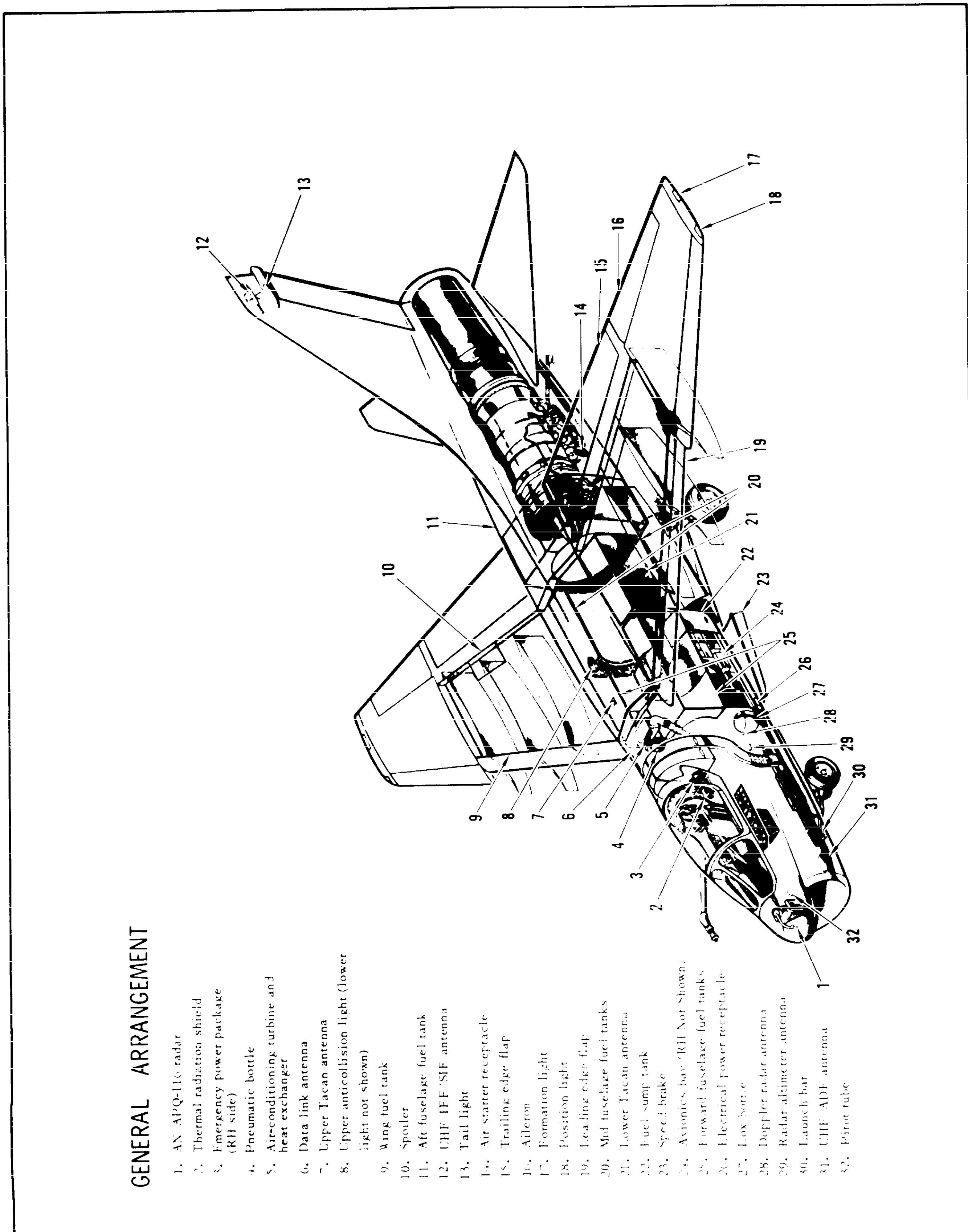


FIGURE 19. Example of aircraft arrangement illustration.

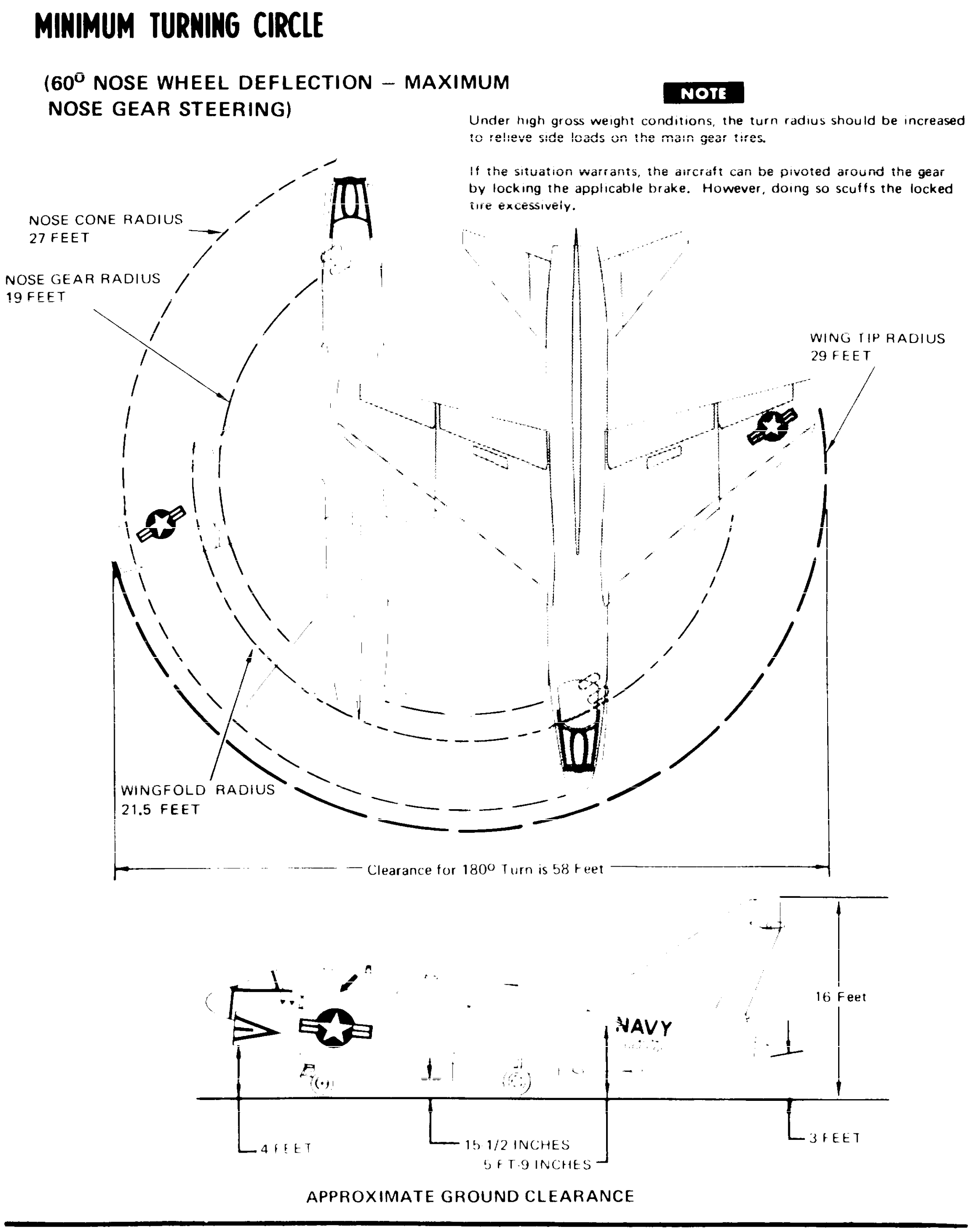


FIGURE 20. Example of turning radii and ground clearance.

STORES COMPUTATIONS

NOTES

1. Basic store drag count includes drag for pylons, racks and launchers.
2. Where two distances are given, the smaller is the distance for a store mounted on the bottom station of a MER or TER.
3. Weights include all mount/store weight except pylon and parent rack.
4. Rolling moments include all mount/store weight except pylon and parent rack.

(1) STORE	(2) MOUNT/NO. OF STORES	(3) BASIC DRAG COUNT (Note 1)				(4) DISTANCE FROM PYLON CENTER TO EDGE OF STORE IN INCHES (Note 2)	(5) WEIGHT IN LBS (Note 3)	(6) ROLLING MOMENT FT LBS (Note 4) Sta 1 or 8 Sta 2 or 7 Sta 3 or 6	REMARKS
		MN 0.6	MN 0.7	MN 0.8	MN 0.9				
FUSELAGE									
PYLON, LAUNCHER									
Pylon LAU-7/A		2.5	2.5	2.5	2.5		13 87		
STORES									
AIM-9B	LAU-7/A/1	7.5	7.5	7.5	11.5		242		
AIM-9D/G	LAU-7/A/1	7.5	7.5	7.5	11.5		276		
WING									
PYLONS, RACKS AND LAUNCHERS									
Pylon 1 or 8		5.0	5.5	9.0	13.0		204		
Pylon 2 or 7		5.0	5.5	9.0	13.0		201		
Pylon 3 or 6		5.0	5.5	9.0	13.0		173		
Parent Rack (PR)							100		
TER		12.0	14.0	23.0	37.5		105		
MER		23.0	24.0	29.0	40.0		223		
LAU-7/A		7.5	8.5	11.5	18.5		87		
AERO 5 (A-5)		7.0	7.5	10.5	16.5		91		
BOMBS									
Mk81 Snakeye	MER/6	44.5	46.0	51.5	71.0	12.75	2,029	23,110 16,435 10,348	

FIGURE 21. Example of external store drag count and weight table.

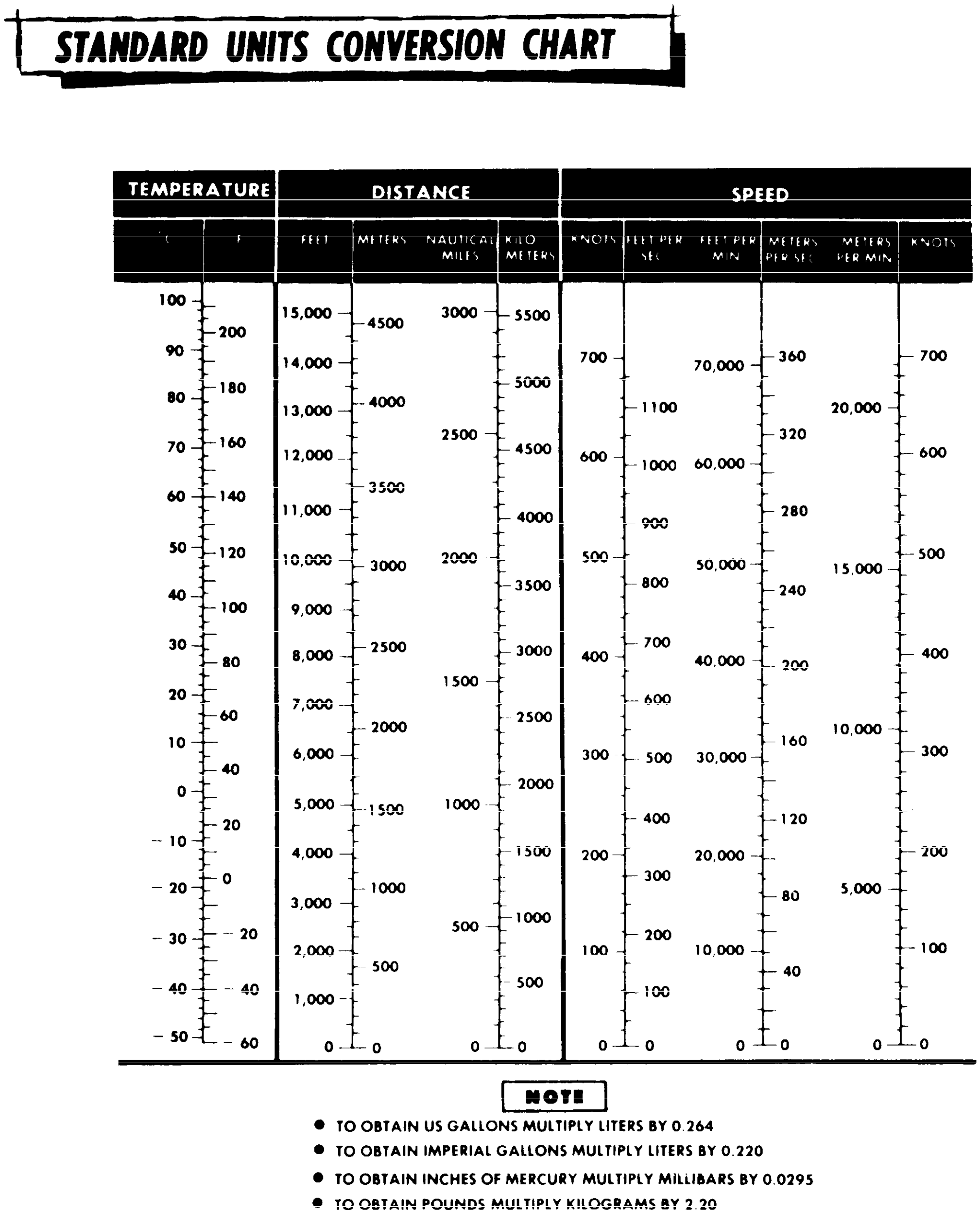


FIGURE 22. Example of standard units conversion chart.

STANDARD ATMOSPHERE

ICAO STANDARD DAY

STANDARD SL CONDITIONS:
TEMPERATURE 15°C (59°F)
PRESSURE 29.921 IN. Hg; 2116.216 LB/SQ FT
DENSITY .0023769 SLUGS/CU FT
SPEED OF SOUND 1116.89 FT/SEC, 661.7 KNOTS

CONVERSION FACTORS:
1 IN. Hg 70.727 LB/SQ FT
1 IN. Hg 0.49116 LB/SQ IN
1 KNOT 1.151 M.P.H.
1 KNOT 1.688 FT/SEC

ALTITUDE FEET	DENSITY RATIO σ	$\frac{1}{\sqrt{\sigma}}$	TEMPERATURE °C	TEMPERATURE °F	SPEED OF SOUND KNOTS	PRESSURE IN. Hg.	PRESSURE RATIO δ
0	1.000	1.0000	15.000	59.000	661.7	29.921	1.0000
1,000	.9711	1.0148	13.019	55.434	659.5	28.856	.9644
2,000	.9428	1.0299	11.038	51.868	657.2	27.821	.9298
3,000	.9151	1.0454	9.056	48.302	654.9	26.817	.8962
4,000	.8881	1.0611	7.076	44.735	652.6	25.842	.8637
5,000	.8617	1.0773	5.094	41.169	650.3	24.896	.8320
6,000	.8359	1.0938	3.113	37.603	648.7	23.978	.8014
7,000	.8106	1.1107	1.132	34.037	645.6	23.088	.7716
8,000	.7860	1.1279	-0.850	30.471	643.3	22.225	.7428
9,000	.7620	1.1456	-2.831	26.905	640.9	21.388	.7148
10,000	.7385	1.1637	-4.812	23.338	638.6	20.577	.6877
11,000	.7155	1.1822	-6.793	19.772	636.2	19.791	.6614
12,000	.6932	1.2011	-8.774	16.206	633.9	19.029	.6360
13,000	.6713	1.2205	-10.756	12.640	631.5	18.292	.6113
14,000	.6500	1.2403	-12.737	9.074	629.0	17.577	.5875
15,000	.6292	1.2606	-14.718	5.508	626.6	16.886	.5643
16,000	.6090	1.2815	-16.699	1.941	624.2	16.216	.5420
17,000	.5892	1.3028	-18.680	-1.625	621.8	15.569	.5203
18,000	.5699	1.3246	-20.662	-5.191	619.4	14.942	.4994
19,000	.5511	1.3470	-22.643	-8.757	617.0	14.336	.4791
20,000	.5328	1.3700	-24.624	-12.323	614.6	13.750	.4595
21,000	.5150	1.3935	-26.605	-15.889	612.1	13.184	.4406
22,000	.4976	1.4176	-28.587	-19.456	609.6	12.636	.4223
23,000	.4806	1.4424	-30.568	-23.022	607.1	12.107	.4046
24,000	.4642	1.4678	-32.549	-26.588	604.6	11.597	.3876
25,000	.4481	1.4938	-34.530	-30.154	602.1	11.103	.3711
26,000	.4325	1.5206	-36.511	-33.720	599.6	10.627	.3552
27,000	.4173	1.5480	-38.492	-37.286	597.1	10.168	.3398
28,000	.4025	1.5762	-40.474	-40.852	594.6	9.725	.3250
29,000	.3881	1.6052	-42.455	-44.419	592.1	9.297	.3107
30,000	.3741	1.6349	-44.436	-47.985	589.5	8.885	.2970
31,000	.3605	1.6654	-46.417	-51.551	586.9	8.488	.2837
32,000	.3473	1.6968	-48.398	-55.117	584.4	8.106	.2709
33,000	.3345	1.7291	-50.379	-58.683	581.8	7.737	.2586
34,000	.3220	1.7623	-52.361	-62.249	579.2	7.382	.2467
35,000	.3099	1.7964	-54.342	-65.816	576.6	7.041	.2353
36,000	.2981	1.8315	-56.323	-69.382	574.0	6.712	.2243
36,089	.2971	1.8347	-56.500	-69.700	573.7	6.683	.2234
37,000	.2843	1.8753				6.397	.2138
38,000	.2710	1.9209				6.097	.2038
39,000	.2583	1.9677				5.811	.1942
40,000	.2462	2.0155				5.538	.1851

FIGURE 23. Example of standard atmosphere table.

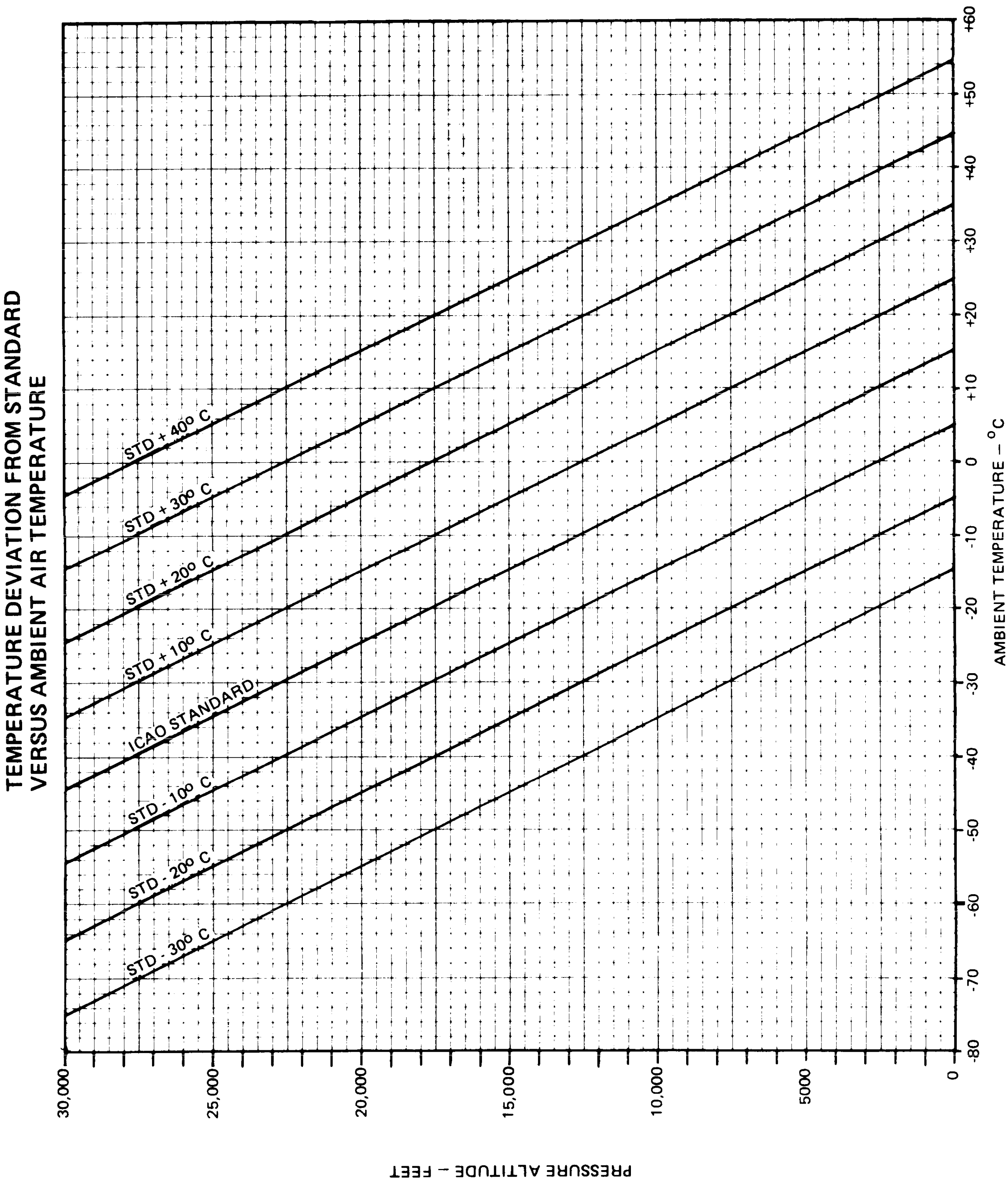


FIGURE 24. Example of temperature deviation from standard chart.

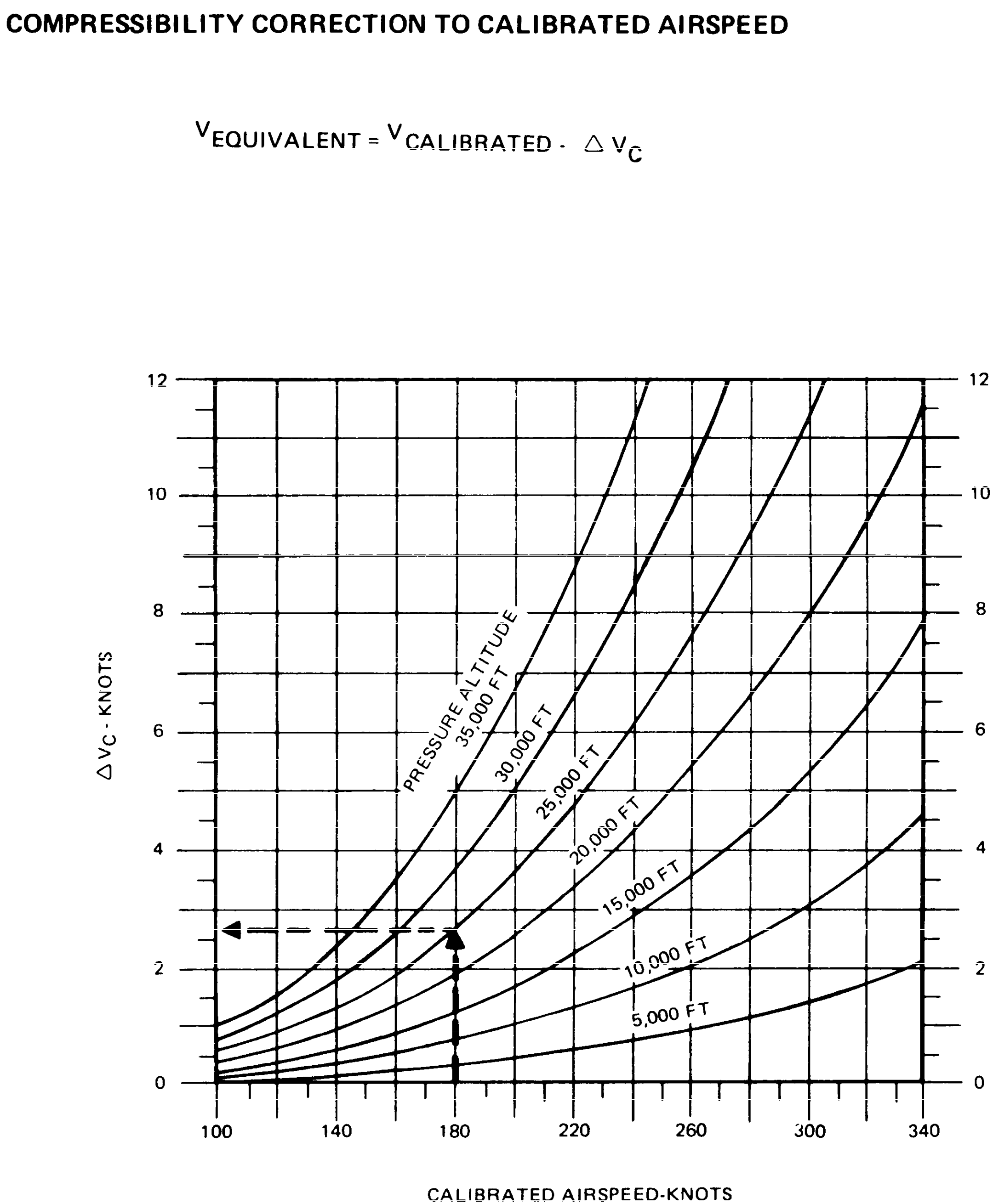


FIGURE 25. Example of compressibility correction to calibrated airspeed.

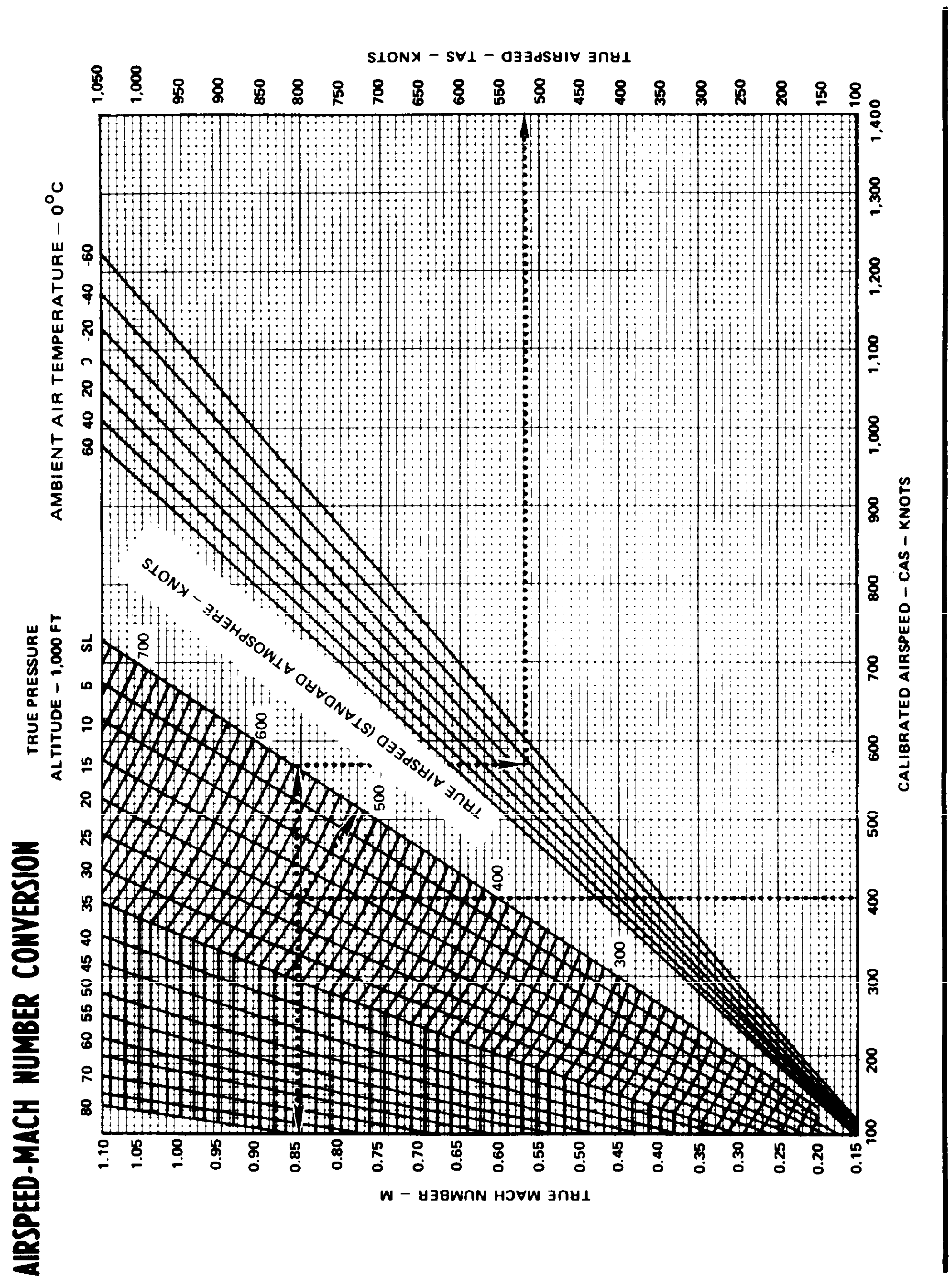


FIGURE 26. Example of airspeed mach number conversion chart.

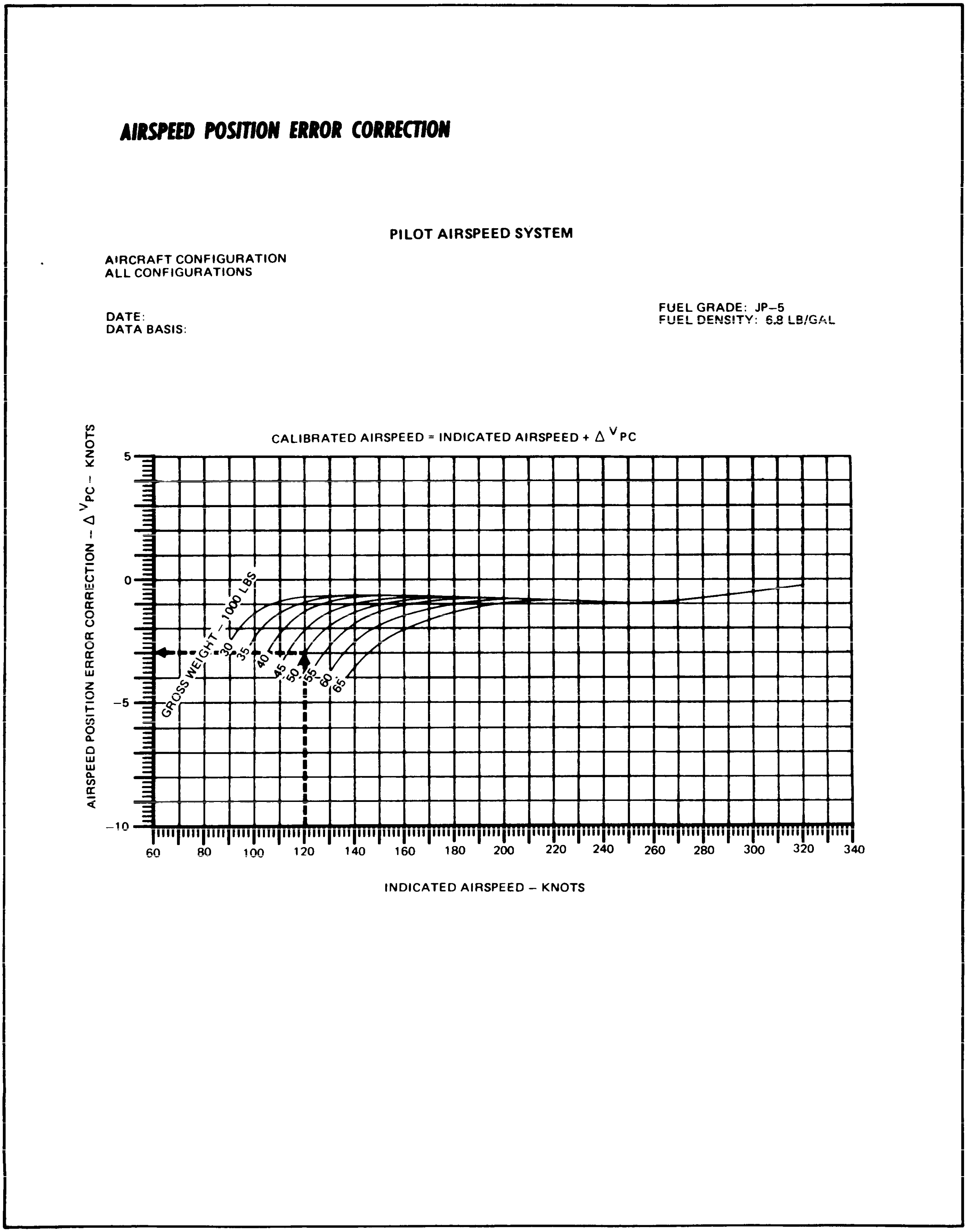


FIGURE 27. Example of airspeed position error correction.

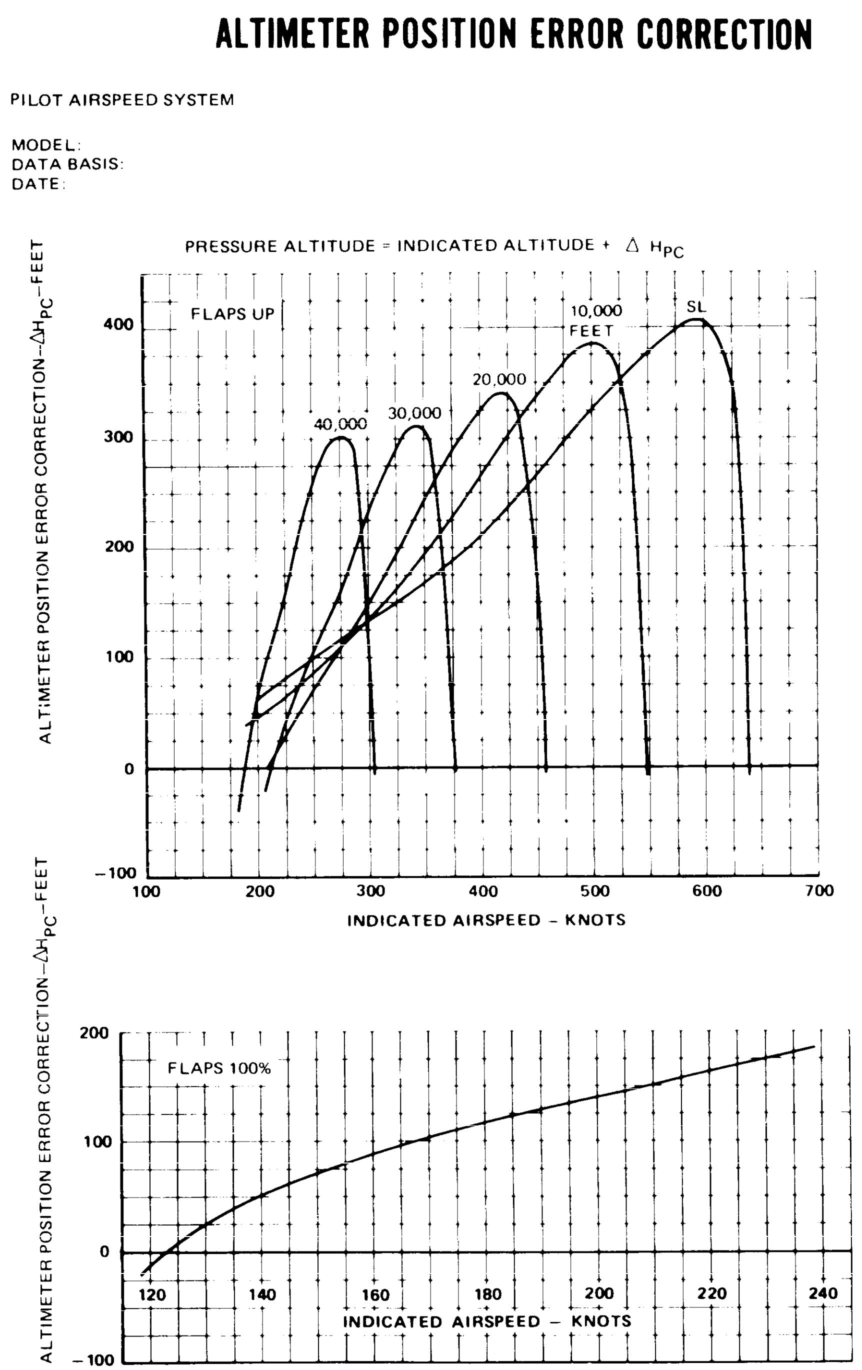


FIGURE 28. Example of altimeter position error correction.

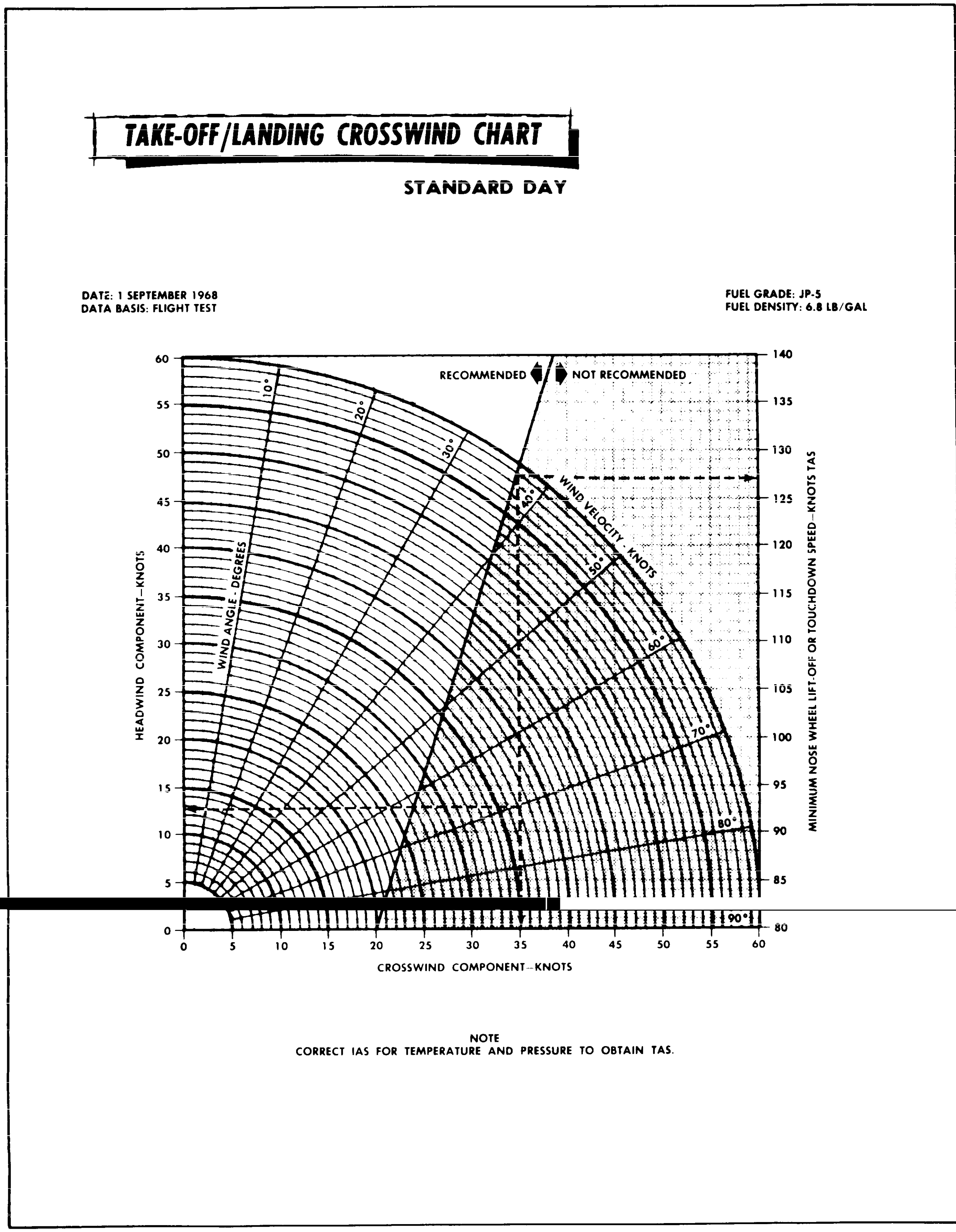


FIGURE 29. Example of takeoff/landing crosswind chart.

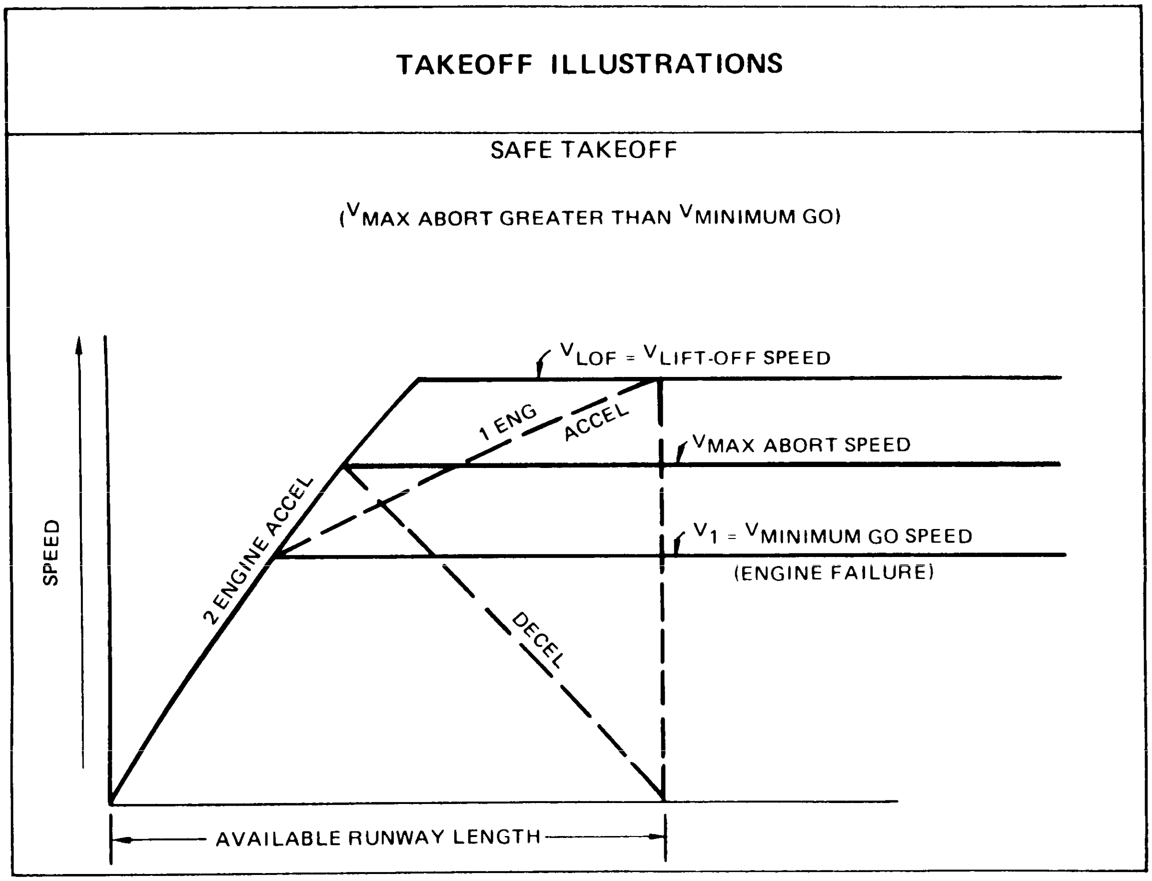


FIGURE 30. Example of takeoff illustrations.

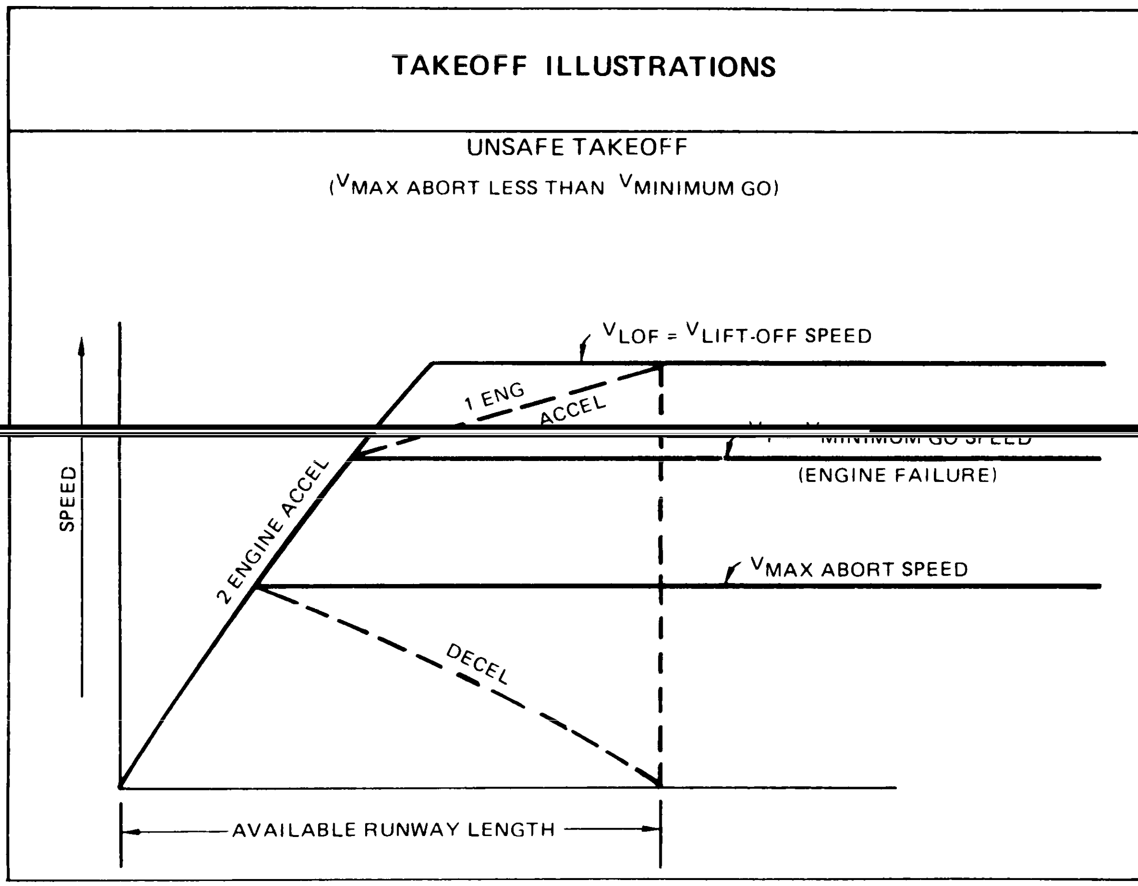


FIGURE 30. Example of takeoff illustrations. - Continued

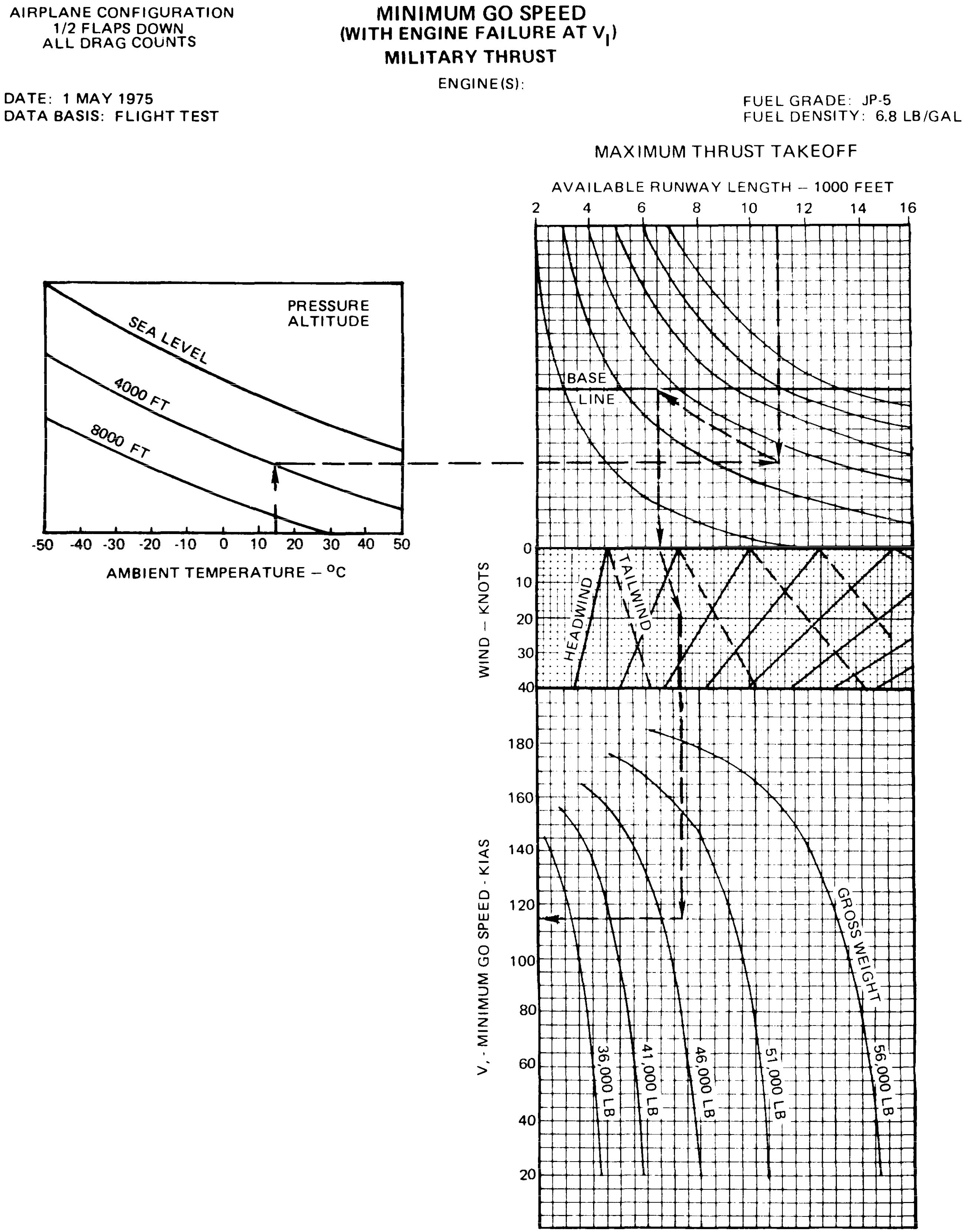


FIGURE 31. Example of minimum go speed.

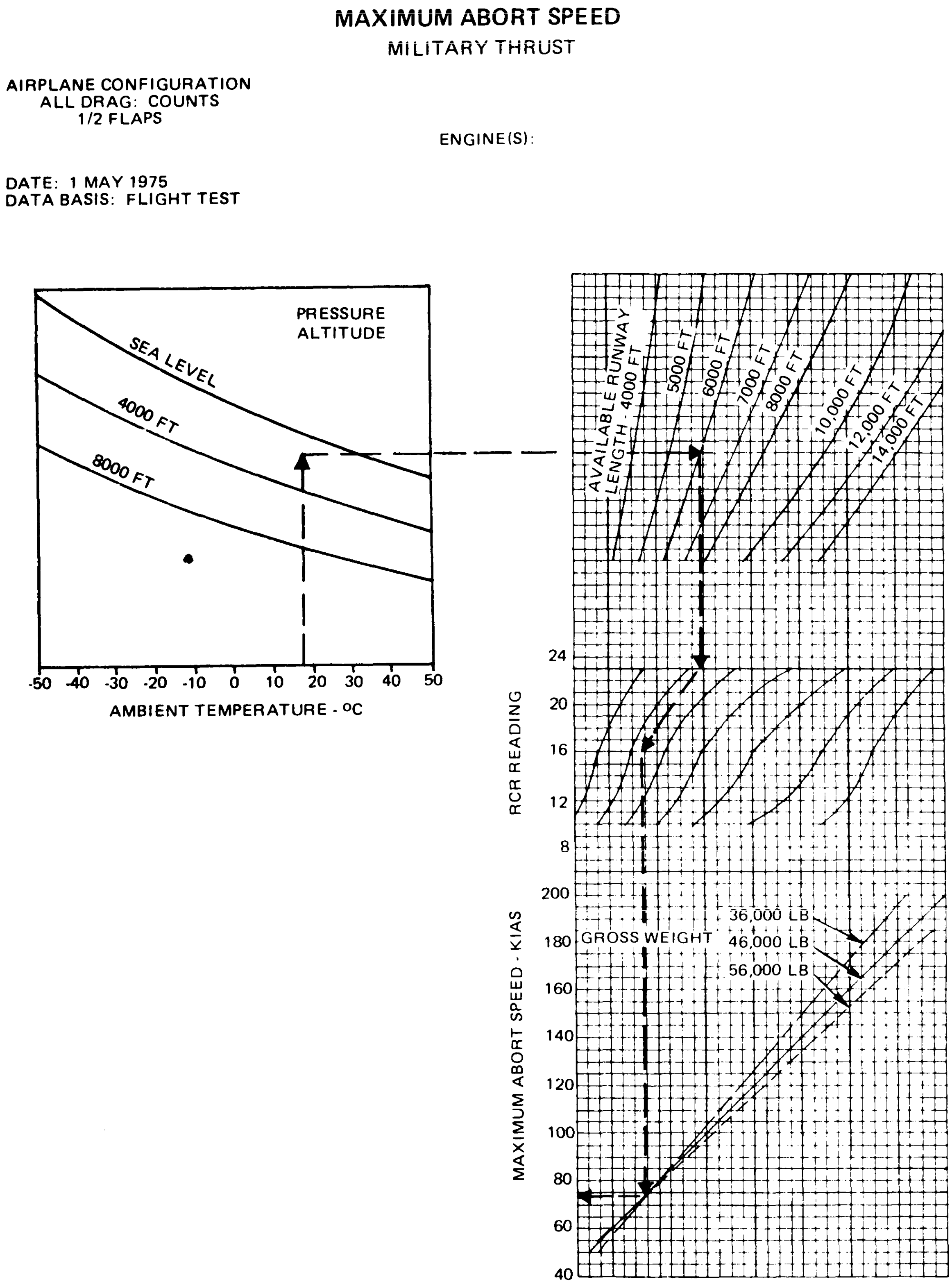


FIGURE 32. Example of maximum abort speed.

LIFT-OFF SPEED AND SPEED AT 50 FOOT OBSTACLE HEIGHT

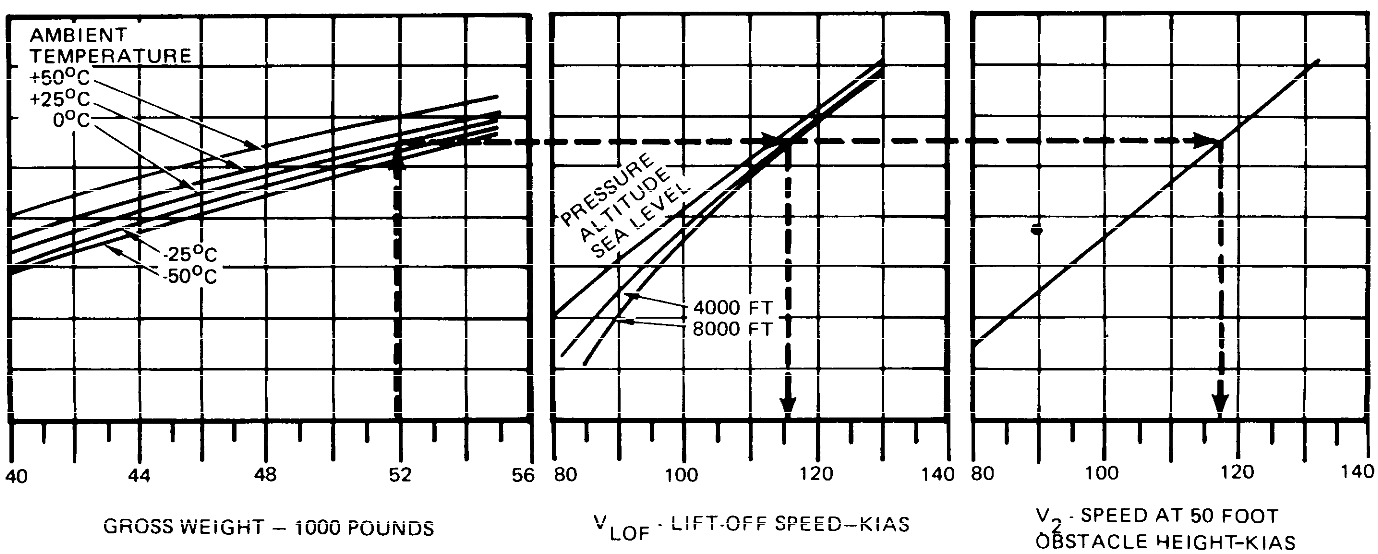
FLAPS 20°

AIRCRAFT CONFIGURATION:
GEAR DOWN, MAXIMUM POWER

DATE: 1 DECEMBER 74
DATA BASIS: ESTIMATED

MODEL:
ENGINE(S):

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL



NOTE
ROTATION SPEED =
LIFT-OFF MINUS 3 KNOTS

FIGURE 33. Example of lift off speed and speed at 50 foot obstacle height.

TAKEOFF DISTANCE

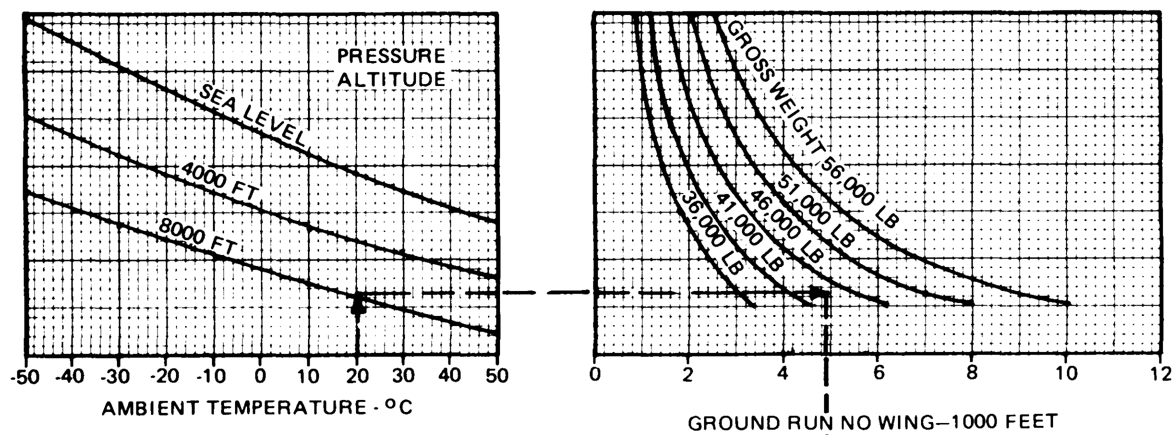
AIRPLANE CONFIGURATION
1/2 FLAPS, GEAR DOWN
ALL DRAG COUNTS

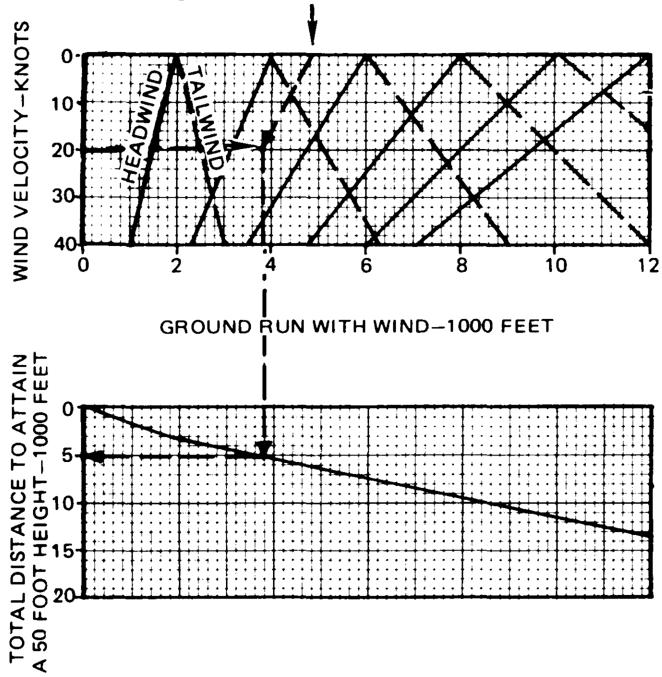
MAXIMUM THRUST
HARD DRY RUNWAY

ENGINE(S):

DATE: 1 MAY 1975
DATA BASIS: FLIGHT TEST

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL





NOTES

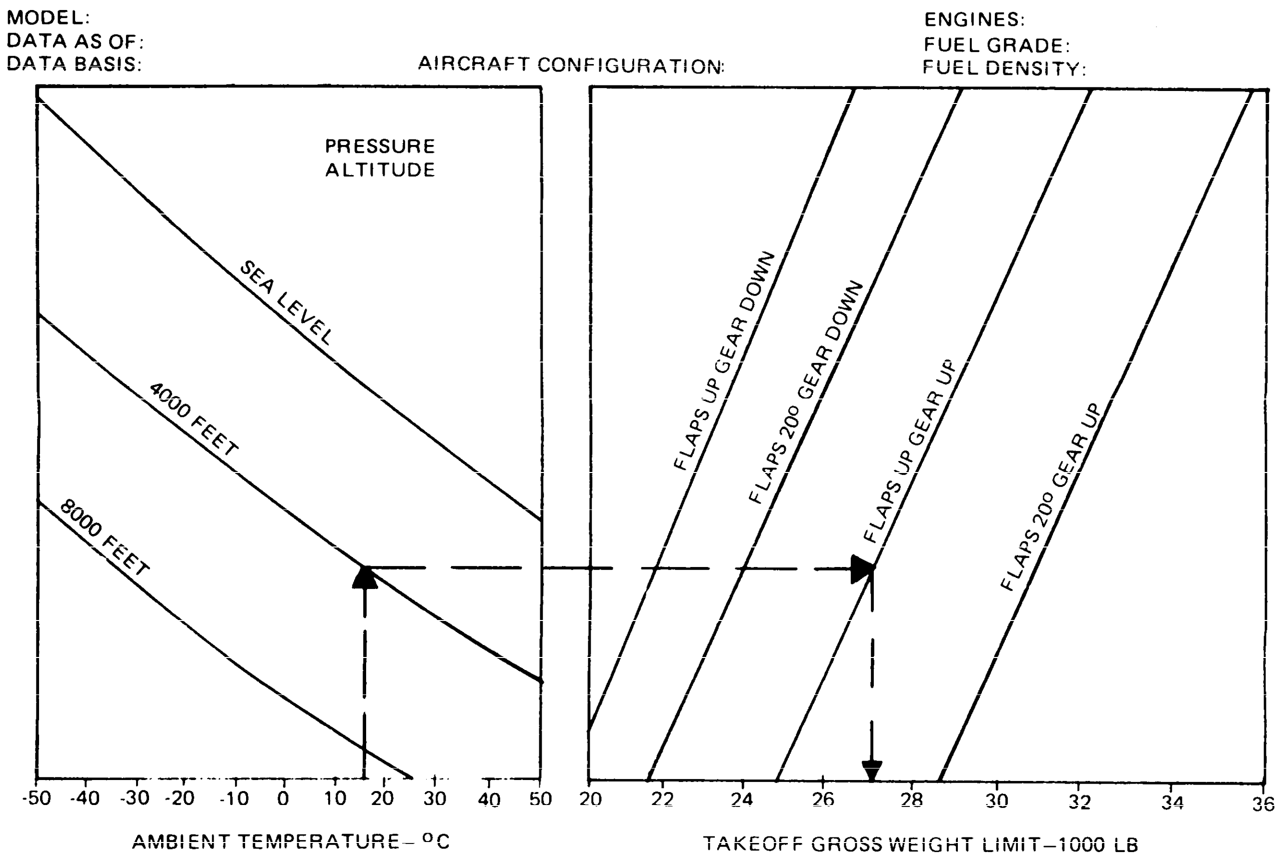
IF ONE AFTERBURNER FAILS TO LIGHT, TAKEOFF DISTANCE WILL BE INCREASED BY 35%.

GROSS WEIGHTS SHOWN REFLECT LIFT–OFF VALUES.

ENGINE START AND TAXI FUEL WEIGHTS ARE FOUND IN PART 3.

FIGURE 34. Example of takeoff distance.

TAKEOFF GROSS WEIGHT LIMITED BY SINGLE ENGINE CLIMB PERFORMANCE MAXIMUM THRUST



NOTES:

1. LIMIT BASED ON RATE OF CLIMB OF 200 FPM WITH ONE ENGINE INOPERATIVE WITH PROPELLER FEATHERED ON THE INOPERATIVE ENGINE.
2. CLIMB SPEED EQUALS LIFT-OFF SPEED, V_{LOF}.

FIGURE 35. Example of takeoff gross weight limit.

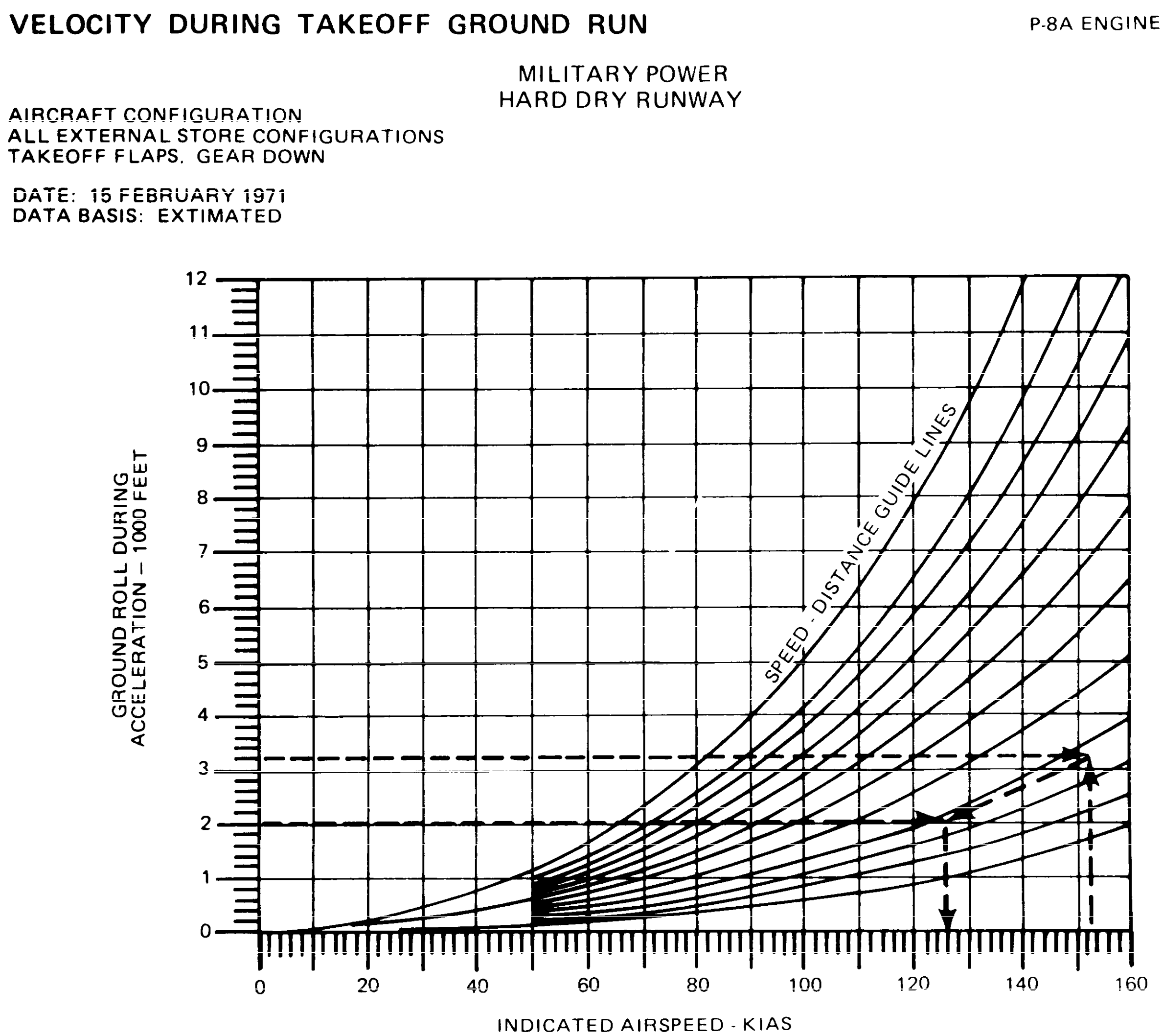


FIGURE 36. Example of velocity during takeoff ground run.

MILITARY POWER CLIMB

CLIMB SPEED SCHEDULE

MODEL:
DATE:
DATA BASIS:

ENGINES:
FUEL GRADE:
FUEL DENSITY:

AIRCRAFT CONFIGURATION:

PRESSURE ALTITUDE – 1000 FT	DRAG COUNT 0 KCAS	0 MACH	20 KCAS	20 MACH	40 KCAS	40 MACH
S.L.	508	.77	459	.69	413	.62
5	474	.78	432	.71	395	.65
10	443	.79	413	.74	383	.69
15	414	.81	392	.77	369	.72
20	386	.83	369	.79	350	.75
25	358	.84	348	.82	336	.80
30	331	.86	328	.86	322	.84

PRESSURE ALTITUDE – 1000 FT	DRAG COUNT 60 KCAS	60 MACH	80 KCAS	80 MACH	100 KCAS	100 MACH
S.L.	379	.57	351	.53	329	.50
5	368	.61	343	.56	318	.52
10	356	.64	330	.59	310	.56
15	345	.68	321	.63	302	.60
20	330	.71	308	.67	289	.63
25	320	.76	300	.72	283	.68
30	309	.81	287	.76	267	.71

NOTE: FUEL ALLOWANCE TAKEOFF AND ACCELERATION TO CLIMB SPEED 850 POUNDS

FIGURE 37. Example of climb performance.

MILITARY POWER CLIMB

Time Required To Climb From Sea Level To Selected Altitude

MODEL:
DATE:
DATA BASIS:

ENGINE:

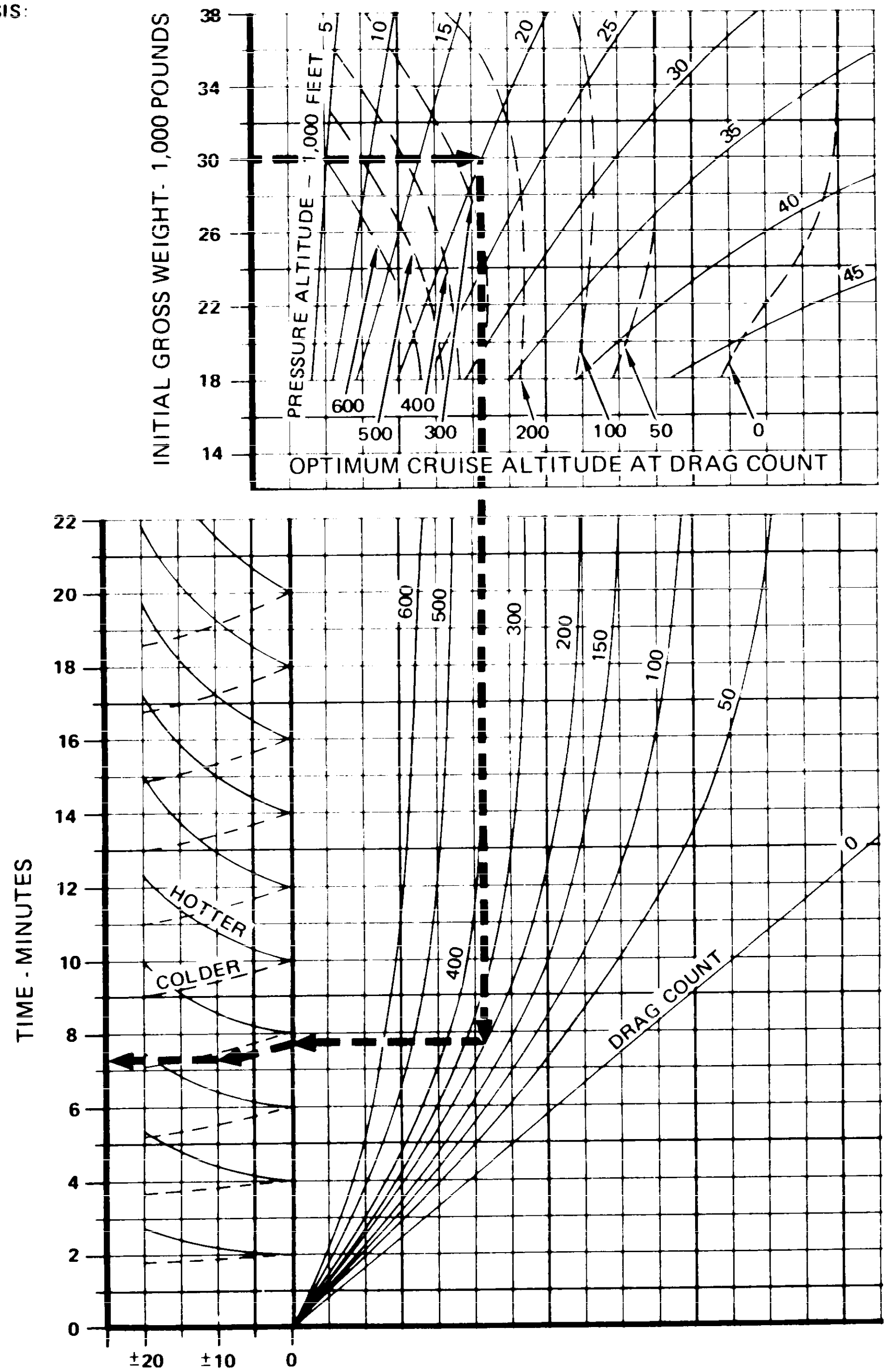


FIGURE 37. Example of climb performance. - Continued

MILITARY POWER CLIMB

Fuel Required To Climb From Sea Level To Selected Altitude

MODEL:
DATE:
DATA BASIS:

ENGINE:

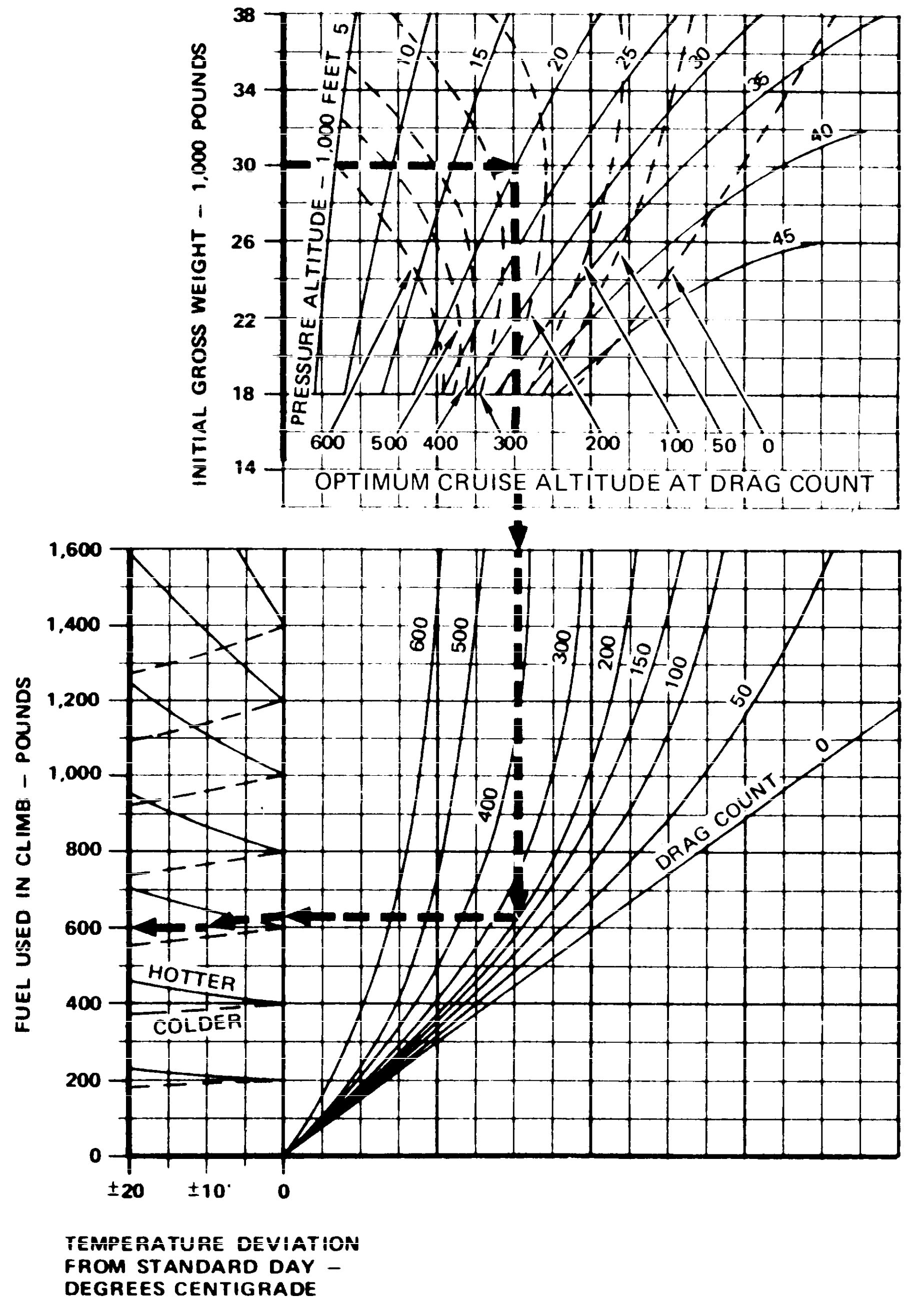


FIGURE 37. Example of climb performance. - Continued

MILITARY POWER CLIMB

Distance Required To Climb From Sea Level To Selected Altitude

MODEL:
DATE:
DATA BASIS:

ENGINE:

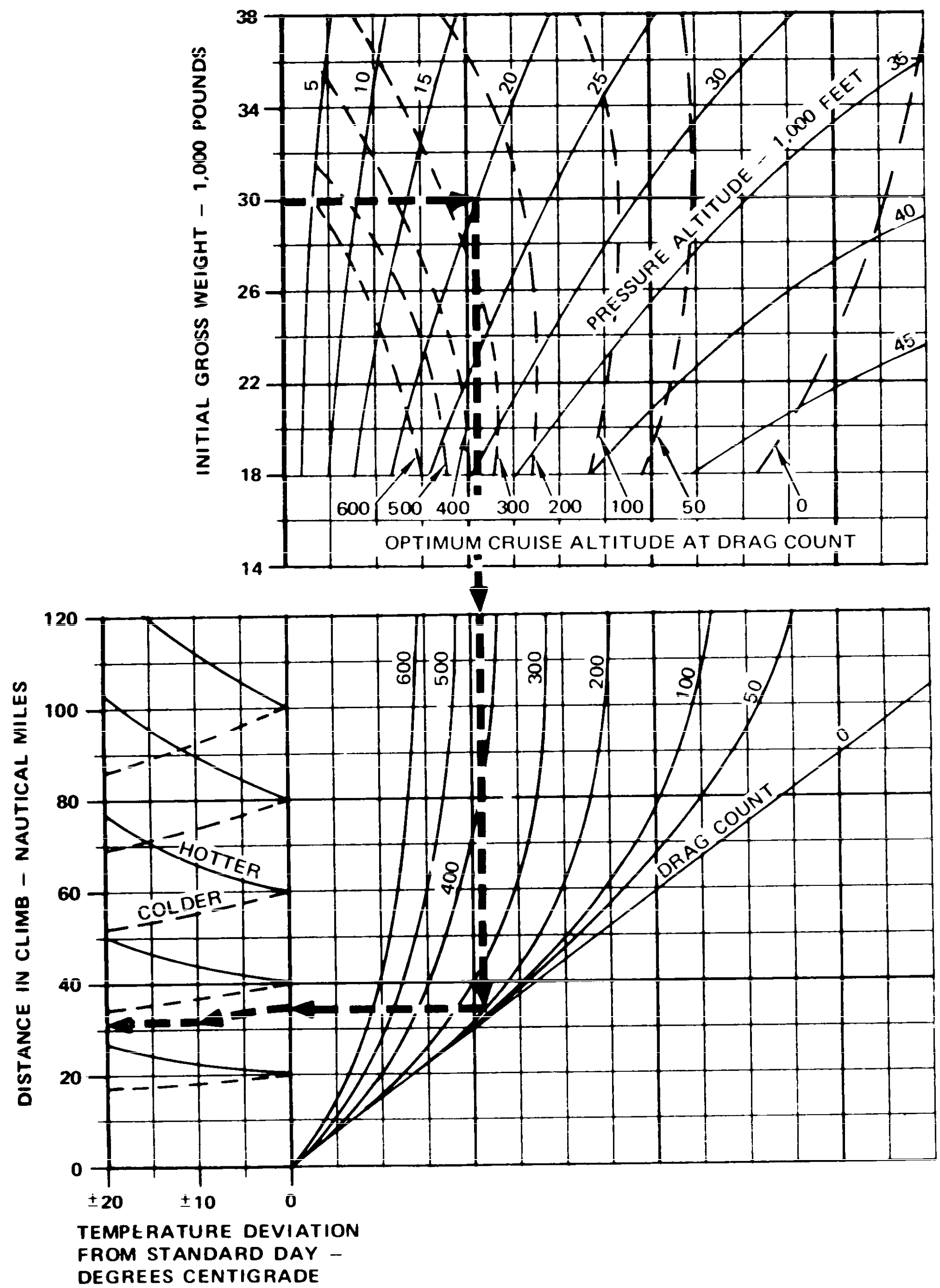


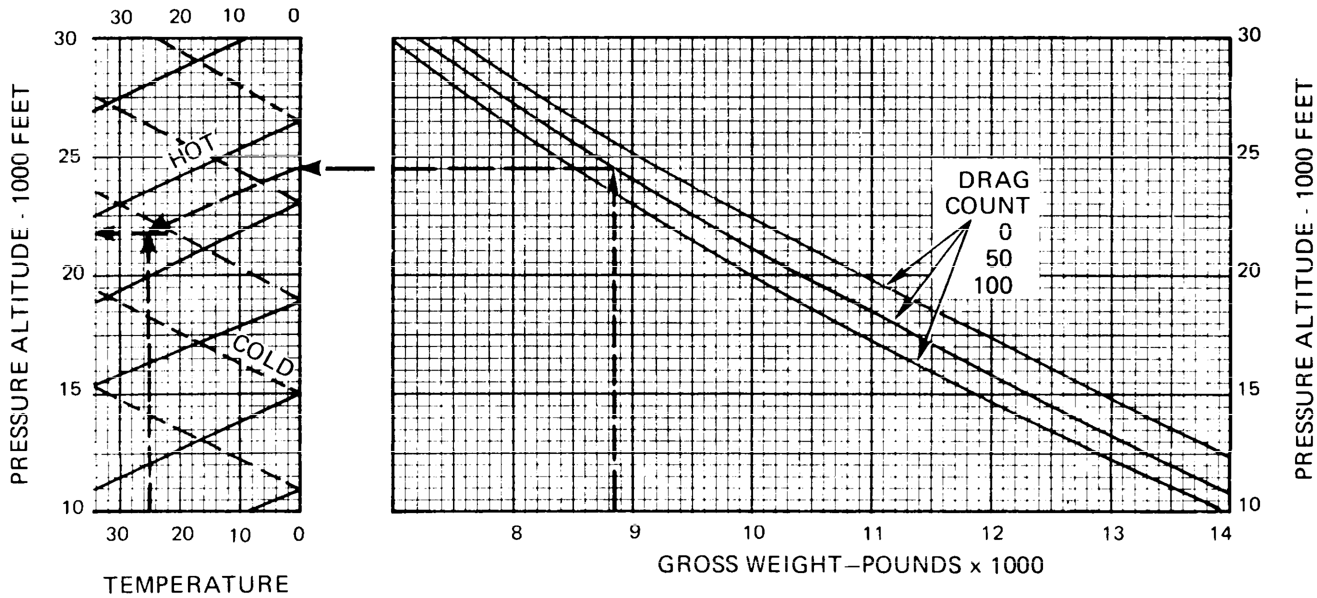
FIGURE 37. Example of climb performance. - Continued

SERVICE CEILING AND COMBAT CEILING 2 ENGINES

MODEL:
DATA BASIS:
DATA AS OF:
CONFIGURATION:

ENGINES:
FUEL GRADE:
FUEL DENSITY:

SERVICE CEILING (100 FEET/MINUTE CLIMB)
MAXIMUM CONTINUOUS THRUST



STANDARD TEMPERATURE		
ALT	°C	°F
SL	15	59
5,000	5	41
10,000	-5	12
15,000	-15	6
20,000	-25	-12

COMBAT CEILING (500 FEET/MINUTE)

MILITARY THRUST

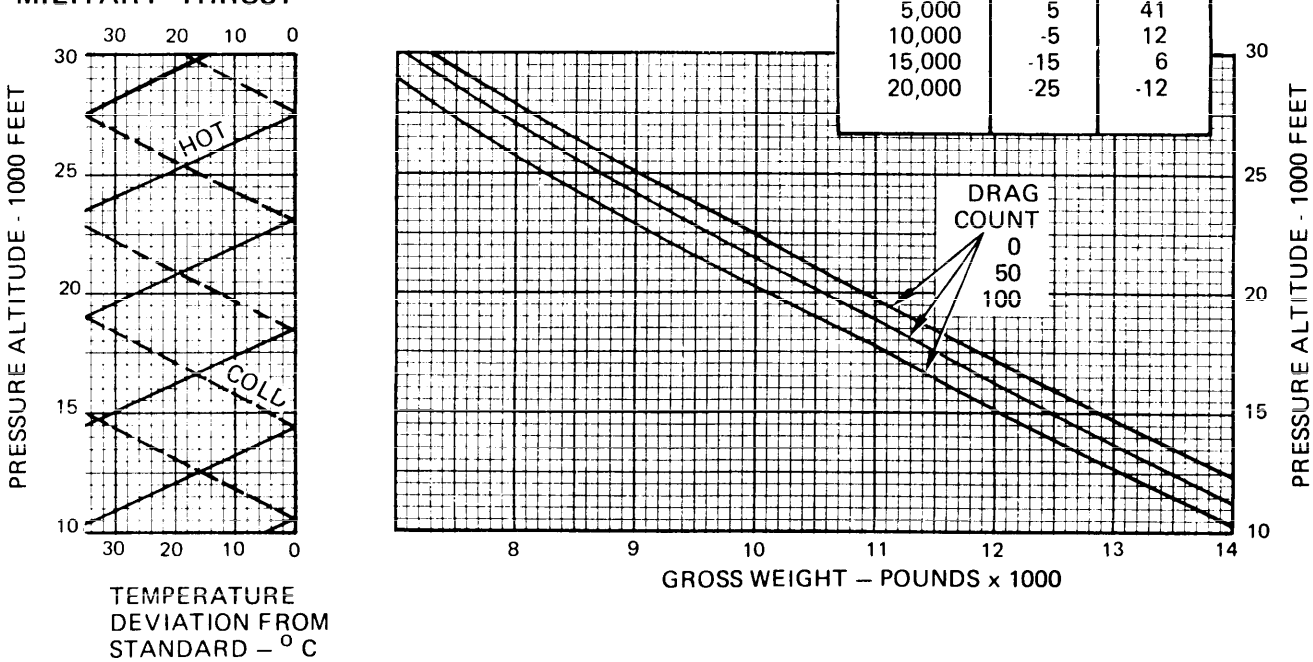


FIGURE 38. Example of service ceiling and combat ceiling.

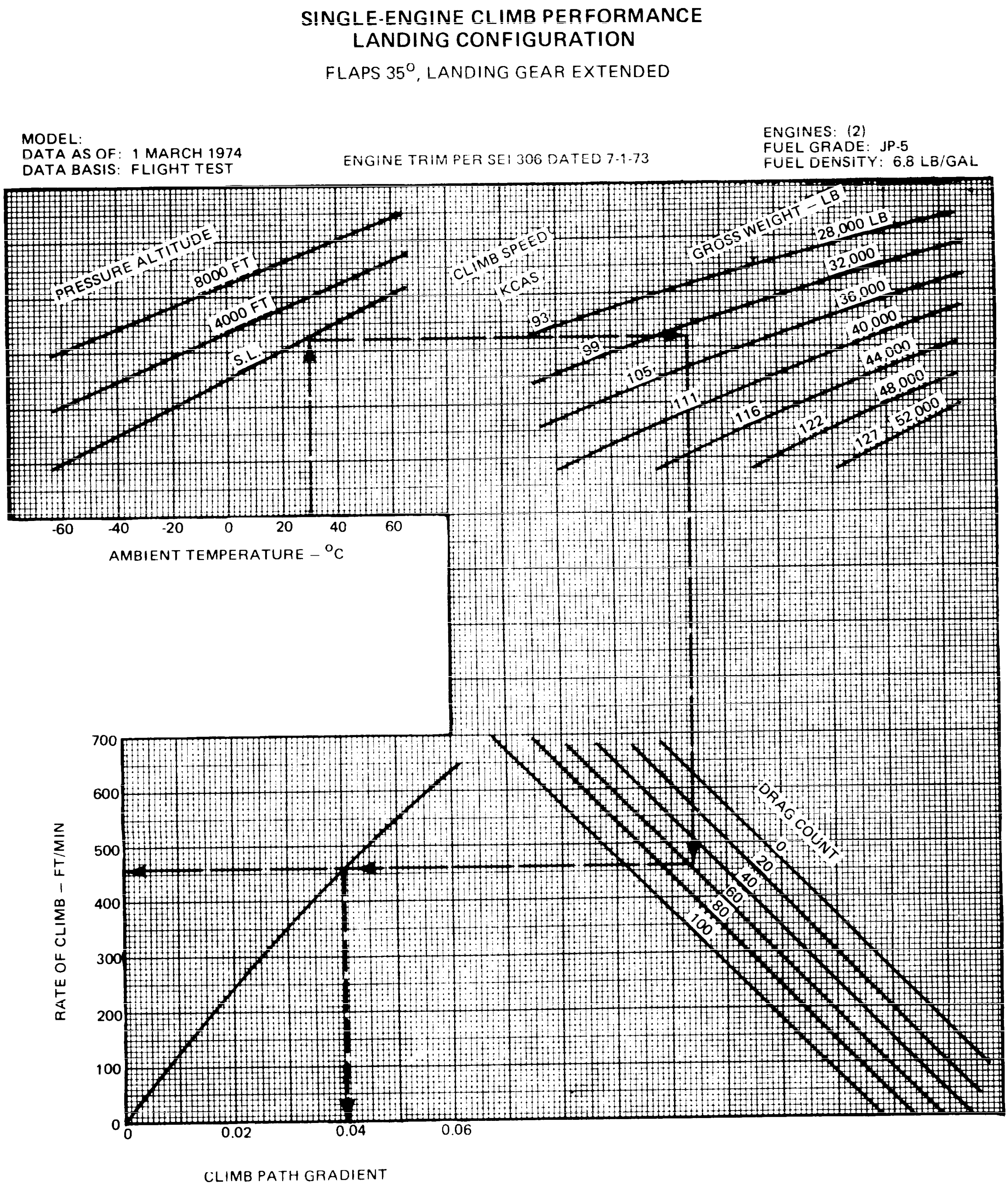


FIGURE 39. Example of one engine inoperative climb performance.

CRUISE PERFORMANCE

Phase 1 — Clean Aircraft Transfer Scale

MODEL: ENGINE:
DATE:
DATA BASIS:

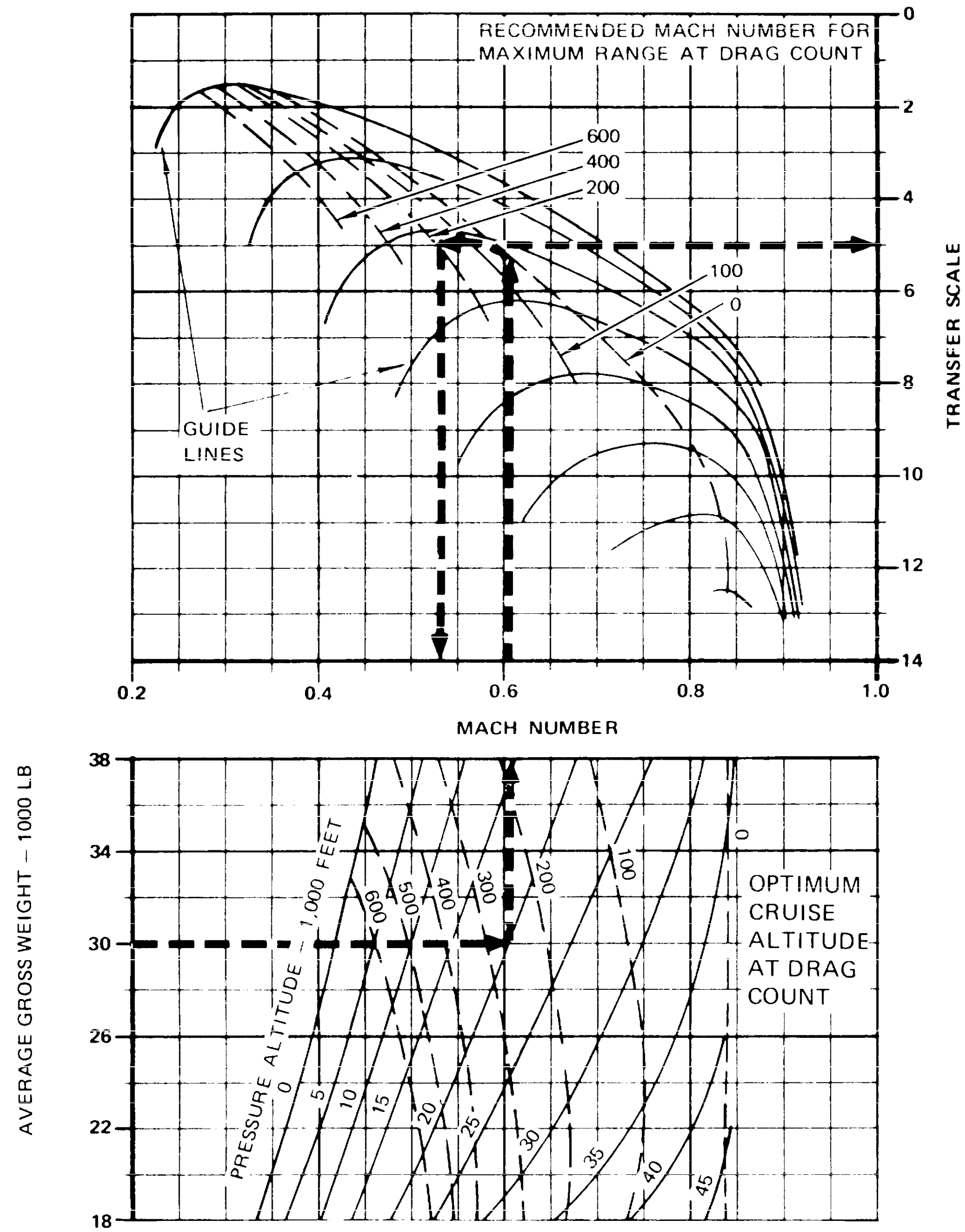


FIGURE 40. Example of cruise performance.

CRUISE PERFORMANCE

PHASE II - Aircraft Reference Number

MODEL:
DATE:
DATA BASIS:

ENGINE:

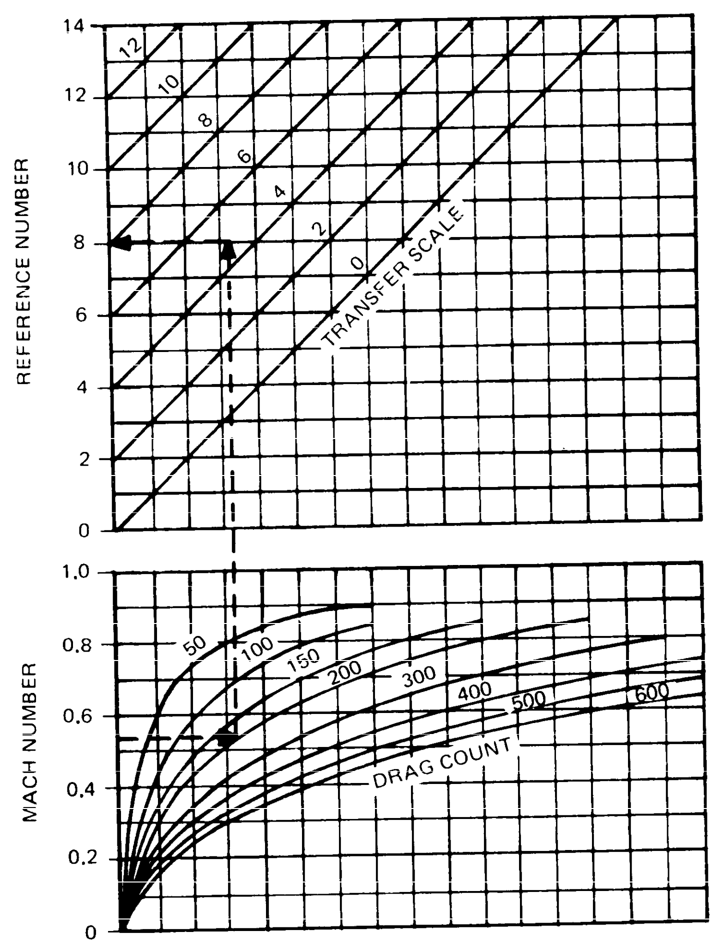


FIGURE 40. Example of cruise performance. - Continued

CRUISE PERFORMANCE

Phase III — Pounds of Fuel Per Nautical Mile

MODEL:
DATE:
DATA BASIS:

ENGINE:

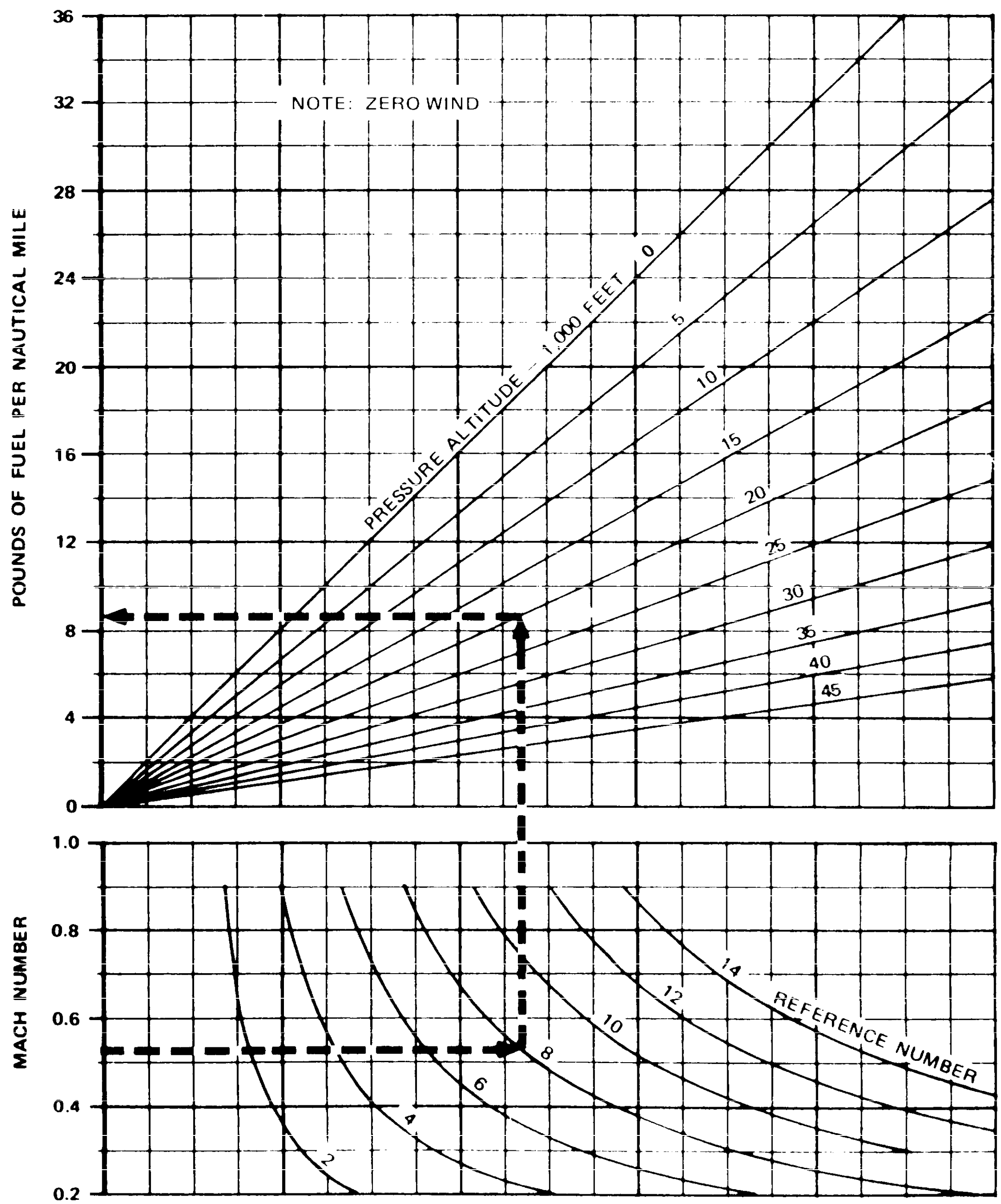


FIGURE 40. Example of cruise performance. - Continued

CRUISE PERFORMANCE

Phase IV – Fuel Flow

MODEL:
DATE:
DATA BASIS:

ENGINE:

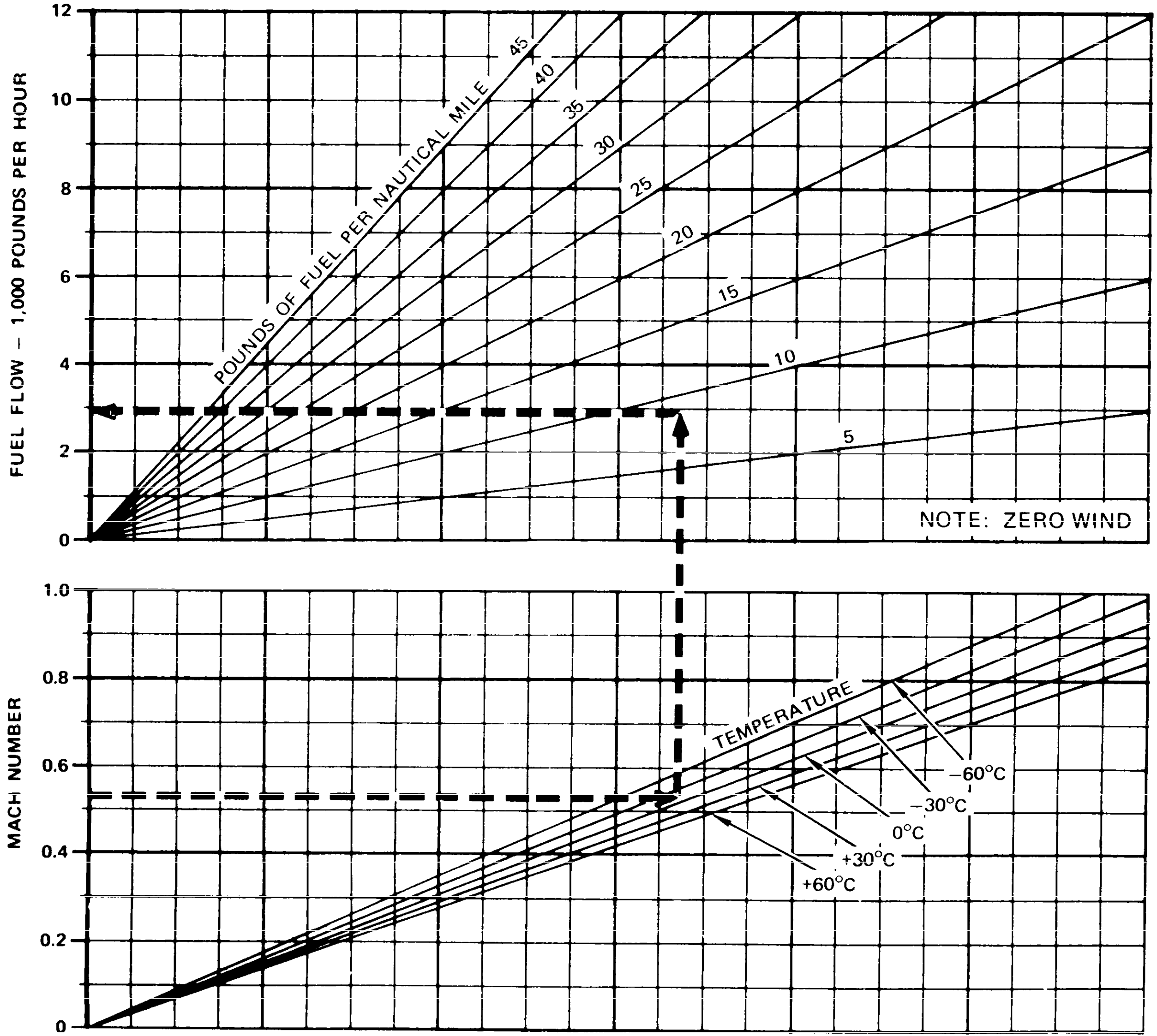


FIGURE 40. Example of cruise performance. - Continued

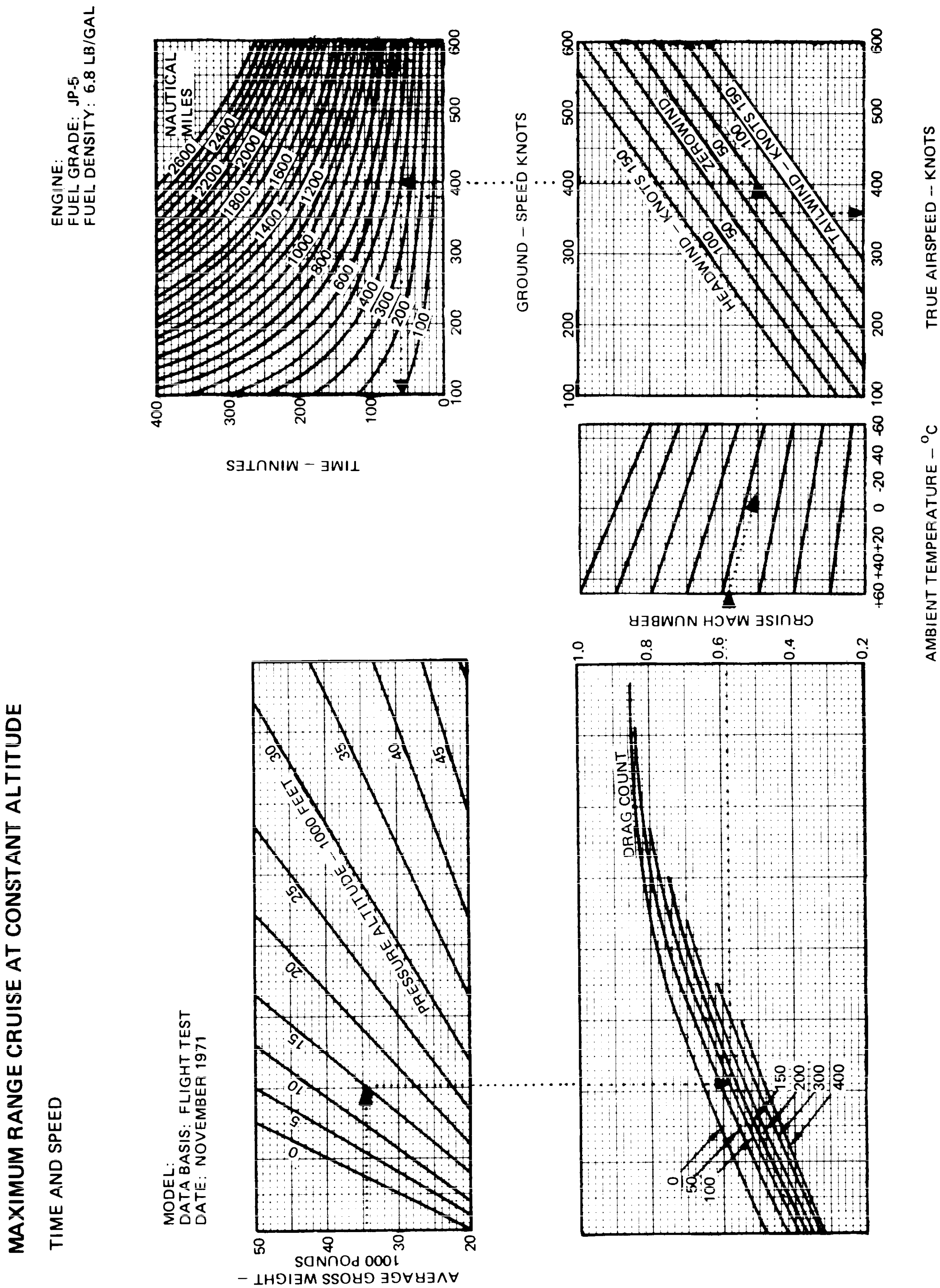


FIGURE 41. Example of maximum range cruise at constant altitude.

MAXIMUM RANGE CRUISE AT CONSTANT ALTITUDE

FUEL REQUIRED

MODEL:
DATA BASSIS: FLIGHT TEST
DATE: NOVEMBER 1971

ENGINE:
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

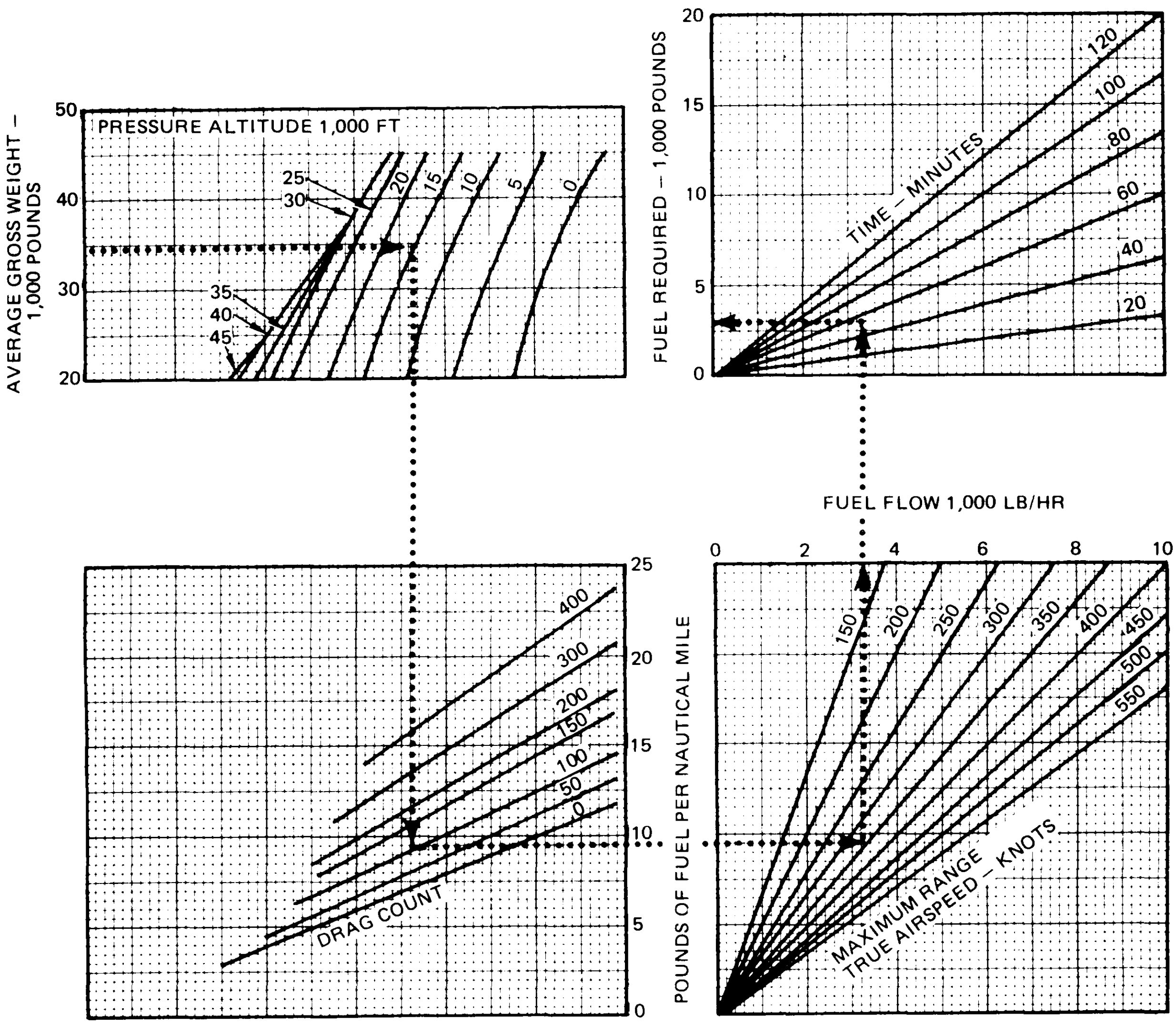


FIGURE 41. Example of maximum range cruise at constant altitude. - Continued

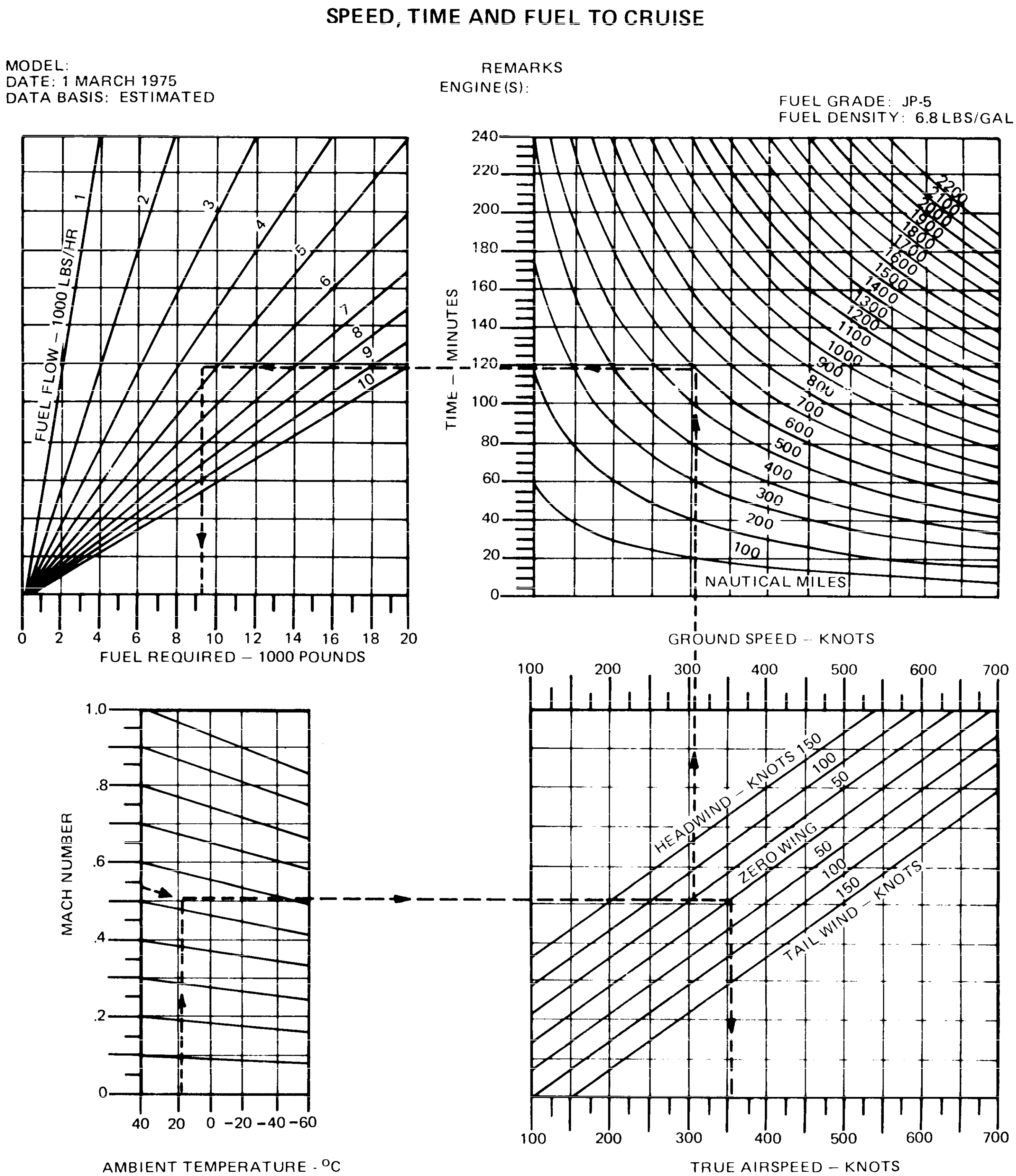


FIGURE 42. Example of speed, time and fuel to cruise.

LOW ALTITUDE CRUISE

GROSS WEIGHT – 45,000 POUNDS

AIRPLANE CONFIGURATION
INDIVIDUAL DRAG COUNTS

REMARKS
ENGINE(S): (2) J79-GE-10

MODEL:
DATE:
DATA BASIS:

FUEL GRADE:
FUEL DENSITY:

	KTAS	TOTAL FUEL FLOW LB/HR — DRAG COUNT 0	20	40	60	80	100	120	TEMP EFFECTS °C	FACTOR
SEA LEVEL (15°C)	360	7672	8475	9277	10102	10953	11788	12678		
	420	9401	10559	11774	12930	14247	15564	16917	-40	.899
	480	11681	13256	14932	16712	18536	20431	22830	-20	.937
	540	14587	16681	18780	21421	24796			0	.973
	600	20463	23565	27573					20	1.008
									40	1.042
4,000 FEET (7°C)	360	6988	7689	8423	9175	9918	10678	11456		
	420	8493	9527	10571	11634	12711	13963	15355	-40	.913
	480	10438	11856	13233	14861	16770	18705	20556	-20	.949
	540	12987	14854	16787	19700	22525			0	.987
	600	19082	22676						20	1.022
									40	1.057
8,000 FEET (-1°C)	360	6365	7002	7639	8292	8969	9635	10333		
	420	7654	8573	9500	10431	11413	12389	13586	-40	.925
	480	9308	10541	11778	13079	14681	16604	18734	-20	.963
	540	11602	13139	14830	17299	20406			0	1.001
	600	17447	21064						20	1.037
									40	1.072
12,000 FEED (-9°C)	360	5829	6384	6934	7532	8100	8709	9317		
	420	6930	7715	8526	9345	10213	11093	11990	-40	.939
	480	8327	9394	10458	11600	12858	14376	16265	-20	.978
	540	10357	11740	13170	15113	17750	19442		0	1.016
	600	15788	19093						20	1.052
									40	1.088
16,000 FEET (-16°C)	360	5420	5900	6395	6876	7420	7929	8494		
	420	6300	6975	7706	8404	9186	9996	10891	-40	.953
	480	7447	8383	9325	10374	11488	12730	14218	-20	.993
	540	9335	10513	11884	13642	15551	17586		0	1.032
	600	14687	17797						20	1.069
									40	1.105

FIGURE 43. Example of low altitude cruise.

RANGEWIND CORRECTION

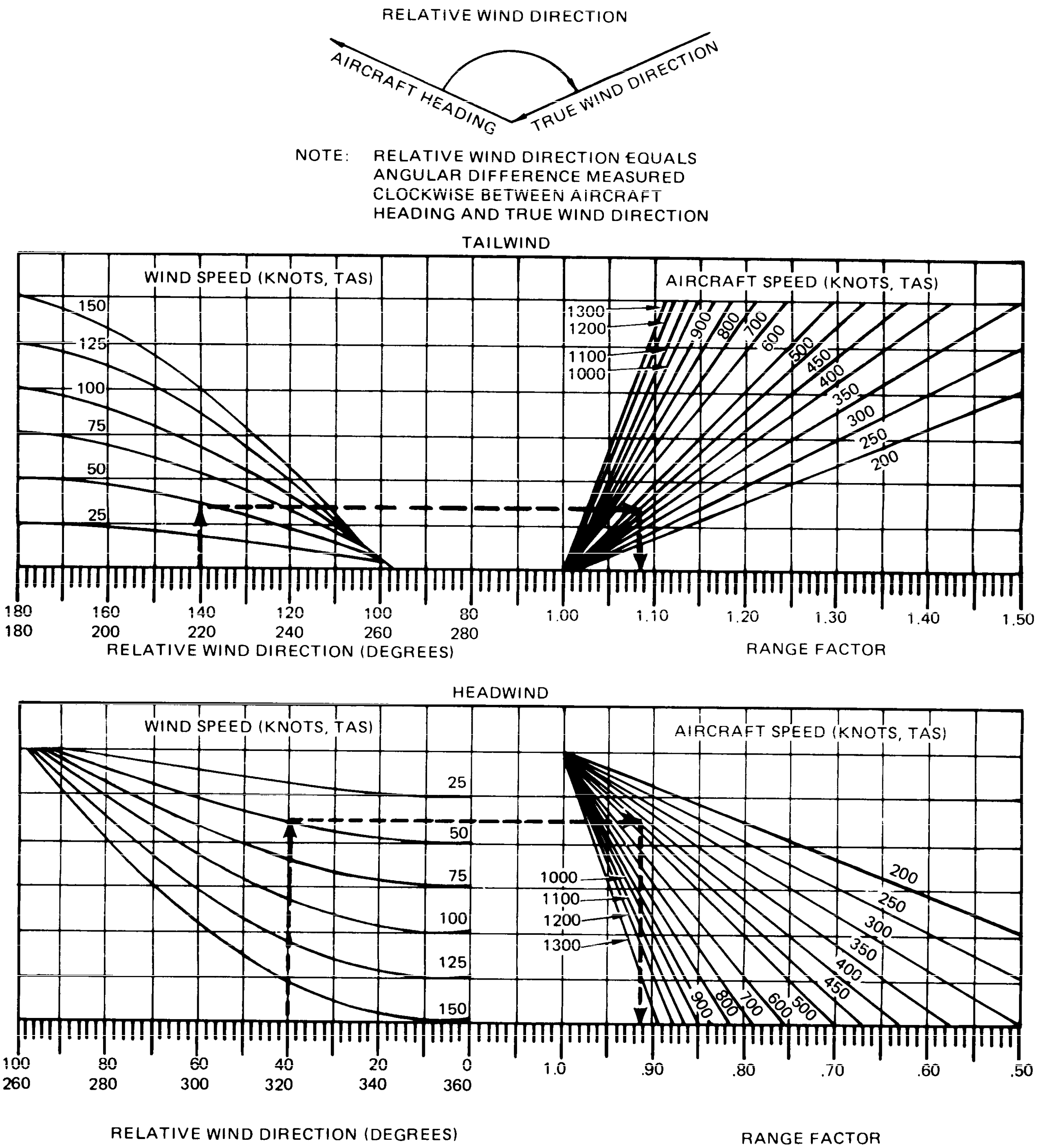


FIGURE 44. Example of rangewind correction.

TWO-ENGINE BINGO RANGE CHART
CONFIGURATION (A)
STANDARD DAY

MODEL:
DATA AS OF: 1 APRIL 1975
DATA BASIS: FLIGHT TEST

ENGINES:
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 220 KNOTS TO 0.6 MACH AND 0.6 MACH TO DESIRED ALTITUDE
- FLIGHT IDLE DESCENT IS AT 0.6 MACH TO 25,000 FT AND 250 KNOTS BELOW 25,000 FT

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE	
DIST TO BASE N M	FUEL REQ LB	TIME REQ MIN	CRUISE ALT FEET	CRUISE CAS KNOTS	DIST TO DESC N M	FUEL REQ LB	TIME REQ MIN
25	1180	6	5000	207	12	1210	7
50	1360	12	10,500	203	12	1420	14
75	1510	17	15,000	202	26	1630	22
100	1660	21	20,000	200	38	1840	29
125	1790	26	24,000	196	49	2050	36
150	1920	30	28,500	193	71	2250	43
175	2030	35	33,500	188	83	2460	50
200	2140	37	39,000	179	112	2670	57
225	2230	42	40,000	177	116	2880	64
250	2330	46	40,000	177	116	3090	71

ALT FEET	CRUISE KCAS
SL	212
5000	207
20,000	200

NOTES:

1. CHART VALID FOR GROSS WEIGHTS BELOW 36,000 LB
2. AT 5000 FT CRUISE FUEL REQUIRED IS 0 TO 200 LB LESS THAN SEA LEVEL CRUISE
3. AT 20,000 FT CRUISE FUEL REQUIRED IS 0 TO 100 LB MORE THAN MAXIMUM RANGE CRUISE

FIGURE 45. Example of bingo chart.

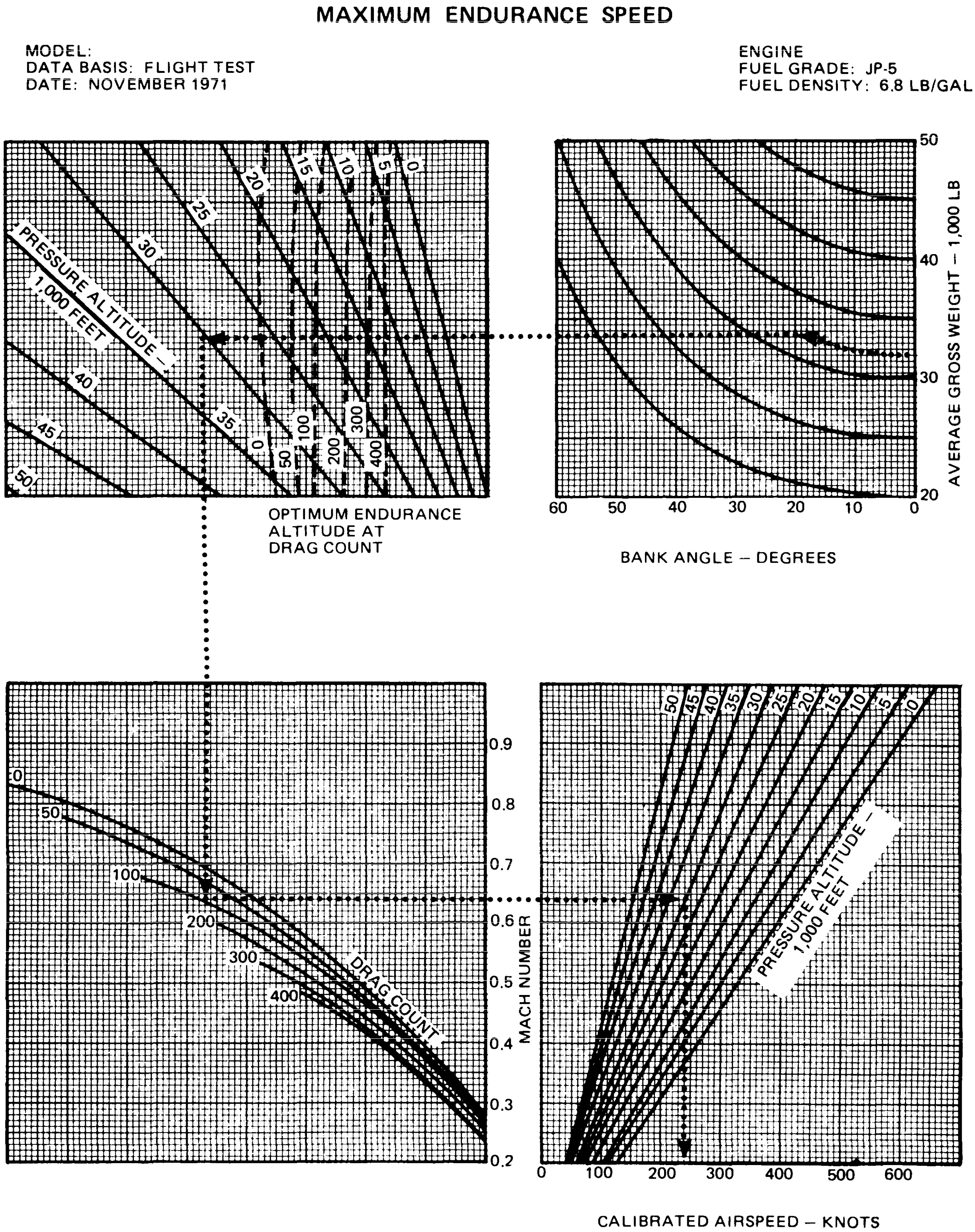


FIGURE 46. Example of maximum endurance.

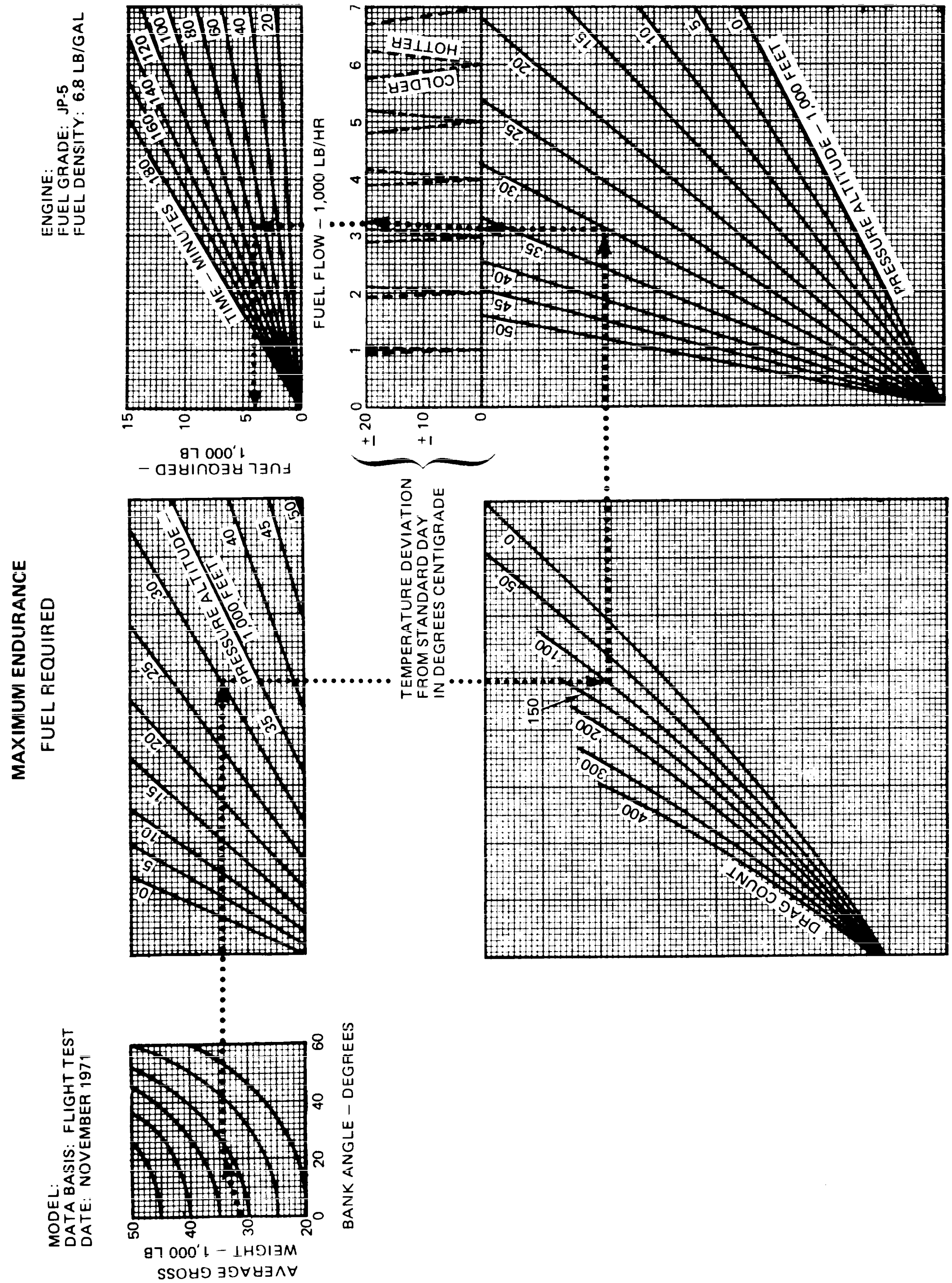


FIGURE 46. Example of maximum endurance. - Continued

AIR REFUELING TRANSFER TIME

DATE:
DATA BASIS:

FUEL GRADE:
FUEL DENSITY:

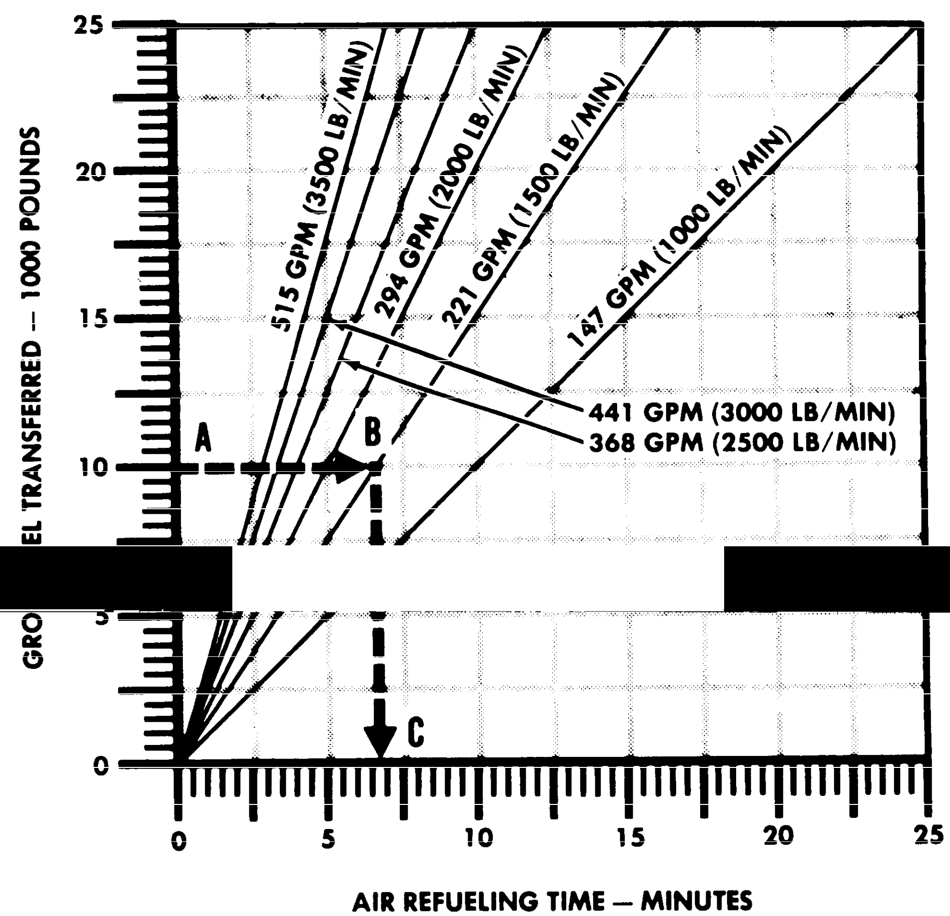


FIGURE 47. Example of air refueling transfer time.

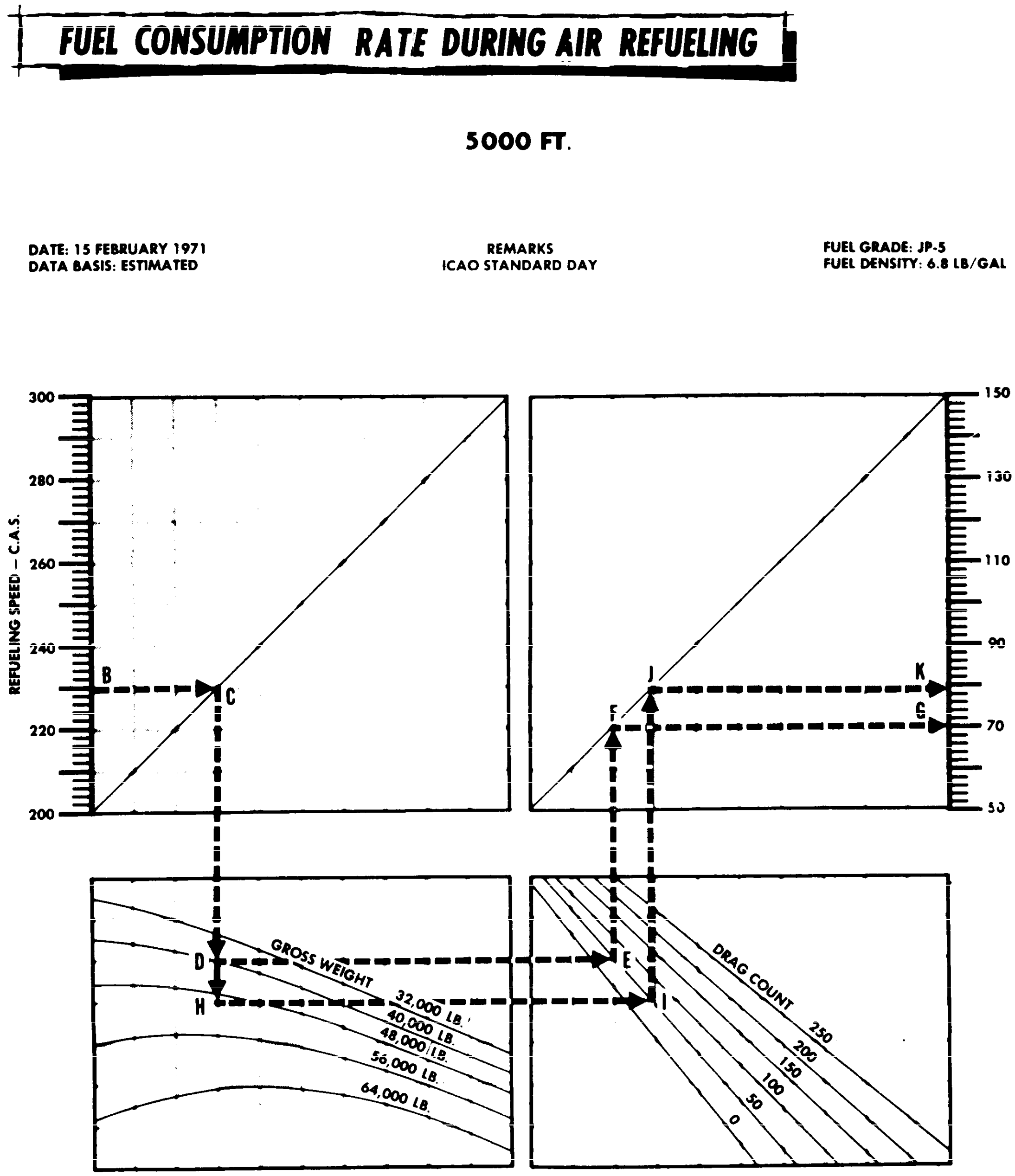


FIGURE 48. Example of fuel consumption rate during air refueling.

MAXIMUM RANGE DESCENT

Descent Speeds

MODEL:
DATE:
DATA BASIS:

STANDARD DAY

ENGINE:

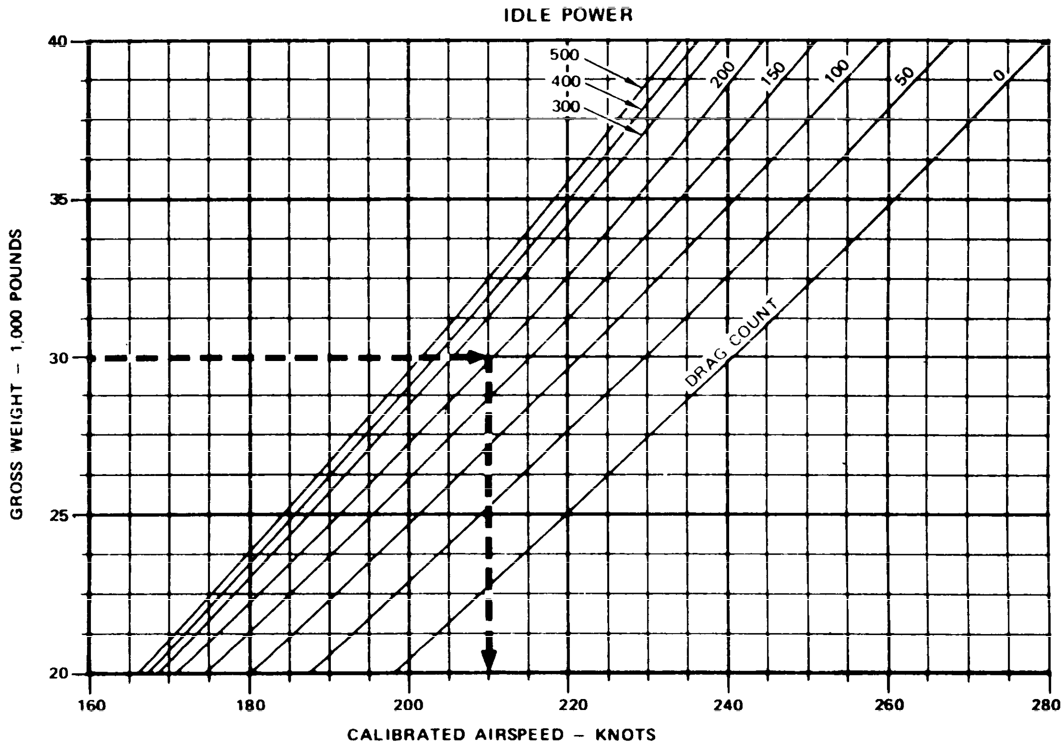


FIGURE 49. Example of maximum range descent.

MAXIMUM RANGE DESCENT

Time Required To Descend From Selected Altitude To Sea Level

MODEL:
DATE:
DATA BASIS:

ENGINE:

STANDARD DAY

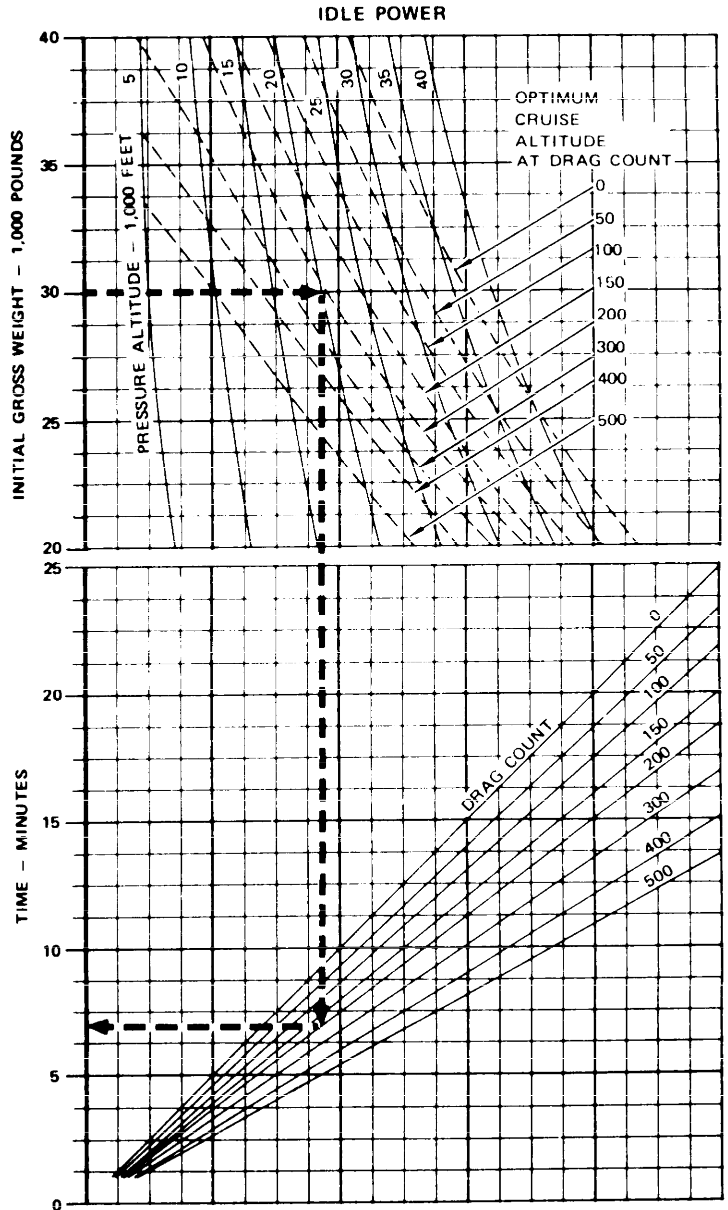


FIGURE 49. Example of maximum range descent. - Continued

MAXIMUM RANGE DESCENT

DISTANCE TO DESCEND FROM SELECTED ALTITUDE TO SEA LEVEL

MODEL:
DATE:
DATA BASIS:

ENGINE:

STANDARD DAY

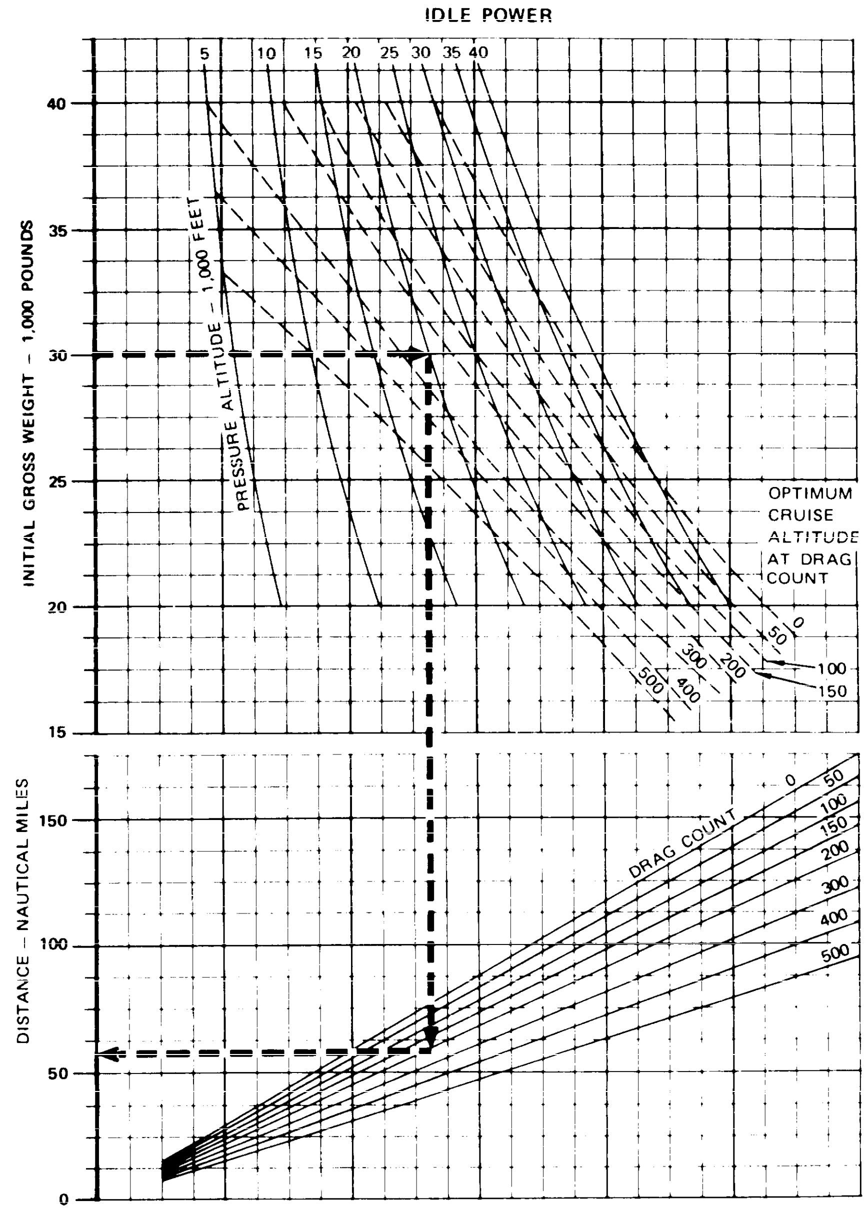


FIGURE 49. Example of maximum range descent. - Continued

MAXIMUM RANGE DESCENT

Fuel Required To Descend From Selected Altitude To Sea Level

MODEL:
DATE:
DATA BASIS:

STANDARD DAY

ENGINE:

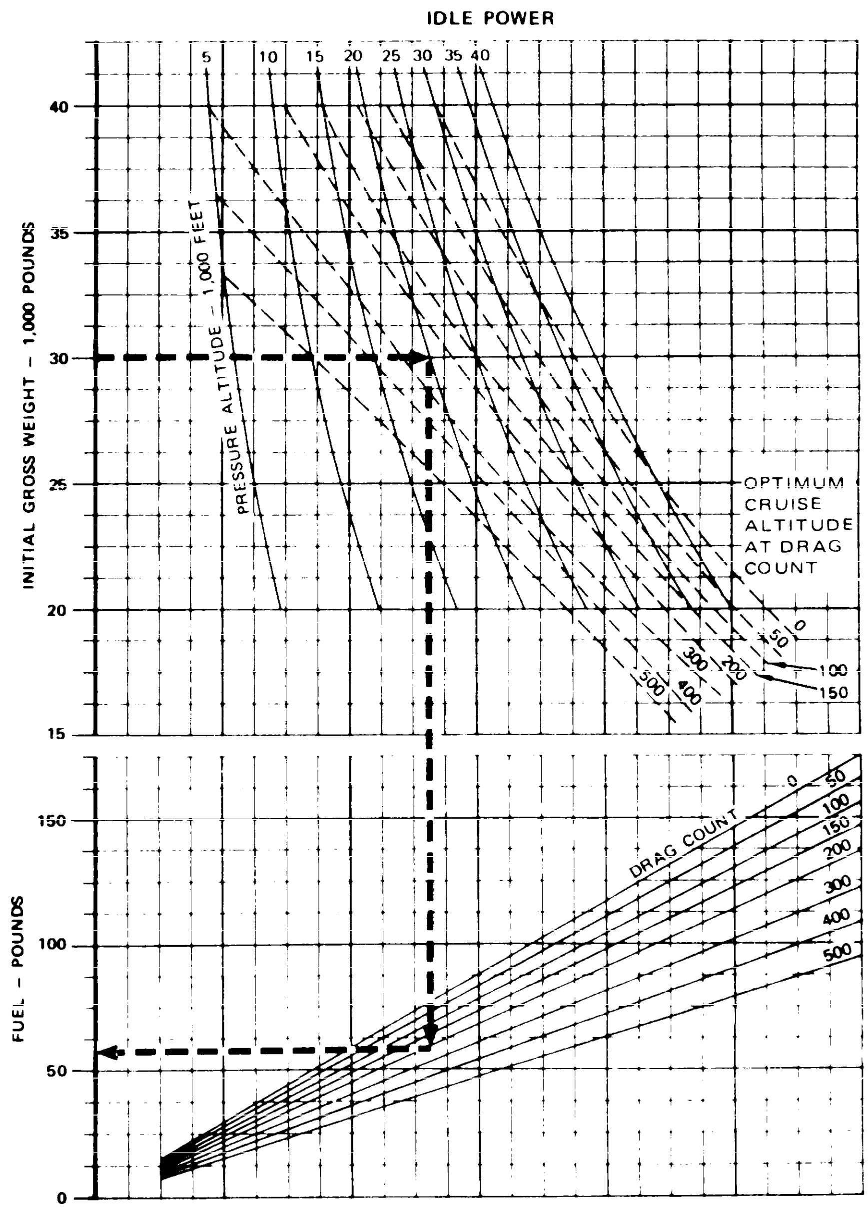


FIGURE 49. Example of maximum range descent. - Continued

LANDING SPEED

MODEL:
DATA AS OF:
DATA BASIS:

ENGINE:
FUEL GRADE:
FUEL DENSITY:

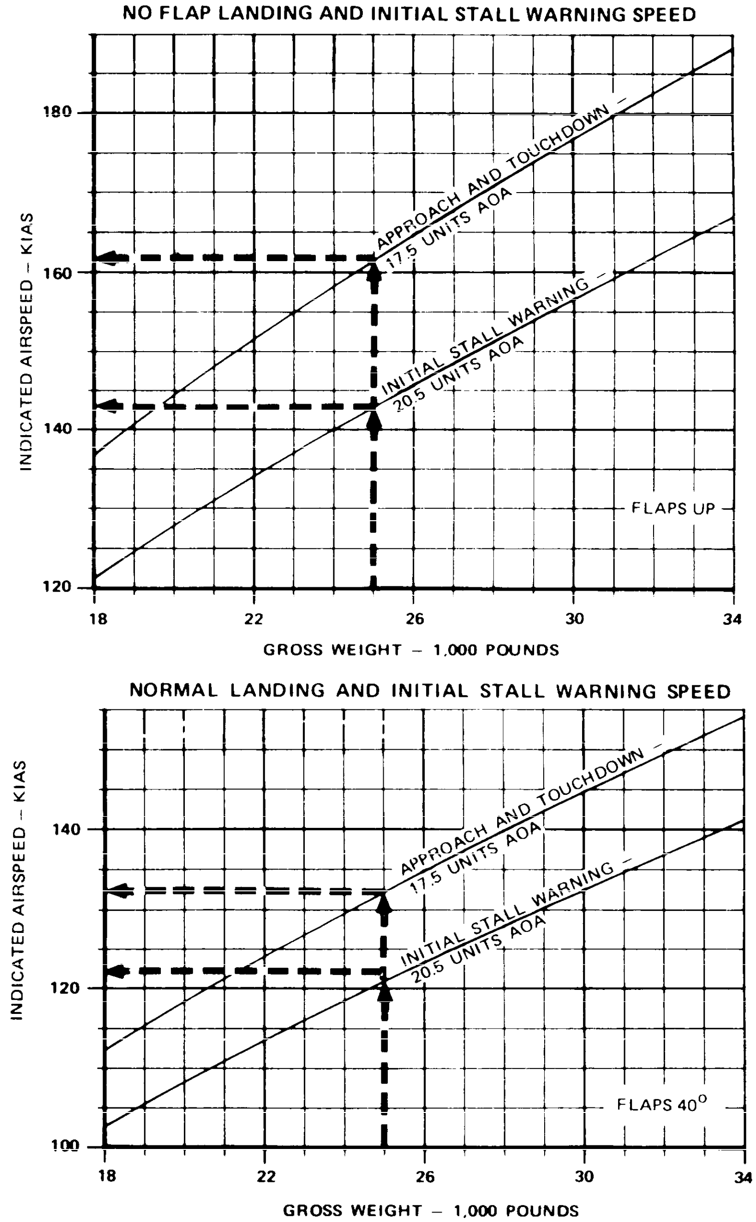


FIGURE 50. Example of landing speeds.

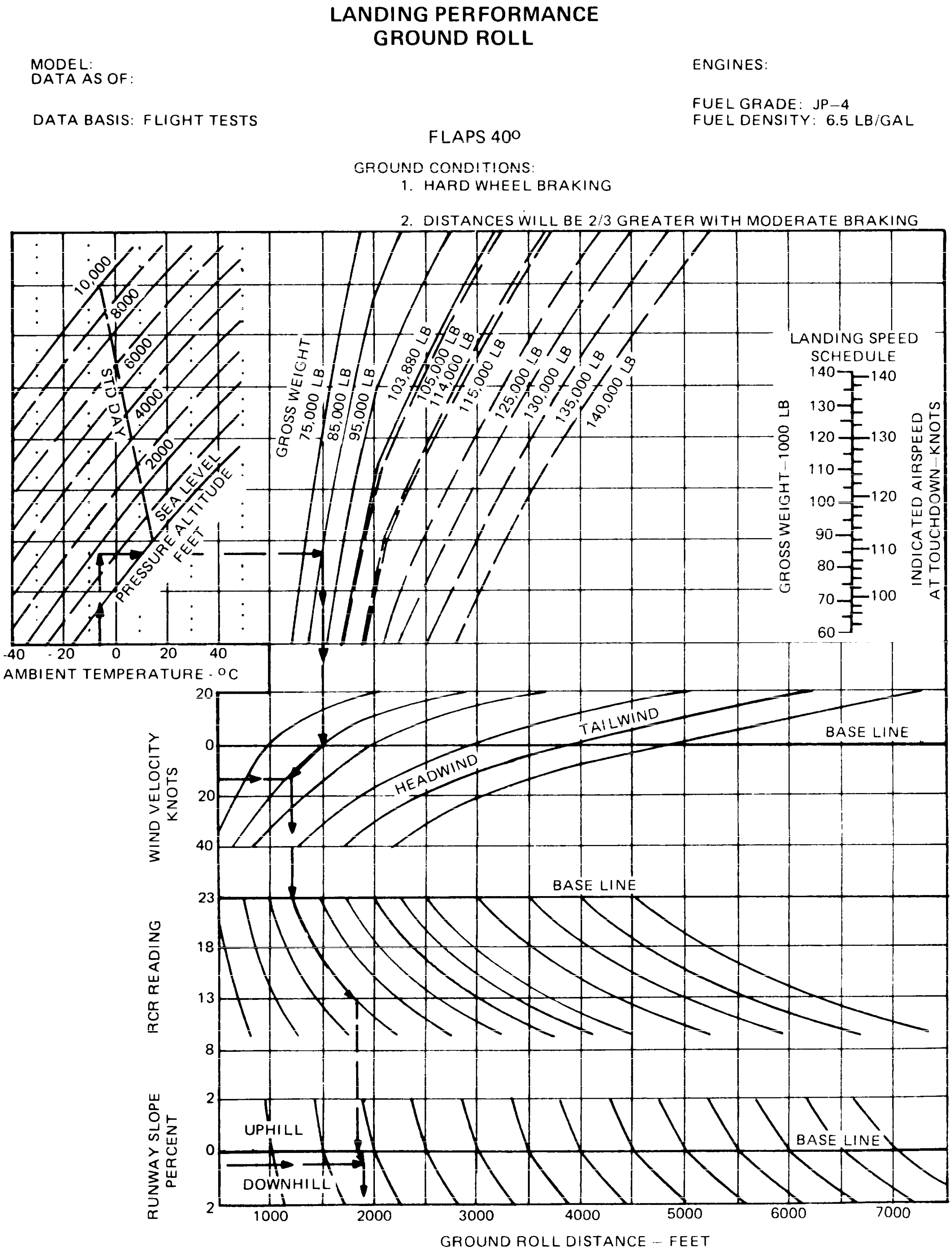


FIGURE 51. Example of landing performance - ground roll.

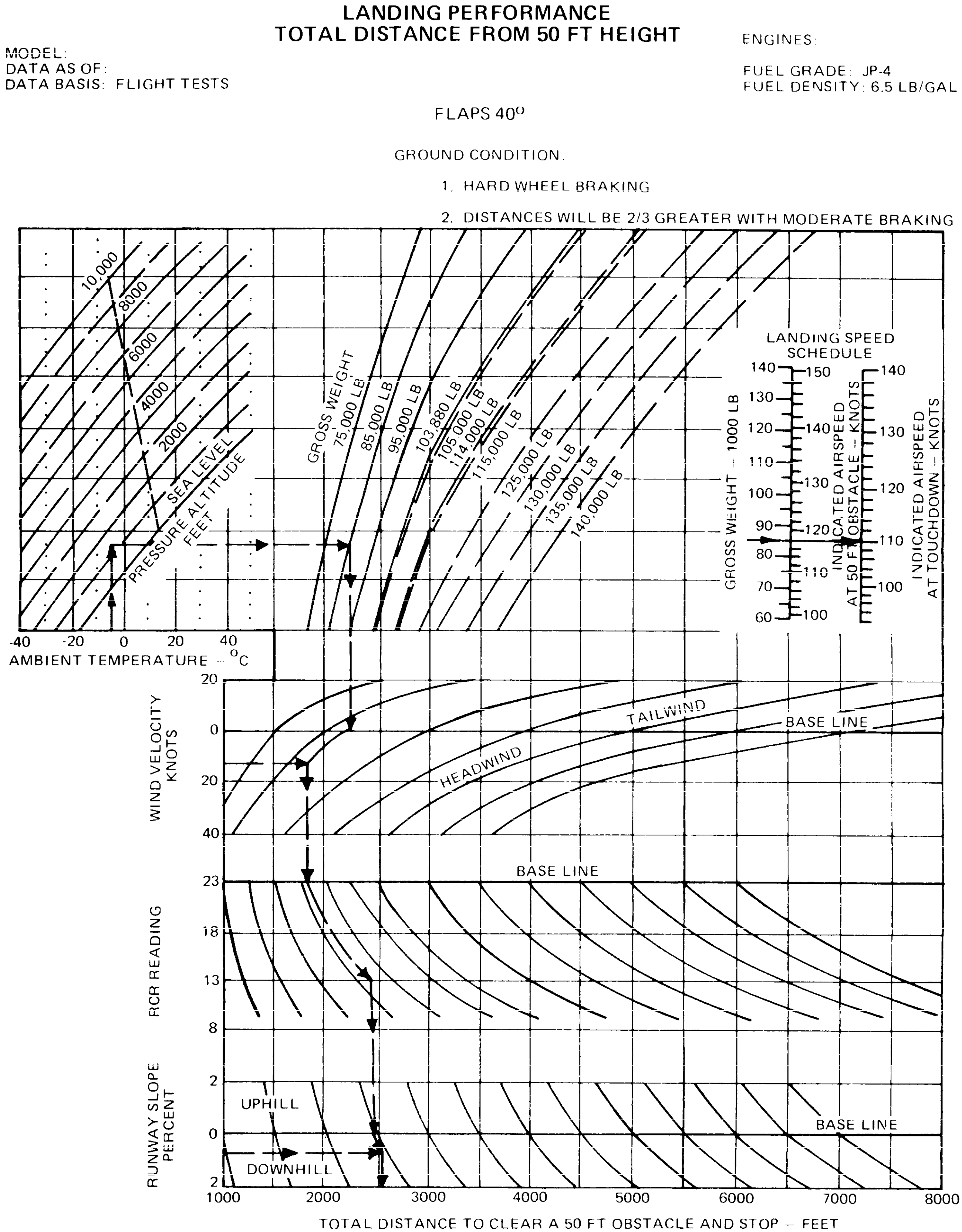


FIGURE 52. Example of landing performance - total distance from 50 ft height.

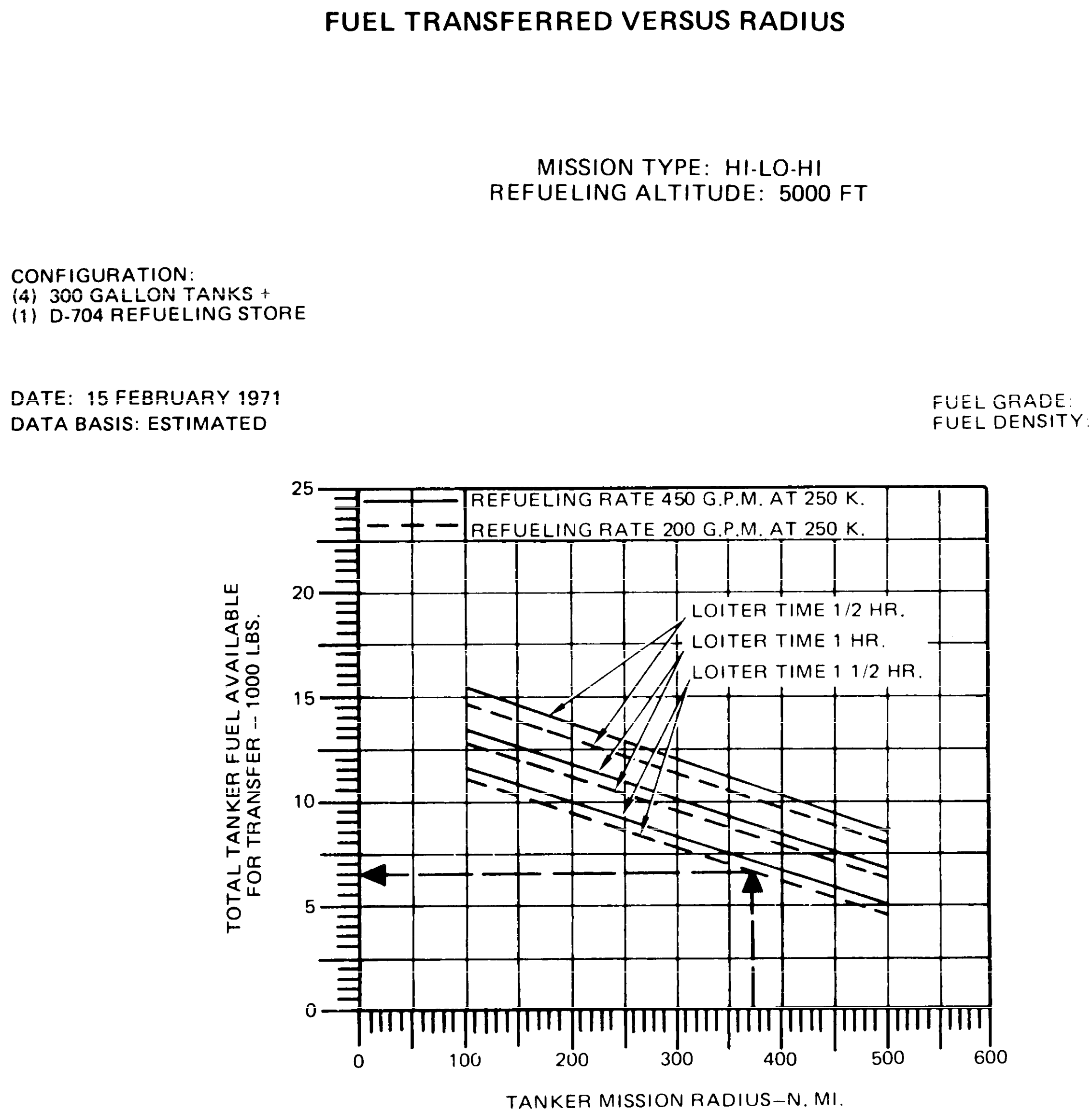


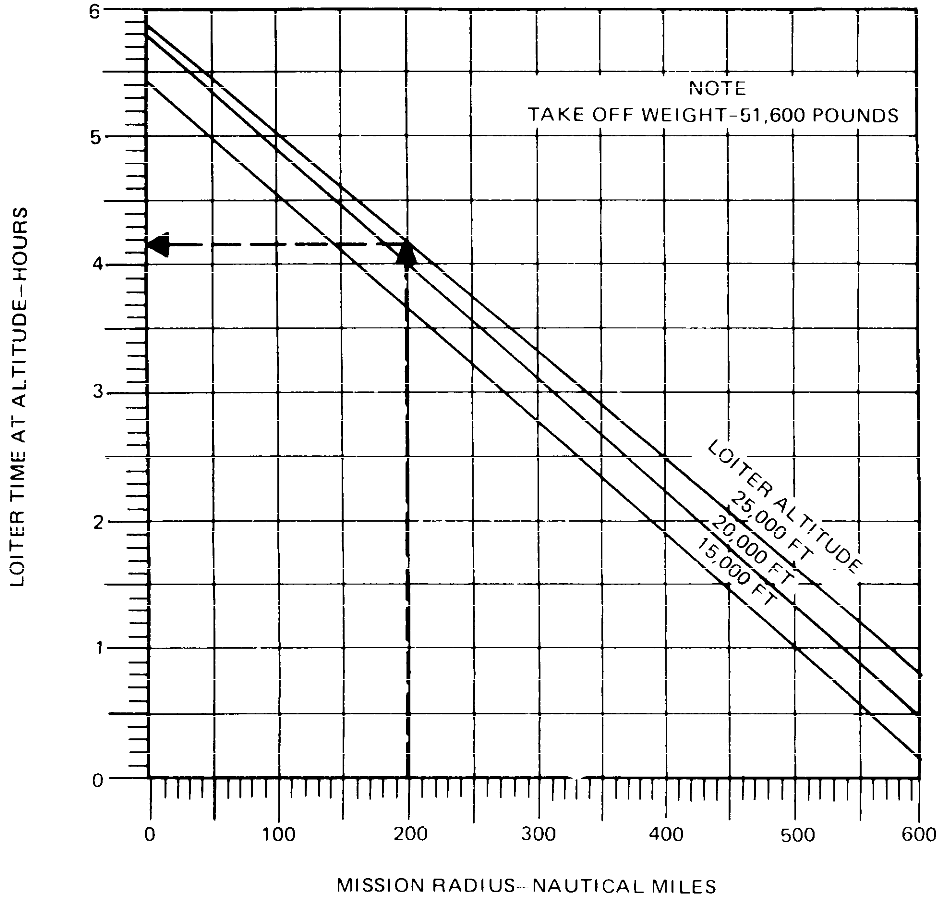
FIGURE 53. Example of fuel transferred versus radius.

LOITER TIME VERSUS RADIUS

AIRCRAFT CONFIGURATION:
CLEAN

DATE: NOVEMBER 1972
DATA BASIS: ESTIMATED

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL



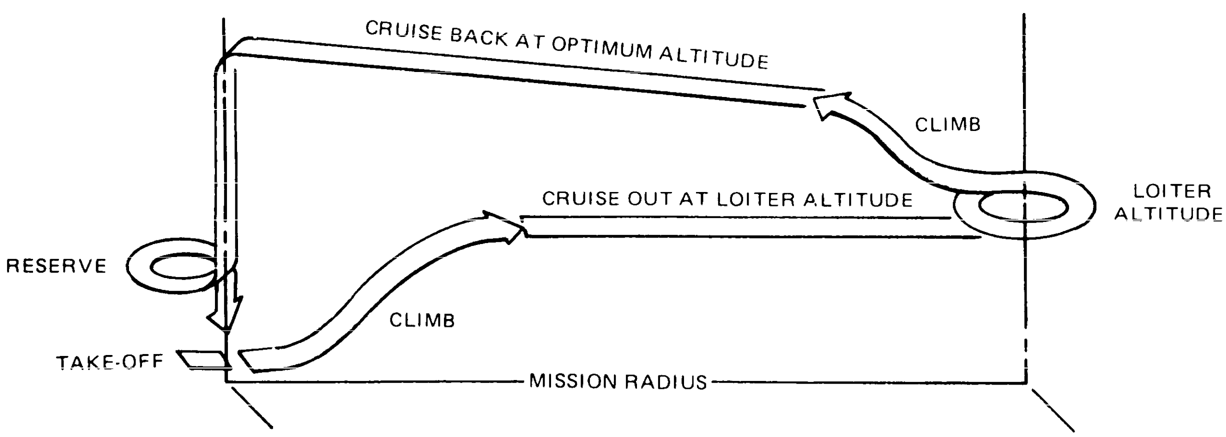


FIGURE 54. Example of loiter time versus radius.

INTERMEDIATE THRUST ACCELERATION

35,000 FEET

AIRPLANE CONFIGURATION
(4) AIM−7

ENGINE(S):
ICAO STANDARD DAY

DATE: 1 JANUARY 1972
DATA BASIS: FLIGHT TEST

FUEL GRADE: JP−5
FUEL DENSITY: 6.8 LB GAL

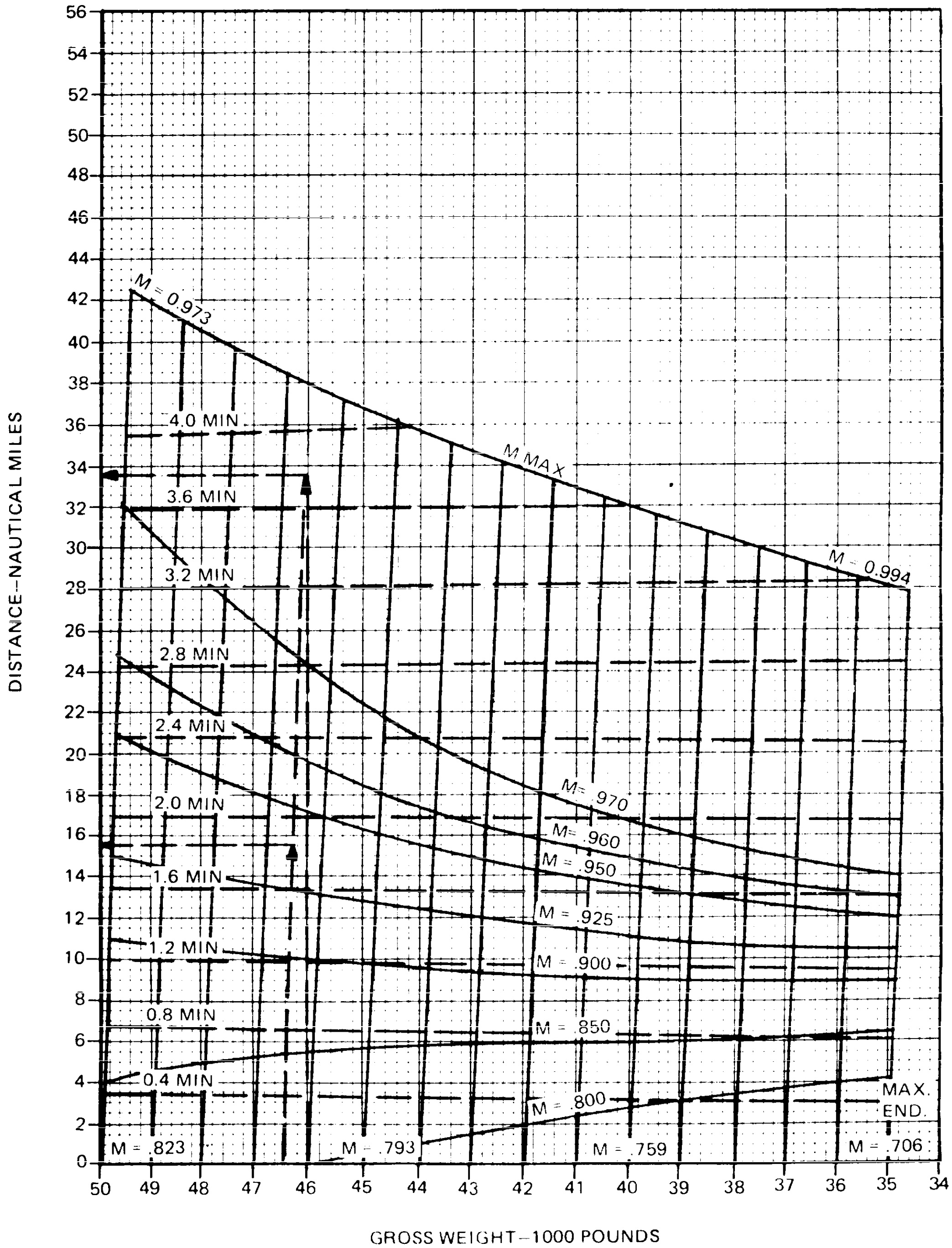


FIGURE 55. Example of level flight acceleration.

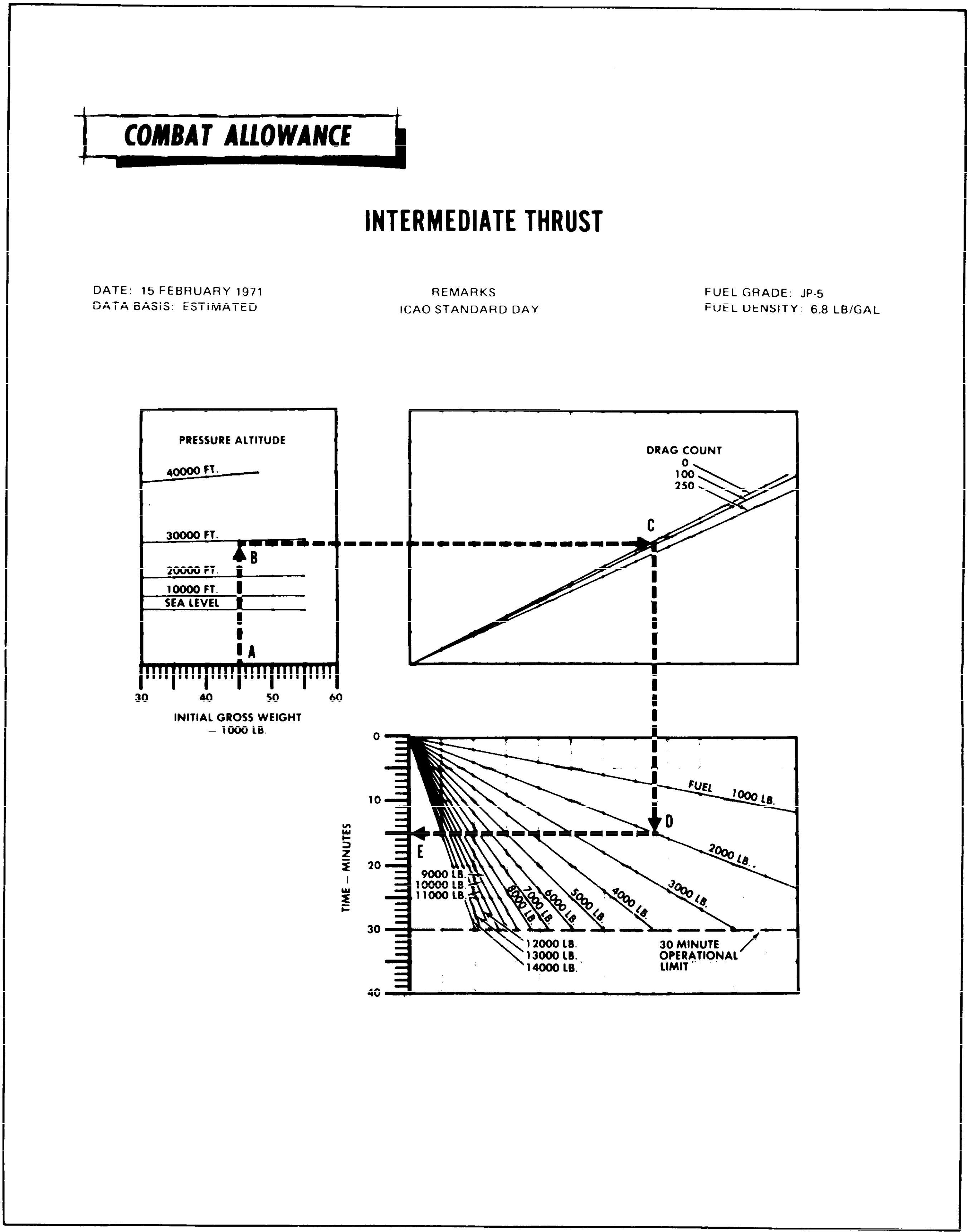


FIGURE 56. Example of combat allowance.

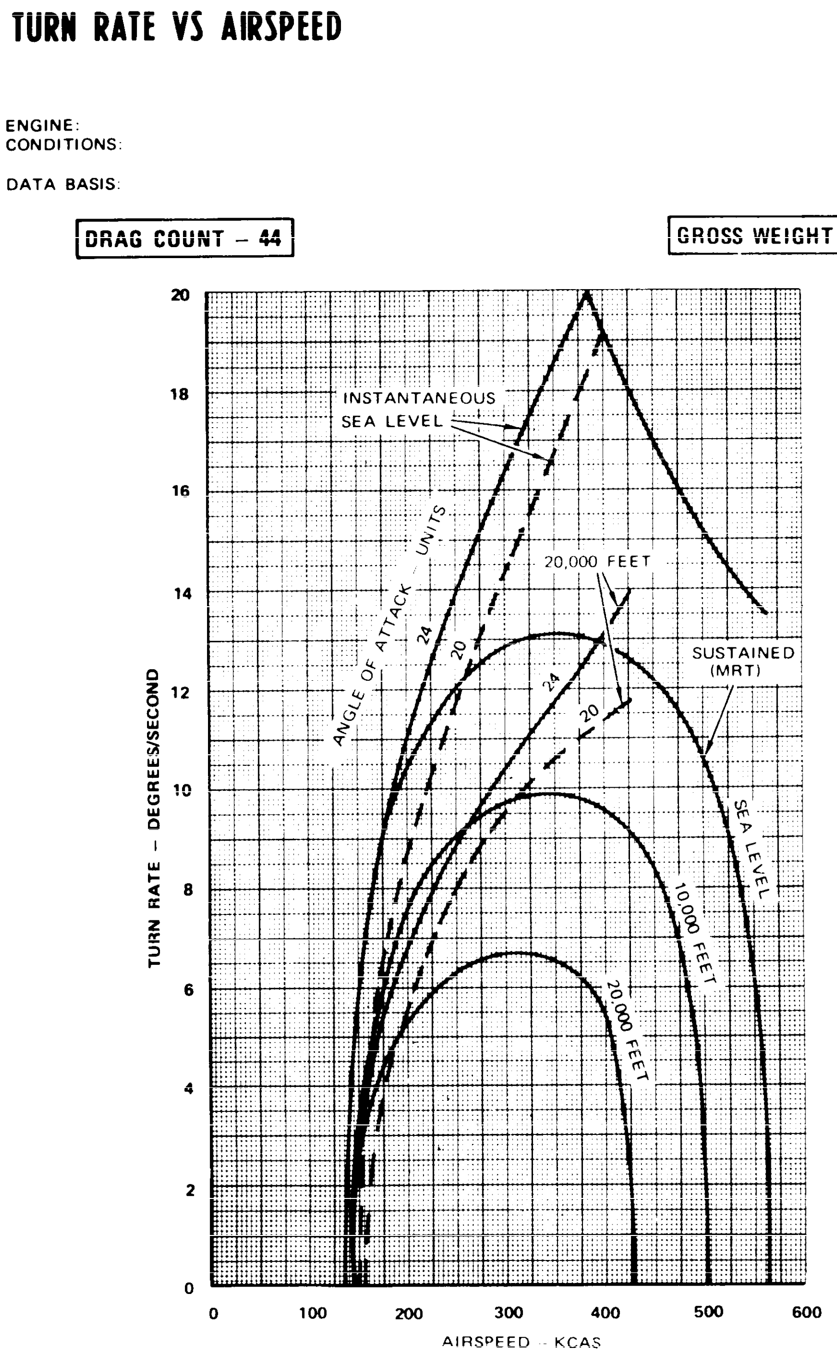


FIGURE 57. Example of turn rate versus airspeed.

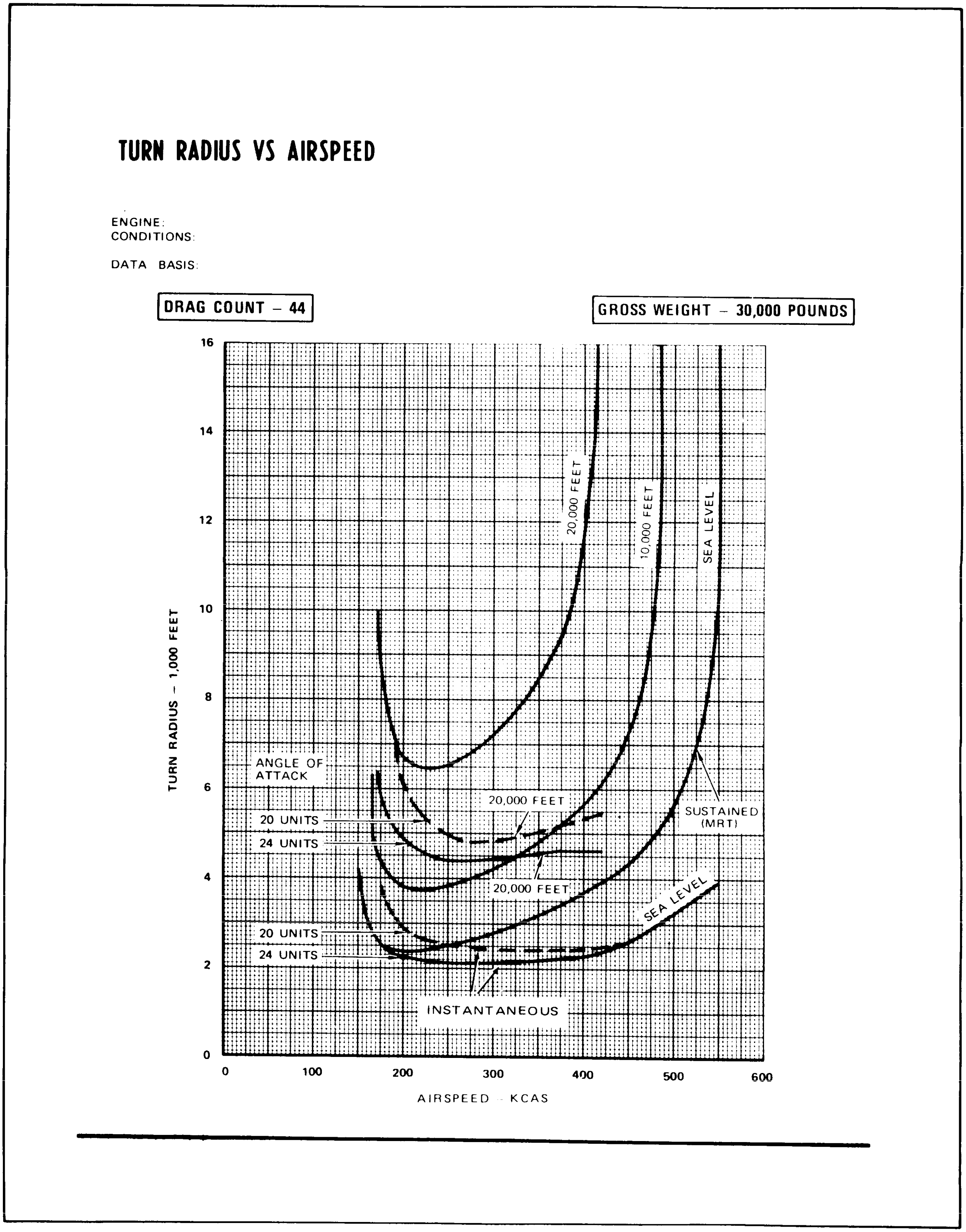


FIGURE 58. Example of turn rate versus airspeed.

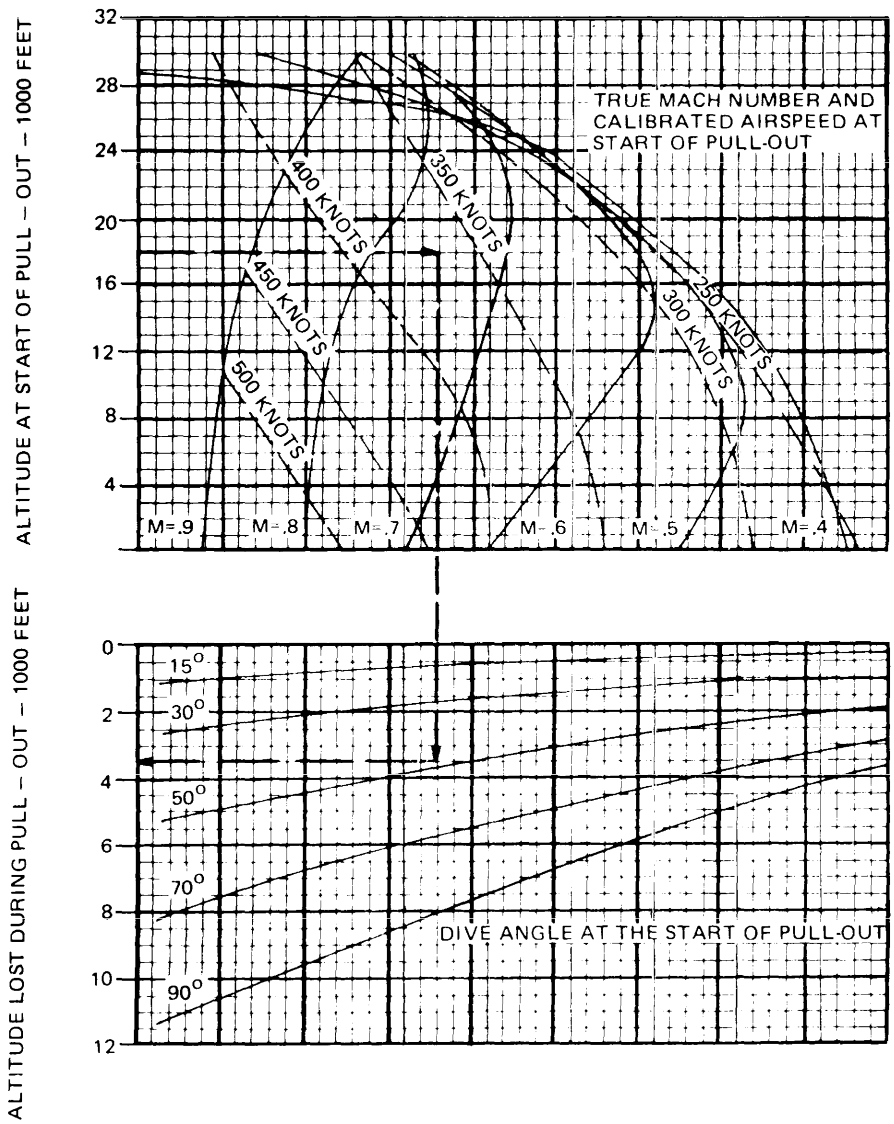
ALTITUDE LOST IN PULLOUT

SUBSONIC SPEED BRAKES RETRACTED

GROSS WEIGHT 40,000 POUNDS

DATE: 1 AUGUST 1968
DATA BASIS: FLIGHT TEST

ENGINE(S):
ICAO STANDARD DAY



NOTES

1. ALTITUDE LOSS WITH MAXIMUM THRUST IS ESSENTIALLY THE SAME WITH MILITARY THRUST.
2. PULLOUT BASED ON 1.0G PER SECOND ACCELERATION BUILDUP TO 19 UNITS (AOA), STABILATOR LIMIT OR 6.0G WHICHEVER OCCURS FIRST.

FIGURE 59. Example of altitude lost in pullout.

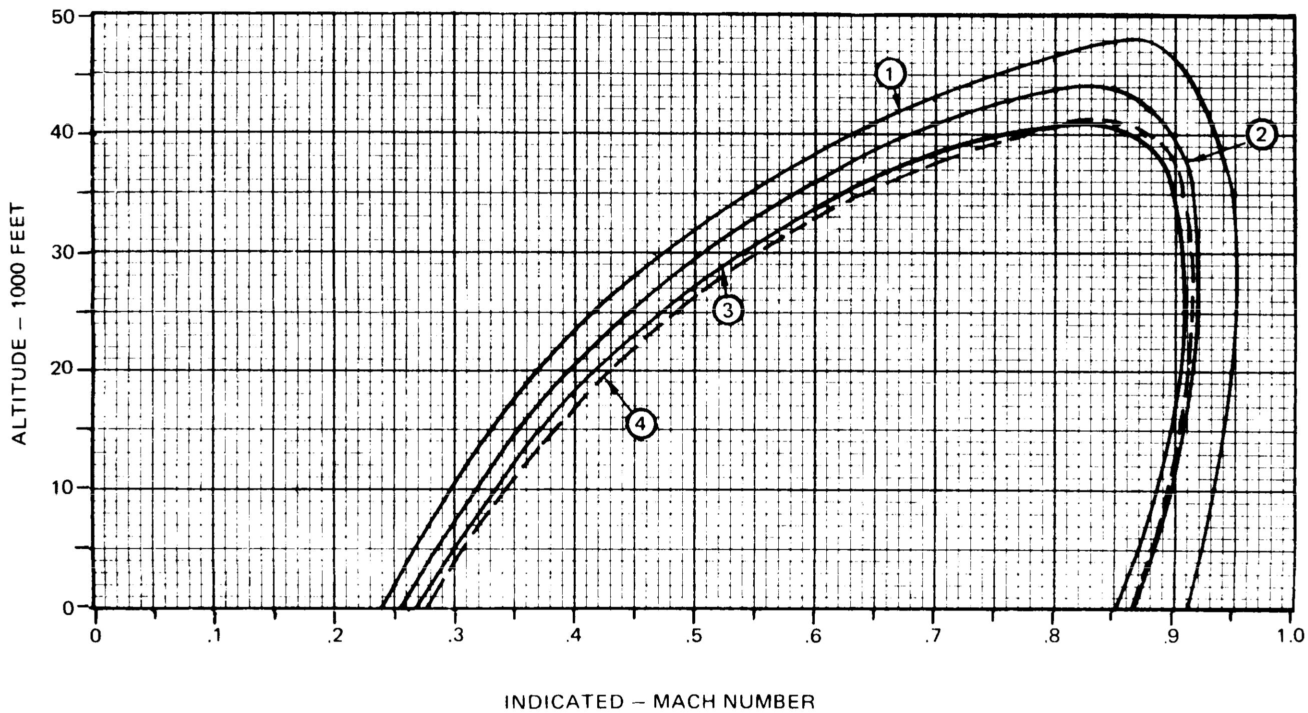
LEVEL FLIGHT ENVELOPE

CONFIGURATION: SEE NOTES BELOW

REMARKS
ENGINE:
ICAO STANDARD DAY

DATE: 1 MAY 1976
DATA BASIS: WIND TUNNEL AND FLIGHT EXPERIENCE

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL



CURVE NO.	CONFIGURATION	GROSS WEIGHT	DRAG INDEX
1	CLEAN	15,275 LB	0
2	(2) AIM-9, (2) GUN PODS AND ℄ RACK	17,090 LB	14.9
3	(2) 120 GAL WING TANKS, (2) LAU-10A LAUNCHERS, AND (2) GUN PODS	18,917 LB	19.9
4	(2) MK-82 SNAKEYES AND (2) MK-83 LDGP	19,584 LB	15.7

FIGURE 60. Example of level flight envelope.

TANKER SPEED ENVELOPE

TANKER CONFIGURATION
1-300 GALLON REFUELING STORE PLUS 2-300 GALLON TANKS
5 PYLONS AND GUNS

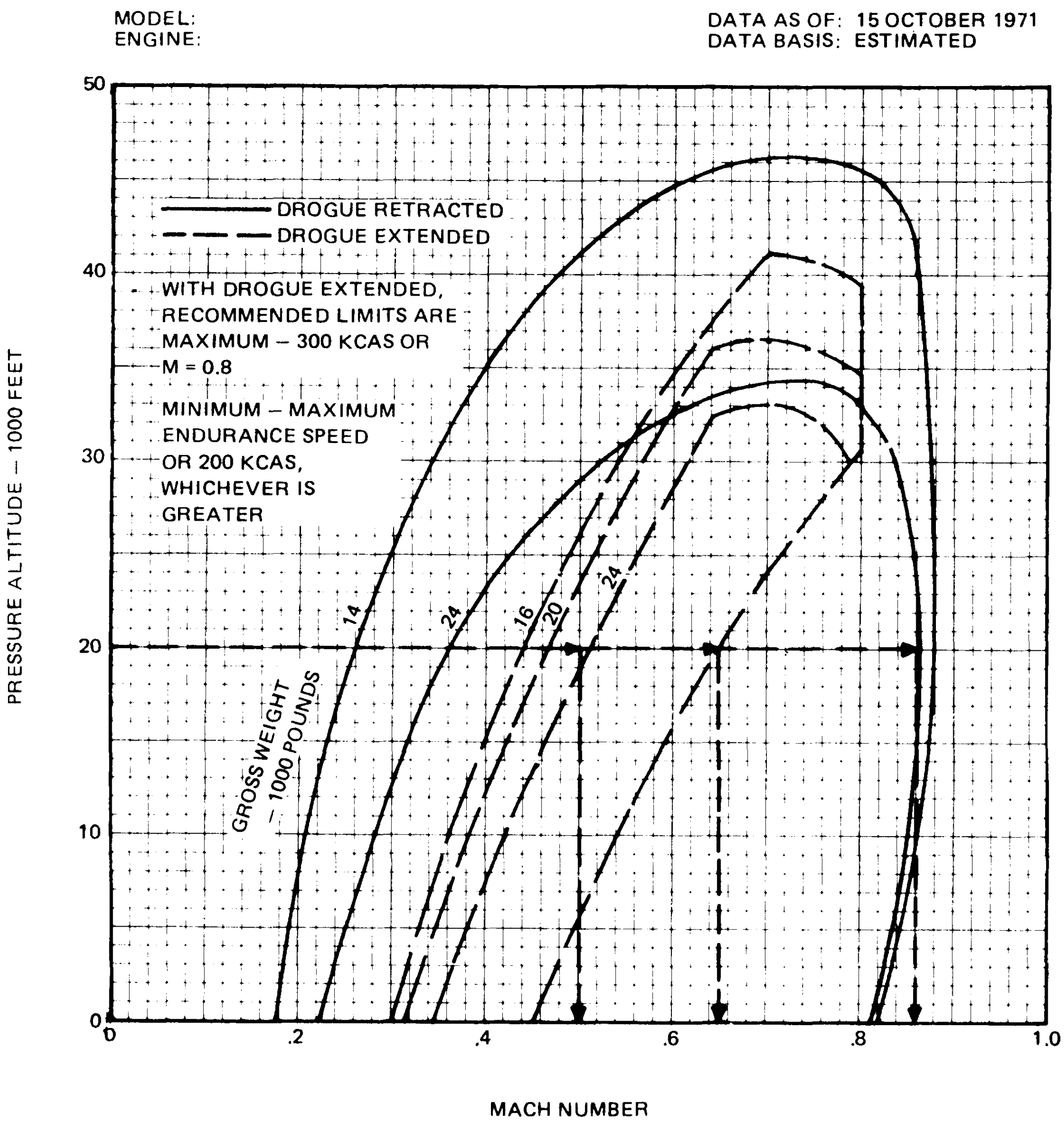


FIGURE 61. Example of tanker speed envelope.

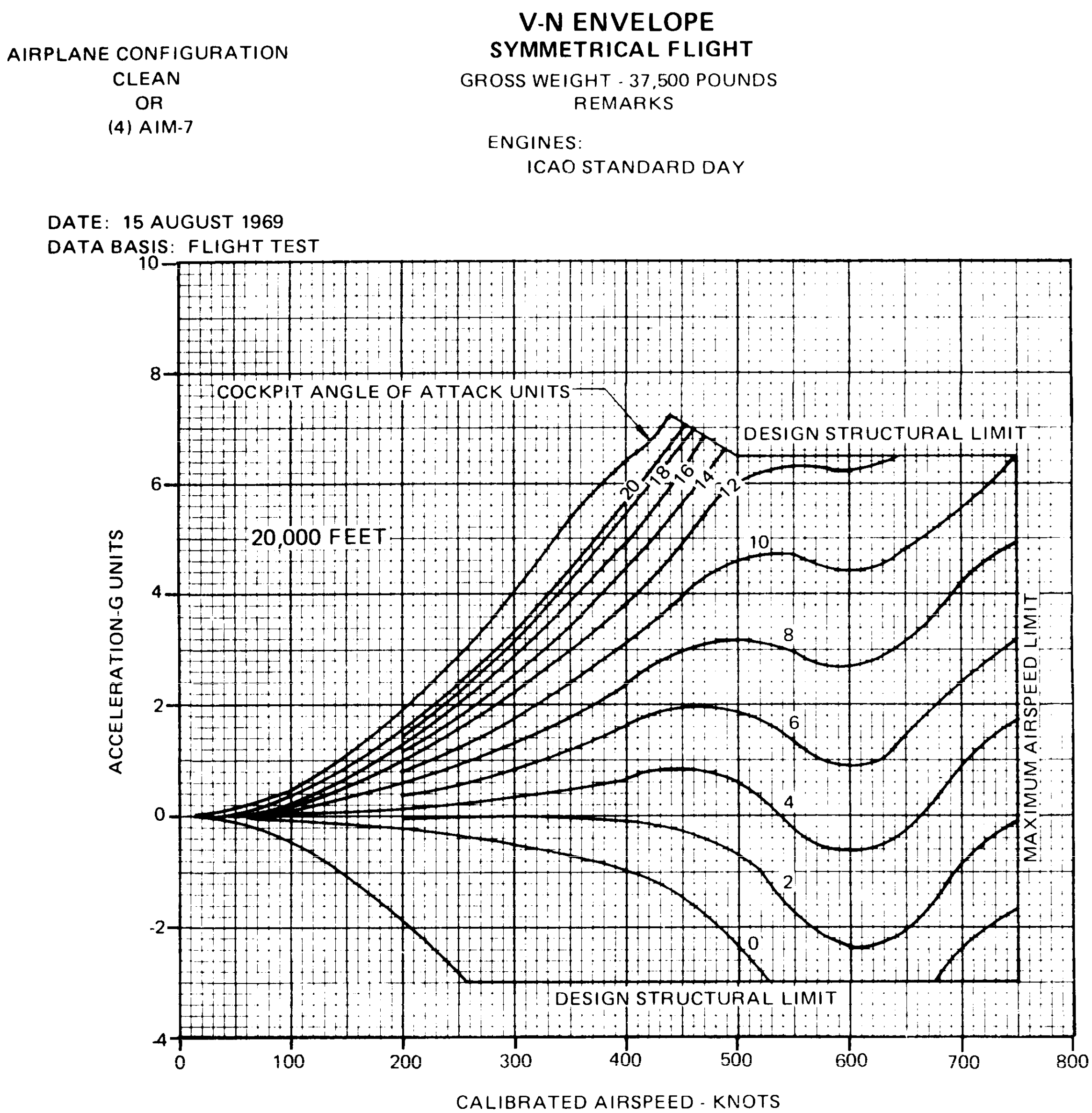


FIGURE 62. Example of V-N envelope.

GLIDE PERFORMANCE

MODEL
DATA BASIS
DATE

CONDITIONS
STANDARD DAY NO WIND
MAXIMUM RANGE

ENGINE

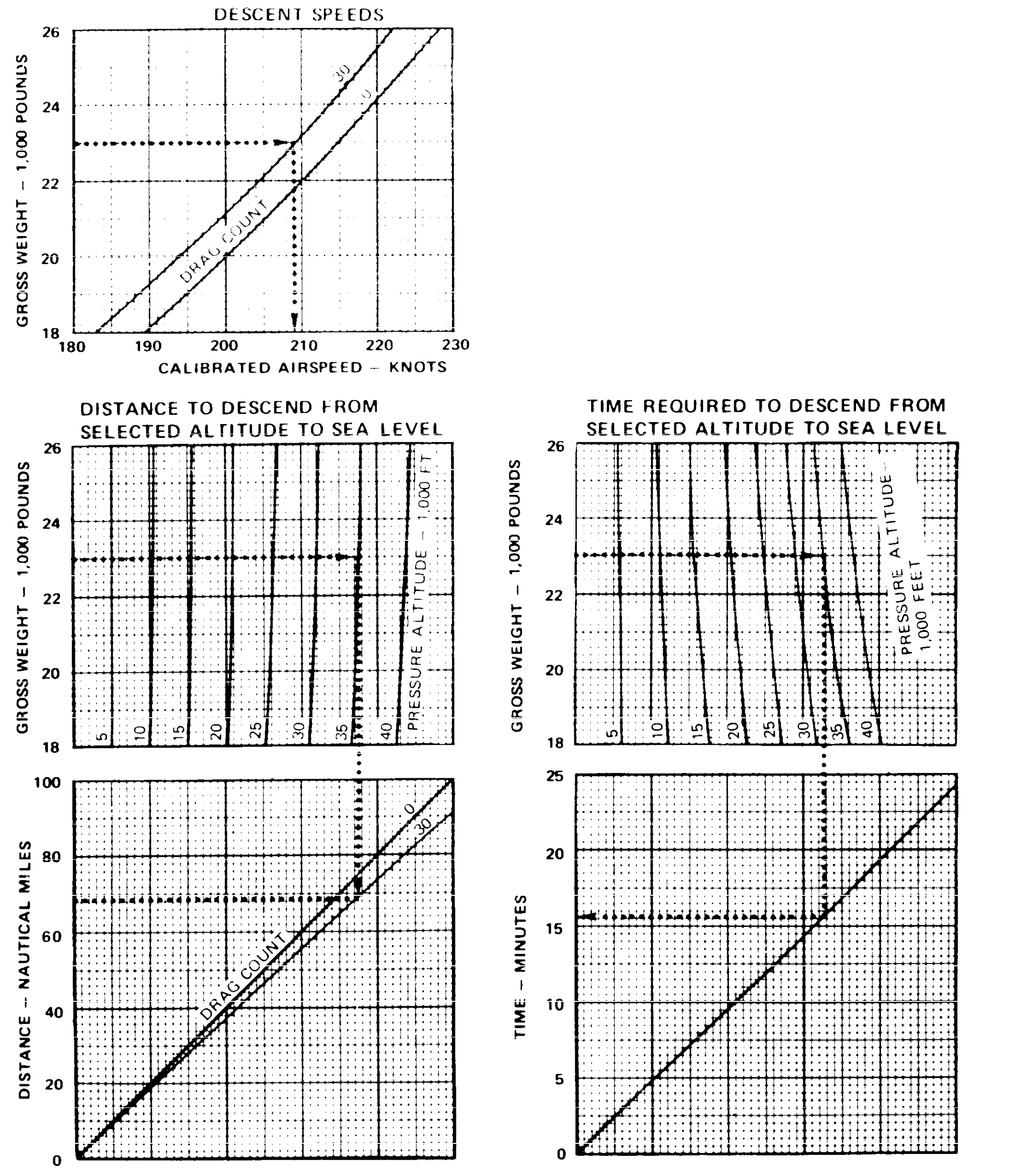


FIGURE 63. Example of glide performance.

AIR START ENVELOPE

MODEL:
DATE: 1 SEPTEMBER 1965
DATA BASIS: FLIGHT TEST

ENGINES (2):
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

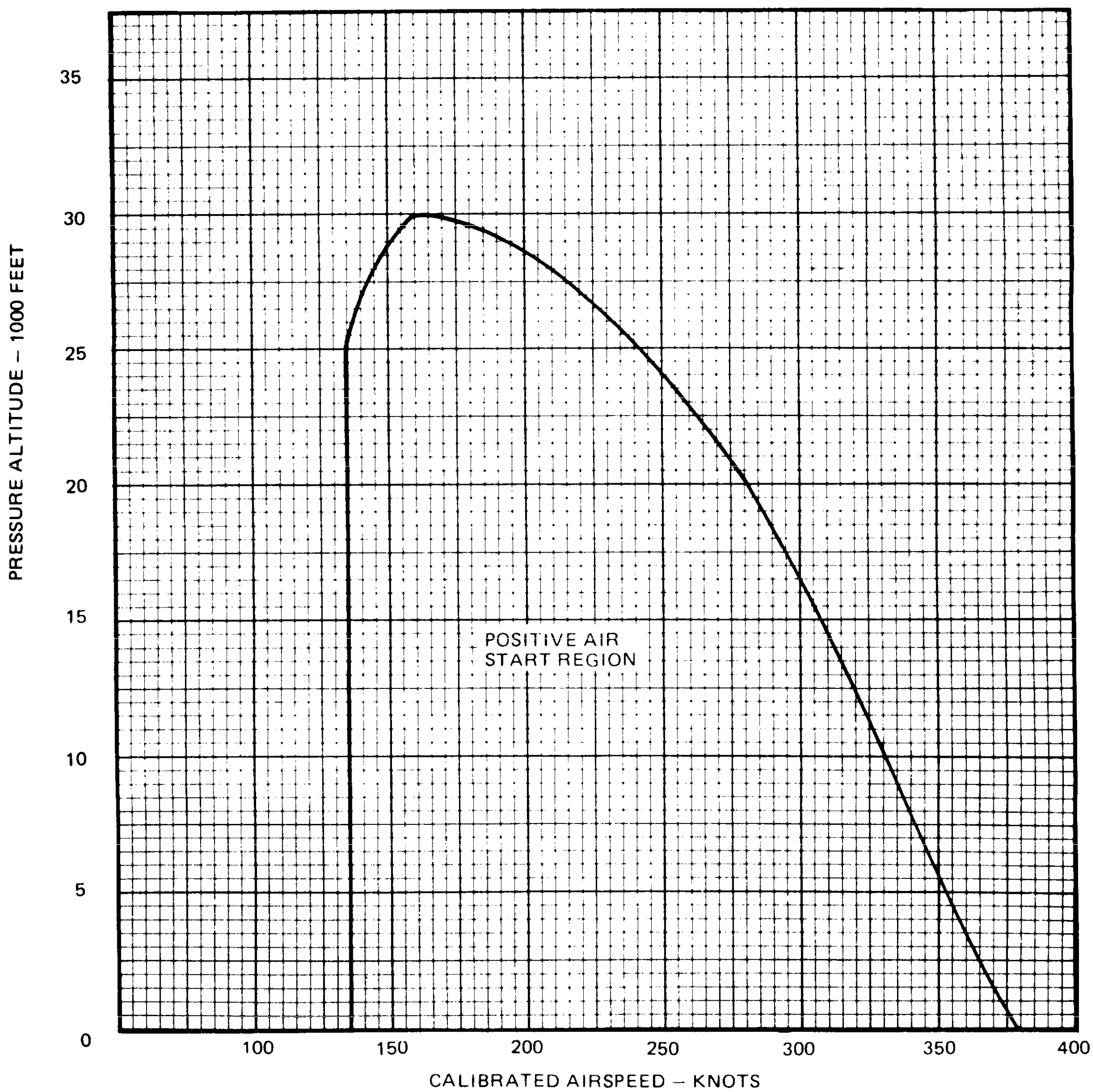


FIGURE 64. Example of air start envelope.

STATIC POWER CHECK FOR TAKE-OFF

MAXIMUM POWER

AIRCRAFT CONFIGURATION:
ALL FLAPS, GEAR DOWN

DATE: NOVEMBER 1972
DATA BASIS: ESTIMATED

MODEL:
ENGINES:

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

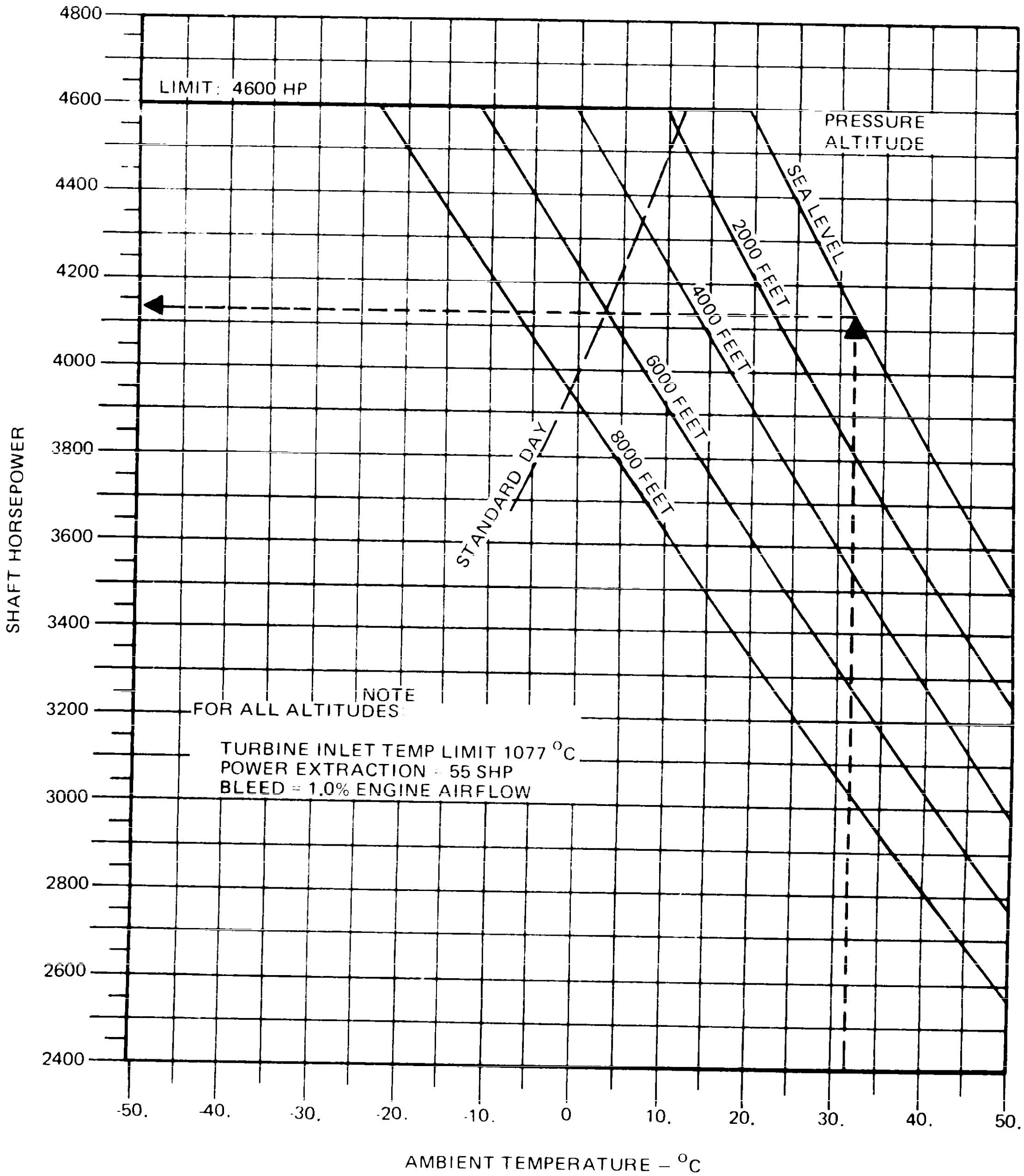


FIGURE 65. Example of static power check for takeoff.

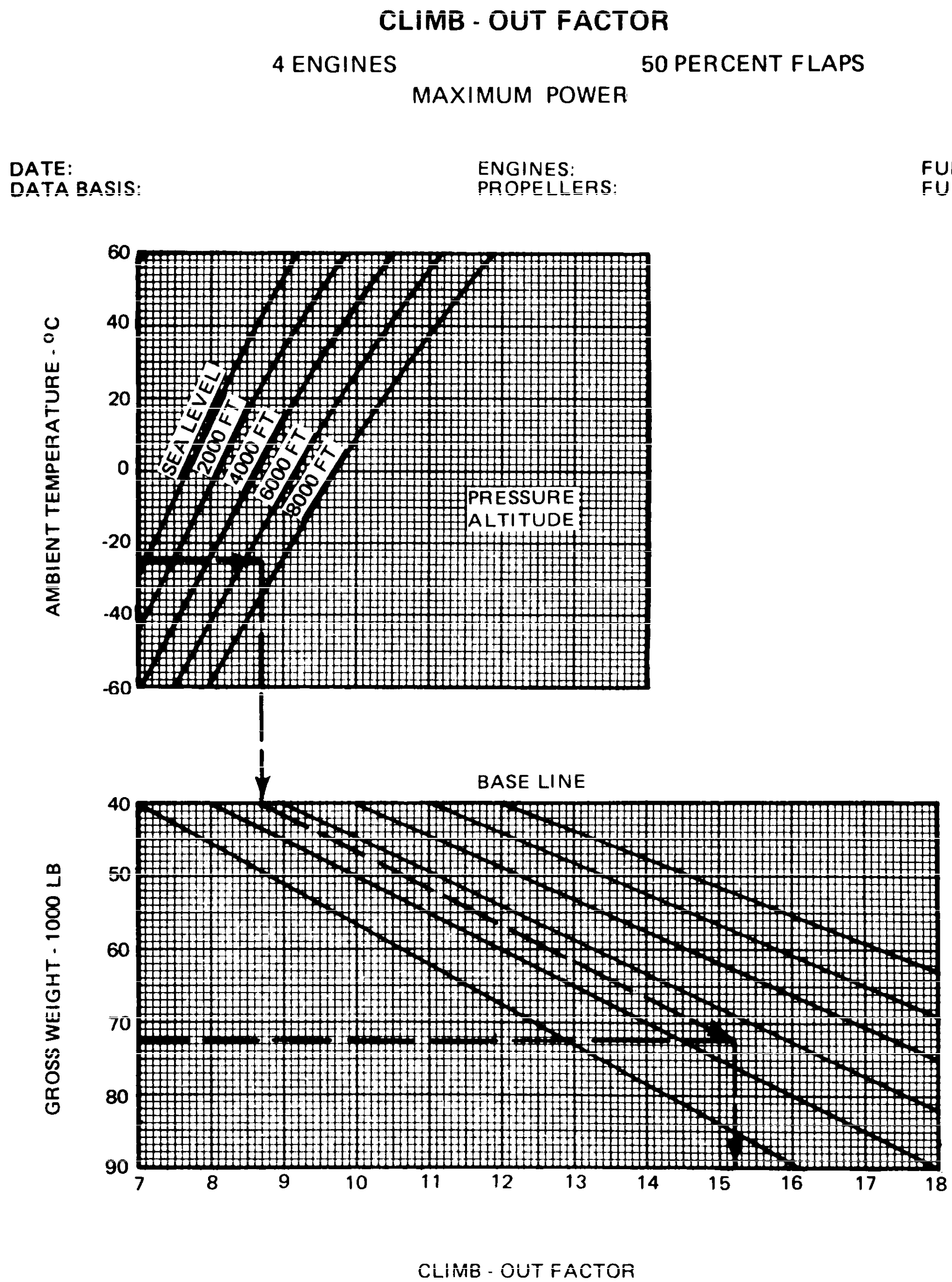
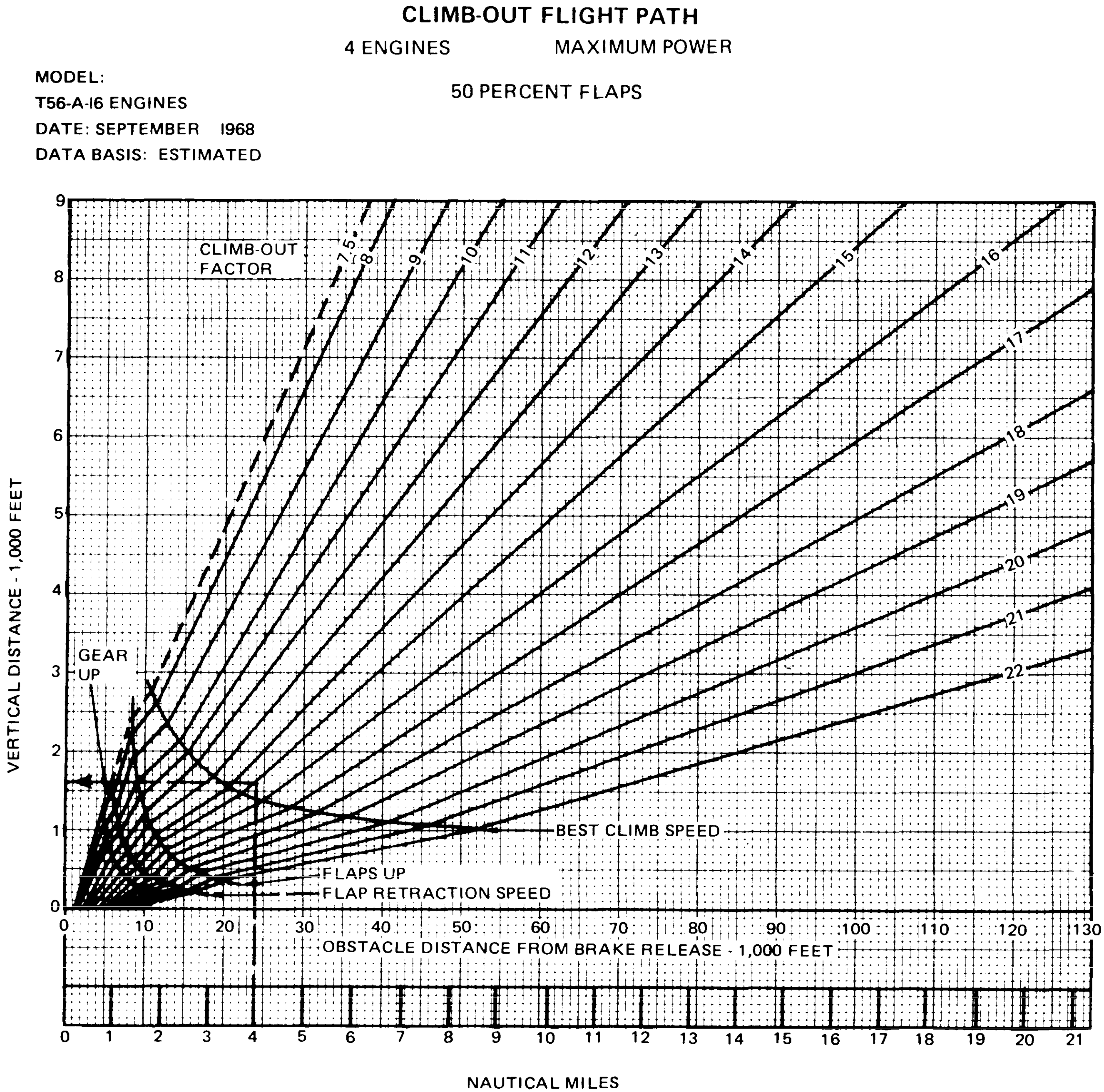


FIGURE 66. Example of climb-out factor.



NOTES:
1. Maintain maximum power until best climb speed or 5 minutes operation is reached, whichever occurs first.
2. Initiate gear retraction 3 seconds after liftoff.
3. Climb at 50 ft obstacle clearance speed.
4. Includes ground effect where applicable.
5. Initiate flap retraction after reaching flap retraction speed.
6. After flaps are up, accelerate to best climb speed.
7. Climb at maximum continuous power at best climb speed.
8. The second sheet of this chart is an enlargement of the initial phase of the first sheet.

FIGURE 67. Example of climb-out flight path.

CLIMB-OUT FLIGHT PATH

4 ENGINES MAXIMUM POWER

50 PERCENT FLAPS

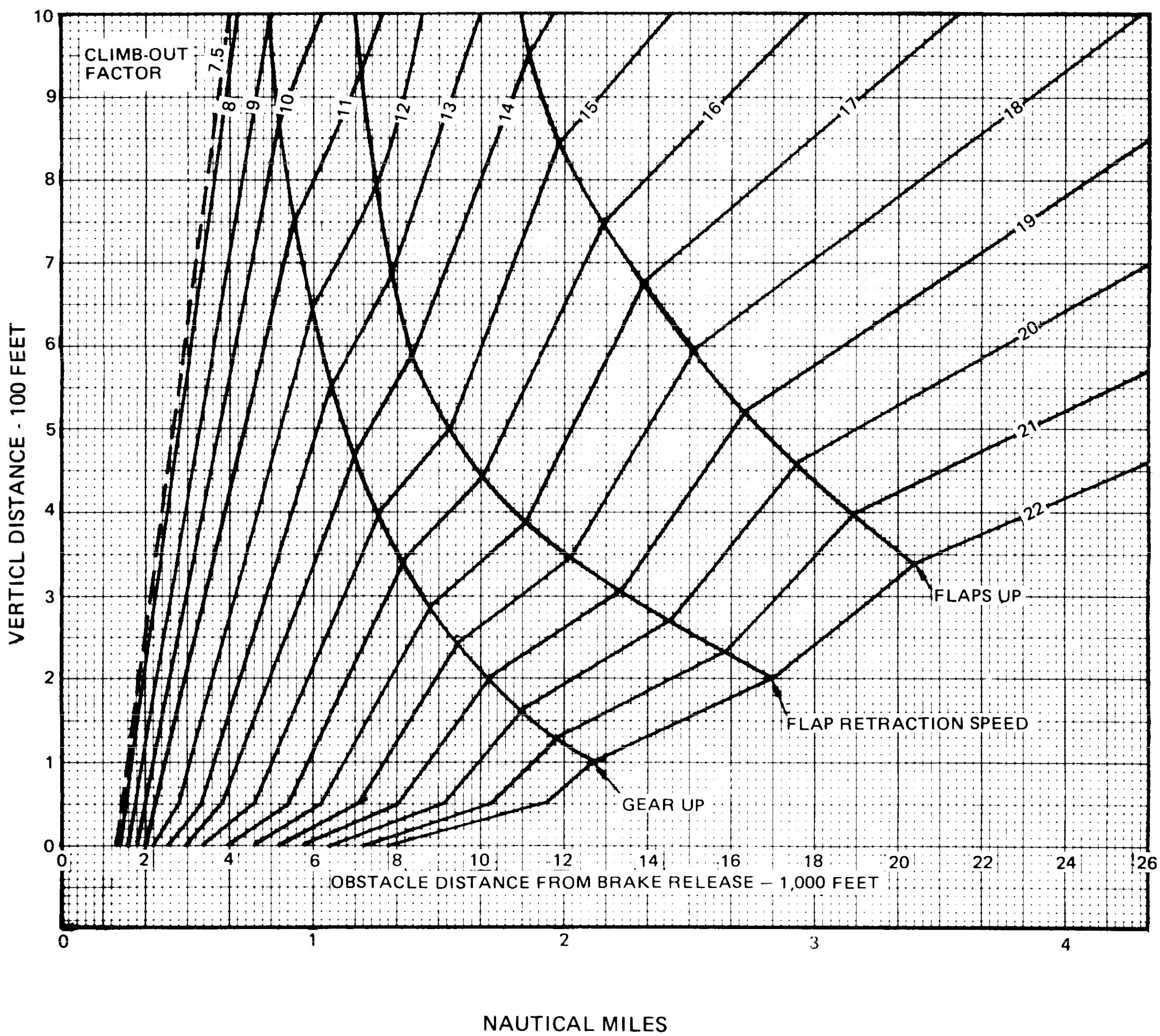


FIGURE 67. Example of climb-out flight path. - Continued

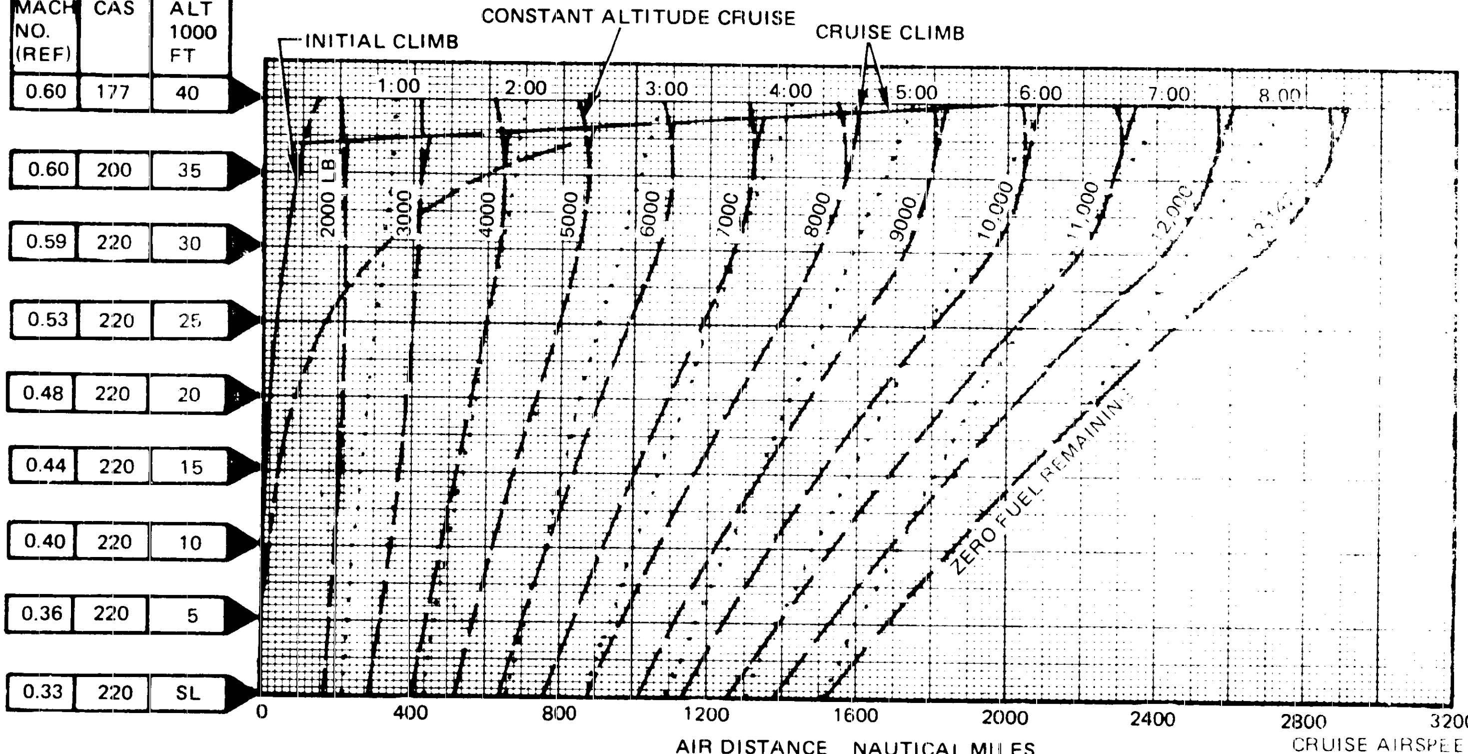
MISSION PROFILE–MAXIMUM RANGE

ENGINE START GROSS WEIGHT – 42,000 LB
STANDARD DAY ZERO WIND

CONFIGURATION Ⓐ

MODEL:
DATA AS OF:
DATA BASIS:

ENGINES:
FUEL GRADE:
FUEL DENSITY:



CRUISE AIRSPEED

FUEL CONS	1000-5000		5000-9000		9000-13,1[illegible]	
AVG WT	39,000		35,000		31,000	
ALTITUDE	CAS	TAS	CAS	TAS	CAS	TAS
CR CLIMB	0.60M	345	0.60M	345	0.60M	345
40,000	—	—	178	346	174	340
35,000	194	338	188	327	182	316
30,000	201	320	195	311	189	302
20,000	212	280	205	271	198	262
10,000	217	251	210	243	203	235
SL	220	220	214	213	205	205

— — — — FUEL CONSUMED

. . . . TIME (START, TAXI, AND TAKE OFF NOT INCLUDED)

—— – – —— LINE OF BEST RANGE FOR CONSTANT ALTITUDE FLIGHT

NOTES:

1. 446 LB FUEL ALLOWANCE FOR ENG START TAXI & TAKEOFF INCLUDED
2. NO ALLOWANCE OR RESERVE FOR LOITER, DESCENT OR LANDING

FIGURE 68. Example of mission profile-maximum range.

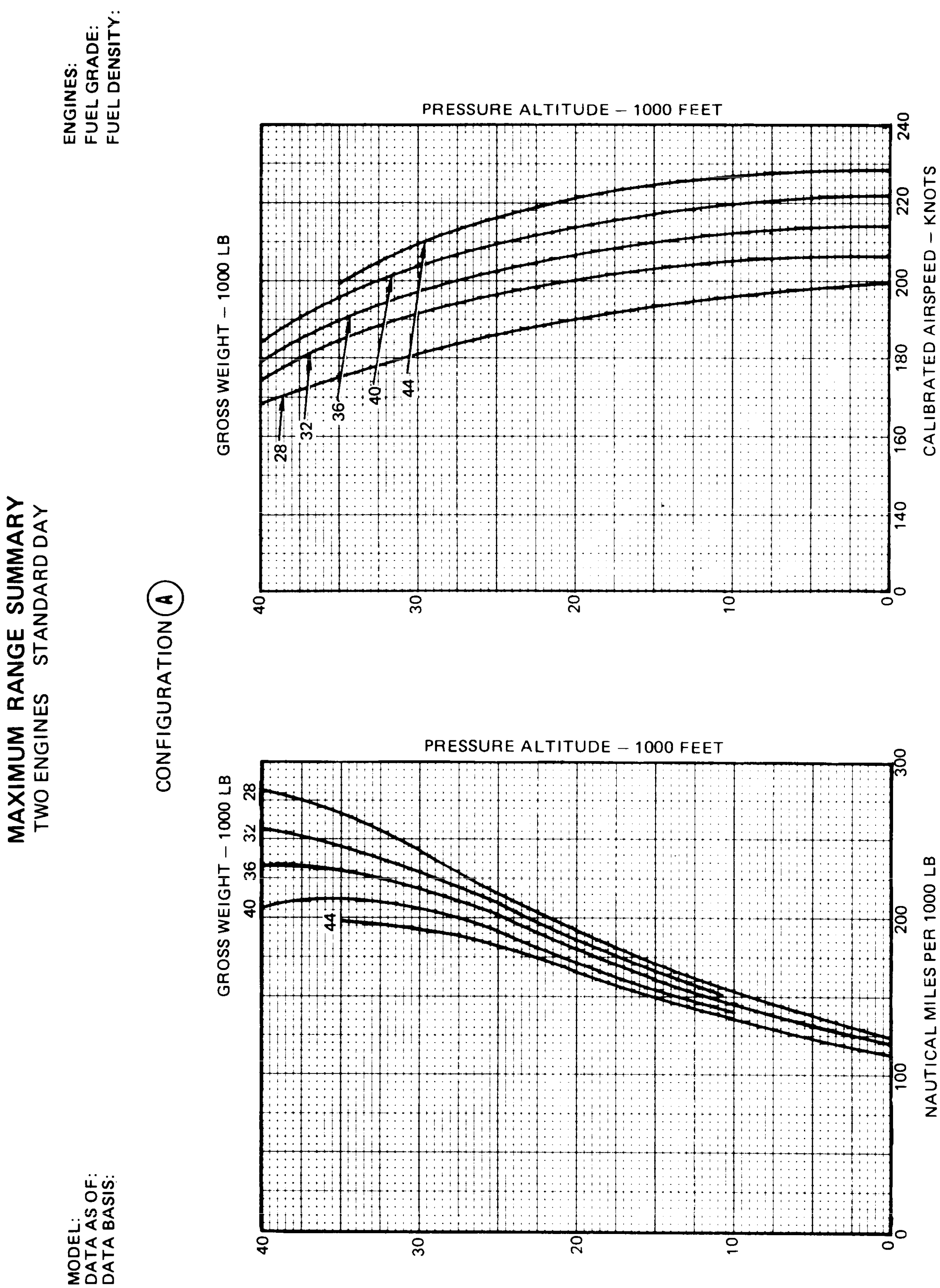


FIGURE 69. Example of maximum range summary.

MAXIMUM RANGE CRUISE

TWO ENGINES STANDARD DAY

MODEL:
DATA AS OF:
DATA BASIS

ENGINES:
FUEL GRADE:
FUEL DENSITY:

PRESSURE ALTITUDE	AMBIENT TEMP		GROSS WEIGHT 9500 POUNDS TORQUE PER ENG	9500 POUNDS FUEL FLOW PER ENG	9500 POUNDS FUEL FLOW TOTAL	9500 POUNDS CAS	8500 POUNDS TORQUE PER ENG	8500 POUNDS FUEL FLOW PER ENG	8500 POUNDS FUEL FLOW TOTAL	8500 POUNDS CAS	7500 POUNDS TORQUE PER ENG	7500 POUNDS FUEL FLOW PER ENG	7500 POUNDS FUEL FLOW TOTAL	7500 POUNDS CAS
FEET	°C	°F	FT LB	LB/HR	LB/HR	KNOTS	FT LB	LB/HR	LB/HR	KNOTS	FT LB	LB/HR	LB/HR	KNOTS
SL	18	64	852	259.6	519.2	178	795	250.1	500.2	175	741	241.0	482.0	172
2000	14	57	846	249.5	499.0	180	786	239.8	479.6	177	728	230.4	460.8	174
4000	10	50	838	239.3	478.6	182	772	228.9	457.8	179	702	217.9	435.8	174
6000	6	43	825	229.3	458.6	184	756	128.5	437.0	180	681	206.6	413.2	175
8000	2	36	805	219.2	438.4	186	735	208.0	416.0	181	661	196.4	392.8	176
10000	-2	29	785	209.7	419.4	187	714	198.3	396.6	182	644	186.9	373.8	177
12000	-6	22	765	200.9	401.8	187	698	189.8	379.6	184	628	178.3	356.6	179
14000	-10	15	749	194.2	388.4	189	689	183.8	367.6	186	614	171.5	343.0	180
16000	-13	8	734	187.6	375.2	189	677	177.4	354.8	187	601	164.6	329.2	182
18000	-17	1	729	182.5	365.9	192	663	170.6	341.2	188	587	157.6	315.2	183
20000	-21	-6	734	179.9	359.8	195	653	165.2	330.4	190	577	151.8	303.6	184
22000	-25	-13	721	175.4	350.8	196	644	160.6	321.2	191	573	147.5	295.0	187
24000	-29	-20	712	171.9	343.8	197	642	157.7	315.4	194	571	144.1	288.2	189

FIGURE 70. Example of maximum range cruise.

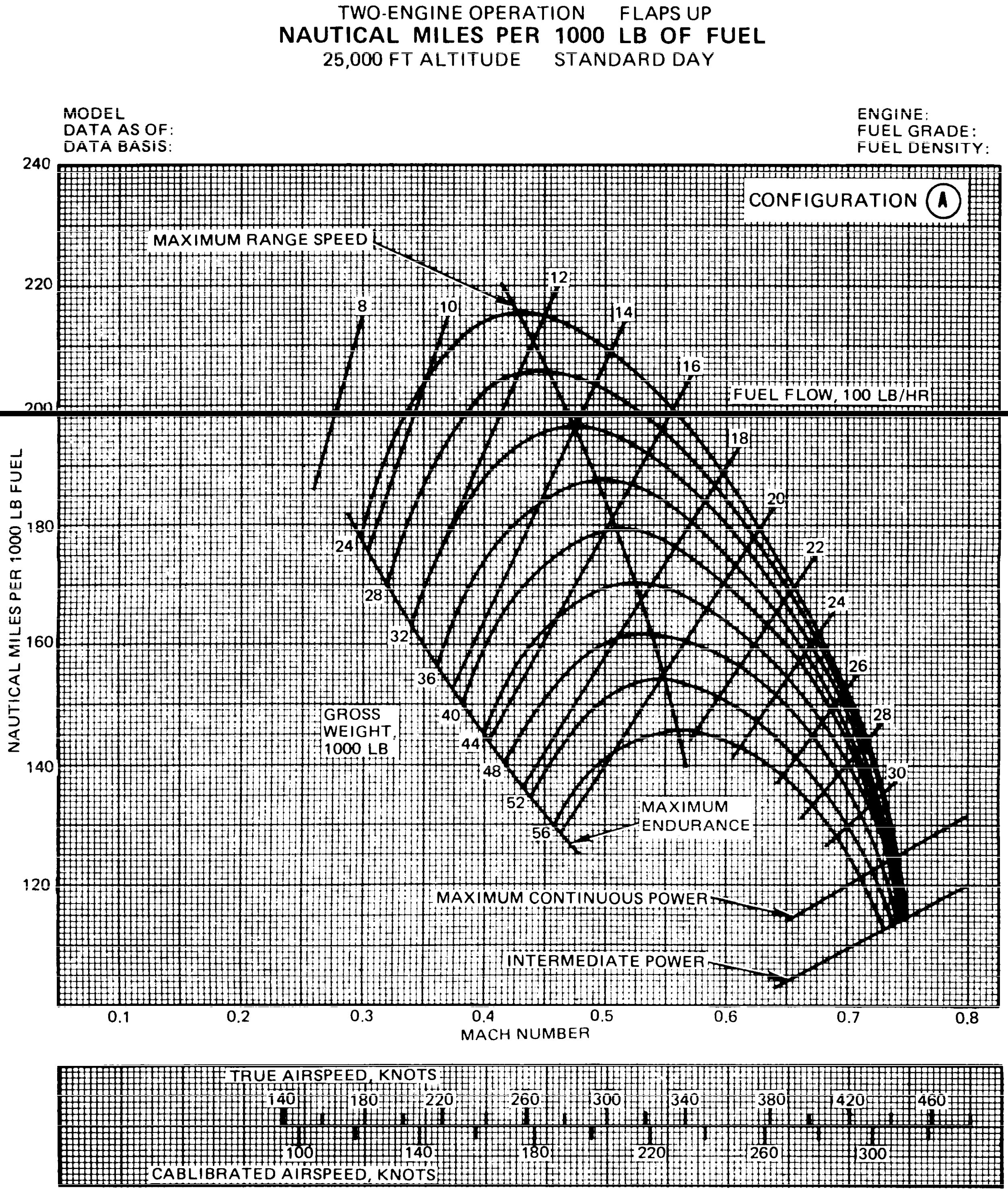


FIGURE 71. Example of nautical miles per 1000 pounds of fuel.

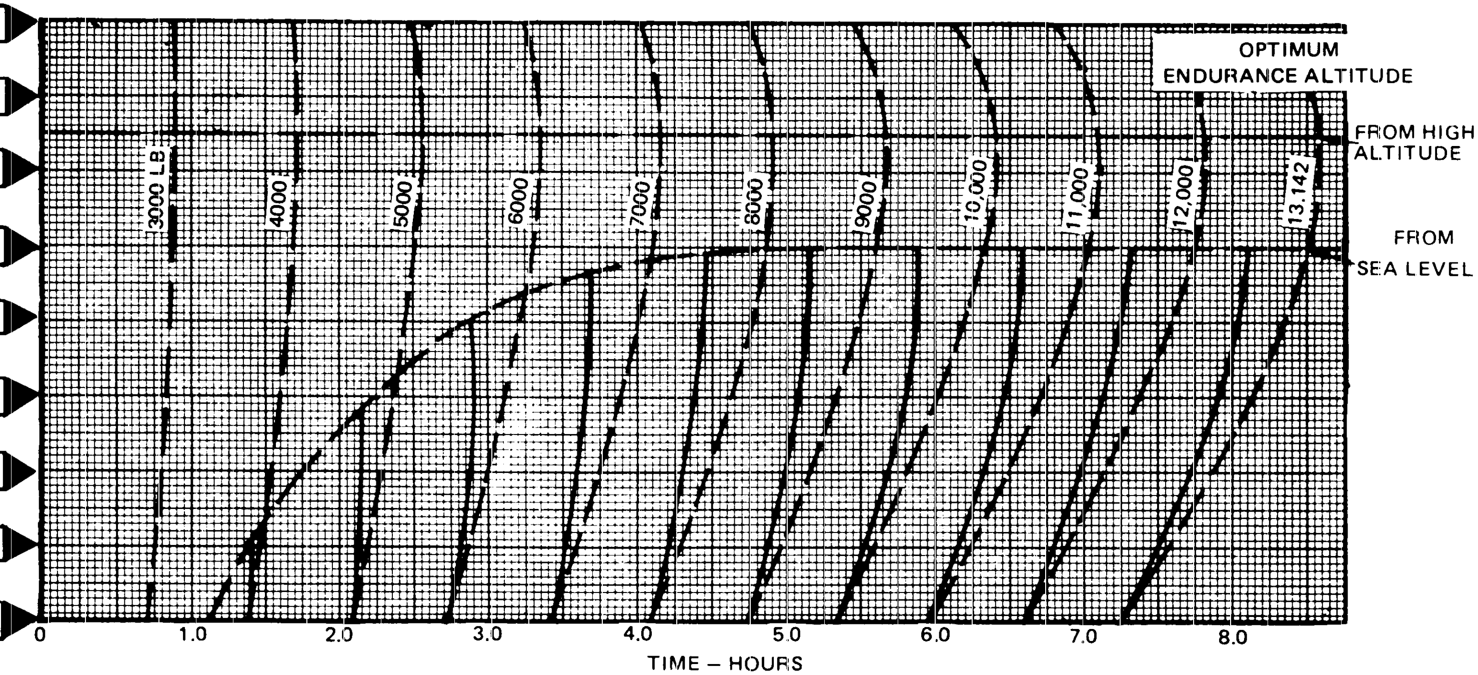
MAXIMUM ENDURANCE PROFILE
TWO ENGINES
STANDARD DAY
CONFIGURATION (A)

MODEL:
DATA AS OF:
DATA BASIS:

ENGINES:
FUEL GRADE:
FUEL DENSITY:

FOR OPTIMUM ENDURANCE, CLIMB OR DESCEND TO APPROPRIATE OPTIMUM LOITER ALTITUDE

INTERMEDIATE POWER CLIMB		
MACH NO.	CAS	ALT 1000 FT
0.60	177	40
0.60	200	35
0.59	220	30
0.53	220	25
0.48	220	20
0.44	220	15
0.42	220	10
0.36	220	5
0.33	220	SL



— — — FUEL REMAINING

——— CLIMB PATH GUIDE LINES

NOTES:

1. READ FROM CHART ENDURANCE AT ANY ALTITUDE OR MAXIMUM ENDURANCE BY CLIMBING FROM SEA LEVEL
2. RESERVE FUEL = 2000 LB
3. DESCENT FROM 40,000 FT REQUIRES 75 LB FUEL AND 4 MINUTES
4. NO ALLOWANCE FOR LANDING
5. BASED ON ZERO FUEL WEIGHT OF 29,000 LB

LOITER SPEEDS

FUEL REM-LB	2000-5000	5000-9000	9000-13,142
AVG WT-LB	32,500	36,000	40,000
ALTITUDE	CAS	CAS	CAS
40,000 30,000 20,000 10,000 SL	142 ↓	148 ↓	156 ↓

FIGURE 72. Example of maximum endurance profile.

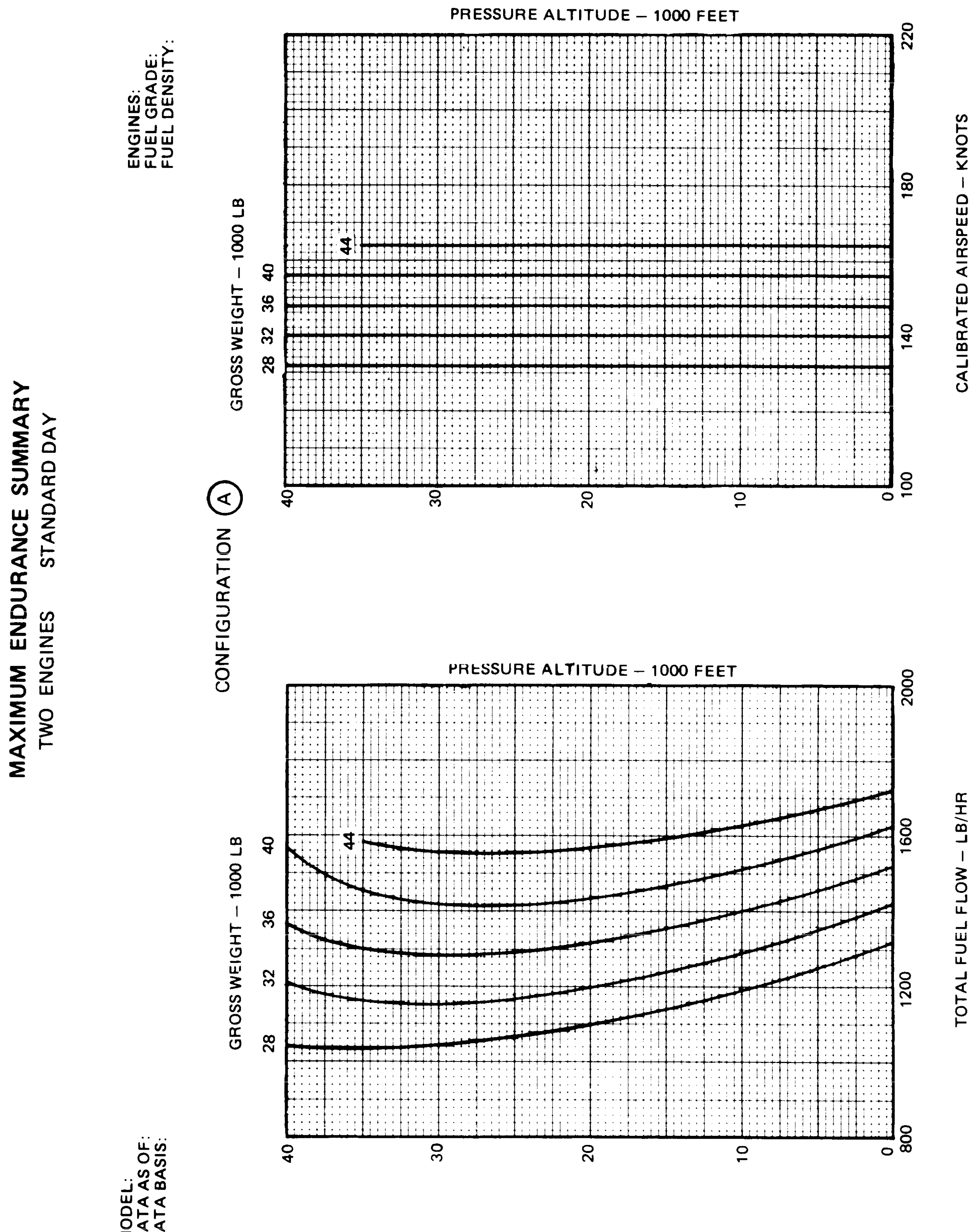


FIGURE 73. Example of maximum endurance summary.

DENSITY ALTITUDE CHART

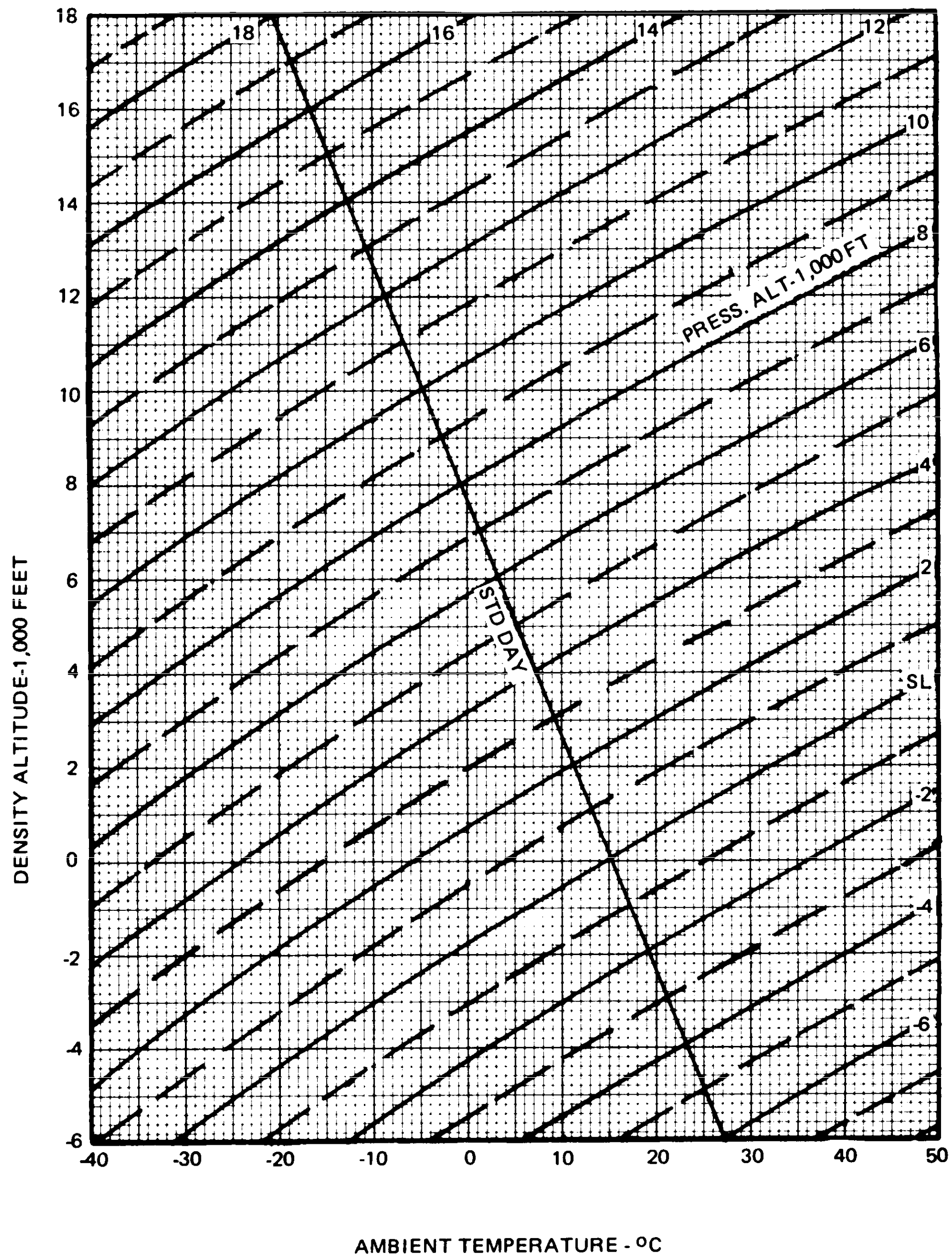


FIGURE 74. Example of density altitude chart.

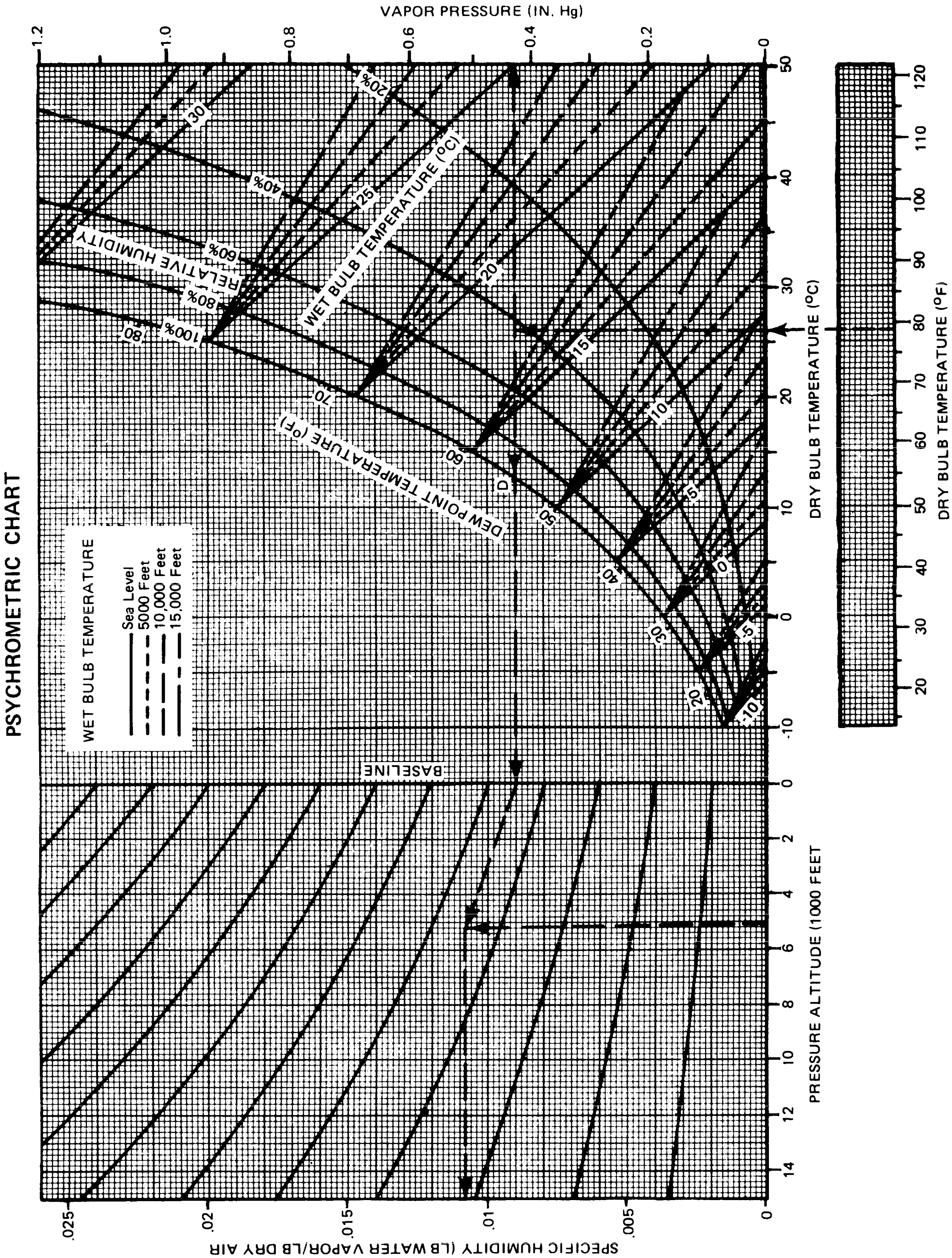


FIGURE 75. Example of psychrometric chart.

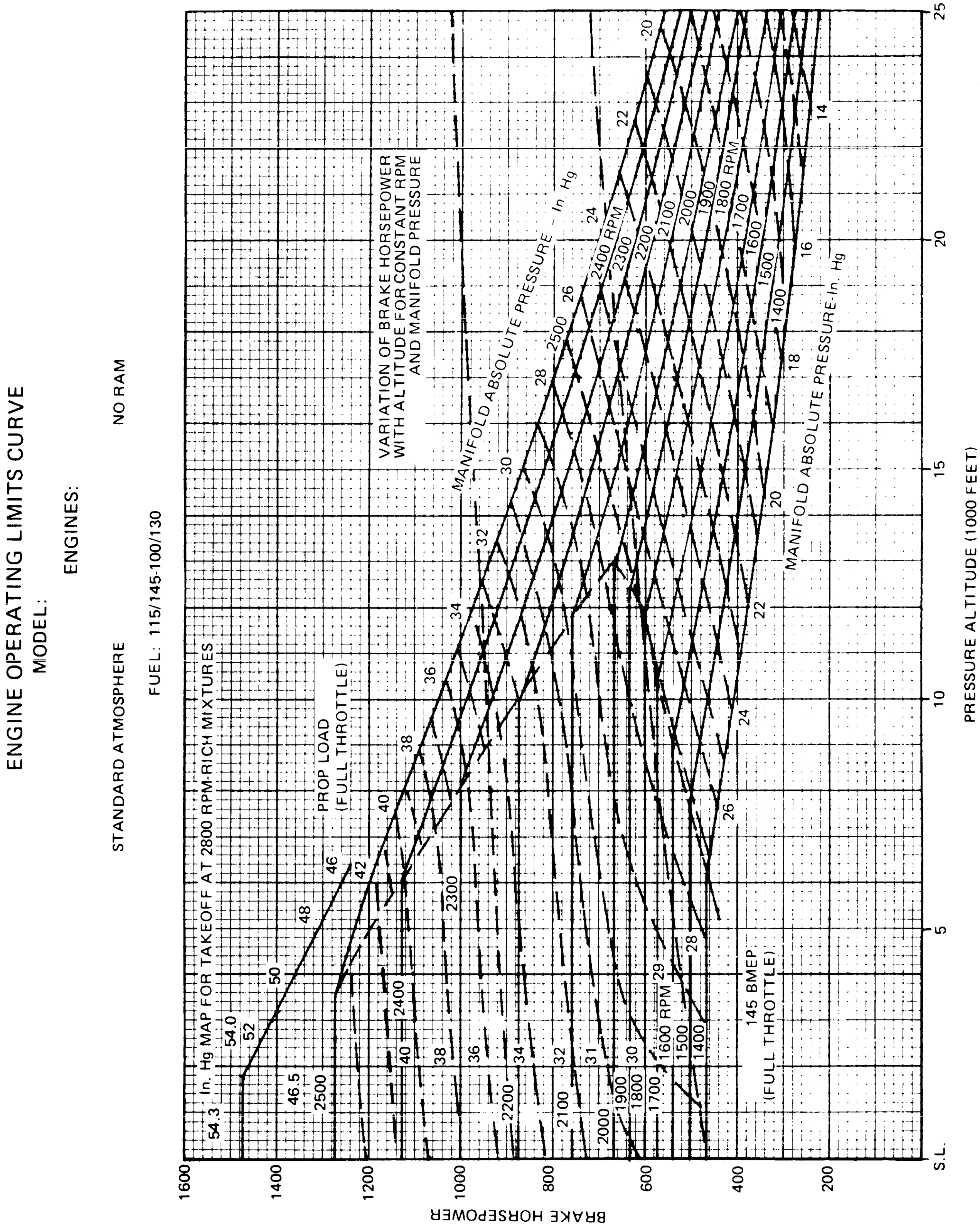


FIGURE 76. Example of engine operating limits curve.

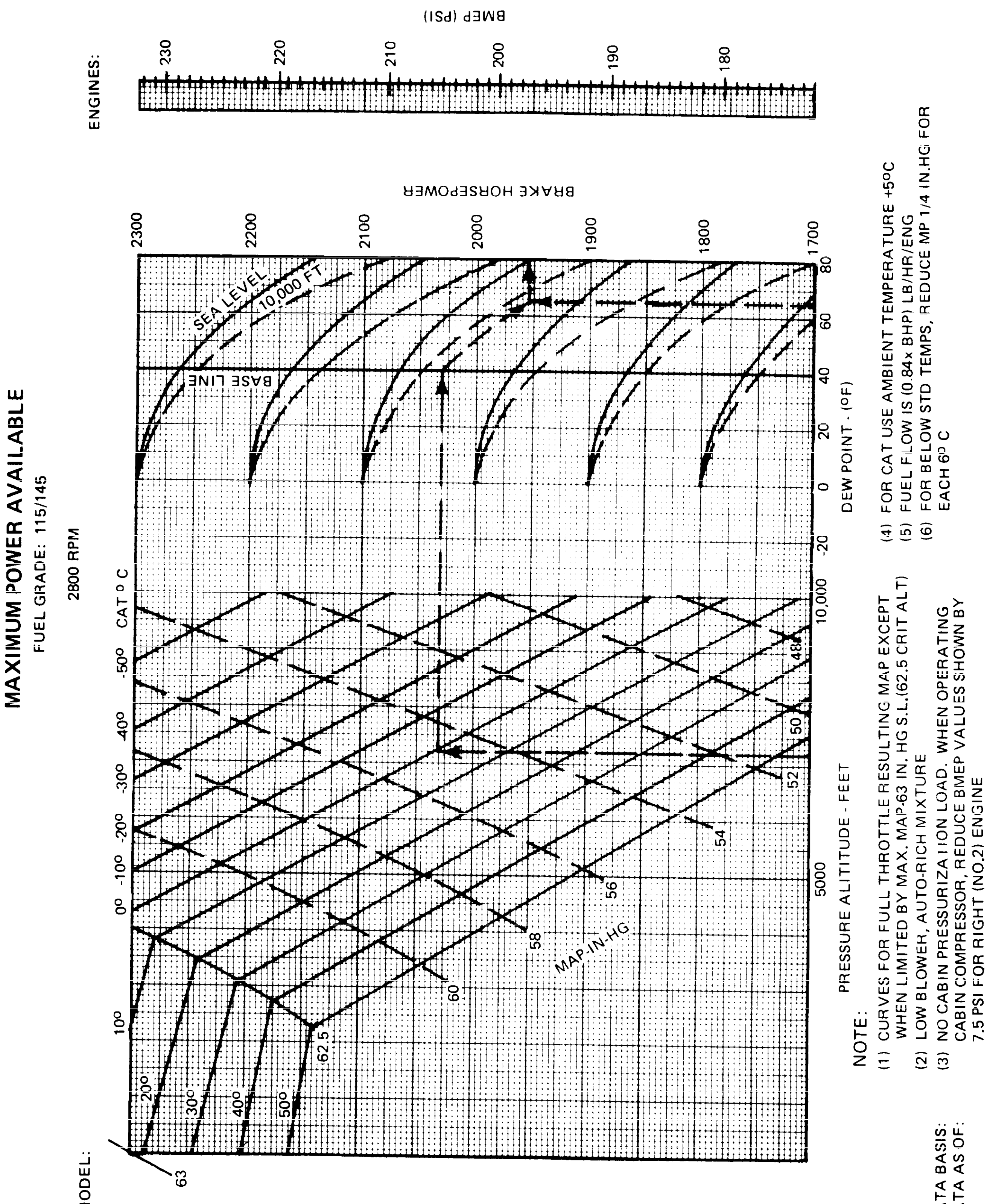


FIGURE 77. Example of maximum power available.

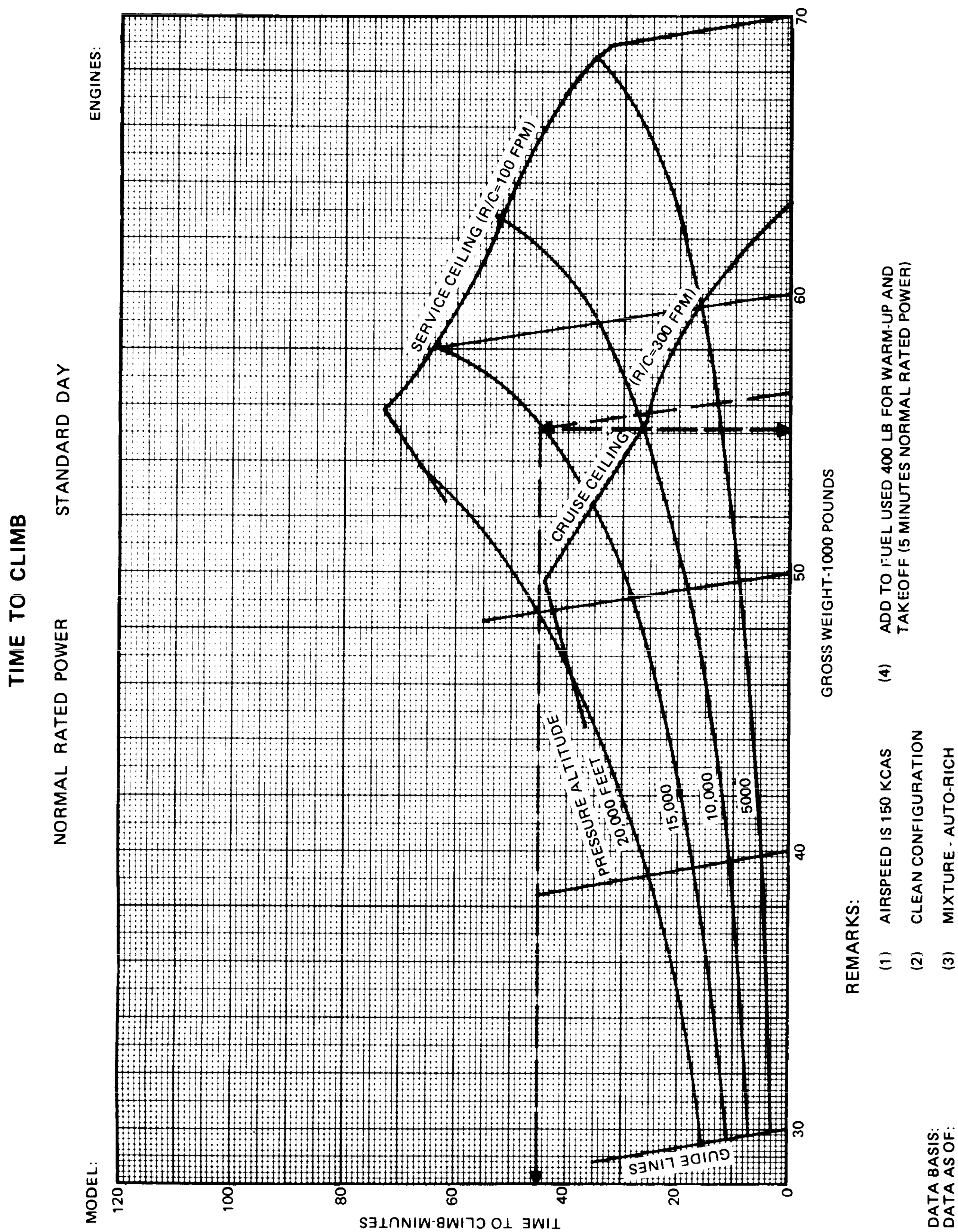
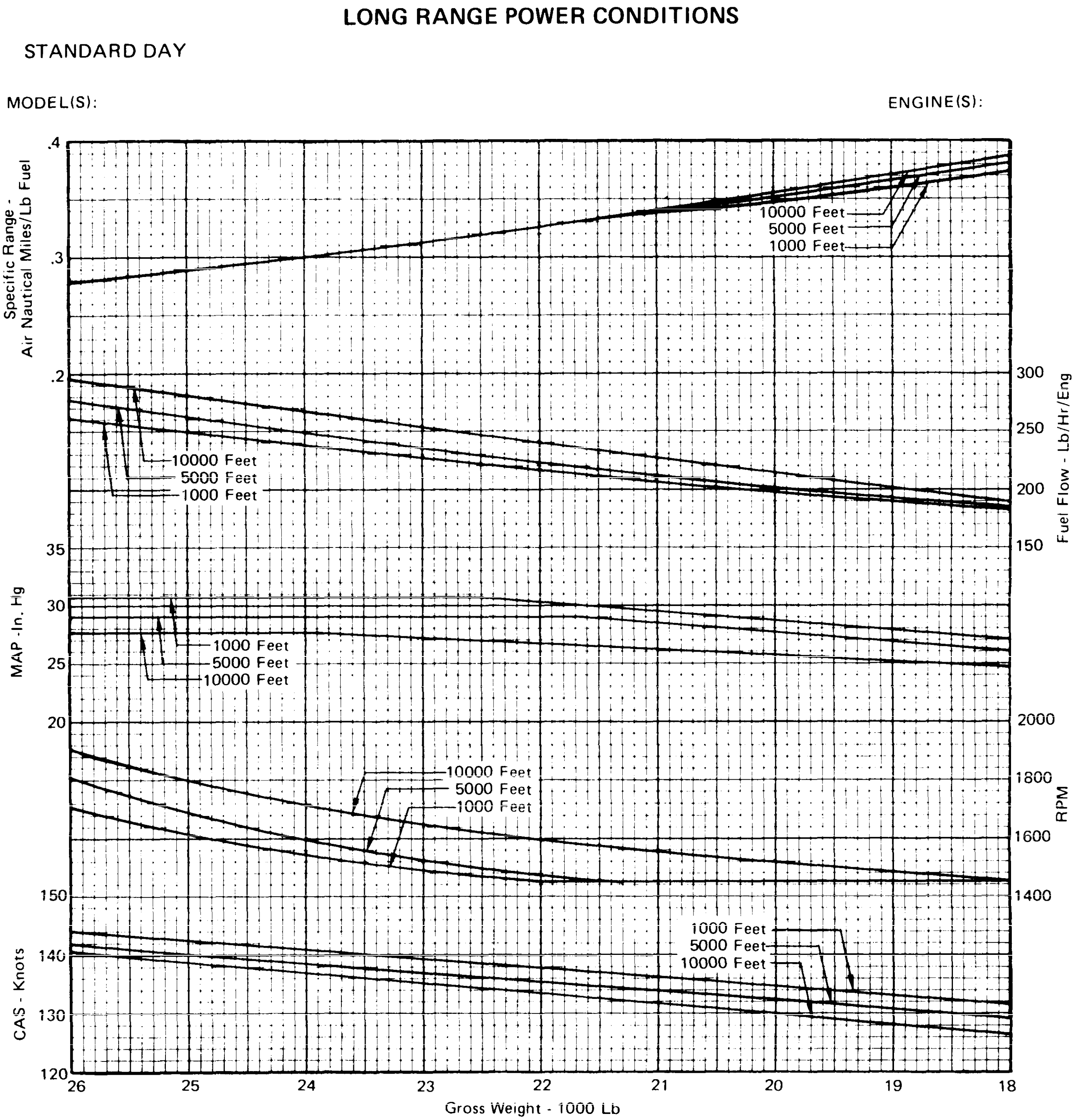


FIGURE 78. Example of time to climb.



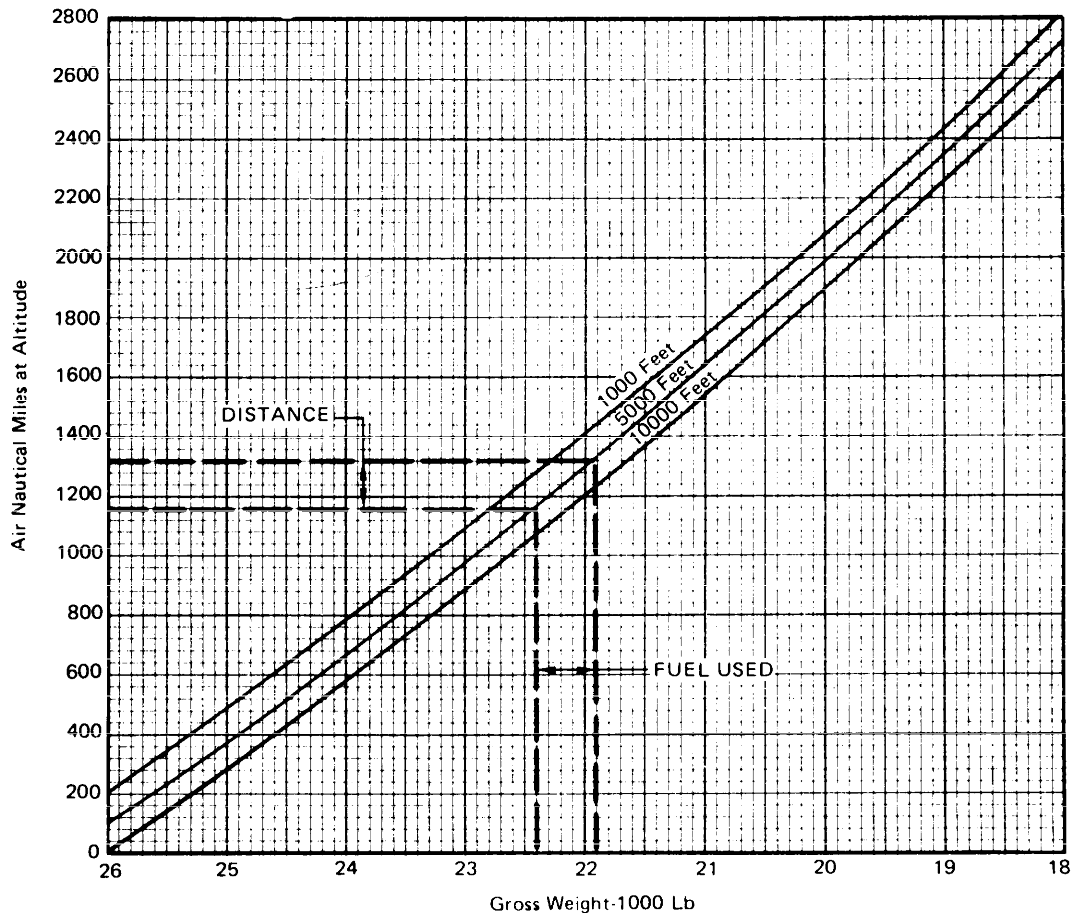
NOTES:
1. For Recommended Cruise Airspeeds.
2. Normal mixture.
3. Cowl flaps closed.
4. Oil cooler flaps closed.

FIGURE 79. Example of long range power conditions.

LONG RANGE PREDICTION – DISTANCE

STANDARD DAY

MODEL(S): ENGINE(S):



NOTES: 1. BASED ON RECOMMENDED CRUISE AIRSPEEDS.
2. NORMAL MIXTURE.
3. COWL FLAPS CLOSED.
4. OIL COOLER FLAPS CLOSED.

FIGURE 80. Example of long range prediction-distance.

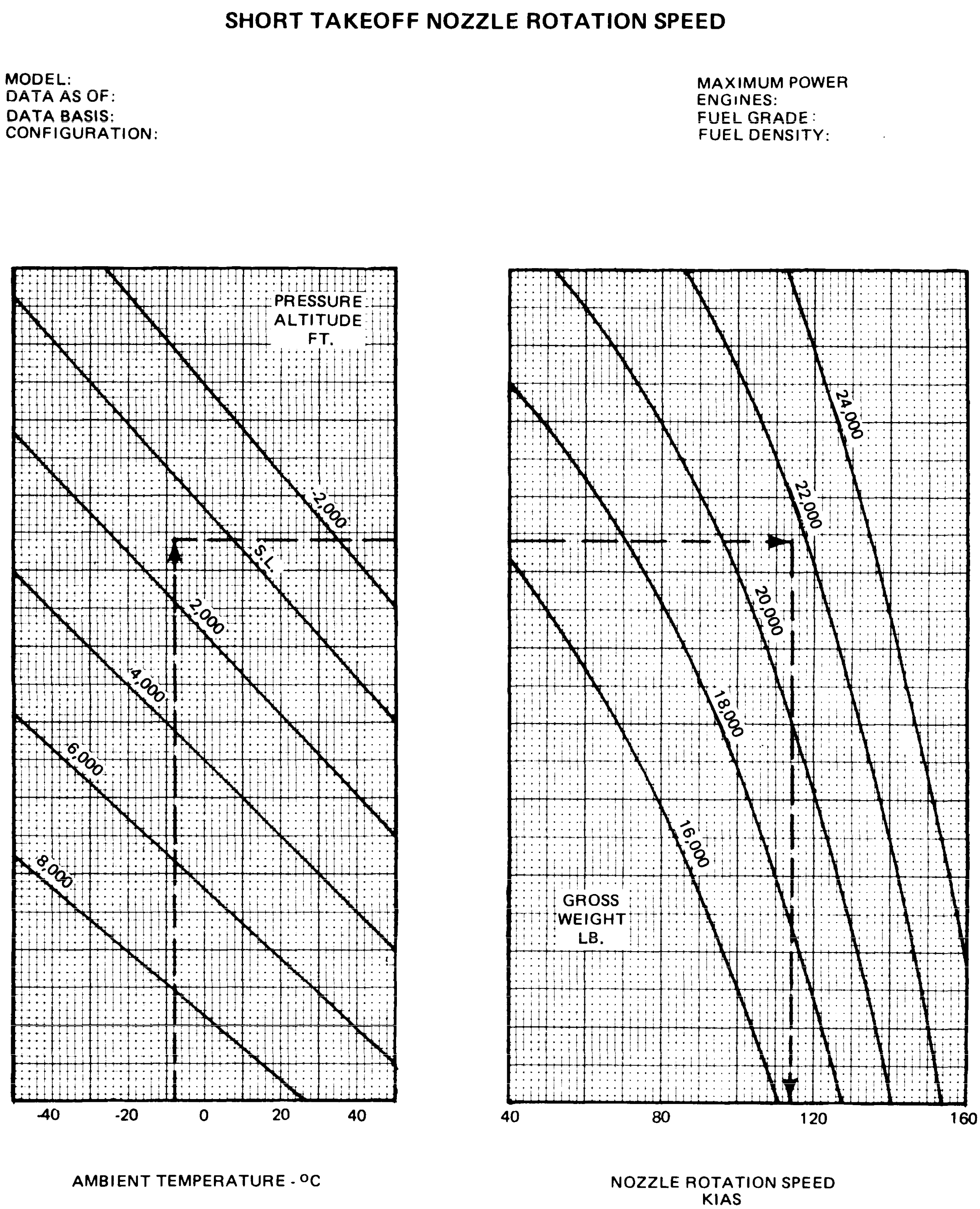
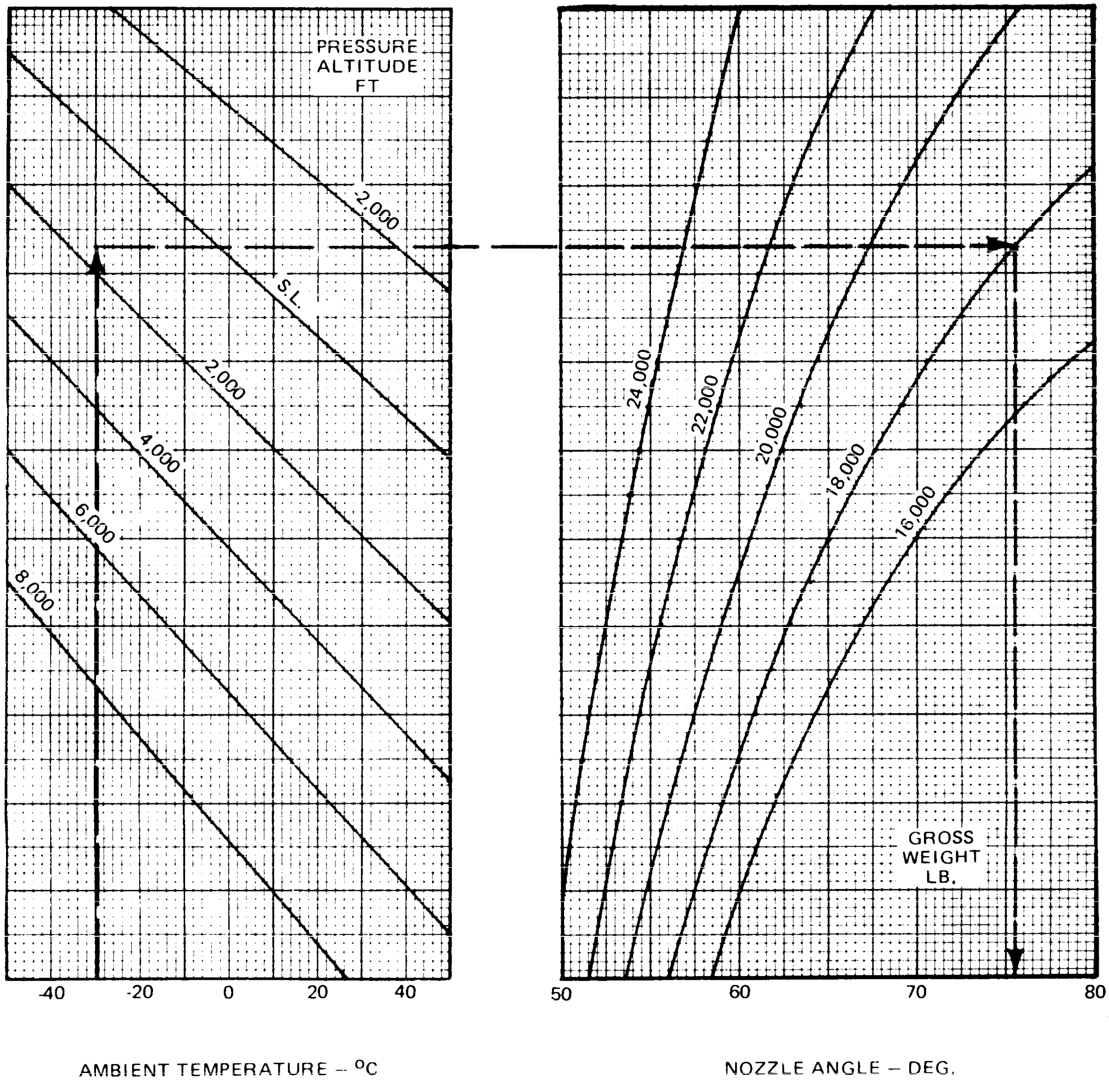


FIGURE 81. Example of short takeoff nozzle rotation speed.

SHORT TAKEOFF NOZZLE ANGLE

MODEL:
DATA AS OF:
DATA BASIS:
CONFIGURATION:

MAXIMUM POWER
ENGINES:
FUEL GRADE:
FUEL DENSITY:



NOTE:

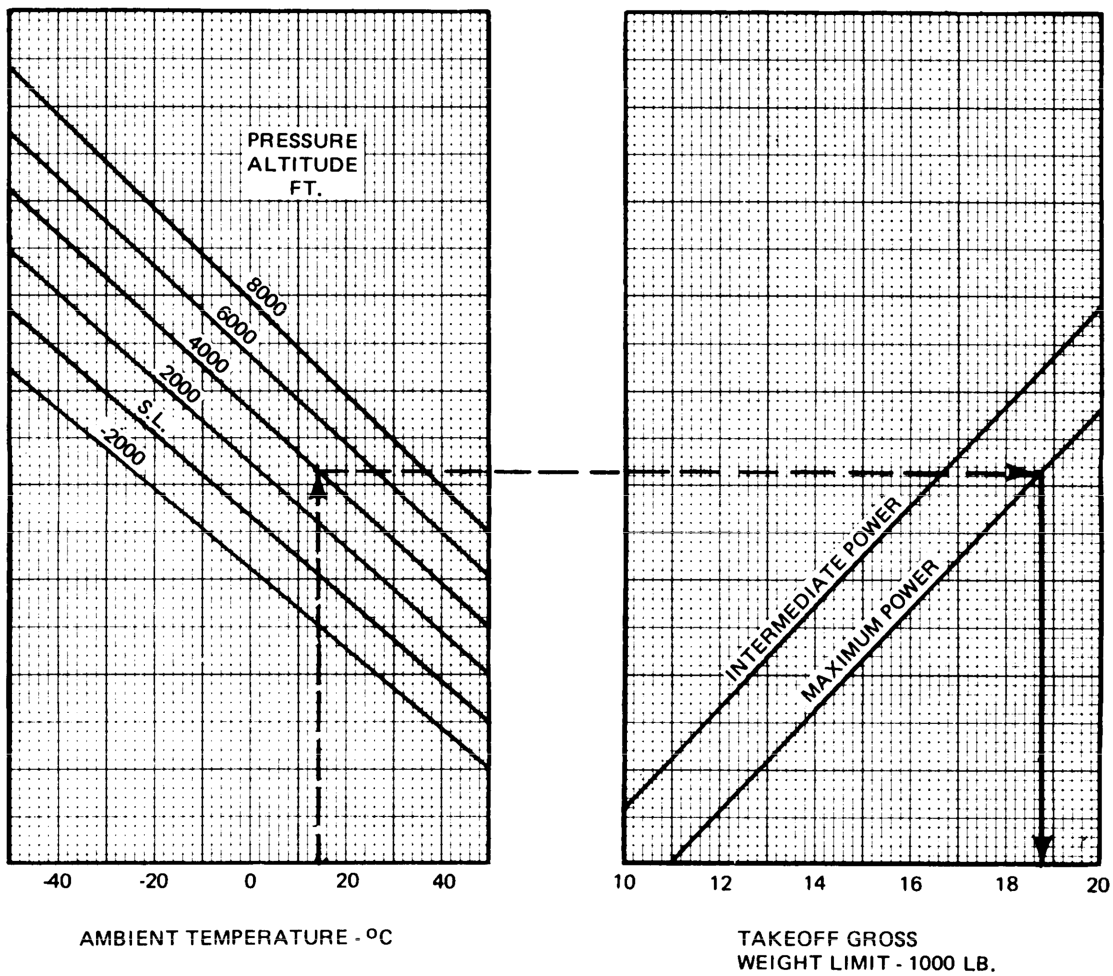
1. NOZZLE ANGLE SET AT 10° DURING GROUND RUN

FIGURE 82. Example of short takeoff nozzle angle.

VERTICAL TAKEOFF GROSS WEIGHT LIMIT

MODEL:
DATA AS OF:
DATA BASIS:
CONFIGURATION:

MAXIMUM POWER
ENGINES:
FUEL GRADE:
FUEL DENSISTY:



NOTE

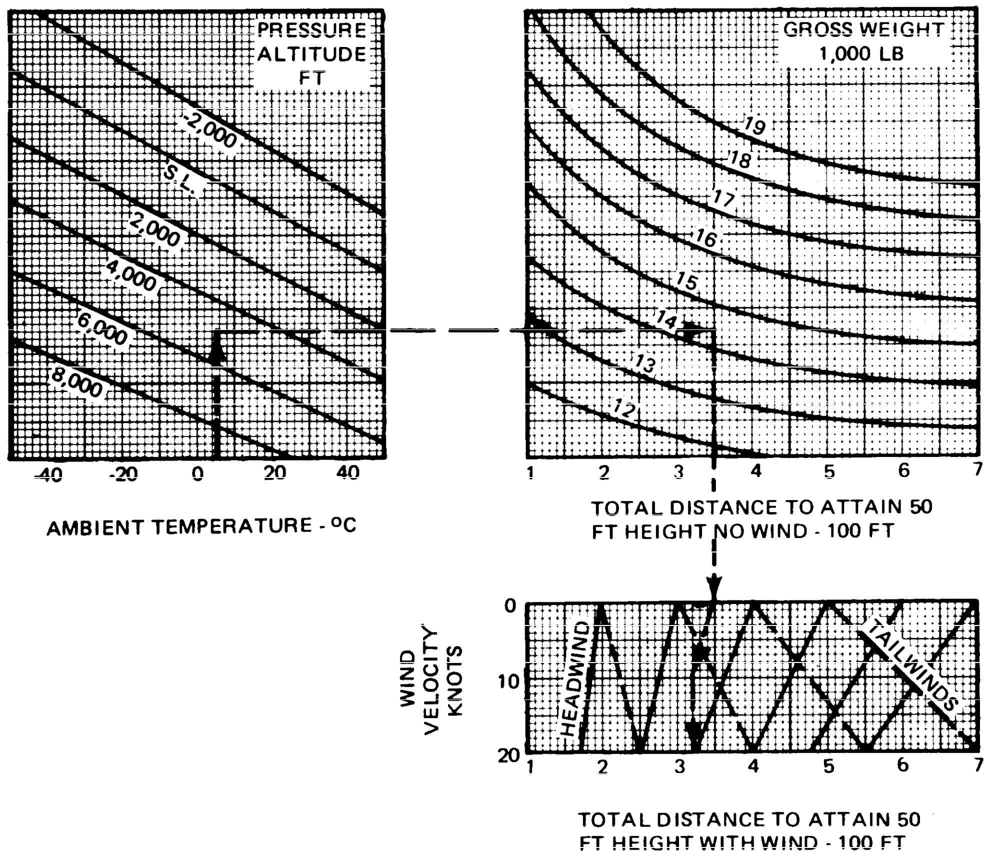
1. WITH FUSELAGE MOUNTED STORES OR GUN PODS, WEIGHT LIMIT MAY BE DEGRADED UP TO 700 POUNDS.

FIGURE 83. Example of vertical takeoff gross weight limit.

ROLLING VERTICAL TAKEOFF DISTANCE

MODEL:
DATA AS OF:
DATA BASIS:
CONFIGURATION:

MAXIMUM POWER
ENGINES:
FUEL GRADE:
FUEL DENSITY:



TAKEOFF TECHNIQUE

1. NOZZLES AT 30°, POWER 50%
2. THROTTLES TO FULL
3. AS POWER PASSES THROUGH 90% ROTATE NOZZLES TO 70°

FIGURE 84. Example of rolling vertical takeoff distance.

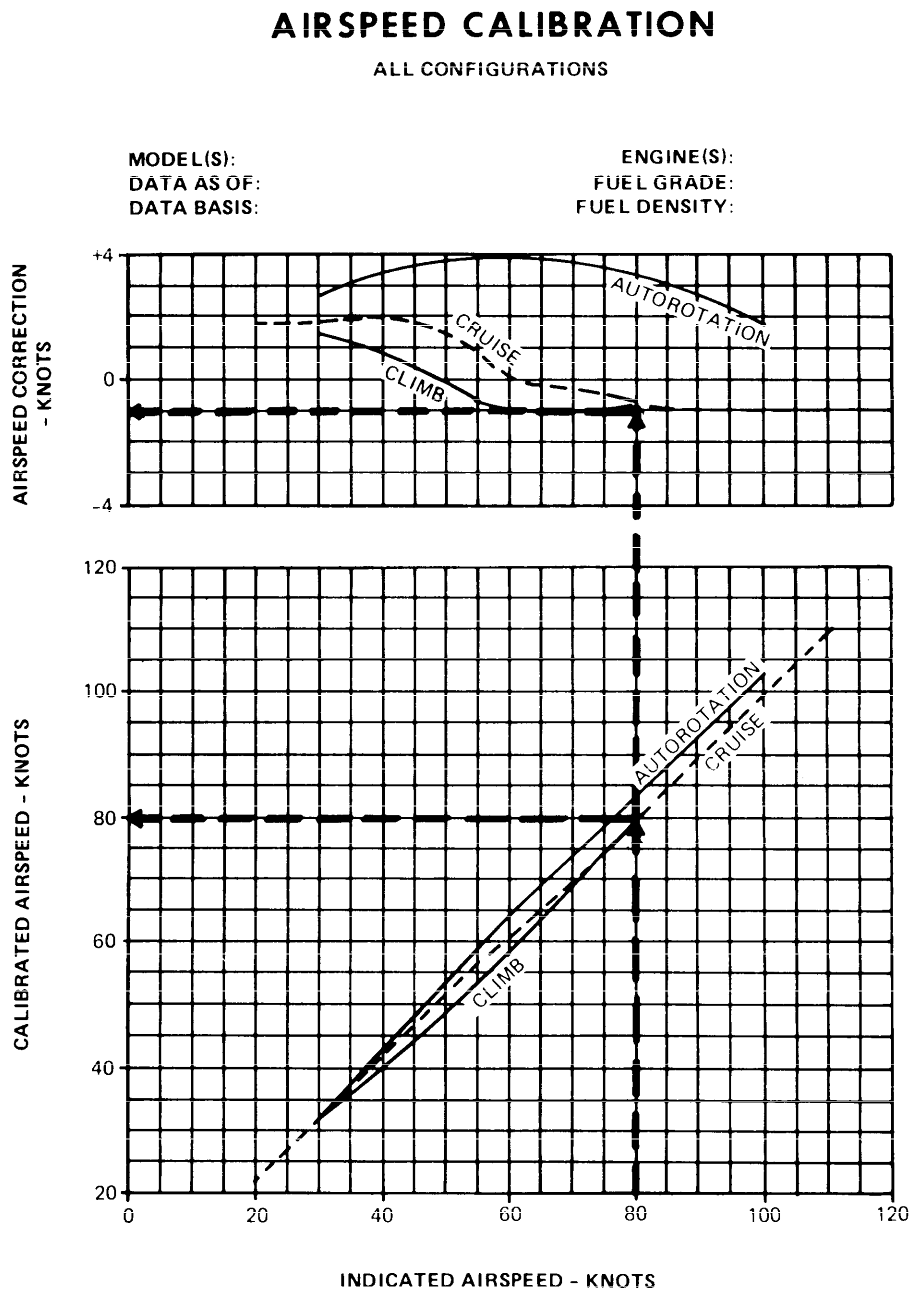


FIGURE 85. Example of airspeed calibration chart (helicopter).

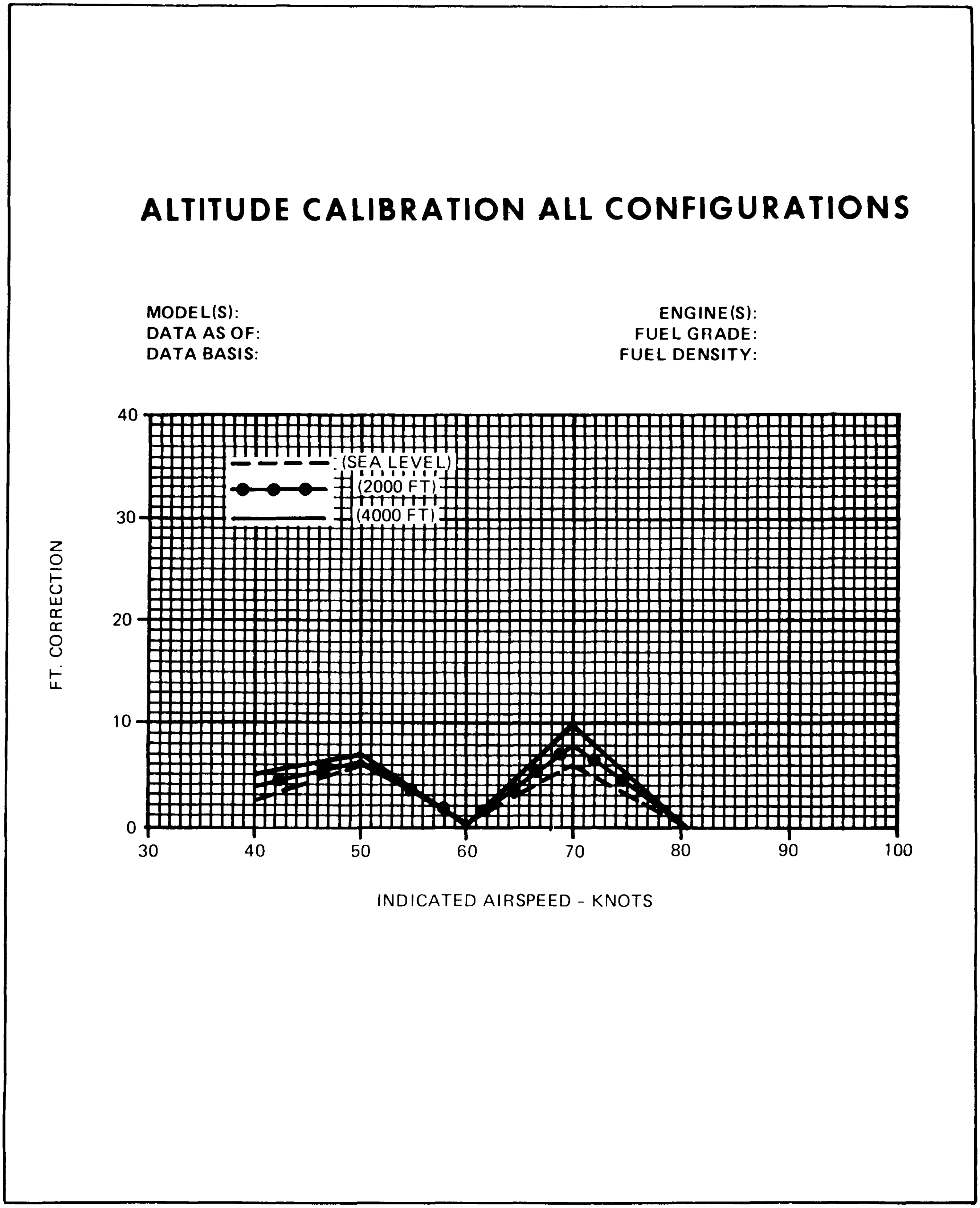


FIGURE 86. Example of altitude calibration chart (helicopter).

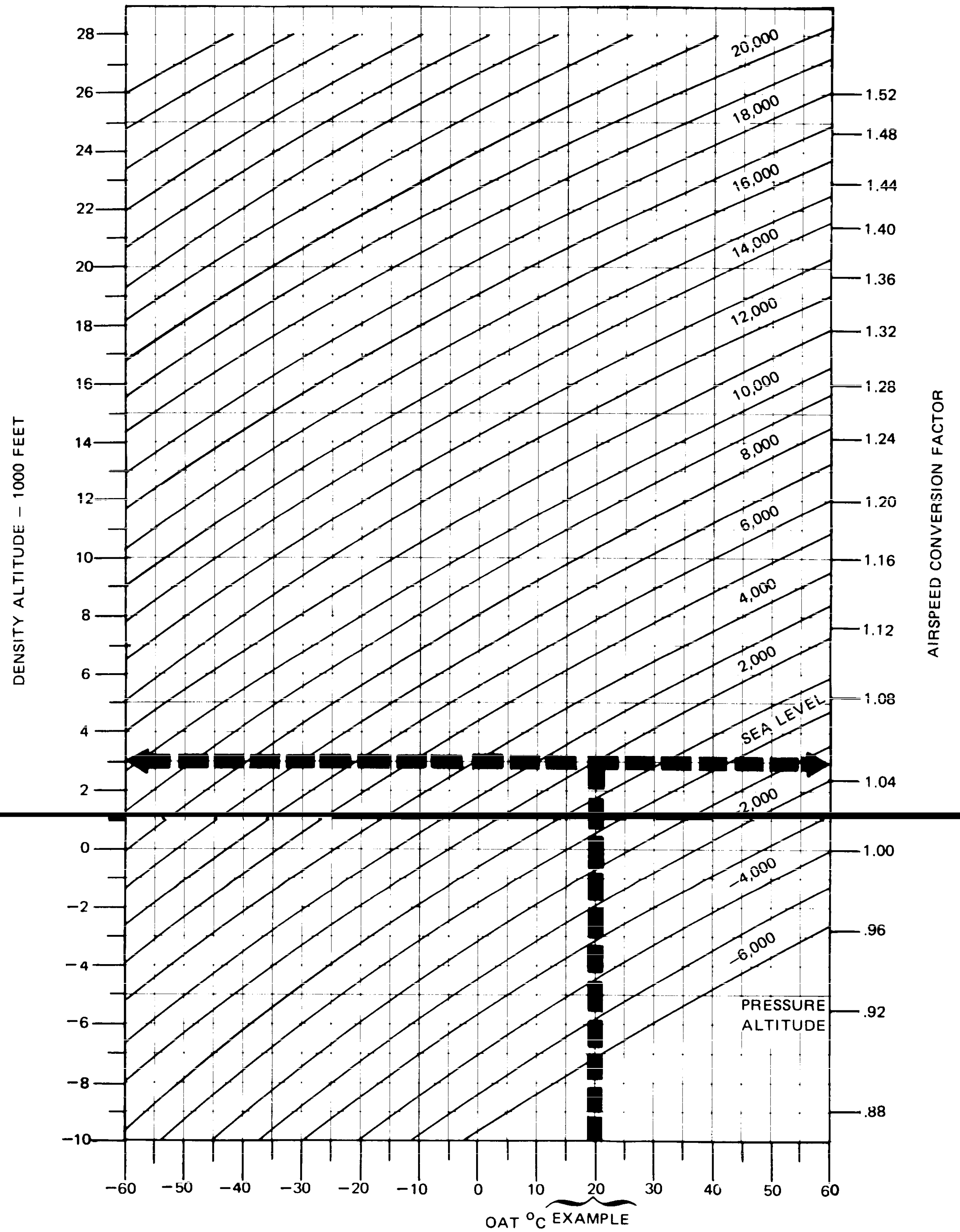


FIGURE 87. Example of density altitude/temperature conversion (helicopter).

SHAFT HORSEPOWER VS TORQUE

DATA AS OF:
DATA BASIS:

ENGINES:
FUEL GRADE:
FUEL DENSITY:

NOTE

MAXIMUM ALLOWABLE ENGINE DETERIORATION IS 10 PERCENT BELOW ORIGINALLY INSTALLED BASELINE POWER, SEE APPLICABLE ENGINE POWER PLANT BULLETIN FOR METHOD OF DETERMINING AND RECORDING ENGINE DETERIORATION.

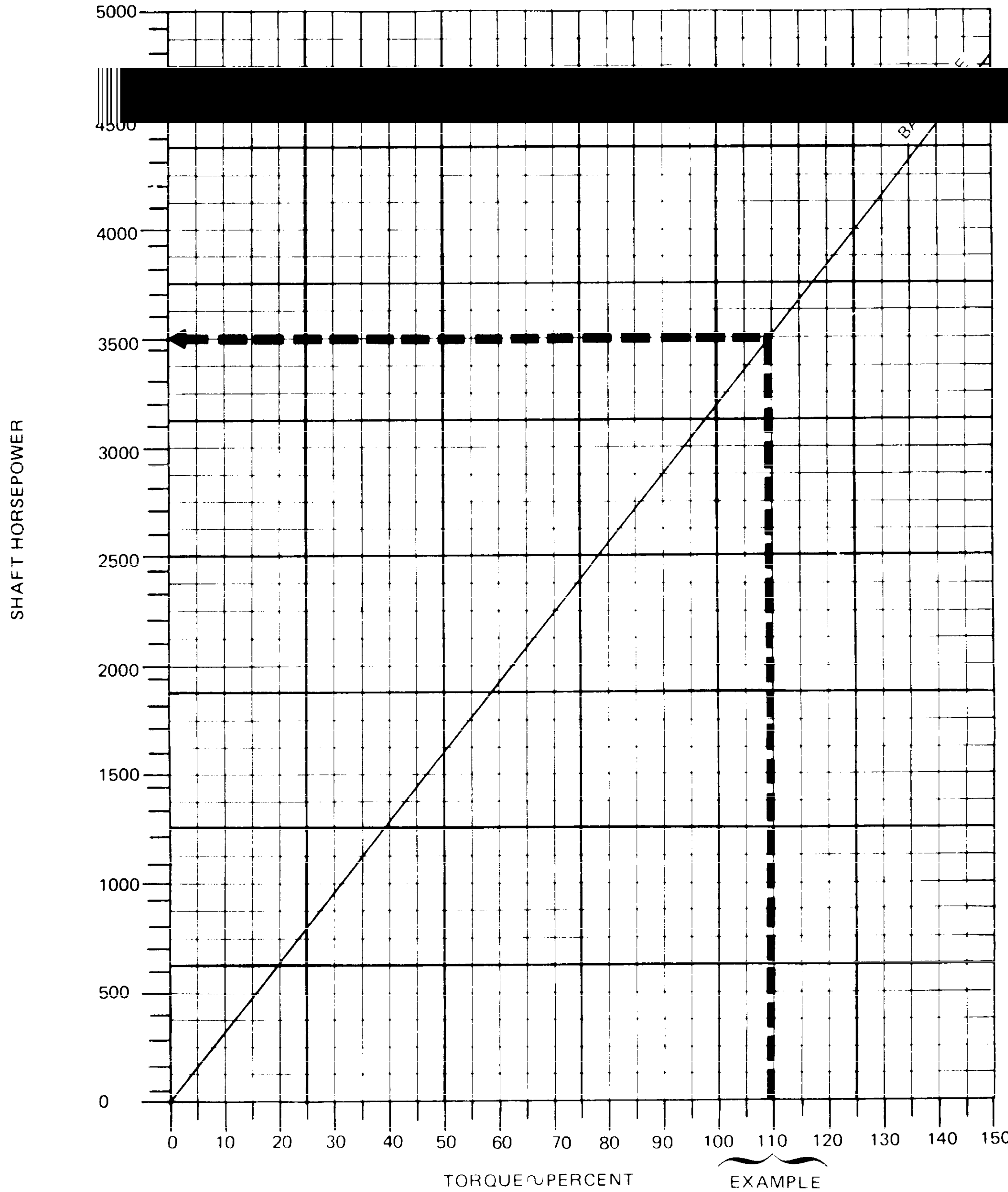


FIGURE 88. Example of shaft horsepower vs. torque (helicopter).

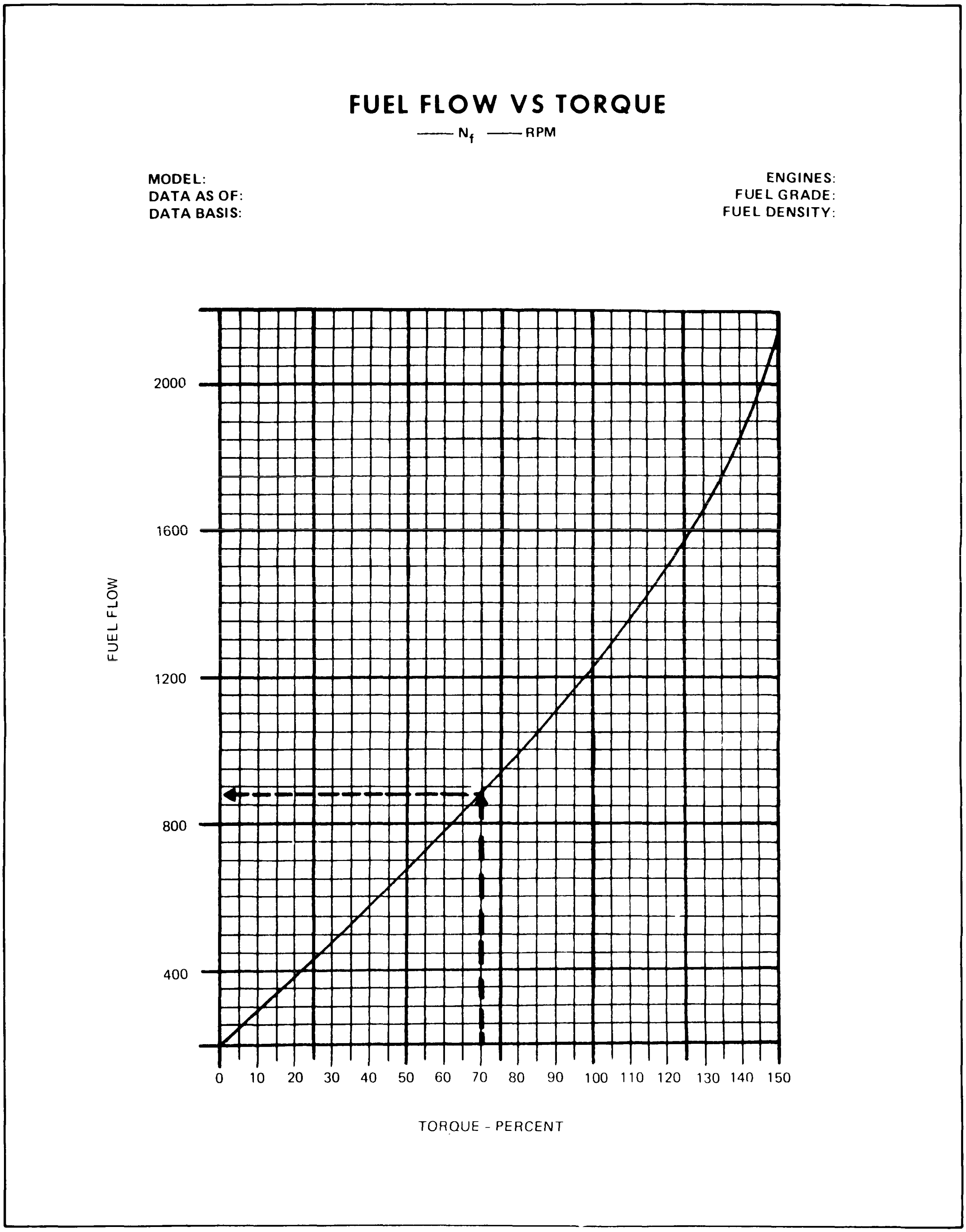


FIGURE 89. Example of fuel flow versus torque (helicopter).

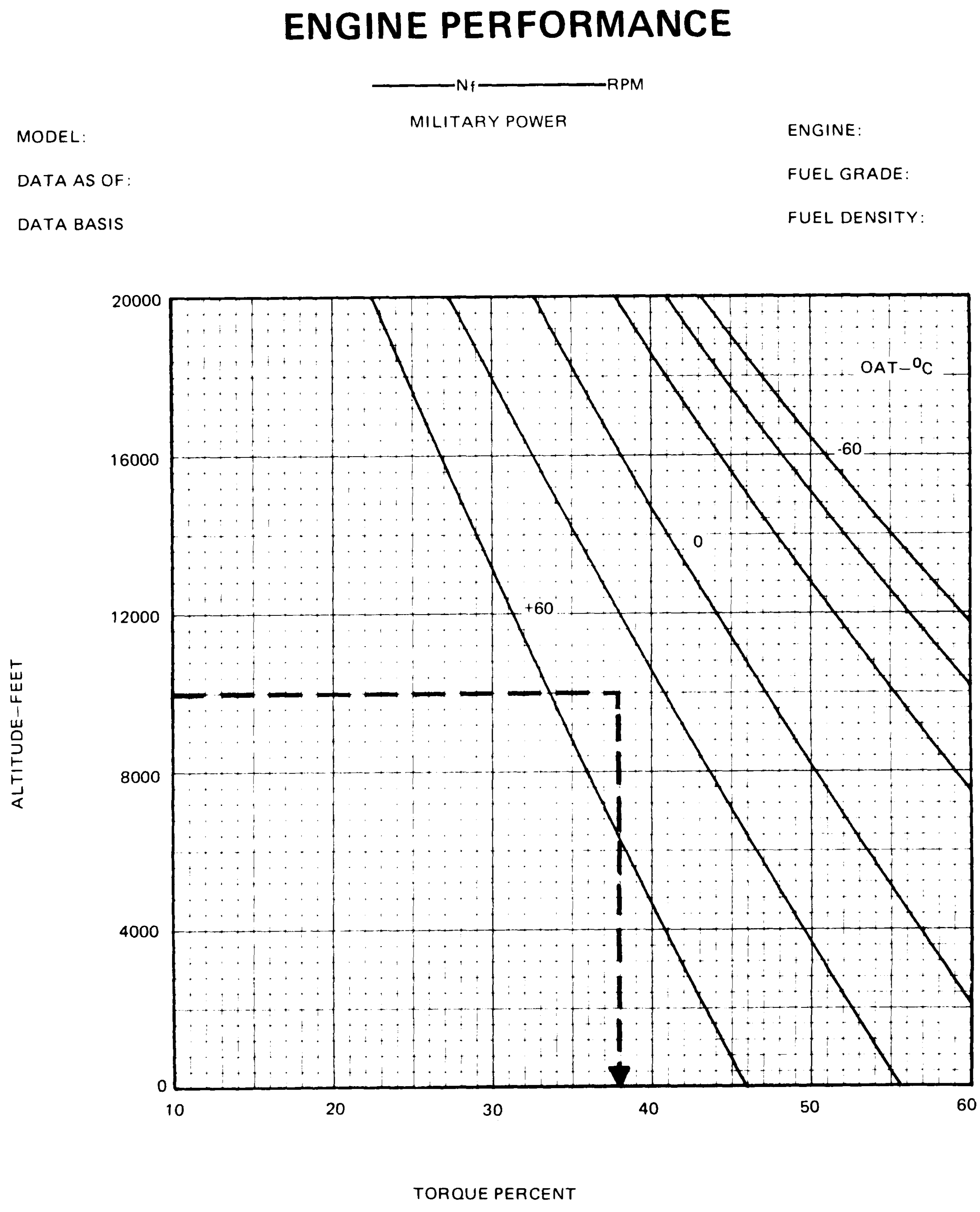


FIGURE 90. Example of engine performance (helicopter).

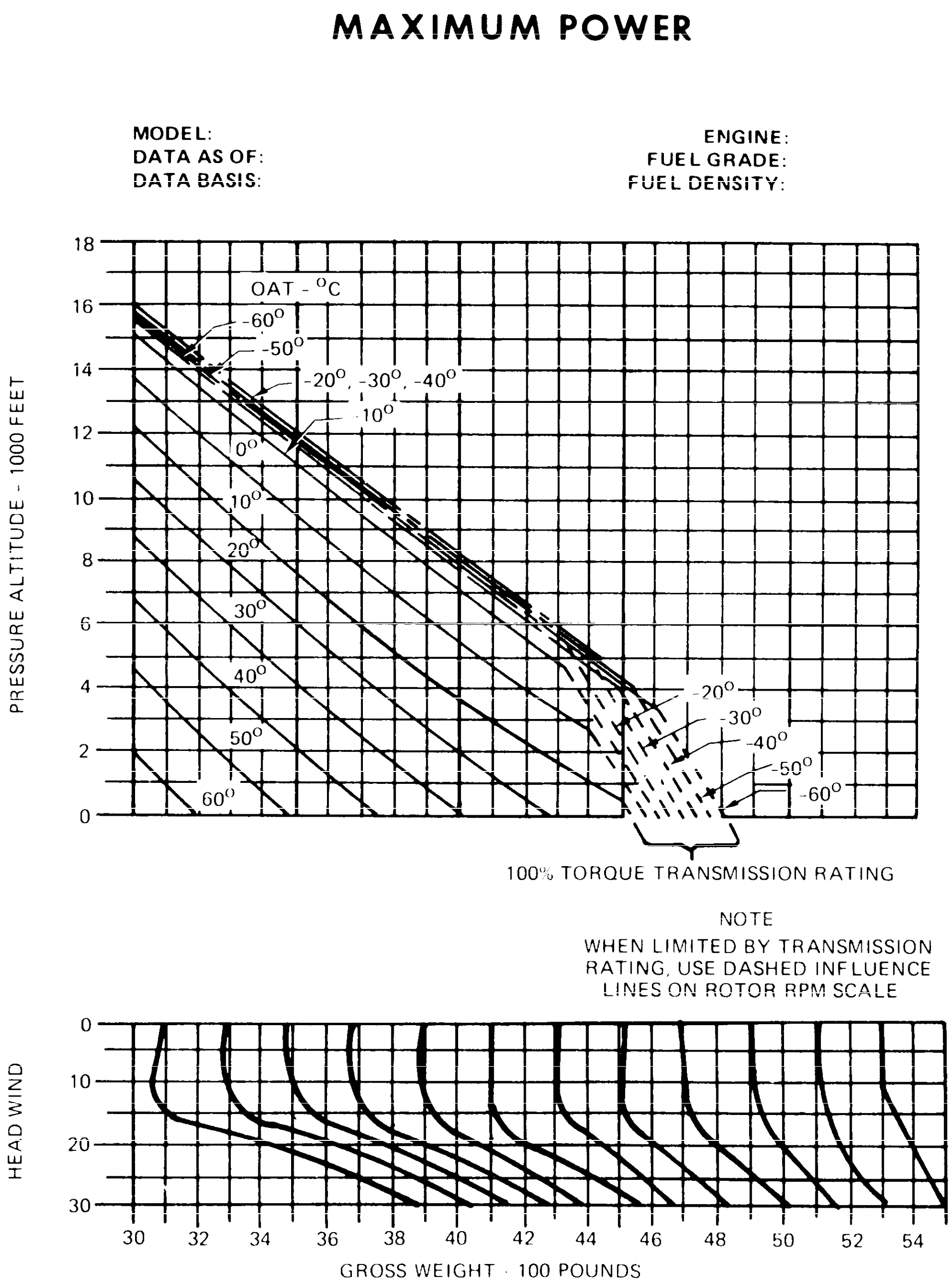


FIGURE 91. Example of maximum gross weight for hovering (helicopter).

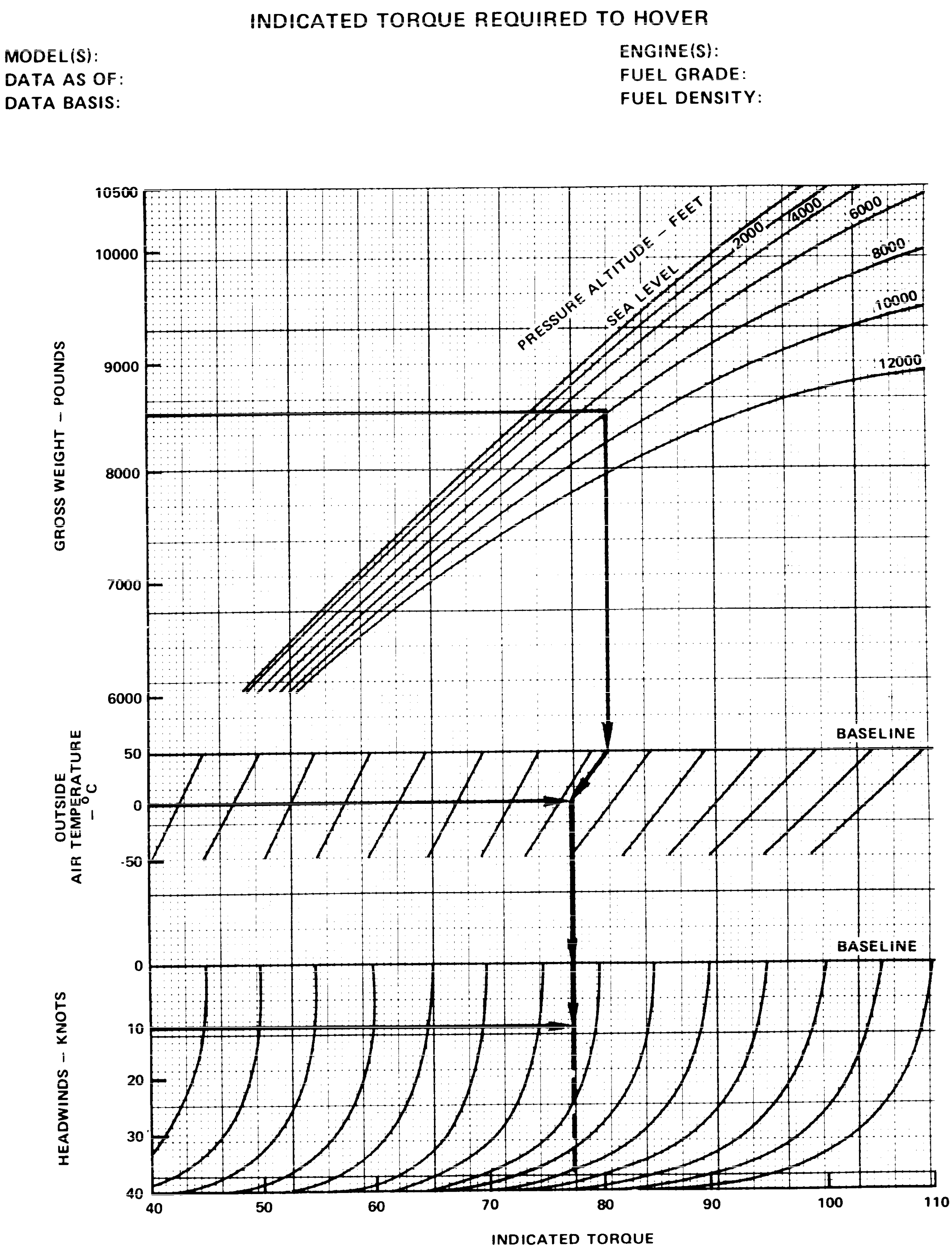


FIGURE 92. Example of indicated torque required to hover (helicopter).

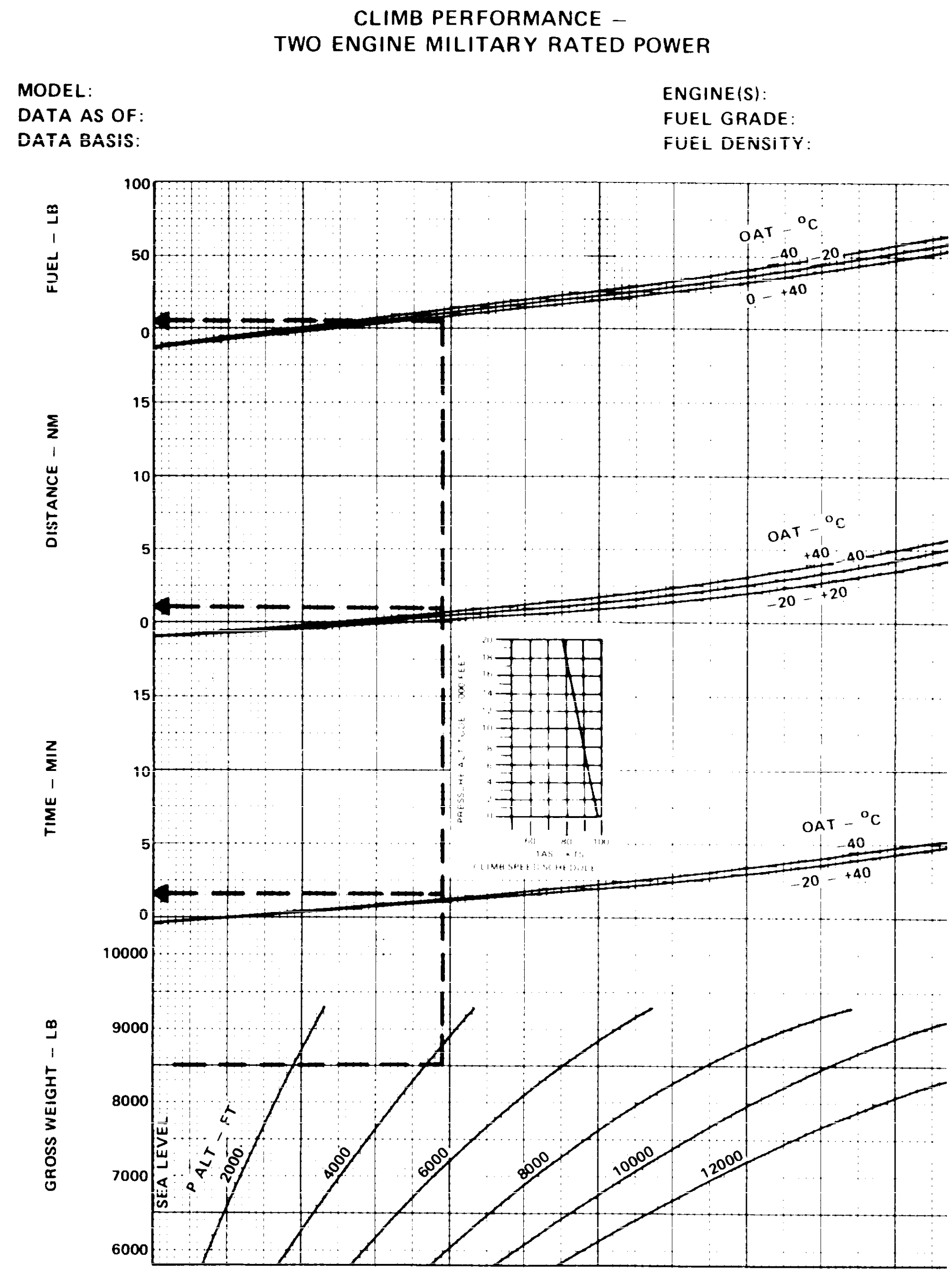


FIGURE 93. Example of climb performance - two engine military rated power (helicopter).

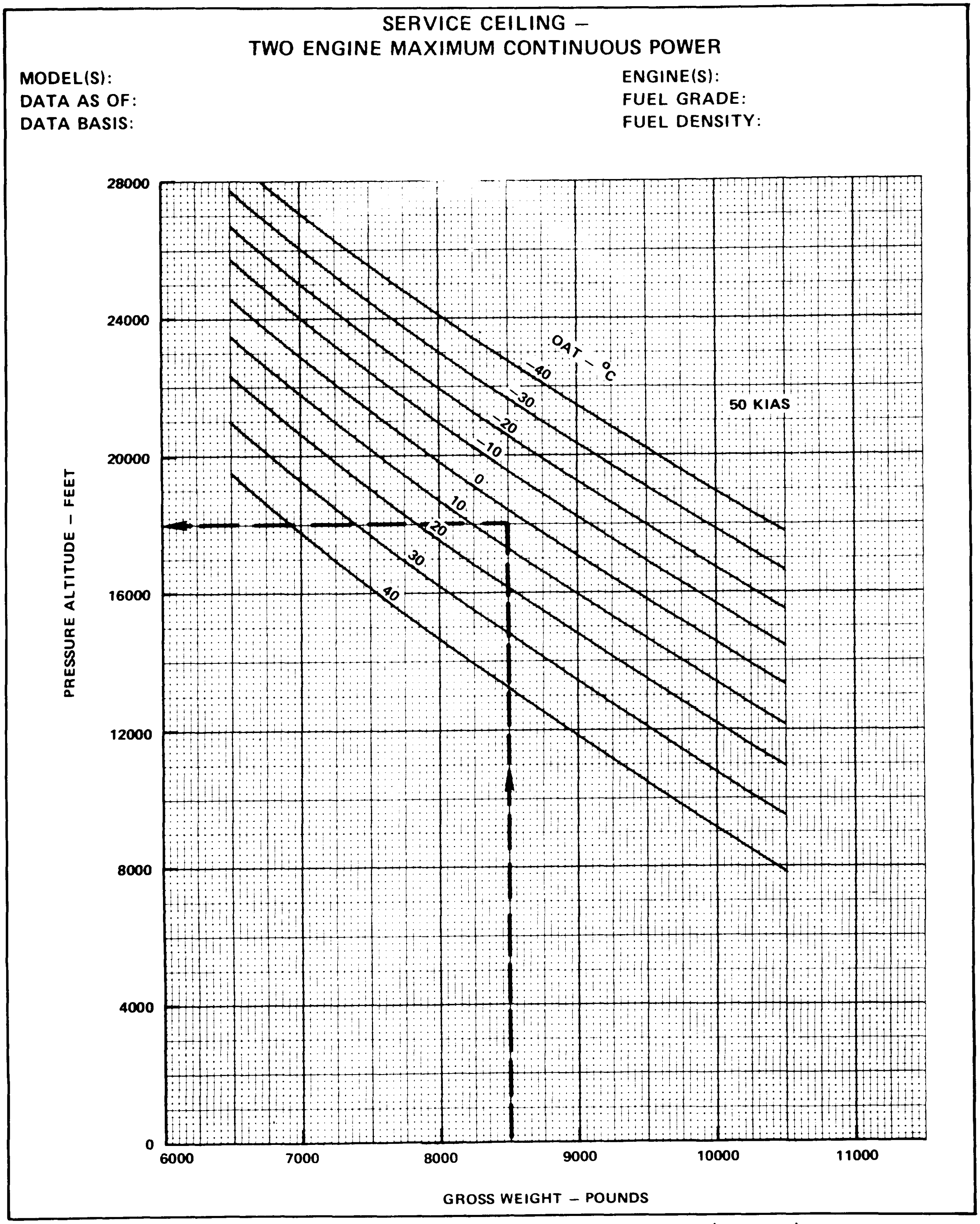


FIGURE 94. Example of service ceiling - two engine maximum continuous power (helicopter).

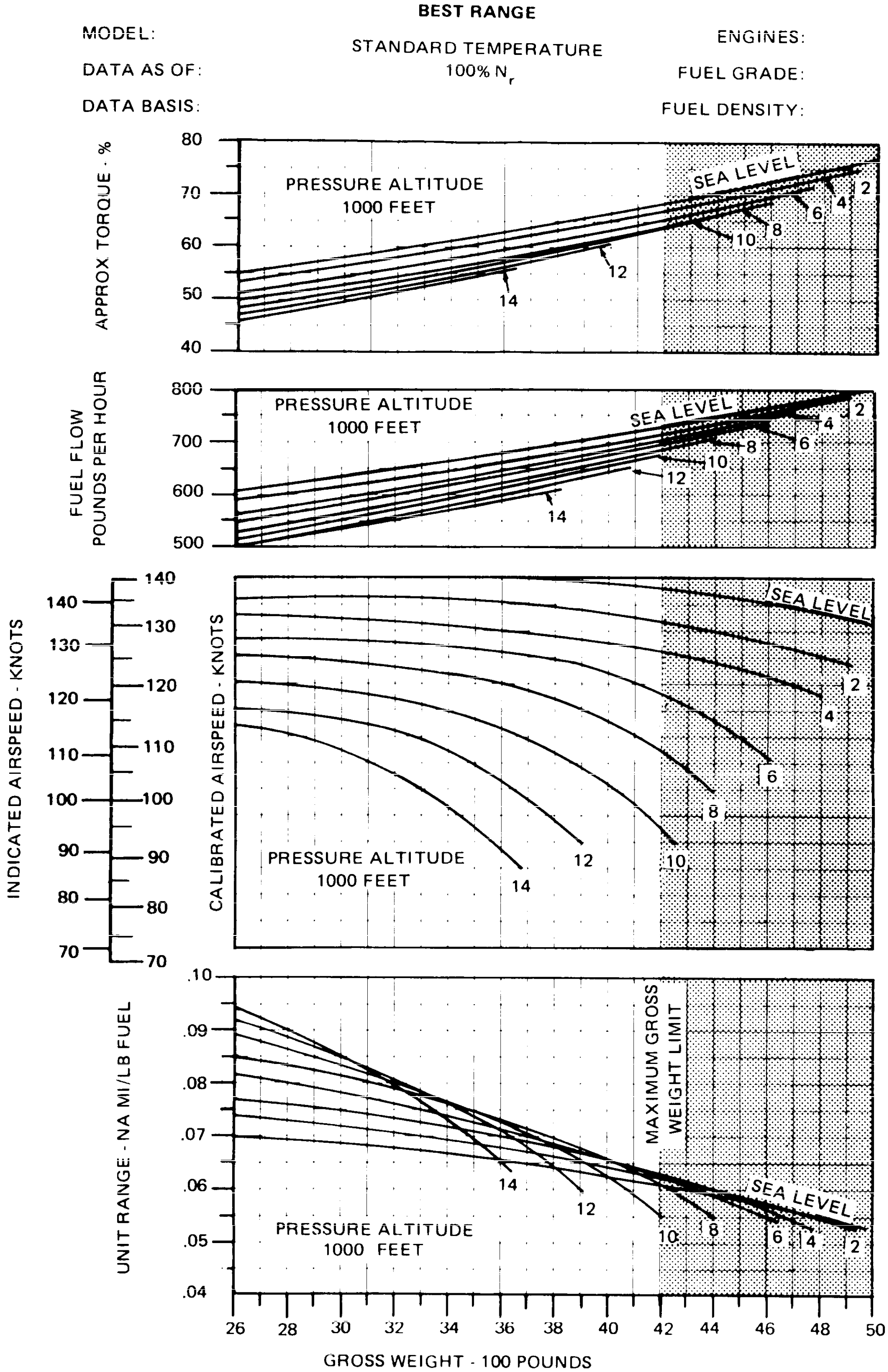


FIGURE 95. Example of best range (helicopter).

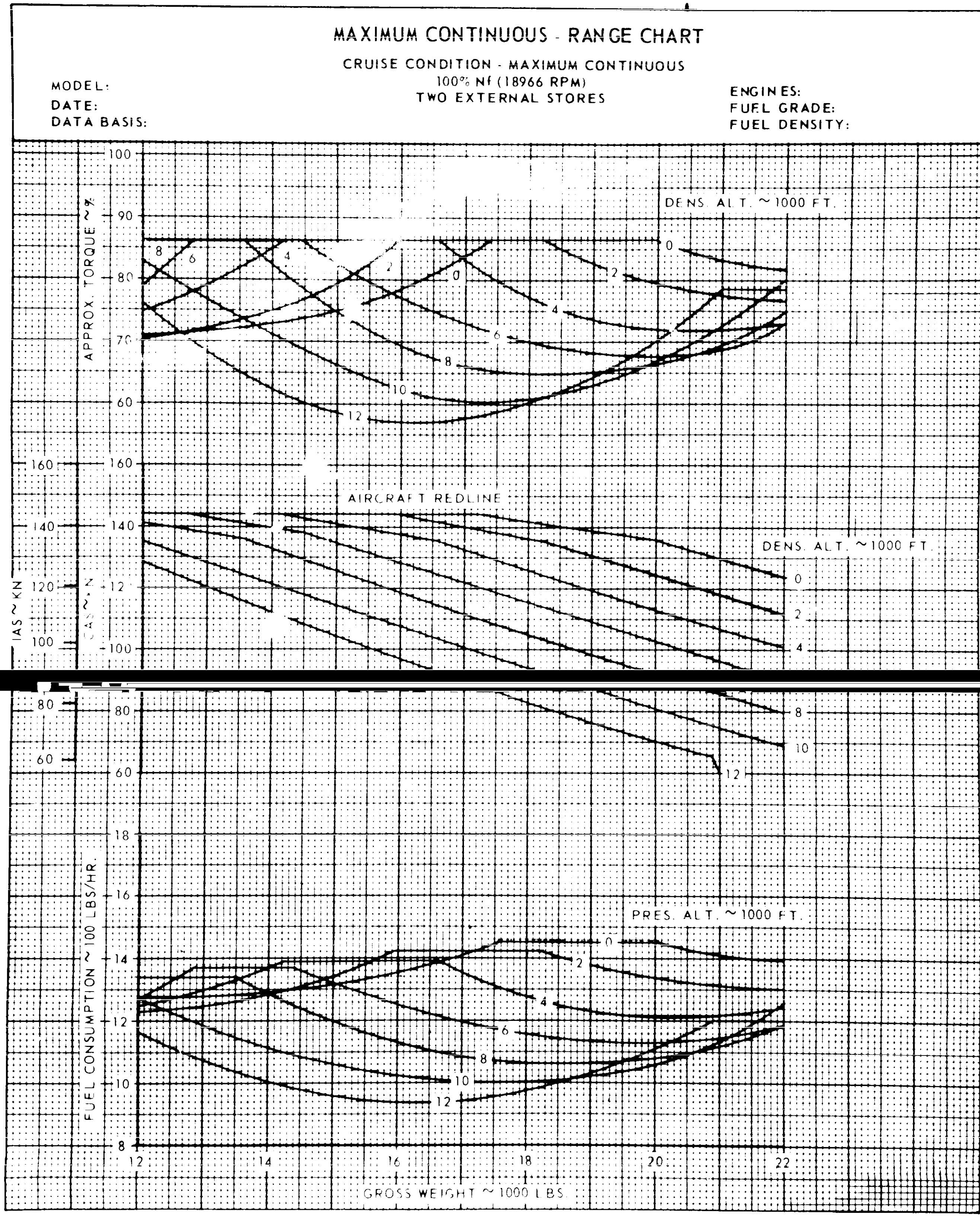


FIGURE 96. Example of range at maximum endurance - two engines (helicopter).

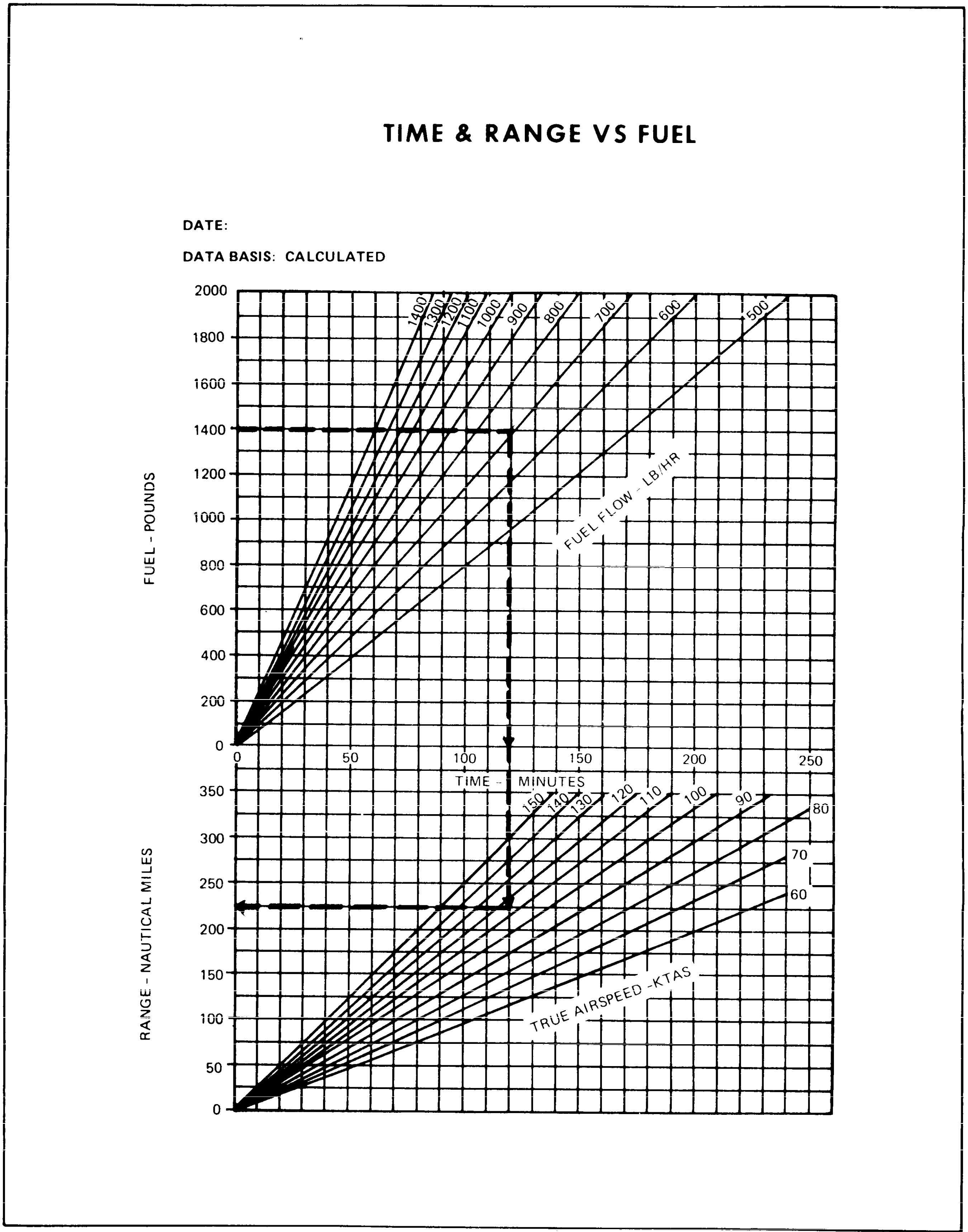


FIGURE 97. Example of time, range, and fuel conversion (helicopter).

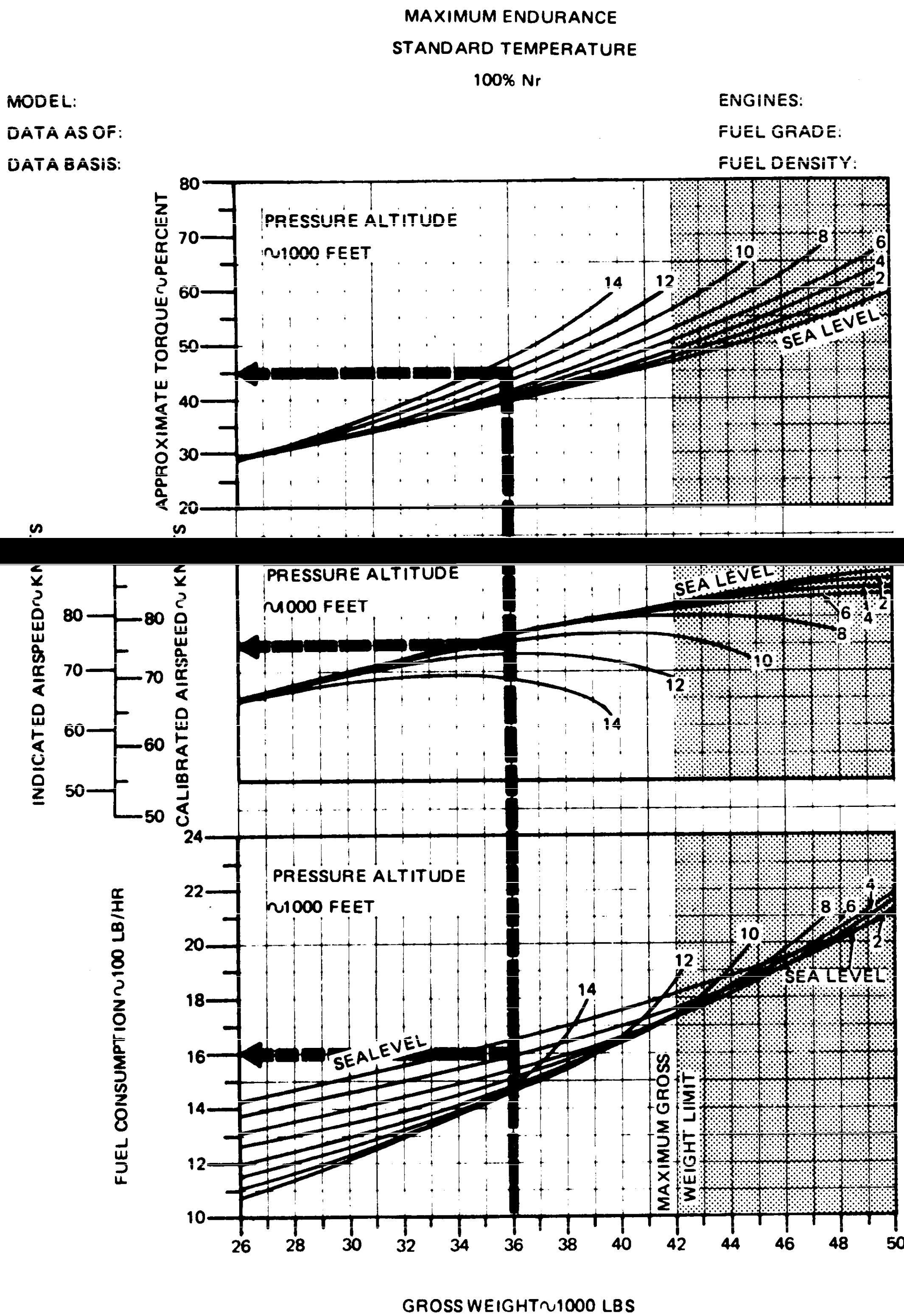


FIGURE 98. Example of maximum endurance - two engines (helicopter).

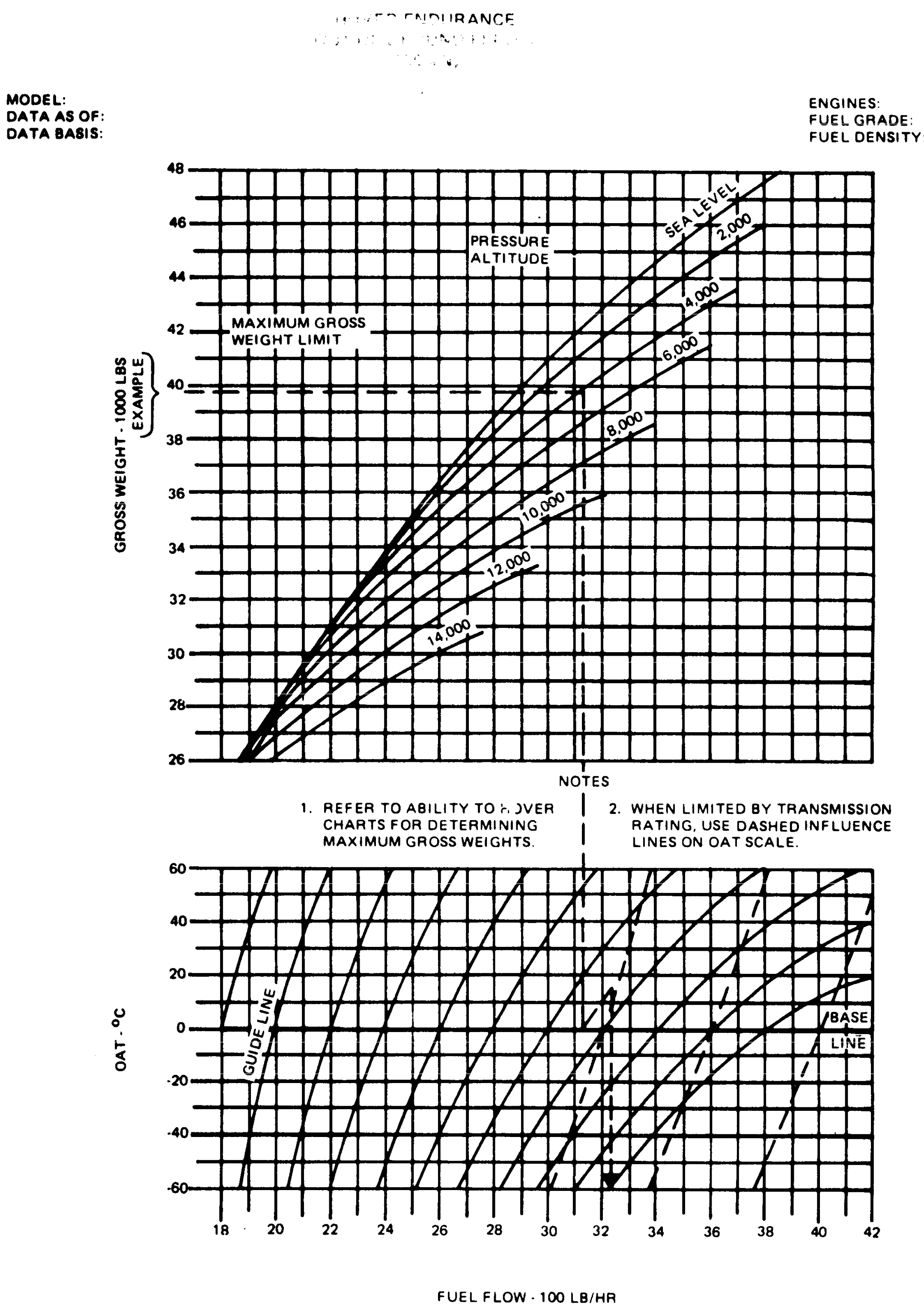


FIGURE 99. Example of hovering endurance - two engines (helicopter).

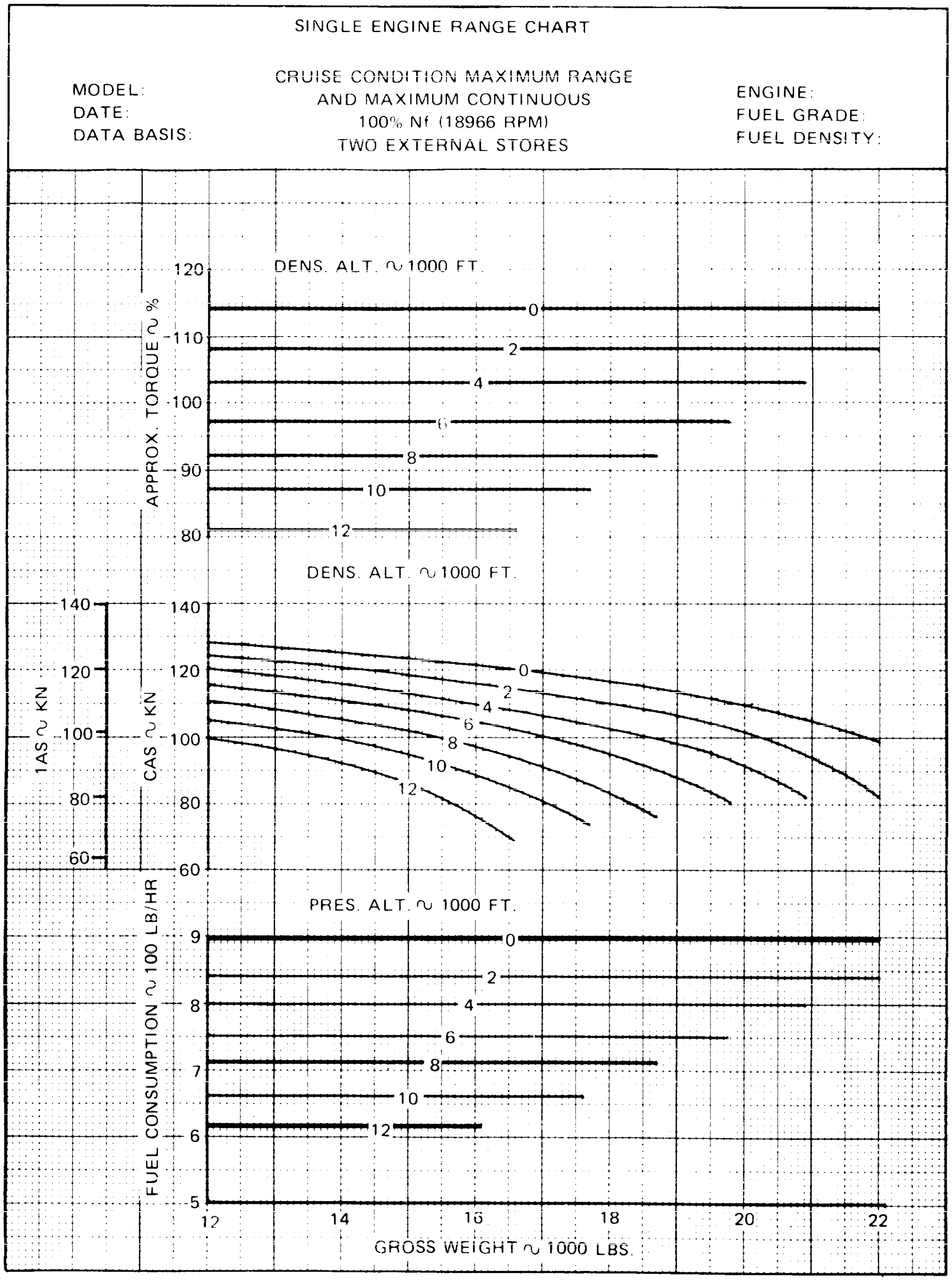


FIGURE 100. Example of single engine range (helicopter).

SINGLE ENGINE MAXIMUM ENDURANCE

100% Nf (18966)
TWO EXTERNAL STORES

MODEL:
DATE:
DATA BASIS:

ENGINE:
FUEL GRADE:
FUEL DENSITY:

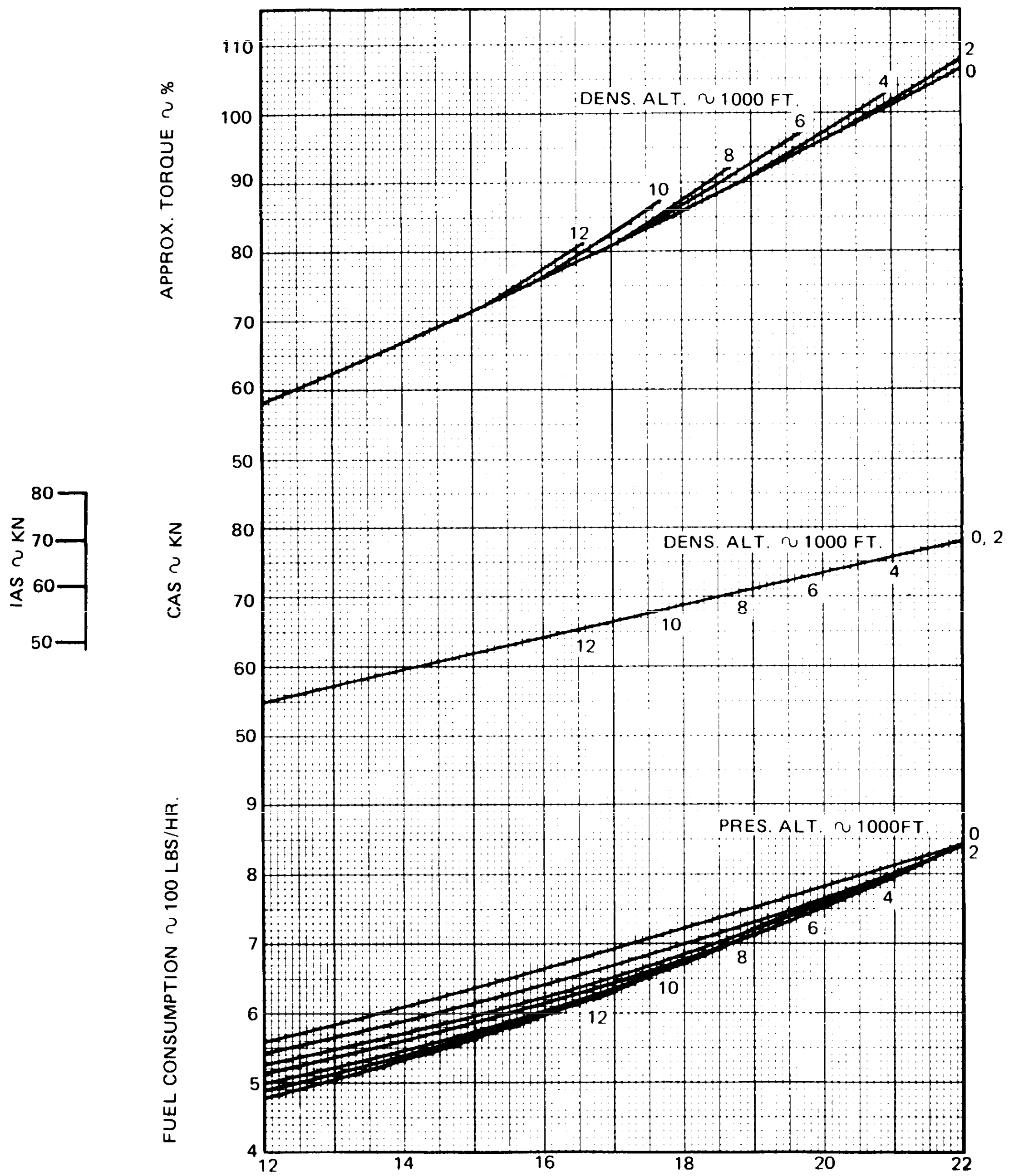


FIGURE 101. Example of engine endurance (helicopter).

SINGLE ENGINE SERVICE CEILING
VELOCITY:

ONE ENGINE MAXIMUM POWER

DATA AS OF:
DATA BASIS:

ENGINE:
FUEL GRADE:
FUEL DENSITY:

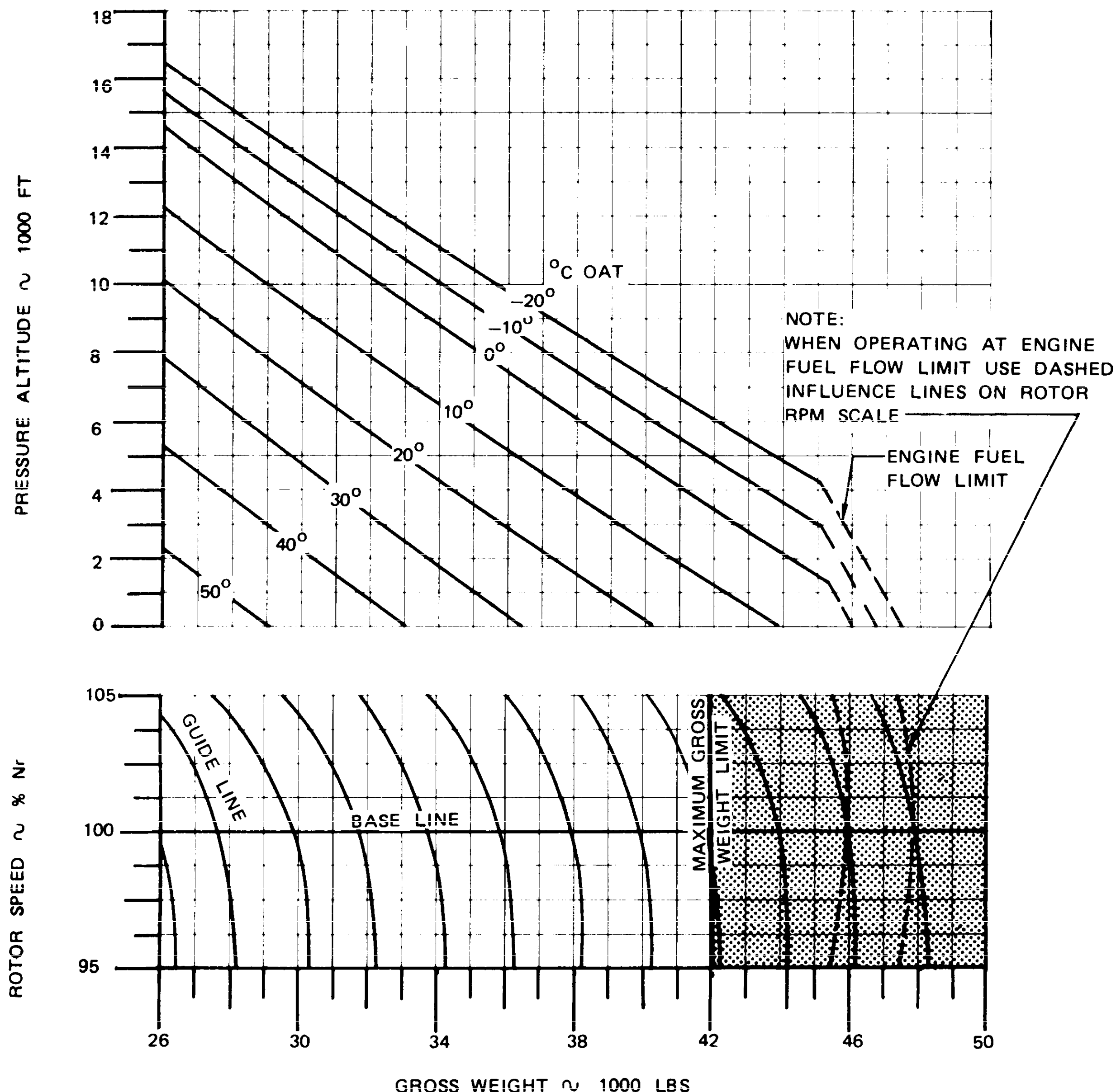


FIGURE 102. Example of single engine service ceiling (helicopter).

ABILITY TO MAINTAIN FLIGHT ON ONE ENGINE

MODEL:
DATE:
DATA BASIS:

ENGINE:
FUEL GRADE:
FUEL DENSITY:

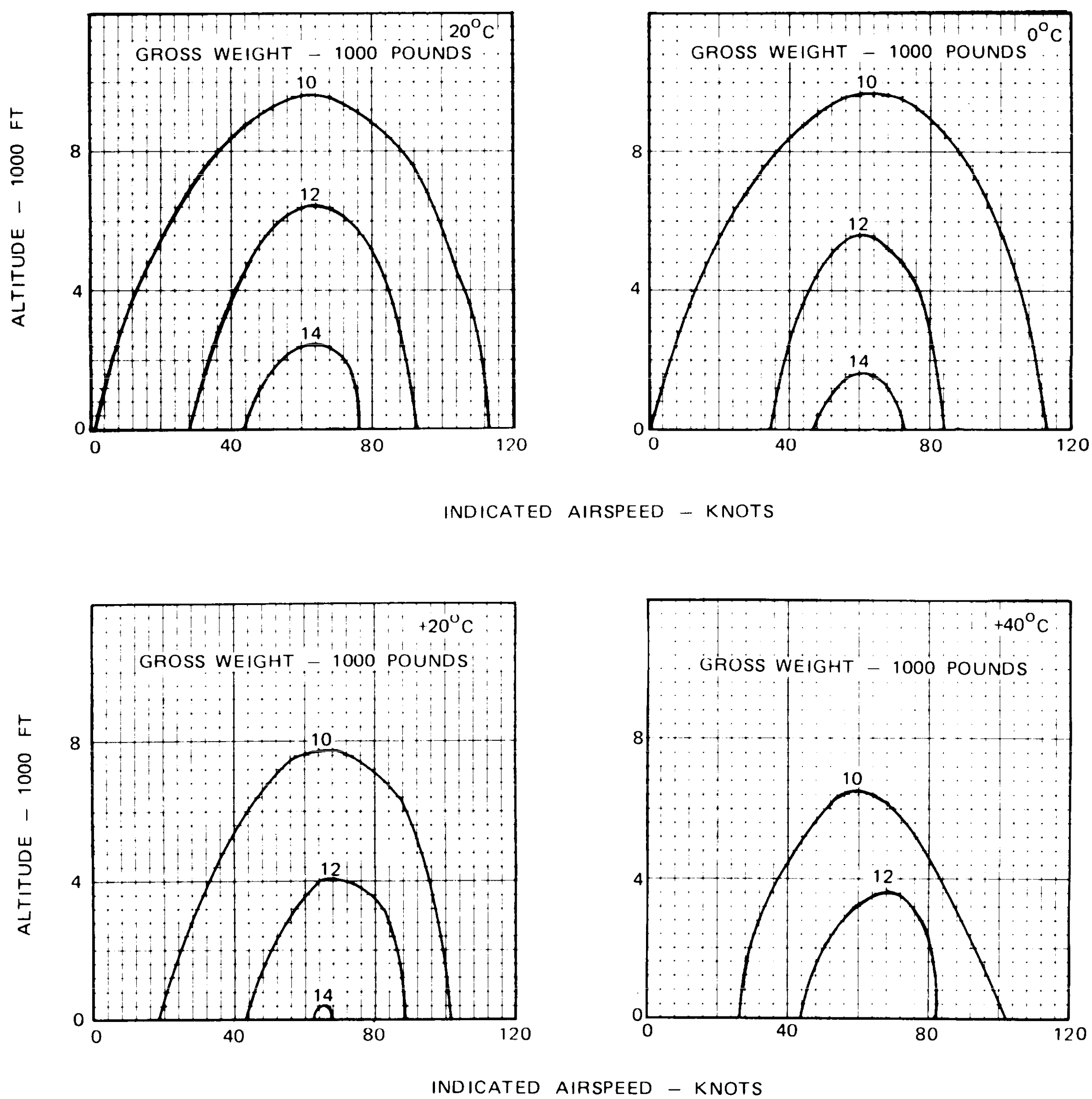


FIGURE 103. Example of ability to maintain flight on one engine (helicopter).

MINIMUM AIRSPEED FOR FLIGHT WITH ONE ENGINE

OUT OF GROUND EFFECT
SEA LEVEL

MODEL: ENGINE:

DATE: FUEL GRADE:

DATA BASIS: FUEL DENSITY:

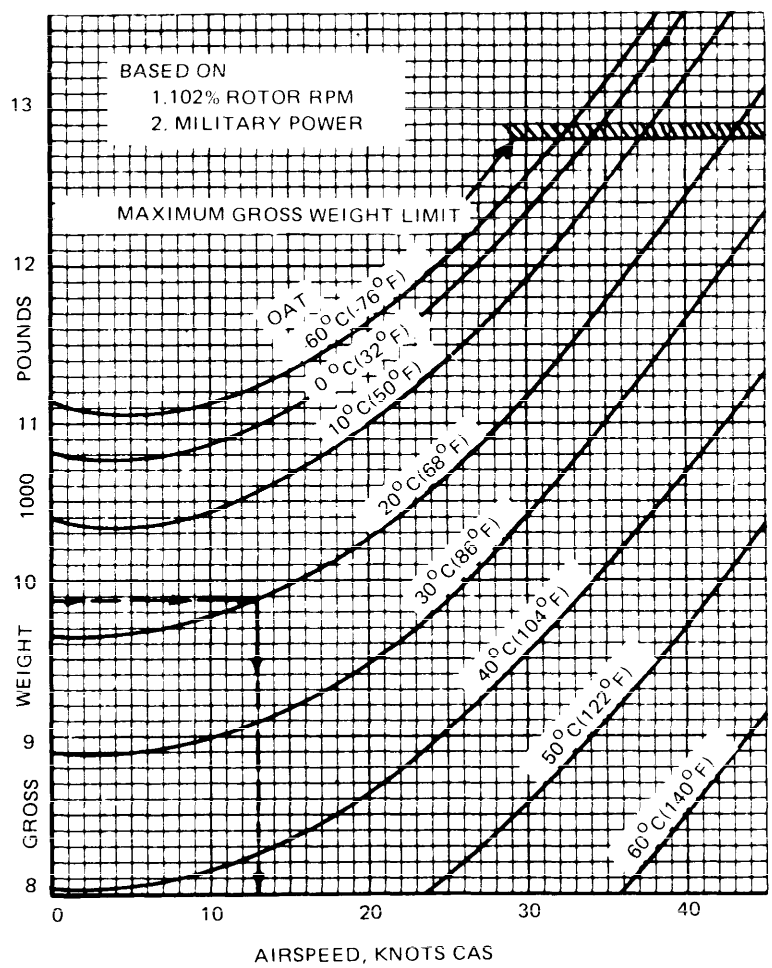


FIGURE 104. Example of minimum airspeed for flight with one engine (helicopter).

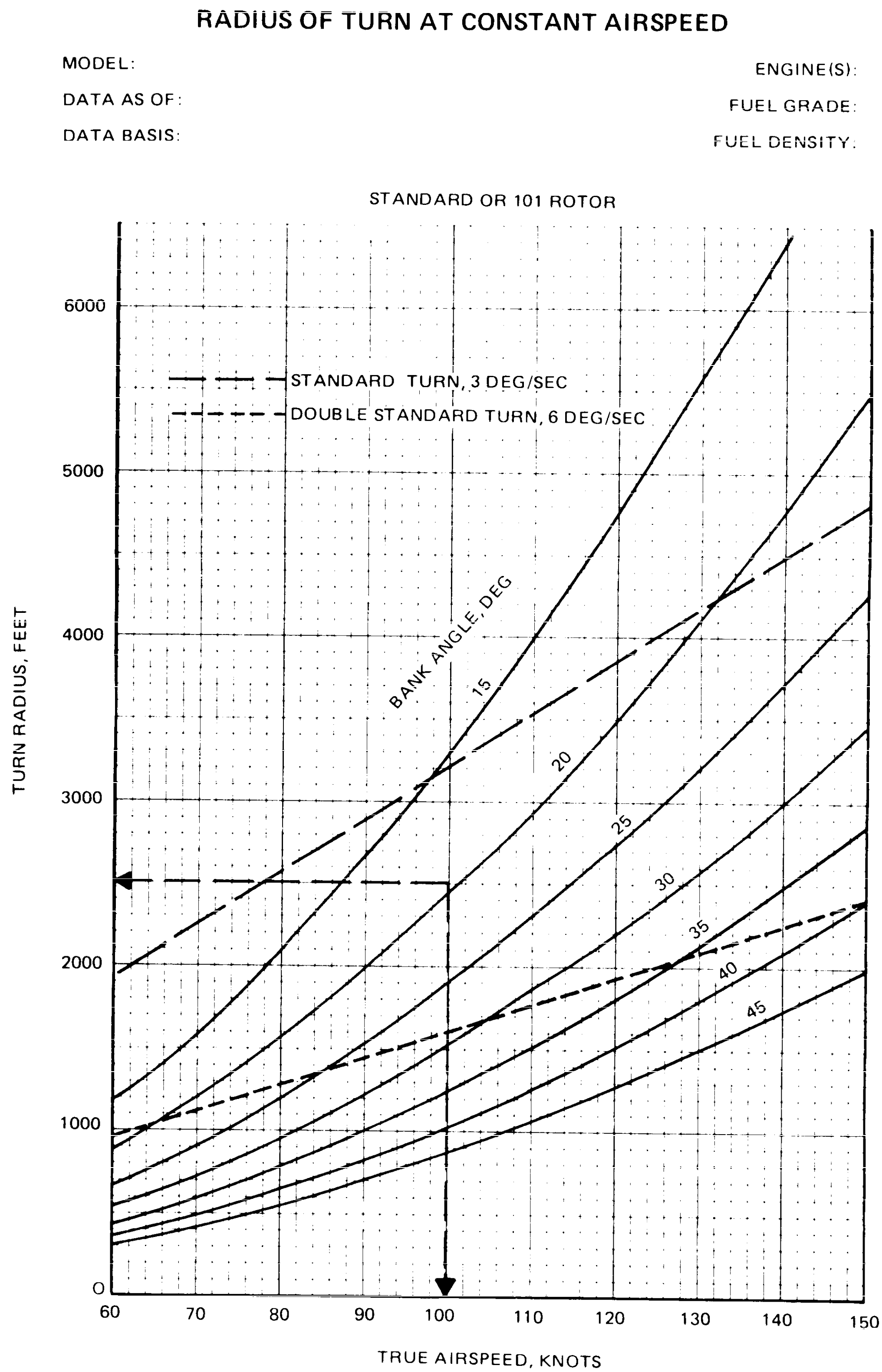


FIGURE 105. Example of radius of turn at constant airspeed (helicopter).

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