NOT MEASUREMENT SENSITIVE

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MILITARY SPECIFICATION

MANUALS, TECHNICAL: REQUIREMENTS FOR OPERATOR'S MANUALS AND CHECKLISTS FOR AIRCRAFT

This specification is approved for use by Department of the Army and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification contains the requirements for preparation of operator's and crewmember's technical manuals describing operational procedures for Army aircraft.

1.2 Classification. Types of technical manuals to be prepared in accordance with this specification are:

Type-10 — Operator's Manual
Type-CL — Operator's Checklist

1.3 Figures/examples. The figures used in this specifiction are examples only. The text of this document takes precedence over the figures.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document shall be addressed to U.S. Army Aviation Systems Command, ATTN: EDS, St. Louis, Missouri 63120-1798 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC A6038 AREA TMSS

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards and handbooks. The following specifications, standards, handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation. (See 6.2.)

SPECIFICATIONS

MILITARY

MIL-M-38784	Manuals, Technical: General Requirements for Preparation of

STANDARDS

MILITARY

MIL-STD-12	Abbreviations for Use on Drawings, Specification, Standards and in Technical Documents.
MIL-STD-210	Climatic Extremes for Military Equipment
DOD-STD-100	Engineering Drawing Practices

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

TM 55-1500-342-23	Army Aviation Maintenance Engineering Manual: Weight and Balance
TB 55-9150-200-24	Engine and Transmission Oils, Fuels and Additives for Army Aircraft
DA PAM 738-751	Functional Users Manual the Army Maintenance Management System-Aviation (TAMMS-A)
AR 95-3	General Provisions, Training, Standardization, and Resource Management
AR 25-30	The Army Integrated Publishing and Printing Program
AR 385-40	Accident Reporting and Records
TM 750-244-1-5	Procedures for the Destruction of Aircraft and Associated Equipment to Prevent Enemy Use

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from Commander, U.S. Army Aviation Systems Command, ATTN: AMSAV-MCT, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished to you.

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

ASTM-D 3951 Standard Practice for Commercial Packaging.

Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19130.

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for associated detailed specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General requirements. General requirements shall be in accordance with MIL-M-38784.

3.1.1 Chapter and section requirements. All chapters shall start on odd numbered pages. Two or more sections may be contained in a chapter. More than one section may be on one right- or left-hand page, provided there is a minimum of 24 picas space remaining to start the next section.

3.1.2 Additional sections and appendixes. Additional sections and appendixes may be added to cover peculiar system application with prior approval of the contracting activity (6.2.).

3.1.3 Nomenclature. The nomenclature of items in the operator's manual shall be the short name used in the applicable aircraft parts manuals, TM 1-XXXX-XXX-23P. The only exception shall be the use of placard item names shown on controls, switches, panels, etc. These items shall be expressed as placarded.

3.1.4 Paragraph numbering and titling. Paragraph numbering shall be in accordance with Figure 1, except procedural steps shall be numbered sequentially in arabic numbers under each procedure title. All paragraph titles shall be bold-face throughout the manual (see example below).

EXAMPLE OF PROCEDURAL STEPS

8-23. BEFORE STARTING ENGINE

1. Seats and pedals — Adjust, seat handles shall be in the full locked position to prevent movement of the seats.

*2. Seat belts and shoulder harness — Fasten and tighten.

3.1.5. Illustrations. Line drawings (black lines on white background) shall be used throughout the manual. Photographic illustrations may be used only when prior approval has been obtained from the contracting activity (6.2.). Illustrations, including diagrams and schematics, shall be clear, simple, and complete, and shall contain all necessary callouts to support the text. The number of callouts on a single illustration or a single sheet of a multi-sheet illustration shall be 25 or less. If more than 25 callouts are required, the total number required shall be equally divided between two identical or similar illustrations (figure 2). Illustrations shall be prepared in accordance with MIL-M-38784 except where the requirements of MIL-M-38784 conflict with the illustration requirements of this specification. Broadsides, (illustrations that have been turned 90 degrees on the page) shall not be used unless authorized by the contracting activity (6.2.).

3.1.6 Graphical data presentation style and format.

3.1.6.1 General requirements. Unless otherwise specified by the contracting activity (6.2.), data that includes more than three variables shall be presented graphically. Data with three variables shall be presented graphically if it represents continuous data (for example, torque available as a function of altitude and temperature).

3.1.6.1.1 Order of precedence. In the event of a conflict between the graphical data presentation requirements in the text of this specification and the sample graphs provided herein, the text of this specification shall take precedence.

3.1.6.1.2 Explanatory text. A brief explanation shall be provided for each graphic presentation including, but not limited to, description, purpose, procedure for use, applicable conditions and effects of their variation.

3.1.6.1.3 Priorities. Unless otherwise specified by the contracting activity (6.2.), the following order of priorities shall be followed while preparing graphical presentations:

a. Minimize the possibility of user mistakes.

b. Cover the full applicable range of data. Unless data ranges are specified in the illustration requirements of this specification, the maximum probable range to be expected in operation (MIL-STD-210) should be used.

c. Provide adequate accuracy. The graphical presentation should be repeatably readable and duplicate the source data to at least one percent of the applicable range of the parameter (for example, a free air temperature range from -60°C to +50°C should be readable to at least 1°C).

d. Clarity and ease of use. Each graph should be designed to directly provide the most often needed parameter (for example, torque required to hover at known conditions of altitude, temperature, weight and skid height). Less often used information (for example, maximum temperature to hover at a given weight and altitude) should be obtainable with additional effort.

e. Standardization (3.1.6.2.)

f. Minimum number of pages.

g. Simplicity.

h. General appearance.

i. Cost of producing.

j. Ease of producing.

3.1.6.2 Tables of standardization. Tables of standardization are provided herein to ensure standardization of graphic illustrations. Type and spacing requirements are summarized in figure 3. Line requirements are summarized in figure 4. The tables of standardization shall be used during preparation of basic, changed, or revised illustrations. The requirements in the tables of standardization are applicable to the final product. If graphic presentation is other than final size, adjustments shall be made to ensure that final size graphs meet the stated criteria.

3.1.6.3 Specific requirements.

3.1.6.3.1 Titles. Titles specified in the illustration requirements of this specification shall be used. If no title is specified, the most succinct title that adequately indicates the nature of the graphical data shall be used.

3.1.6.3.2 Designator symbols. Designator symbols shall be used to indicate limited effectivity of the material as required in 3.2.3.5.

3.1.6.3.3 Subtitles. Subtitles shall be used only when needed to differentiate between similar data on different graphs (for example, takeoff techniques, cruise altitudes, etc).

3.1.6.3.4 Condition heading. The value (range), parameter name, and units of each condition that apply to the presented data shall be listed with each condition separated. When abstract conditions (for example, clean configuration forward cg etc.) are used, they shall be described in detail and/or quantified in the accompanying text (for example, forward cg indicates cg within three inches of the forward limit). Conditions that apply to more than three similar graphs shall be listed only on the first example page and shall be referred to on all subsequent graphs in the series. General aircraft or system limits shall not be listed. Any condition known not to effect the data shall not be listed. The effect of variation of each listed condition on the presented data shall be discussed in text. If the effect of condition variation is not known and cannot be estimated, it shall be so stated in the text. General conditions (for example, rigging, instrument errors, fuel types, etc.) applicable to all data in a chapter shall be discussed in a paragraph titled "General Conditions" which shall appear near the beginning of the chapter. The information in the "General Conditions" paragraph shall not be repeated on the graphs within the chapter.

3.1.6.3.5 Sub-graph titles and conditions. On some graphical data pages, it may be desirable to include separate subgraphs with data on the same general subject. Titles and conditions different from the main conditions shall be given for the subgraphs in accordance with 3.1.6.3.1 and 3.1.6.3.4.

3.1.6.3.6 Notes. Notes should not be used on graphical charts. Notes may be placed on areas adjacent to chart, when absolutely necessary, in order to prevent misuse or misinterpretation of the data. If the note does not fit this condition, it should appear in the text.

3.1.6.3.7 Data basis. Data basis information shall include data type (for example, flight test, estimated, etc.) and each actual data source document (for example, AEFA TR 66-04, Nov 70) used to compute the data presented on that page.

3.1.6.3.8 Figure numbers. (MIL-M-38784).

3.1.6.3.9 Examples. An example shall be provided on the graphical data page to demonstrate primary use of each type of graph. If there are two equally important uses or methods of use of the charts a maximum of two examples may be presented on the graph page. Additional examples (text only) of other uses or methods of use of the data (where applicable) shall be included in explanatory text. These examples shall be in the same format as those on the graphical data page.

3.1.6.3.9.1 Example text. The example text shall be located on the left side of the graphical data page. If multiple examples are used, each example shall be sequentially numbered using roman numerals (for example, EXAMPLE I, EXAMPLE II, etc). If a single example is used, it shall be identified by the heading "EXAMPLE". The example text shall be clear yet succinct. Omit articles, conjunctions, prepositions, etc. Wanted parameter names only shall be used. A maximum of three parameters shall be used. If more wanted parameters are available, use additional examples in the explanatory text (3.1.6.1.2) to explain them. Use one line each to list known parameters and values. If the known parameter value is obtained from elsewhere in the manual, or the source is not evident, paranthetically (below known parameter line) describe the most probable

source (for example; (from example 1) or (computed from winds aloft)). Method will be described using one line per distinct step. Known values shall not be repeated in the method. If needed or useful intermediate values are obtained using the method, these values shall be stated.

3.1.6.3.9.2 Example values. Example values shall be chosen to represent reasonably critical conditions. Standard, benign, and absolute extreme conditions shall not be used. If restricted or special conditions are shown on the chart, the example values shall be chosen to illustrate their effect. Values shall be chosen to require graphical interpolation on every parameter.

3.1.6.3.10 Scaling. Scale and data line increments shall conform to the rule of 1, 2, or 5 X 10 units per division (major and minor) except as noted herein. This will generally require 5 or 10 minor divisions per major division. The preferred scale grid will be 5 X 5 (minor divisions per major division). 10 division grids are undesirable and shall be used only when absolutely necessary. 4 division scale grids shall be used only with the permission of the contracting activity. Unsymmetrical (4 X 5) grids are permitted. For highly nonlinear variation (for example; torque required for in-ground-effect hover versus height), approximately equal increments of the dependent variable(s) shall be used. The minimum minor grid spacing shall be 6 points, unless otherwise specified by the contracting activity (6.2.).

3.1.6.3.11 Units. The primary units of measure and name for each parameter presented or discussed shall be the most commonly used for the subject aircraft. If the parameter is available on an aircraft indicator, the units used shall be those on the indicator. In other cases, the units used shall be the same as those of the most often used source of the data. In some instances, two nearly equal common units may be in use or a transition may be in progress from an older unit to a new unit. When this occurs, the primary unit of measure shall be the new unit. Where practical, the new unit shall be used on the primary scale and the old unit shall be presented on a (redundant) secondary scale. When scales or data include negative values, + and - prefixes shall be used with all numbers for that parameter. For data values on the graph, brackets shall be used around the prefixes.

3.1.6.3.12 Data range. The data range presented shall be as stated in 3.1.6.1.3. Scales shall extend to the next major division beyond the extreme or limit value(s) and no further.

3.1.6.3.13 Grid. A grid corresponding to the primary scales shall be used. Grids shall be prepared to the graphical line standards (figure 4).

3.1.6.3.14 Scales. The scale title shall include the parameter name and units of measure. When used, multipliers shall be included with the units (for example, GROSS WEIGHT 1000 pounds). Multipliers shall be used only to meet specific illustration requirements in this specification for values with three zeros or more or when significant improvement in the appearance of the graph would result. Resulting fractional values (for example, GROSS WEIGHT 1000 pounds = 20.2) shall be avoided. Secondary scales should be located on the opposite side of the grid from the primary scale. Scale numbers shall be used for each major or every other (most even value) major scale increments unless the secondary scale correspond to markings on an aircraft indicator. In this case, the increments and value labelling shall be the same as those on the indicator.

3.1.6.3.15 Data line labels and values. Data line labels shall include the parameter name, multiplier (if any), and units. They shall be located approximately at the midpoint of, and oriented parallel to, the data line, to read from the bottom of the page. Data line labels and values shall be prepared in accordance with the Tables of Standardization (figure 3 and 4). Data line numbers shall be the same size and type as the labels. The use of "stick-on" numbers and labels shall be held to a minimum unless they are of the transparent type. Data line labels and values shall be located according to the following order of preference (method "a" shall be used for primary data line numbers):

a. Parallel centered interrupting the line, alternately staggered to avoid masking a continuous area of the grid.

b. At the end of, and parallel to, the data line (suitable for secondary data lines).

c. Adjacent and parallel to the data line (suitable for secondary data lines).

d. Outside the data lines with leader lines to each data line (suitable for secondary data lines).

3.1.6.3.16 Primary data lines. Primary data lines shall be prepared in accordance with figure 4. Scales shall be chosen so that the mid-range of approximately linear data is oriented at approximately 45°. Increments shall be chosen so that the majority of the data lines are separated by at least one minor grid width and no more than one major grid width. Converging data lines shall be truncated (alternately) where separation decreases to 1/2-1 minor grid spacing so that actual convergence does not occur.

3.1.6.3.17 Secondary data lines. Operating limits, restricted operating conditions, optimum (minimum/maximum, recommended or critical operating conditions shall be depicted on each graph as applicable. Secondary data lines shall be prepared in accordance with figure 4.

3.1.6.3.18 Layout and sizing. Scales and grid size shall be chosen to take maximum advantage of the available space to provide the most easily read graph, consistent with the previously specified range and readability requirements. Several single graphs on the same general subject may be included on a single page. For sequential graphs the following requirements apply. The general layout shall have the example text near the upper left corner of the page. The first step graph shall be near the upper right. The sequence shall be for the user to enter on left of first graph, move right, reflect down at right angles, reflect left, reflect down, reflect right, etc., until the primary "wanted" parameter is read out on the final scale. A transfer grid (in the direction of transfer only) shall be provided between each step graph. Intermediate parameters may be provided on secondary scales by continuing through the reflector data lines or by reflecting in the opposite direction to the primary direction.

3.1.6.3.19 Original graphical data designs. For original (sequential) graphical designs, the following requirements also apply:

a. Each "known" parameter shall be required to be used only once in the sequence, unless its use will simplify a procedure.

b. The sequence shall proceed from the best known (or most certain) parameter to the least certain parameter consistent with technical requirements.

c. Each sequential stop shall reflect at right angles (90° parameter transfers only). "Paralleling" data transfers shall be avoided.

3.1.7 Dimensional data. Except for Chapter 6 weight and balance values, linear dimensions shall be stated in feet and inches, or in inches and decimal fractions thereof, e.g. "6 ft 3 in", "4.062 in", etc. No more than 3 decimal places shall be used. When dimensions are less than a foot, they shall be expressed in inches and decimal fractions thereof. All dimensions, tolerances, clearances, measurements, and decimal equivalents, appearing in Chapters 8 and 9 shall be stated in text and on illustrations in bold capital lettering.

EXAMPLE: Check accumulator pressure gage — 650 to 850 PSI.

3.1.8 Manufacturer's names. The use of manufacturer's names in the operator's manual or checklists is prohibited without prior approval of the contracting activity (6.2.).

3.1.9 Definition of abbreviations and terms. Abbreviations contained in the operator's manual and checklist shall be in accordance with MIL-STD-12. Abbreviations and definition of terms used shall be contained in Appendix B.

3.1.10 Placard items. All placard items shall appear in the text and procedural steps as labeled on the equipment in bold face capital letters.

3.1.11 References. References shall be in accordance with MIL-M-38784, except that direct reference to a figure will be (fig 8-12) and to a paragraph will be (8-12).

3.1.12 Use of "shall", "should", and "may". Use "shall" whenever a manual expresses a provision that is binding. Use "should" and "may" whenever it is necessary to express non-mandatory provisions.

3.2 Operator's Manual. (-10) This manual shall describe briefly and concisely the operation of the complete aircraft. The description of aircraft, aircraft systems, sub-systems, and components shall contain only that detail required to explain the operation and operational procedures, and check necessary for the pilot to safely and efficiently operate the aircraft, aircraft systems, and mission equipment during flight and ground operation. Arrangement of manual shall be as follows:

Cover	
Table of Contents	
Chapter 1	— Introduction
Chapter 2	— Aircraft and Systems Description and Operation
Chapter 3	— Avionics
Chapter 4	— Mission Equipment
Chapter 5	— Operating Limits and Restrictions
Chapter 6	— Weight/Balance and Loading
Chapter 7	— Performance Data
Chapter 8	— Normal Procedures
Chapter 9	— Emergency Procedures
Appendix A	— References
Appendix B	— Abbreviations and Terms
Index	— Alphabetical

3.2.1 General.

3.2.1.1 Size. Operator's technical manuals shall be prepared for a final trim size of 8-1/2 inches wide by 11 inches in length. The usable area for preparation of the manuals shall be in accordance with MIL-M-38784.

3.2.1.2 Type style, size, and spacing. Type style, size, and spacing shall be in accordance with MIL-M-38784.

3.2.1.3 Publication number assignment. The publication number shall be as assigned by the contracting activity (6.2.).

3.2.1.4 Marginal copy. Marginal copy shall consist of the publication number and page number.

3.2.1.5 Publication number. The publication number shall appear at the outer edge of the top margin.

3.2.1.6 Page, table, and illustration numbers. Pages, tables, and illustrations shall be numbered in accordance with MIL-M-38784 except that no page shall be numbered "zero" (for example, 2-0, 3-0, etc.).

3.2.1.7 Change symbols. Changes to text and tables including new material on added pages shall be identified by a vertical bar in the outer margin of the column of text in which the change appears, extending close to the entire area of the material affected. Change symbols for single-column text shall be placed in the margin opposite the binding. Change symbols for double column text shall be placed in the margin adjacent to the binding for the columns of text nearest the binding. The change symbols shall be placed in the outer margin opposite the binding for the column of text farthest from the binding. Pages with emergency markings, which consist of black diagonal lines around three edges, shall have the vertical bar or change symbol placed in the margin between the text and the diagonal lines. Change symbols shall indicate the current changes only. A miniature pointing hand symbol shall be used to denote a change to an illustration. However, a vertical line in the

outer margin (opposite the binding) rather than miniature pointing hands, shall be utilized when there have been extensive changes made to an illustration. Change symbols shall not be used to indicate changes in the following:

a. Introductory material.

b. Indexes and tabular data where the change cannot be identified.

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

3.2.1.8 Page arrangement. All text shall be arranged in a double column page. When authorized by the contracting activity (6.2,) duplicate pages of the -10 may be prepared indicating configuration or equipment differences. The pages will be numbered identically, with the difference indicated by a designator symbol (3.2.3.5) in the upper right corner of the page. The following statement shall be added verbatim to the "General" paragraph in Chapter I:

"Duplicate pages have been provided indicating aircraft applicability in the upper right corner of the -10 pages affected. Remove and discard pages which are not applicable to the assigned aircraft."

3.2.2 Front matter. Front matter shall include the following in addition to the requirements of MIL-M-38784.

3.2.2.1 Summary of Change Sheet. A statement shall be included on a separate sheet of paper describing what new information or major changes have been made by the change.

3.2.2.2 Cover. Front covers shall be prepared in accordance with figure 5. A distribution statement, destruction notice, and export warning, if applicable, shall appear on the cover or on the title page or title block page, in accordance with MIL-M-38784. Entries appearing on the cover will be as follows:

a. Warning Data.

b. Table of Contents.

c. Introduction.

d. Description and Operation.

e. Avionics.

f. Mission Equipment.

g. Operating Limits and Restrictions.

h. Weight/Balance and Loading.

i. Performance Data.

j. Normal Procedures.

k. Emergency Procedures

l. References.

m. Abbreviations and Terms.

n. Alphabetical Index.

A 3/8-inch bleed-to-edge indicator shall be used on both the right edge of the cover and corresponding right-hand pages. Chapter 9, Emergency Procedures, shall not have bleed-to-edge indicators in the text, but shall have diagonal lines around all borders of the page (3.2.11.)

3.2.2.3 Table of contents. A table of contents listing chapters and sections in the same order and with the exact title used in the text shall be placed at the beginning of each publication. Table of contents preceding individual parts, chapters, or sections shall not be used. Each volume of a multivolume manual shall have its own table of contents.

3.2.2.4 Reporting errors and recommended improvements.

The following boxed statement shall precede the Table of Contents:

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve these procedures, please let us know. Write a letter or complete and mail a DA Form 2028, Recommended Changes to Publications and Blank Forms, to Commander, US Army Aviation Systems Command, ATTN: AMSAV-MC, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be provided to you.

Types of comments that should be avoided on DA Form 2028 are those that: (1) Ask a question instead of giving an answer; (2) Are based on minor differences of opinion or wording; (3) Point out obvious editorial errors, misspellings, or errors in punctuation, unless the errors change the intended meaning. (Refer to AR 25-30)

3.2.3 Chapter 1 — Introduction. This chapter shall consist of the following paragraphs:

3.2.3.1 General. The first paragraph of Chapter 1 shall be titled "General" and shall contain the following statement:

"These instructions are for use by the operators. They apply to (insert assigned aircraft designation)."

3.2.3.2 Warnings, cautions, and notes. The following statements and headings shall appear verbatim in the style and format shown:

Warnings, Cautions, and Notes. Warnings, Cautions, and Notes are used to emphasize important and critical instructions and are used for the following conditions.

WARNING

An operating procedure, practice, condition or statement, which if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure, practice, condition or statement, which if not strictly observed, could result in damage to or destruction of equipment, loss of mission effectiveness or long term health hazards to personnel.

NOTE

An operating procedure, condition or statement, which it is essential to highlight.

3.2.3.3 Description. This paragraph(s) shall be a summary of the aircraft's description and primary mission, omitting any commercialism or extraneous mission capabilities statements. The following statement shall be included:

"This manual contains the best operating instructions and procedures for the (insert aircraft designation) under most circumstances. The observance of limitations, performance and weight balance data provided is mandatory. The observance of procedure is mandatory except when modification is required because of multiple emergencies, adverse weather, terrain, etc. Basic flight principles are not included. THIS MANUAL SHALL BE CARRIED IN THE AIRCRAFT DURING ALL FLIGHTS."

3.2.3.4 Introductory material. Additional special information of an introductory nature may be included with the approval of the contracting activity (6.2.) The following statements shall be included in Chapter 1:

3.2.3.4.1 "Appendix A, references. Appendix A is a listing of official publications cited within the manual applicable to and available for flight crews.

NOTE

The appendix shall contain only those publications referenced in the manual, and shall not contain Department of the Army blank forms."

3.2.3.4.2 "Appendix B, abbreviations and terms. Definitions of all abbreviations and terms used throughout the manual are included in appendix B."

3.2.3.4.3 "Index. The index lists, in alphabetical order, every titled paragraph, figure, and table contained in this manual. The index is keyed to provide the paragraph, figure, or table number as well as the page number."

3.2.3.4.4 "Army aviation safety program. Reports necessary to comply with the safety program are prescribed in AR 385-40."

3.2.3.4.5 "Destruction of Army material to prevent enemy use. For information concerning destruction of Army material to prevent enemy use, refer to TM 750-244-1-5."

3.2.3.4.6 "Forms and Records. Army aviator's flight record and aircraft maintenance records which are used by the operators and crewmembers are prescribed in DA PAM 738-751 and TM 55-1500-342-23."

3.2.3.4.7 "Explanation of change symbols. Changes to the text and tables, including new material on added pages shall be indicated by a vertical bar in the outer margin extending close to the entire area of the material affected. Pages with emergency markings, which consist of black diagonal lines around three edges, shall have the vertical bar or change symbol placed along the outer margins between the text and the diagonal lines. Change symbols show current changes only. A miniature pointing hand symbol is used to denote a change to an illustration. However, a vertical line in the outer margin, rather than miniature pointing hands, is utilized when there have been extensive changes made to an illustration. Change symbols are not used to indicate changes in the following.

a. Introductory material.

b. Indexes and tabular data where the change cannot be identified.

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

3.2.3.5 Series and effectivity codes. Designator symbols such as **C** shall be used in conjunction with text contents, text headings and illustrations titles to show limited effectivity of the material. If applicable, one or more symbols may follow a text heading or illustration title to indicate proper effectivity, unless the material applies to all series and configurations within the manual. If the material applies to all series and configurations, no designator symbols will be used. Where practicable, descriptive information shall be condensed and combined for all series to avoid duplication. A table showing effectivity codes and designation symbols shall be included.

3.2.3.6 Use of words shall, should, and may. The final paragraph in Chapter 1 shall be as follows:

USE OF WORDS SHALL, SHOULD, AND MAY.

Within this technical manual, the word "shall" is used to indicate a mandatory requirement. The word "should" is used to indicate a non-mandatory but preferred method of accomplishment. The word "may" is used to indicate an acceptable method of accomplishment.

3.2.4 Chapter 2 — Aircraft and systems description and operation. This chapter shall describe the airframe and all aircraft systems and controls. Each system shall be described under its own heading. The nomenclature of the system shall be used as the primary paragraph heading and the name of each control or indicator as the subordinate paragraph heading. The description of each control and item of equipment shall be brief, concise and include an index number and figure reference, as appropriate. Include flight crew oriented malfunction isolation charts as required and only as approved by the contracting activity (6.2.) (figure 6). Maintenance type fault isolation charts shall not be used.

3.2.4.1 Controls. Each control contributing to the operation of a system shall be described and its location given. The function of the control and the end result produced when the control is moved to each of its possible positions shall be included in the description. Any effect which this control may have on other systems, or which they may have on the control shall be stated. If movement of the control requires any special action because of locks, gates, etc, it shall be so stated. Insofar as practical, a separate paragraph and illustration shall be devoted to each control and the name of that control shall be the paragraph heading. It is preferable to divide the control description into two portions—normal controls and emergency controls, if emergency capabilities exist. However, these titles shall not be used as headings.

3.2.4.2 Indicators. All indicators, instruments, and warning devices which are a part of the aircraft system shall be described and illustrated. This shall include location, function, power source, and interpretation of the indications.

3.2.4.3 Section I — Aircraft. This section shall provide a complete and concise description of the aircraft. The following subjects and illustrations shall be covered. Additional data may be presented as required to provide a complete description.

3.2.4.3.1 General. This paragraph(s) shall contain a description of the airframe. Major assemblies such as fuselage, wings, and tailboom shall be described. Each compartment of the aircraft such as cockpits and cabins shall be described and illustrated as required.

3.2.4.3.2 Illustrations and tables. The following illustrations and tables shall be included in Section I to the extent required to fully describe the aircraft general arrangement, turning radius, main differences, etc.

a. General arrangement. The aircraft general arrangement shall depict all access openings which will be checked during preflight of the aircraft (figure 2). General arrangement shall be placed as near to the beginning of Section I as practicable. These diagrams shall show antenna locations but shall not include individual controls or aircraft systems. Diagrams which are needed for clarity shall be used, e.g., right side, left side, top and bottom views of the aircraft. Other information which must be included may either be in this diagram or in one or more separate illustrations as indicated in paragraphs 3.1.5. Two or more of these illustrations such as crew movement and compartment diagram may be combined into one.

b. Turning radius, ground clearance, dimensions and danger area (figure 7 & 8). Diagrams illustrating minimum turning radius, based on maximum design gross weight, for the wings, gear, propellers, rotors, etc., shall be included as necessary. Minimum turn shall be based on turn permitted on one wheel (tire hub) with and without power steering assist. Minimum ground clearance shall also be included. The turning radius for skid equipped aircraft will be based on turning the aircraft on an identifiable reference point on the aircraft or an identifiable reference point on the ground. An illustration shall be included showing danger areas around the aircraft for all modes of operations on or near the ground. Areas to be avoided to prevent damage to equipment or injury to personnel shall be depicted or described. These figures shall be provided for idle and maximum power. Danger areas shall also be shown for turbine disintegration area. For rotary wing aircraft illustrations shall be based on hover power required at maximum gross weight. Danger areas of main rotors, tail rotors, or propellers shall be depicted.

c. Main differences table (figure 9). A brief table indicating the most significant differences in design and operation between each aircraft series included in the manual shall be provided when specified by contracting activity (6.2.). Special emphasis shall be placed on features which will affect recognition and operation of the various series.

d. Compartments (figure 10). Each compartment (i.e., cockpit, cabin) that can carry payload or that can be entered by personnel shall be illustrated and identified.

3.2.4.3.3 Landing gear system. Such information as the means of preventing accidental retraction of the gear, position of landing gear doors when the gear is extended, and extension and retraction times shall be included.

a. Steering systems. The steering system, including any special or unusual features, shall be described.

b. Brake system. The brake system, and for seaplanes, the special water drag systems, including all emergency provisions, shall be described.

3.2.4.3.4 Instruments, panels and consoles. All instruments, panels and consoles shall be illustrated. Minor variations in number or type of controls and instruments shall be indicated by detailed views to the illustration and by notations in the key. The panels or console may be shown more than once when major changes in configuration are involved. When specified by the contracting activity, several configurations may be covered by one illustration labeled "typical".

3.2.4.3.5 Canopies. When specified by the contracting activity, several configurations may be covered by one illustration labeled typical. All normal and emergency canopy controls, both external and internal shall be described and illustrated (6.2.).

3.2.4.3.6 Doors. All doors to include ramps, hatches, etc., their controls (normal and emergency), and their source of power, shall be described.

3.2.4.3.7 Seats. Pilots, copilots, and other flight compartment seat controls shall be described and illustrated. Emergency and ejection seat controls inertia reel, harness, and seat belts shall be described and illustrated in detail, emphasizing how they are affected by other systems such as the canopy.

3.2.4.4 Section II — Emergency equipment. All emergency equipment except that which forms part of a complete system shall be included. Emergency landing gear controls shall be treated under landing gear system, emergency fuel pumps under fuel system, etc. Emergency equipment to be described in this section shall include hand fire extinguishers, engine fire extinguishers, emergency alarms, pyrotechnic equipment, axes, emergency hatches, signal lamps, ditching jackets, first aid kits, survival kits, etc.

a. Emergency procedures. Emergency procedures shall be contained only in Chapter 9.

b. Illustrations. Illustrations showing locations of emergency equipment or systems shall be shown only in Chapter 9.

c. Reference. Reference shall be made to Chapter 9 for emergency procedures and location diagram, as appropriate.

3.2.4.5 Section III — Engines and related systems. A description of the engines and all its related controls as outlined in the following paragraphs shall be included.

3.2.4.5.1 Engines. The paragraph(s) shall cover the more important characteristics and special features of the engine(s). Model designation shall be included for all engines used in the subject aircraft. The following systems shall be discussed:

a. Engine cooling. All engine cooling equipment and controls such as cowl flaps and engine cooling fans shall be described.

b. Engine/engine inlet anti-icing/deicing system. The anti-icing/deicing system controls shall be described and illustrated.

c. Engine fuel control system. This system applies to jet and turbine powered aircraft and extends from the engine fuel control unit through the burner ring or combustor section. This system must not be confused with the fuel supply system which extends from the fuel tanks to the engine fuel control unit. Where applicable, special emphasis shall be placed on the emergency fuel control systems. Any special or unusual characteristics of the system shall also be given, but they shall not contain theory of operation. It is important, for example, that the pilot know that the engine fuel control system will automatically restrict operation at certain altitudes. Coverage of the throttle/power lever shall be included, and all systems effected by throttle/power lever operation shall be mentioned.

d. Oil supply system. Data on all controls affecting the oil system, such as oil coolers shall be included.

e. Ignition. The ignition system controls shall be described.

f. Starter. Starter controls shall be described.

g. Infrared suppressors. The infrared suppressor system shall be described.

h. Engine instruments and indicators. The tachometer, manifold pressure gage, torquemeter, engine analyzer, engine oil pressure, engine oil temperature, engine fuel pressure, fuel flowmeter, and all other engine condition or operating instruments shall be described. For the purpose of the operator's manual, the fuel and oil supply systems are considered to end at the point where they deliver the fluid to the carburetor, fuel control unit, or the engine-driven oil pump.

3.2.4.6 Section IV — Fuel System. This section shall describe the aircraft fuel system as follows:

3.2.4.6.1 Fuel supply system. It shall be stated that fuel grades and specifications are included in Section XV, Servicing. Coverage of drop tank release controls shall be included.

3.2.4.6.2 Controls and indicators. Fuel system controls and indicators shall be described.

3.2.4.6.3 Fuel system management. The fuel system management shall be described, including auxiliary fuel, booster pump use, fuel transfer procedure, tank selection procedures, and courses of fuel flow. All possible courses of fuel flow, such as inoperative engines and failed boost pump, shall be included. Sequence in which fuel tanks must be used shall be stated with reasons therefor (strength or balance). As applicable, reference shall be made to the pertinent portion of Chapter 6 when weight distribution becomes a problem. The required sequence of use of tanks to maintain a favorable center of gravity shall be described in detail. Remarks regarding control of the aircraft in the event of failure of the transfer system and resultant unbalanced conditions because of improper fuel distribution shall also be included.

3.2.4.6.4 Illustrations. Diagrams of the typical courses of fuel flow, including fuel system control positions for takeoff, cruising, landing, and emergency operation shall be included if required to describe fuel management, when specified by the contracting activity (6.2.).

3.2.4.7 Section V — Flight control system. Section V shall cover in detail the flight control system as follows:

3.2.4.7.1 Description. These paragraphs shall describe the flight control system and its location. The system shall be described in its entirety under its own heading. The nomenclature of the system shall be used as the primary paragraph heading and the name of each control or indicator as the subordinate heading.

3.2.4.7.2 Flight control system. Coverage of flight controls, indicators, trim tabs, force trim, control locks, etc., shall be discussed as stated in 3.2.4.1 and 3.2.4.2. In addition, all other controls located on the control sticks, wheels, yokes, pedals, cyclic and collective, shall be mentioned.

3.2.4.7.3 Automatic flight control system. Detailed coverage of automatic stabilization equipment, stability augmentation control system and auto pilot shall be provided. All modes of operations shall be described. If any additional systems are required to operate in conjunction with the stabilization equipment, a statement shall be included to that effect. Applicable precautionary data shall be included or conditions of partial or temporary electrical power failure, manual override, etc. A reference shall be made to navigation equipment description and operation contained in Chapter 3, Section II (as applicable).

3.2.4.7.4 Illustrations. Illustrations shall be provided for each control column or control stick. Details shall be shown for switches and control buttons, friction devices, locks, etc. Variations in controls between aircraft series or serial numbers, or both, shall also be shown.

3.2.4.8 Section VI — Hydraulic and pneumatic systems. The hydraulic and pneumatic systems section shall provide a description of all systems. The following items shall be covered:

a. Test switches.

b. Indicators and gages.

c. Caution/warning lights.

d. Controls.

3.2.4.9 Section VII — Power train system. The power train system shall be described to include the transmission and gearbox systems, drive shafting, system controls, and indicators.

3.2.4.10 Section VII — Rotors or propellers. Section title shall be "Rotors" or "Propellers" as applicable. Describe the propellers or rotors and their functions. Include a description of operation.

3.2.4.11 Section IX — Utility systems. This section shall describe pressurization systems; the rain removal, anti-icing, deicing, and defrosting systems; the oxygen system; and miscellaneous equipment. These paragraphs shall be further broken down to cover such major units as the anti-icing and deicing systems, and the pressurization system when the nature of the equipment so dictates. Coverage here shall be brief and shall concern itself largely with location of the equipment and its controls, source of power, illustration of the controls (if not illustrated previously), and a brief discussion of function and operation. Equipment which is peculiar to the specific aircraft, such as special switches for control of peculiar installation, shall be covered in detail. Arrangement and order of systems shall be as follows:

3.2.4.11.1 Defrosting/defogging system. Controls and operation on the source of defrosting/defogging air and means of supplying it to the various sections of the aircraft shall be given. Any effect that the defrosting/defogging system has on other systems, or effect that other systems have on the defrosting/defogging system shall be clearly stated. Information shall be included on all sources of defrosting/defogging air and means of controlling that air.

3.2.4.11.2 Anti-icing/deicing system. Controls and operations on the source of anti-icing/deicing and means of supplying it to the various sections of the aircraft shall be given. Any effect that the anti-icing/deicing system has on other systems, or effect that other systems have on the anti-icing/deicing system shall be clearly stated. Information shall be included on all sources of anti-icing/deicing and means of controlling. Anti-icing and deicing system limitations shall be contained in Chapter 5.

3.2.4.11.3 Pressurization system. Source of pressurized air and method of controlling it shall be included. Allowable pressure differentials shall be stated for all expected flight altitudes. Any effect that the pressurization system has on another system, or effect of other systems on the pressurization system, shall be described.

3.2.4.11.4 Oxygen system. For the crew oxygen system, an oxygen duration chart shall be included showing hours of oxygen available for various combinations of oxygen pressure versus altitude. Duration shall be shown for normal and for 100% use of oxygen. One chart shall be included for each independent system in the aircraft. For the passenger oxygen system, and oxygen duration chart shall be included showing manhours of oxygen available for various combinations of oxygen pressure versus altitude. The location of each portable oxygen bottle and all recharger points in the aircraft shall be stated. The type of regulator shall be specified. The type of mask shall be specified when unique to the aircraft.

a. Illustration. An oxygen system block diagram shall be included only in those instances in which such a diagram will clarify the operation of the system. The diagram is not required for a simple system.

b. Oxygen duration charts. Oxygen duration charts or tables shall be included in accordance with requirements set forth in this paragraph (figure 11).

3.2.4.11.5 Miscellaneous equipment. Information shall be included on all nonemergency equipment which is not part of a system. A description and normal and emergency operation procedures shall be included for all equipment not otherwise covered. Equipment covered in this paragraph shall include seats (other than pilot, copilot, and flight engineer), hatches, heated blanket provisions, data case, beaching gear, night flying curtains, ladders, relief equipment, food warmers, water containers, tool kits, etc. Items covered as aircraft loading equipment in Chapter 6 shall not be covered here. Items dealing with aircraft servicing, and ground handling shall be contained in Section XV.

3.2.4.12 Section X — Heating, ventilation, cooling, and environmental control systems. This section shall describe the heating, ventilation, cooling, and environmental control systems. Each system shall be broken down into paragraphs titled "description", "normal operation", and "emergency operation". Coverage here shall be brief and shall concern itself largely with location of the equipment and its controls, source of power, illustration of the controls, and a brief discussion of function. The equipment which is peculiar to the specific aircraft, such as special switches for control of the installation, shall be covered in detail.

3.2.4.13 Section XI — Electrical power supply and distribution systems. The electrical power supply and distribution systems and controls shall each be described and illustrated under its own heading (figure 12). Where pertinent, reference shall be made to auxiliary power systems that are described elsewhere. The external power source and the relation of auxiliary power plant to electrical system shall be described. General arrangement and order of the primary system shall be covered first with the secondary system to follow.

3.2.4.13.1 DC power supply system.

a. Battery.

b. Starter-generators, generators, alternators and converters.

c. Indicators, gages, and controls.

d. Circuit breaker and junction boxes.

e. Auxiliary power.

f. Ground power.

3.2.4.13.2 AC power supply system.

a. Inverters and alternators.

b. Indicators, gages and controls.

c. AC circuit breaker and junction box diagram.

d. Auxiliary power.

e. Ground power.

3.2.4.13.3 Circuit breaker diagrams. The location of each circuit breaker panel shall be shown, and on standardized installation, each circuit breaker in the panels shall be identified. The illustration shall depict a typical installation of both systems (AC/DC) which may be combined on one illustration. In those instances where a standardized circuit breaker location does not exist, the location of circuit breakers or fuses shall be given. This diagram shall be located near the description of the electrical system.

3.2.4.14 Section XII — Auxiliary power unit. This section shall include a description of the auxiliary power unit covering all controls, its operations, and its relation to other systems. Starting, stopping, and inflight operating procedure checks shall be contained in Chapter 8, and emergency procedures in Chapter 9.

3.2.4.15 Section XIII — Lighting. Information shall be included on all lighting equipment such as formation, landing, fuselage, cabin, instruments, wheel well, taxi, navigation, and anti-collision. Coverage shall be brief and concern itself largely with locations, controls, source of power, and a brief discussion of function. Illustration may be used if equipment is not illustrated in Chapter 2 or elsewhere.

3.2.4.16 Section XIV — Flight instruments. All flight instruments, indicators, gages, and miscellaneous instruments and systems shall be described in this section. Such special problems as erroneous readings of the airspeed indicating system resulting from installation error or hovering shall be included with references to correction charts if applicable. Complex systems shall be included under a separate primary head, stating whether the instruments under discussion are vacuum or electri-

cally operated. The complete vacuum system shall be described here if it is used solely in conjunction with the instruments under discussion; otherwise, it shall be described under engines and related systems.

3.2.4.16.1 General. The following is a condensed listing of flight instruments, and miscellaneous instruments and systems which shall be included as applicable.

a. Airspeed, turn and slip, vertical velocity, and attitude indicators.

b. Pressure altimeter and free air temperature indicators.

c. Standby compass.

d. Indicators for radio aids to navigation to include radar altimeter, flight direction systems, etc.

e. Miscellaneous instruments and systems shall include such items as:

(1) Master caution systems.

(2) RPM high-low warning systems.

(3) Trainer instrument panel.

(4) Clocks.

3.2.4.16.2 Illustrations. Line drawings shall be provided for all instruments. Each indicator, gage, and control shall be shown (figure 13). Each item shall be indexed or placarded, and references shall be entered in the text as appropriate. The names of the instruments may be placed in the instrument or indicator outline. This is preferred to index numbers. Items shall have index numbers when placards are not legible.

3.2.4.17 Section XV — Servicing, parking, and mooring. Servicing shall contain flight crew oriented instructions for normal and closed circuit refueling and for replenishment of fuel, oil, hydraulic fluid, other fluids, tire pressures, and all other such items involved in servicing the aircraft, that a crew could be expected to perform away from military maintenance support. Reference shall be made to the servicing diagram, and to the table of fuel, lubricants, specifications, and capacities for identification of fuel, oil, and other materials used. The precautions to observe in servicing a particular tank or reservoir, such as grounding and prevention of fire hazards, shall be stated clearly and instructions included regarding access to any out-of-the-way or unusual places requiring service. Servicing instructions shall be supplemented with a diagram showing locations of regular and alternate servicing points. NO STEP areas on walkways leading to tanks shall be indicated, with necessary precautions. Reference shall be made to graphs or date in other parts of the text pertinent to servicing, such as tire pressure versus gross takeoff weight, and capacities of tanks.

3.2.4.17.1 Servicing diagram. Each servicing point (tanks, reservoirs, filler caps, receptacles, oxygen bottles, accumulators, etc.) shall be shown as viewed (figure 14). For example, fuel drains on the bottom of the aircraft shall be shown from a below-the-aircraft viewpoint. Illustrations of sight gages and other indicators shall clearly depict proper servicing levels.

3.2.4.17.2 Servicing table. The servicing table shall be in tabular form as shown in figure 15. Each item of equipment (engine, transmission, gearboxes, reservoirs (hydraulic, anti-icing), auxiliary power unit, oxygen systems, tire pressure, etc.) shall be listed under "System". Under "Specification", the military specification for the fuel, oil, fluid, or lubricant shall be listed. Included within this column shall be a reference to any notes on temperature ranges, mixing of oil, etc. Fuel capacities shall be given to include total, servicing capacity, and usable capacity in U.S. measurements, to the nearest tenth of a gallon, and metric equivalents.

3.2.4.17.3 Fuel System Servicing Instructions.

a. Approved fuels. A tabular listing of primary, alternate, and emergency fuels, to include NATO and commercial brand names authorized for use in the aircraft for which this manual applies (figure 15). The fuels contained in this listing shall only be those authorized for use by TB 55-9150-200-24 and by the contracting activity (6.2.). This information shall not be repeated in the text.

b. Warnings/cautions. Warnings/cautions regarding additives to fuel shall be included as furnished by the contracting activity (6.2.).

c. Fuel types (figure 15).

(1) Primary fuels. The primary fuels used in the aircraft to which the manual applies shall be stated to include any restrictions in their use.

(2) Alternate fuels. Alternate fuels authorized for use in the aircraft to which the manual applies shall be stated to include any restrictions in their use. If an alternate fuel is not authorized, it shall be stated.

(3) Emergency fuels. Emergency fuels authorized for use in the aircraft to which the manual applies shall be stated to include any restrictions and limitations in their use. If an emergency fuel is not authorized, it shall be stated.

d. Additional servicing instructions. Instructions shall include a tabular listing of acceptable commercial engine oils as indicated in TB 55-9150-200-24 and as authorized for use in the aircraft (figure 15).

3.2.4.17.4 Ground handling. Ground handling shall be presented in concise form, giving all instructions and necessary precautions for ground handling transient aircraft, including any information needed in extreme cold, heat, humidity, and dust; and description and instructions for operating any ground handling equipment involved. Left and right turning limits while towing (with or without external stores) shall be stated. Aircraft ground handling procedures relating to electronics equipment shall be stated when applicable (figure 14).

3.2.4.17.5 Parking and mooring. Instructions for parking and mooring and the installation and stowage of aircraft covers, control locks, chocks, and tiedown devices shall be described and referenced on an illustration. Ground handling, parking, mooring, covers, locks, tiedown ropes, and devices may be shown on a single page illustration.

3.2.5 Chapter 3 — Avionics. Except for mission avionics, this chapter shall describe the avionics equipment configuration including all its systems and controls, and shall provide the proper techniques and procedures to be employed when operating the equipment.

3.2.5.1 Requirements. The following general procedures shall be observed during preparation of chapter contents.

a. Nomenclature and short names. Nomenclature and short names shall be in accordance with 3.1.3.

b. Illustrations. Illustrations shall be prepared in accordance with 3.1.5.

3.2.5.2 Section requirements. For each item of avionics equipment contained within Section II, III, IV, and any additional sections approved by the contracting activity (6.2.), the following sequence shall be followed in providing textual data.

a. Description.

b. Controls and functions.

c. Operation.

d. Emergency operation (if applicable).

3.2.5.2.1 Description. As many paragraphs shall be used as necessary to describe controls, indicators, instruments (if applicable), jacks, switches, etc, used by the pilot, copilot, or crewmember in the operation of the avionics equipment.

3.2.5.2.2 Controls and functions.

a. Each control including built-in test capability contributing to the operation of the avionics equipment shall be described and its location established. A separate paragraph shall be used for each control panel. Reference shall be made to illustrations in Chapter 2, Description, regarding circuit breaker panels, etc.

b. A tabular listing shall be included with each control panel paragraph. The listing shall be divided into two columns, titled "Control and Function" or "Control/Indicator and Function", whichever is applicable. Each control or indicator shall be listed and its purpose defined. The purpose shall be defined in terms of what the operator of the control will see, hear, or do as a result of the control setting. Terms of simple, immediate, observable results shall be used. No attempt shall be made to give the operator the exact technical details about what happens when the control is used.

3.2.5.2.3 Operation. A series of paragraphs shall be used to describe the operation details for each item of avionics equipment. Whenever standard operational avionics data exists within the government, such data shall be furnished to the contractor by the contracting activity (6.2.). Whenever operational avionics data, standard or otherwise, does not exist, the contractor shall develop and furnish to the government such data (6.2.). Complete operating procedures shall be included as follows:

a. Modes of operation. When separate modes of operation are available (when the equipment may serve two or more systems), as designated by the contracting activity, each mode shall be described. For example, the operating procedures for a VHF omnirange receiver would include operation as a communication receiver, an omnirange receiver, and a localizer receiver. These shall be listed as modes of operation and each shall be briefly described.

b. Operation. Explain the sequence of setting and the position to which the controls should be set to ensure identical results each time the equipment is energized and to prevent the possibility of damage through improper settings or sequence of operation. When appropriate, call attention to operating tolerances. (For example, if the accuracy of an omnirange course selector is ± 2 degrees, it shall be so stated). When operation of a unit is common, related or dependent on the operation of a similar or independent control unit, this information shall be included in the operating procedure. Only those controls normally used by the operator shall be included. Control adjustments that are the responsibility of maintenance personnel shall not be included.

c. Dual operating controls. If the configuration provides for a parallel operation from various positions in the aircraft, similar, separate, and complete coverage for each position shall be provided. When the procedure is identical to a position previously covered, it may be covered by a reference to the procedure.

3.2.5.3 Section I — General. This section shall contain the following as applicable. Refer to 3.2.5.2 for sequence of information.

3.2.5.3.1 Description. This paragraph shall provide a brief description of the contents in this chapter and shall contain a statement similar to the following:

"This chapter covers the avionics equipment configuration installed in Army (insert assigned aircraft designation). It includes a brief description of the avionics equipments, its technical characteristics, capabilities, and locations. For mission avionics equipment, refer to Chapter 4, Mission Equipment."

3.2.5.3.2 Avionics equipment configuration. A brief and concise general description of the aircraft avionics configuration shall be provided.

3.2.5.3.3. Power source. A brief description of the power source for avionics equipment shall be provided, including any special procedures or limitations involved in the use of external power, battery power, etc.

3.2.5.4 Section II — Communications. This section shall contain all information for communications equipment installed in the aircraft. Refer to 3.2.6.2 for sequence of information.

3.2.5.5 Section III — Navigation. This section shall cover all navigation systems and indicators, as applicable. When there is doubt as to whether the system should be covered under communications or navigation, the primary use of the system shall be the deciding factor, and a suitable reference shall be made in the text to aid the operator in locating the material. The following systems and indicators, as applicable shall be described. Refer to 3.2.5.2 for sequence of information.

a. Automatic direction finder (ADF).

b. Gyro compass and magnetic indicators.

c. Marker beacon.

d. Flight director.

e. (VHF) OMNI directional range.

f. TACAN.

g. Instrument landing system.

h. Doppler.

i. Inertial navigation system (INS).

j. Autopilot.

k. Other.

3.2.5.6 Section IV — Transponder and radar. This section shall cover all transponders, collision warning systems, and radar systems and indicators, as applicable.

3.2.6 Chapter 4 — Mission equipment. This chapter shall describe all standard mission equipment that may be utilized with the aircraft. Coverage shall include power supply, description, controls and function, operating procedures, and illustrations. Controls, functions and operating procedures shall be in the same format as Chapter 3.

3.2.6.1 Section I — Mission avionics. This section shall contain unclassified information regarding mission avionics equipment that is not a part of the standard flight communication, navigation, transponder, and radar equipment. It contains electronic equipment such as radio monitoring systems, side looking airborne radar (SLAR), infrared devices, and photographic equipment. Detailed information shall be given regarding the photographic equipment, covering types of cameras, control stations, camera doors, capabilities of the equipment, etc. Gun camera equipment shall also be covered. Mission avionics equipment that requires extensive explanation of operating procedures may be covered in this section or in an appendix. Use of an appendix for mission avionics equipment will be authorized only by the contracting activity (6.2.). Classified information on mission avionics equipment shall be covered in a separate classified supplement to the manual.

3.2.6.2 Section II — Armament. This section shall indicate interrelation of all armament equipment when installed. Coverage shall be included on all authorized gunnery, rocket, tow target, control, and computer equipment. Armor protection shall be covered under the individual item which the protection is installed for seat protection armor shall be covered under seat, engine protection under engine, etc. When the extent of data so dictates, armament requirements may be covered as separate sections. Subsequent sections will be renumbered.

3.2.6.2.1 Armament control system. This shall contain the operating instructions for the armament control system. Such information as presentation on the scope or sight, as applicable, shall be included. Warmup time, preflight, inflight, before landing, and after landing checks shall follow the armament system description. Checklist format and style shall be in accordance with 3.2.10.2.5

3.2.6.2.2 Gunnery equipment. Information shall be included on all guns and turrets, including quantity of ammunition which can be carried for each gun. For remote controlled turrets, station from which turret is operated, method of gaining control of the turret, method of transferring control, etc., shall be specified. All gunnery controls shall be covered, including gun sight, and gun heater. Coverage shall be included regarding provisions which are made and precautions which shall be observed to preclude damaging the aircraft through its own gunfire.

3.2.6.2.3 Rocket equipment. Information shall be included regarding the types and number of rockets that can be carried. Typical combinations of rockets and firing order shall be covered.

3.2.6.2.4 Missiles. Coverage shall be included for missile-carrying capability including number, type, etc.

3.2.6.3 Section III — Cargo handling. A section shall be included covering cargo handling systems and equipment to include hoist, winches, and cargo hooks.

3.2.6.4 Section IV — Passive Defense. Coverage shall be included for passive defense equipment.

3.2.6.5 Additional sections. Additional sections may be used as required to describe systems not covered in other sections.

3.2.7 Chapter 5 — Operating limits and restrictions. This chapter shall include all important operating limits and restrictions that shall be observed during ground and flight operations. Special emphasis shall be placed on any unusual restrictions which are particularly characteristic of the aircraft. Only the limits and restrictions that actually limit operation need to be included. For example, if the design of the aircraft precludes overloading, a loading limitation discussion is unnecessary. All time limited operations shall be expressed with a time limit and the upper and lower boundaries.

3.2.7.1 Section I — General. This section shall contain general information on aircraft limits and restrictions, including decals and placards. The following statements shall be included.

3.2.7.1.1 "Purpose. This chapter identifies or refers to all important operating limits and restrictions that shall be observed during ground and flight operations."

3.2.7.1.2 "General. The operating limitations set forth in this chapter are the direct results of design analysis, tests, and operating experiences. Compliance with these limits will allow the pilot to safely perform the assigned missions and to derive maximum utility from the aircraft."

3.2.7.1.3 "Exceeding operational limits. Any time an operational limit is exceeded, an appropriate entry shall be made on DA Form 2408-13. Entry shall state what limit or limits were exceeded, range, time beyond limits, and any additional data that would aid maintenance personnel in the maintenance action that may be required."

3.2.7.1.4 Minimum crew requirements. The minimum crew required for flight shall be listed. The following statement shall be included:

"The minimum crew required for flight is (fill in as appropriate). Additional crewmembers as required will be added at the discretion of the commander, in accordance with pertinent Department of the Army regulations."

3.2.7.2 Section II — System Limits. This section shall contain all aircraft system limits that may restrict operation.

3.2.7.2.1 Instrument operating ranges and markings. Each instrument that indicates an operating limit shall be illustrated and accurately reflect the actual markings on the instrument (figure 16). Illustrations that depict instrument markings other than those that show operating limits shall be included, if specified by the contracting activity (6.2). The information appearing on the instrument marking illustration shall not be repeated in the text or table. If the instrument marking limits can not be adequately explained in the space provided for the captions, explanations shall be included under the appropriate paragraph heading in this section. The paragraph shall state all limit ranges, including gaps that may be shown in range markings. Appropriate statements similar to the following shall be used at the beginning of the section:

a. Instrument marking color codes. Operating limitations and ranges are illustrated by the colored markings which appear on the instruments. RED markings indicate the limit above or below which continued operation is likely to cause damage or shorten life. The GREEN markings indicate the safe or normal range of operation. The YELLOW markings indicate the range when special attention should be given to the operation covered by the instrument.

b. Instruments glass alignment marks. When instrument markings appear on the glass, a short vertical white mark extending from the bottom part of the dial glass onto the fixed base of the indicator is provided for the purpose of verifying alignment.

3.2.7.2.2 Propeller limitations. Propeller limitations shall be discussed, covering such points as reverse pitch, restricted rpms, etc.

3.2.7.2.3 Rotor limitations. For rotary wing aircraft, rotor limitations during both flight and ground operation shall be discussed, covering such points as restricted rpms, autorational rpms, limitations for startup and shutdown during high winds, and wind gust spread, etc.

3.2.7.2.4 Additional limitations. All system limits and restrictions not described by the instrument markings shall be included. Limits and restrictions that should be observed when operating utility, heating, ventilation, cooling or rain removal systems shall also be included.

3.2.7.3 Section III — Power limits. Power limits shall include such points as engine and drive train, and idle limitations. This shall include limitations that must be observed when alternate fuel grade is used. Acceleration limits and restrictions which apply to the engine shall be covered. Limits shall be expressed in terms of observable indications which are available to the flight crew e.g., 360° C TOT for 10 sec. 46 lbs. 10 PSI, etc. Terms such as military power, takeoff power etc., should not be used.

3.2.7.4 Section IV — Loading limits. All loading limits pertaining to the aircraft shall be contained in this section.

3.2.7.4.1 Center of gravity limitations. The following statement shall be included:

"Center of gravity limits for the aircraft to which this manual applies and appropriate charts for computation of the center of gravity are contained in Chapter 6."

3.2.7.4.2 Weight limitations. All minimum/maximum aircraft weight limitation to include: parking, towing, taxiing, takeoff and landing from prepared/unprepared fields, shall be provided. For aircraft in which weight distribution is a problem, (such as minimum fuel to be carried in the wings at various gross weights), coverage of the limitations involved shall be included. Reference shall be made to fuel management in Chapter 2, as necessary.

3.2.7.4.3 Turbulence. Restrictions regarding severity level of turbulence for which the aircraft is qualified will be discussed. Limitations shall be stated.

3.2.7.4.4. Other limitations. Any other types of limitations that affect operation shall be covered, such as:

a. Additional restrictions to be observed when carrying stores. For aircraft equipped to carry a variety of external stores, information concerning the stores to be carried at each station and the maximum lateral unbalanced load that can be carried shall be included.

b. Limitations as to the weight for external sling loads on rotary wing aircraft and speed restrictions, if any.

c. Floor loading limits which are to be observed when carrying internal cargo shall be covered.

d. Jettisoning limits. Restrictions to jettisoning external stores and sling loads shall be discussed.

3.2.7.5 Section V — Airspeed limits maximum and minimum. Airspeed limitations shall be discussed, including such points as level flight airspeed, diving airspeed, airspeed for various degrees of flap extension, airspeed for various stabilator positions, airspeed for door opening, and airspeeds under various conditions of weight and configuration. For rotary wing aircraft, sideward and rearward airspeed limits and restrictions shall be discussed. Airspeeds shall be expressed as indicated airspeed (KIAS), unless otherwise approved by contracting activity (6.2.).

3.2.7.5.1 Airspeed operating limits chart. This chart shall present operating limits for forward flight at various gross weights, pressure altitudes, free air temperatures, rotor speeds, speed trim, etc., as applicable (figure 17).

3.2.7.6 Section VI — Maneuvering limits. Coverage for maneuvering flight limitations to include aerobatic flight, if applicable, shall be included. Acceleration limitations shall be covered, including such points as maximum acceleration with tip tanks, and maximum bank angle at high gross weight. Coverage of the maximum permissible accelerations under various flight conditions at specific gross weights and fuel weight shall be included. For aircraft not equipped with G meters, G forces will be expressed in terms that are recognizable by the pilot such as, airspeed and bank angle. Restrictions on control movements shall be covered. Permissible bank angles and side slip shall be included. Prohibited maneuvers shall be listed as appropriate.

3.2.7.6.1 Flight envelope chart. For aircraft with G meters, plots of load factor versus speed for the full range of gross weight shall be shown. The speeds at which maneuvers are restricted and unrestricted as related to the load limit factors shall be presented (figure 18). When changes in configuration result in variations in airspeed position error, separate airspeed scales shall be presented. Where direct reading Mach meters are provided, charts for both IAS and IMN shall be provided.

3.2.7.7 Section VII — Environmental restrictions. This section shall cover altitude, temperature, rain, snow, icing, hail, and oxygen limits, as applicable. Maximum wind velocity and gust spread, maximum wind velocity for crosswind operation, wind from the critical azimuth and normal operation shall be included, as applicable. Operation under wind azimuth direction and wind velocity conditions which should be avoided shall be discussed. Where appropriate, charts will be used to depict the preceding conditions.

3.2.7.7.1 Flight under IMC (instrument meteorological conditions). The following statements shall be included verbatim as applicable:

a. "This aircraft is qualified for operation in instrument meteorological conditions."

b. "This aircraft is restricted to visual flight conditions."

3.2.7.8 Additional sections. Additional sections may be used to allow for added limits or restrictions to fit specific aircraft upon prior approval of the contracting activity (6.2.).

3.2.8 Chapter 6 — Weight/balance and loading. Weight/balance and loading data shall be provided as follows:

3.2.8.1 Section I — General. This section shall state that Chapter 6 contains sufficient instructions and data so that an aviator knowing the basic weight and moment of the aircraft can compute any combination of weight and balance. When weight and balance computers/calculators are provided for the aircraft, instructions and examples of their use shall be based on gear down with supplementary data for gear up conditions (when required).

3.2.8.1.1. Class. The following statement shall be included verbatim:

"Army (insert assigned aircraft designation) are in class (insert class). Additional directives governing weight and balance of class (insert class) aircraft forms and records, are contained in AR 95-3."

3.2.8.1.2 Aircraft compartment and station diagram. This paragraph(s) and diagram shall provide a general description of the aircraft compartments, and shall show the reference datum line and stations in inches. The primary purpose of this diagram is to aid personnel in the computation of aircraft weight/balance and loading (figure 19).

3.2.8.2 Section II — Weight and balance. This section shall contain information necessary for the computation of weight and balance for loading and individual aircraft. Instructions for completion of weight and balance forms (DD Form 365 series) shall not be provided; however, TM 55-1500-342-23 which provides these instructions may be referenced. Sufficient information shall be provided in this section to permit the flight crew to readily use the data presented in the other sections of this chapter to determine loading arrangements, fuel burn or transfer sequences, ordinance off load sequences, and other weight and balance procedures to assure the aircraft remains within weight and balance limits for the entire flight.

3.2.8.3 Section III — Fuel/oil. Fuel quantity data shall be in chart form (figure 20). The names of the tanks shall be identical to the name appearing on the tank selector (a more explanatory title may be carried in parentheses if desired). Any group of tanks or cells which are interconnected to fill and drain shall be treated as a single tank. The chart shall include data on each tank (including droppable and ferry) that is designed for use with the aircraft. Tank volume shall be given in terms of usable fuel rather than total tank volume. Fuel quantities shall be given in gallons regardless of the type of instrumentation. All gallon figures shall be followed by the conversion to pounds. The grid lines within the chart shall be based on fuel weight in pounds. It shall be stated that the weights are based on a given specific gravity at standard day temperature.

3.2.8.3.1 Oil data. The following statement shall be included:

"For weight and balance purposes, oil is considered a part of aircraft basic weight."

When specified by the contracting activity (6.2.), a statement of usable oil capacity, equivalent in pounds, total moments, and fuselage station number, shall be included. Aircraft that have a large useful oil capacity shall have a tabular listing if oil loading computation is critical. Weight shall be based on specific gravity at standard day temperature.

3.2.8.4 Section IV — Personnel. This section shall contain all essential information and instructions for preparation, loading, and unloading of personnel, including airborne troops.

3.2.8.4.1 Personnel compartment and entrances. A general description of the personnel compartment and entrances, including profile and cross-section drawings showing all dimensions (in inches) and description of any critical dimensions which limit full use of the personnel compartment, shall be provided.

3.2.8.4.2 Personnel loading and unloading. Personnel loading and unloading shall include but not be limited to a checklist and description of steps necessary for loading and unloading troops as follows:

a. Troop seat installation.

b. A description and operation of safety belts and harnesses.

c. A check of comfort and emergency provisions.

d. Instructions for troop loading and unloading procedure.

3.2.8.4.3 Personnel weight. The following statement shall be included:

"When aircraft are operated at critical gross weights, the exact weight of each individual occupant plus equipment should be used. If weighing facilities are not available, or if the tactical situation dictates otherwise, loads shall be computed as follows:

a. Combat equipped soldiers: 240 pounds per individual.

b. Combat equipped paratroopers: 260 pounds per individual.

c. Litter and patients weight combined: 265 pounds.

d. Crew and passengers with no equipment: compute weight according to each individual's estimate."

3.2.8.4.4 Personnel moments. Personnel moments chart for all seats, litters, etc., shall be provided (figure 21).

3.2.8.5 Section V — Mission Equipment. Loading data charts for mission equipment shall provide a tabular listing containing the quantity, weight and moment of each load item up to the maximum quantity for which provisions are available. Only items of load (Chart E Items) shall be listed. Items which are part of basic weight (Chart C Items) shall not be part of this listing. Data shall be provided for all applicable mission system loadings including armament, avionics, sling, hoist, litters etc. Example: Armament systems with rockets. Listings shall provide weight and moment of required pylons and launchers. Tabular listing of rockets shall be inclusive to maximum capacity of launchers. Since rockets vary in weight by type, separate listings are required (figure 22).

3.2.8.6 Section VI — Cargo loading. This section shall contain the following in the order named, with text, as applicable. Only the information that is unique to the specific aircraft shall be included.

3.2.8.6.1 Description and illustrations. A general description of cargo compartment and entrances, including profile and cross-section drawings showing all dimensions (in inches) and description of any critical dimensions which limit full use of cargo compartment, shall be provided.

a. Dimensions. A plan view showing dimensions of cargo floor, designation, location, and strength of tie-down fittings, diagram and limitations on use of fittings, including the desirable cone of action when using fittings, shall be provided. Also, a plan view of cargo floor showing variations in floor strength and weight concentration limitations in various areas shall be included, as applicable.

b. Litter provisions. A suitable view of litter provisions showing location shall be included.

c. Aerial delivery system. A general description of, and operating instructions for, aerial delivery system shall be included, when applicable.

d. Loading/unloading aids. A list and description of all cargo loading aids, unloading aids, cargo securing equipment (ramps, hoists, winching provisions, tiedowns, etc.), and stowage provisions shall be presented.

3.2.8.6.2 Equipment loading and unloading. This shall include a checklist and procedures for loading and unloading vehicles and equipment as follows:

a. Assembly of equipment for loading; for example, vehicle tiedown devices, checks for wheels and springs, skid pans, and loading aids.

b. Preparation of cargo compartment and floor, including stowage of seats, etc., and installation of fittings.

c. When applicable, preparation of the aerial delivery system.

d. Operation of cargo doors, ramps, load assist devices, aircraft support jacks, etc., including installation and operation, as applicable. Instructions for checking of landing gear should be included when required.

e. Assembly and checking of unloading aids and releasing of cargo tiedown devices.

3.2.8.6.3 Preparation of general cargo. This shall include preloading information for use of loading crew personnel as follows:

a. A statement to the effect that loading personnel should assemble, prior to loading, data such as weight, dimensions, center of gravity location, and contact areas of the item of equipment for use in positioning the load.

b. A reference to the applicable weight and balance computation in Section II, and the balance computer if furnished, as the source of information for the computation of final load position of the aircraft.

3.2.8.6.4 General instructions for loading, securing, and unloading cargo. This section shall include general methods of loading, safe lashing, and unloading of cargo, vehicles, and equipment. Rigging of cargo for aerial delivery shall be included, when applicable. The instruction shall include information to acquaint service personnel with the factors involved in properly loading, securing loads, and unloading the aircraft.

3.2.8.6.5 Cargo center of gravity planning. A cargo moments chart (figure 23) shall be provided. In addition for those aircraft specifically designed to carry cargo, detail instructions for cargo center of gravity planning shall also be provided. These instructions shall include data for determining allowable cargo center of gravity which take into account expected variations in:

a. Aircraft Basic Weight

b. Aircraft Center of Gravity @ Basic Weight

c. Fuel loading

d. Cargo weight

e. Crew and other useful load items carried

3.2.8.6.6 Loading procedure. This shall include a checklist of the action required from the time the aircraft is prepared for loading until the aircraft is ready for flight. It shall also include instructions and notes on loading equipment into the aircraft, checking of items with CG markings of wheeled vehicles and items 10 feet or longer, and placing it in position, determining the amount of shoring required as applicable to loading flight conditions, and general instructions for loading and lashing miscellaneous cargo. Reference shall be made to the appropriate regulation regarding handling of dangerous equipment.

3.2.8.6.7 Securing loads. This shall include the following points in the order named.

a. Restraint criteria shall be approved in the aircraft system specification, including fore, aft, sideward and vertical factors.

b. Rules for application of tiedown devices required, including instructions for tying down the equipment or cargo, methods of attachment of tiedowns to vehicles, etc., including illustrations of typical procedure, as applicable.

c. Computation of the number of tiedown devices required, which shall include practical methods for determining the strength of the lashing when attached to the load. Where practicable, the instructions shall take into account that the load in a tiedown device shall be compatible with the strength of the fitting. The inclusion of typical problems and their solution will be of aid to loading personnel.

d. Check applied restraint which shall include instructions on checking and determining the restraint that will be applied by the tiedown device to a load that is acted upon by the forces encountered during flight and crash landing of magnitudes previously established by the restraint criteria.

3.2.8.6.8 Tiedown devices. This shall contain a description with illustrations, including operating instruction, of the tiedown devices being furnished in the aircraft.

3.2.8.6.9 Unloading procedure. This shall include a procedure for unloading the aircraft and stowing associated equipment.

3.2.8.7 Section VII — Center of gravity. This section shall cover all aircraft center of gravity limitations (longitudinal and lateral).

a. Number of charts. Where possible, the gross weight and CG limitations of the aircraft shall appear on a single chart; however, additional charts may be used if necessary to adequately portray the various configurations of the aircraft.

b. Explanatory text. Text shall complement the chart as required to include the criteria affecting aircraft loading; explain the components of the chart; illustrate the use of the charts; emphasize that charts are designed to illustrate degree of risk involved at various weights and CGs as well as to establish limitations.

c. Detailed chart requirements. The various criteria that affect gross weight shall be represented as indicated in the following paragraphs except that criteria which are well beyond the weight capabilities of the aircraft need not be shown. Each component of the chart shall be clearly identified.

(1) Gross weight. The chart shall be based on gross weight. Gross weight is defined as the total weight of the aircraft and its contents. Gross weight includes operating weight plus fuel, cargo, ammunition, bombs, external auxiliary fuel tanks, etc. The gross weight in pounds shall be shown on the left side of the chart, and shall range from the aircraft's minimum operating weight to maximum gross weight allowable.

(2) Total moments. Total moment lines shall be shown as depicted on figure 24.

(3) Center of gravity (arm). The center of gravity (arm) shall be shown as depicted on figure 24.

(4) Center of gravity limits. The CG limits shall be plotted from the minimum operating weight to the maximum gross weight Highlighting of critical limits shall be presented by shading and/or cross hatching.

d. Detailed text requirements. The purpose of the chart and the reason for presenting weight data in this manner shall be included.

(1) Explanation of the chart. Each of the various components of the chart shall be explained.

(2) Example. At least one example shall be included to illustrate the application of the chart. The example shall concern an aircraft whose gross weight is within the CG range on which the chart is based.

3.2.9 Chapter 7 — Performance data.

3.2.9.1 General. This chapter shall contain all the performance data charts necessary for the completion of preflight and inflight mission planning. The data presented shall cover the maximum range of conditions and performance for which the aircraft is qualified (3.1.6.1.3). Explanatory text applicable to the use of data presented for each particular aircraft shall be included. Explanatory text shall be prepared in accordance with 3.1.6.1.2. Performance data shall appear in all Operators Manuals, including the initial issue. Information contained on the charts shall be based on, and shall be consistent with, the recommended operating procedures and techniques set forth elsewhere in the manual. Performance data charts shall be prepared in accordance with the requirements in 3.1.6 thru 3.1.6.3.19.

3.2.9.1.1 Presentation of data. Data shall be presented as specified in 3.1.6 thru 3.1.6.3.19. Each section shall include an explanation of all applicable charts and a synopsis of pertinent terms used with each chart.

3.2.9.1.2 Graph/chart presentation style and format. (3.1.6 thru 3.1.6.3.19.)

3.2.9.1.3 Data basis. Unless otherwise specified by the contracting activity (6.2.) the preparation of performance data charts shall be derived from flight test reports when available. The basis for data (3.2.9.2.6) presented shall be clearly defined at the bottom of each chart to include data type and source data document. Army Test reports shall be used when available. When flight test reports are not available, referenced estimates shall be clearly identified as ESTIMATED. Conservative estimates shall be used until verified by flight test. Further explanation shall be required when data is not based strictly on the particular aircraft. The results of government reports shall be referenced and used in preference to flight test data obtained by contractors. To justify the basis of data as flight test, all performance information incidental to the determination of the data entered on the chart shall be based on the results of flight tests. Exceptions to this may be authorized by the contracting activity for new aircraft, provided adequate flight tests have been completed for the prototype. However, for these exceptions, an evaluation of all changes which affect performance shall be obtained by additional flight test.

3.2.9.1.4 Identification. Each chart shall contain a positive and concise means of identification to include the following:

a. Titles. Titles shall be centered above the chart and shall contain the name of each chart. The name of each chart shall define what type of information is obtained from that particular chart, (3.1.6.3.1).

b. Condition headings. Condition headings (3.1.6.3.4) shall be centered below the title and, when required, shall contain as applicable the following type of information:

(1) Pressure altitude information as applicable to each chart.

(2) Conditions to which chart applies (example: takeoff, landing, etc.).

(3) Technique to be used in conjunction with the chart (example: sling load takeoff, level acceleration takeoff, etc.).

(4) Condition of auxiliary equipment (ECU, BLEED AIR, ON/OFF etc.).

(5) Configuration, external tanks, armament, etc.

(6) Wing flap position.

(7) Rotor or prop rpm.

(8) Engine rpm.

(9) Fuel type.

(10) Hovering condition (IGE or OGE).

(11) Power requirements.

(12) Runway conditions.

(13) Wind conditions.

(14) Gear up/down.

(15) Power required.

c. Figures. Figure titles shall be centered below all chart information and shall match the title shown at the top of each chart.

3.2.9.1.5 Factors affecting data. Conditions which may affect the data but are not presented as variables on any specific chart, shall be listed as conditions under the title of the chart. An explanation of the effects of their variation shall be included in the text for that chart in a paragraph titled "Conditions". Conditions that may affect all or most performance data (such as fuel type, instrument errors, etc.) shall be described in a paragraph near the beginning of the chapter titled "General Conditions" and shall not be repeated in the individual charts or sections.

3.2.9.1.5.1 Configuration. Unless otherwise specified by the contracting activity (6.2.), the baseline configuration for all presented data shall be the most probable combat configuration and need not be the "clean" configuration (negative drag increments are permissible). This baseline configuration shall be labeled and presented as a condition only on applicable charts. The baseline configuration shall be completely defined in the "Drag" section. Where inherent configuration variations exist (such as antenna variations, IR suppressors, engine inlet configurations, etc.), the data shall be based on the most conservative configuration combination (highest drag, lowest power/thrust available, highest fuel consumption, etc.). The effects of alteration of these items shall be discussed in each section as applicable.

3.2.9.1.5.2 Fuel. All charts shall be based on the primary fuel for the engine/engines installed unless additional charts are required by the contracting activity for alternate fuels (6.2.).

3.2.9.1.5.3 Atmospheric conditions. The range of probable operating atmospheric conditions is described in MIL-STD-210. Where data is presented incrementally, it shall be presented to the next increment beyond the range in MIL-STD-210 to permit interpolation. Unless otherwise specified by the contracting activity (6.2.), standard day, standard conditions, standard temperature, or density altitude shall not be mentioned or presented. The following conversions for pressure altitude to static air pressure shall be used:

$$P, \text{in. hg.} = 29.92125\ (1 - Hp, \text{feet}/145{,}442.1)^{5.255876}$$

OR

$$Hp, \text{feet} = 145{,}442.1\ (1 - P, \text{in. Hg}/29.92125)^{.1902632}$$

3.2.9.1.6 Allowances. Allowance shall be made for all installation losses and a complete analysis of such allowances shall be included in the performance data substantiation report. The following allowances shall be included. An increase allowance of 5 percent shall be made for fuel consumption data only when data is based on estimates; however, this shall not be stated in the manual.

3.2.9.1.7 Limitations and restrictions. Applicable operating limits shall be shown. Restricted operating regions shall be depicted by shaded areas. Data may be presented to the next normal increment beyond operating limits to aid interpolation. Such data beyond operating limits shall be presented as dotted lines. (Note: maximum gross weight is an operating limit.)

3.2.9.1.8 Definitions. Definition of terms used through this chapter such as takeoff speed, takeoff distance, rotation speed, minimum control speed, skid height, etc., shall be included in appendix B.

3.2.9.1.9 Computers. Upon receipt of computer or equivalent information from the contracting activity (6.2.) the contractor shall prepare descriptive and operational information for inclusion in this chapter. Reference shall be made to the number, date, or number and date of the computer which is compatible with the date contained in the current manual.

3.2.9.1.10 Rotary wing performance data. Unless otherwise specified by the contracting activity (6.2.), the following performance data charts shall be presented for rotary wing aircraft:

a. Turbine engines.

(1) Fuel flow (figure 25).

(2) Maximum torque available (insert condition/time) (figure 26).

(3) Hover (figure 27) (sheet 1, hover ceiling; sheet 2, torque required to hover).

(4) Takeoff (figure 28).

(5) Drag (figure 29).

(6) Cruise (figure 30).

(7) Climb-descent (figure 31).

(8) Air data calibration (figure 32).

b. Reciprocating engines. Information to be depicted in a manner similar to turbine engine data.

c. Additional charts. Additional charts peculiar to certain aircraft, such as multi-engine, shall be included as necessary, with approval of the contracting activity (6.2.). Additional charts if required will completely define the operation or restrictions to operation of the aircraft.

3.2.9.1.11 Fixed wing performance data. Unless otherwise specified by the contracting activity (6.2.), the following performance data shall be presented for fixed wing aircraft:

a. Turbine engines.

(1) Crosswind — takeoff or landing (figure 33).

(2) Idle fuel flow (figure 25).

(3) Torque available for takeoff (figure 34).

(4) Takeoff — normal (figure 35).

(5) Normal rotation/takeoff airspeed (figure 36).

(6) Acceleration check distance (figure 37).

(7) Accelerate — stop distance (figure 38).

(8) Accelerate after lift off (figure 39).

(9) Minimum single engine control airspeed (Vmc) (figure 40). Flaps down and up, if applicable.

(10) Single engine climb (figure 41).

(11) Cruise climb (figure 42).

(12) Drag (figure 29).

(13) Cruise (figure 44).

(14) Climb/descent (figure 43).

(15) Approach speed (figure 45).

(16) Landing (figure 46).

(17) Air data calibration (figure 32).

b. Reciprocating engines. Information to be depicted in a manner similar to turbine engine data.

c. Additional charts. Additional charts peculiar to certain aircraft such as multi-engine shall be included as necessary, with approval of the contracting activity (6.2.). Additional charts if required, will completely define the operations or restrictions to operation of the aircraft.

3.2.9.2 Section I — Introduction. This section shall contain an explanation of the performance data to include the purpose, scope, limits, use, and conditions.

3.2.9.2.1 Purpose. This paragraph shall contain the following:

"The purpose of this chapter is to provide the best available performance data for the (insert assigned aircraft designation). Regular use of this information will allow you to receive maximum safe use of the aircraft. Although maximum performance is not always required, regular use of this chapter is recommended for the following reasons:

a. Knowledge of performance margins will allow you to make better decisions when unexpected conditions or alternate missions are encountered.

b. Situations requiring maximum performance will be more readily recognized.

c. Familiarity with the data will allow performance to be computed more easily and quickly.

d. Experience will be gained in accurately estimating the effects of conditions for which data are not presented.

The information is primarily intended for mission planning and is most useful when planning operations in unfamiliar areas or at extreme conditions. The data may also be used inflight, to establish unit or area standing operating procedures, including pilot aid cards, and to inform ground commanders of performance/risk tradeoffs."

3.2.9.2.2 General. This paragraph shall contain the following:

"The data presented covers the maximum range of conditions and performance that can reasonably be expected. In each area of performance, the effects of altitude, temperature, gross weight, and other parameters relating to that phase of flight are presented. In addition to the presented data, judgment and experience will be necessary to accurately determine performance under a given set of circumstances. The conditions for the data are listed under the title of each chart. The effects of different conditions are discussed in the text accompanying each phase of performance. Where practical, data are presented at conservative conditions. However, NO GENERAL CONSERVATISM HAS BEEN APPLIED."

CAUTION

"Exceeding operating limits can cause permanent damage to critical components. Overlimit operation can decrease performance, cause immediate failure, or failure on a subsequent flight."

3.2.9.2.3 Limits. This paragraph shall contain the following:

"Applicable limits are shown on the charts. Performance generally deteriorates rapidly beyond limits. If limits are exceeded, minimize the amount and time. Enter the maximum value and time beyond limits on DA Form 2408-13 so proper maintenance action can be taken."

3.2.9.2.4 Use of charts. The following topics shall be discussed.

a. Chart explanation (3.1.6.3). A sample problem typical of a normal mission accomplished by the aircraft shall be included on the first chart of the section and/or on the preceding page. Additional examples may be prepared as required for other charts within a section. When possible, actual chart values shall be used throughout the problem. Data for the problem in which derivation may not be entirely clear shall be explained. The majority of the charts provide a standard pattern for use as follows: Enter first variable on top left scale, move right to the second variable, deflect down at right angles to the third variable; deflect left at right angles to the fourth variable, deflect left at right angles to the fourth variable, deflect down, etc., until the final variable is read out at the final scale. Additional discussion, problems or illustrations may be used throughout the chapter to clarify the usage of charts when authorized by the contracting activity (6.2.).

b. Reading the charts. A paragraph similar to the following shall be provided.

The primary use of each chart is given in an example to help you follow the route through the chart. The use of a straight edge (ruler or page edge) and a hard fine point pencil is recommended to avoid cumulative errors. The majority of the charts provide a standard pattern for use as follows: enter first variable on top left scale, move right to the second variable, deflect down at right angles to the third variable, deflect left at right angles to the fourth variable, deflect down, etc., until the final variable is read out at the final scale. In addition to the primary use, other uses of each chart are explained in the text accompanying each set of performance charts. An example of an auxiliary use of the charts referenced above is as follows: Although the hover chart is primarily arranged to find torque required, maximum skid height or maximum gross weight can also be found. In general, any single variable can be found if all others are known. Also, the tradeoffs between two variables can be found. For ex-

ample, at a given altitude and a desired hovering skid height you can find the maximum gross weight capability as FAT changes.

3.2.9.2.5 Data basis. This paragraph shall contain the following statements and definitions:

"The type of data used is indicated at the bottom of each performance chart under DATA BASIS. The applicable report and date of the data are also given. The data provided generally is based on one of the following categories."

a. Flight test data. Data obtained by flight test of the aircraft at precisely known conditions using sensitive calibrated instruments.

b. Calculated data. Data based on tests, but not on flight test of the complete aircraft.

c. Estimated data. Data based on estimates using aerodynamic theory or other means but not verified by flight test.

3.2.9.2.6 Specific conditions. This paragraph shall contain the following:

"The data presented is accurate only for specific conditions listed under the title of each chart. Variables for which data is not presented, but which may affect that phase of performance, are discussed in the text. Where data is available or reasonable estimates can be made, the amount that each variable affects performance will be given."

3.2.9.2.7 General conditions. General conditions in addition to specific conditions listed on each chart shall be included in text as applicable. Example of general conditions which might affect performance of the aircraft are: rigging, pilot technique, sideslip, aircraft variation, engine variation, and instrument variation. Information shall be included which defines what effect the general conditions listed will have on the performance data of the aircraft.

3.2.9.2.8 Performance discrepancies. The following shall be included.

"Regular use of this chapter will also allow monitoring of instruments and other aircraft systems for malfunction, by comparing actual performance with planned performance. Knowledge will also be gained concerning the effects of variables for which data is not provided, thereby increasing the accuracy of performance predictions."

3.2.9.3 Sections II and subsequent. The sections shall be titled as described in either 3.2.9.1.10 or 3.2.9.1.11. These sections shall contain the following requirements. Additional supporting paragraphs may be included as required.

a. Description. This paragraph shall provide a description of the performance data presented in each applicable section to include those parameters obtainable from the chart and information relative to any peculiarity of data presented.

b. Use of charts. Reference shall be made to EXAMPLES used on each chart. Additional use of charts may be included when approved by the procuring activity. Reference to related charts which may be used in conjunction with the chart, and all information relative to peculiarities of data presented on the chart shall be included in this paragraph.

c. Conditions. Each condition which has a direct or indirect effect on the chart data presented, shall be discussed, explaining the effect it may have on the aircraft.

3.2.9.3.1 Rotary wing chart content. Performance data chart for rotary wing aircraft which are presented within Chapter 7, shall conform to the following outlined criteria. Paragraph 3.2.9.1.10 contains chart sequence.

a. Fuel Flow. The fuel flow chart shall show fuel flow at both the airframe idle throttle position and at normal rotor speed with flat pitch. The chart shall also present fuel flow conditions when the engine is operational at different configura-

tions, i.e., bleed air ON/OFF. Pressure altitude and FAT shall be used as the criteria for fuel flow computations. Reference shall be made to other charts within the chapter that present fuel flow data at cruise conditions. Fuel flow data shall be based on the primary fuel type used. Additional fuel flow data shall be included for alternate or emergency fuels only upon approval of the contracting activity (6.2.). Information shall be included in the supporting text to define additional pertinent information which may affect fuel flow. All data shall be based on normal operation engine rpms (figure 25).

b. Maximum torque available (insert time) (figure 26). These charts shall show the effects of altitude and temperature on the maximum torque available and shall take into consideration calibration factors used to correct for known errors in torque indicating systems, as applicable. Separate charts shall be provided for each applicable set of time limited torque available data. For example, separate charts shall be provided for Intermediate (30 minute) and One Engine Inoperative Contingency (10 minute) torque available data. Data for continuous torque available shall not be provided unless it is also the maximum torque available. Information shall be provided to allow the operator to correct the data presented on the charts to account for variations in torque available due to operation of IR suppressors, systems requiring bleed air, or other similar operating conditions. Information shall also be provided to allow the operator to correct the data presented to account for known variations in the torque available of the individual engines installed in the aircraft compared to the standard or specification engines depicted by the charts.

c. Hover. This chart shall present the torque required to hover at given conditions of skid height, gross weight, temperature and altitude. Aircraft limitations shall be presented to include marginal areas of performance. When unsafe performance areas could be encountered, the full range of precautionary data will be presented and safe limits presented to better clarify the use of the data (figure 27). Basic in-ground-effect (IGE) hover data shall be based on hovering over a level surface. If IGE hover data is presented for other than level surfaces, information shall be included in the supporting text or on the charts. Compressibility effects on hover power required may be presented in a table as shown on figure 27.

d. Critical data. Critical wind azimuth and velocities at varying gross weights, pressure altitudes, and FAT during hover and low speed flight shall be presented as required. A separate chart may be used.

e. Takeoff. This chart shall consist of all takeoff data required to clear various obstacle heights and shall be based on maximum performance (minimum hovering skid height capability, maximum torque available, etc.). All approved techniques such as level acceleration, coordinated climb, and sling load techniques shall be covered on additional charts as required by the procuring activity (6.2.). The primary parameters used for take-off performance shall be maximum hovering height capability, FAT, gross weight, and maximum torque available. Additional performance charts shall be referenced when required. Takeoff limits shall be stated and indicated on all charts. All takeoff conditions shall be based on calm winds, level hard surfaces, normal rotor/engine speeds, and optimum torque available (figure 28).

f. Drag (figure 29). The baseline configuration used for other performance data shall be completely defined in this section. This shall include inherent or basic equipment variations existing or anticipated (for example, antennas, IR Suppressors, inlet configuration, etc.) and any external stores included in the baseline configuration (for example, 8 TOW missiles and mounts without fairings). Tabular data shall be prepared to show each drag item and the drag area change in square feet based on additional engine torque or horsepower required. Negative drag increments from baseline configuration are permissible. The drag data shall fall into one of these major categories: (1) inherent or basic aircraft modifications or basic equipment changes; (2) external stores and store combinations; (3) crew alterable configurations (for example, windows, doors, dive brakes, prop(s) feathered and windmillings, etc.); and (4) for helicopters with sling capability, drag of various standard sling loads. A procedure shall be provided for estimating drag of sling loads for which data is not provided. Information to determine the change in maximum range or long range cruise speeds with drag variations shall be provided. A supplementary graph on the cruise chart depicting torque/horsepower change for drag area change shall be provided. It shall cover the airspeed range from minimum power to limit airspeed. It shall also cover a drag range to one-half the basic aircraft drag or the largest drag increment combination, which ever is larger. One or two alternate total configurations may be depicted on these subgraphs using special line coding with approval of the contracting activity (6.2.). If alternate configurations are depicted, they shall be completely defined in this section.

g. Cruise (figure 30). This chart shall present torque requirements for level flight at various airspeeds, gross weights, pressure altitudes, and FAT. The particular altitudes and temperatures at which cruise data are to be presented shall be specified by the contracting activity (6.2.). Indicated airspeeds for all airspeed systems, used on the aircraft referenced, shall

be shown on the charts. Fuel flow shall be shown for different engine operation, i.e., bleed air ON or bleed air OFF. Torque available shall be shown for maximum torque, and continuous bleed air ON/OFF. When torque available is greater than the torque limit, only the torque limit shall be shown. Vne shall be shown on each chart as appropriate. Airspeeds for maximum range, endurance, and rate of climb shall be included on each chart. This information shall be presented for each engine when performance data pertains to multi-engine aircraft. Maximum performance, precautionary, and limits data shall be shown on each chart and explained in the text. Other performance data charts relative to the cruise charts shall be referenced and all cruise data shall be based on normal operational rotor and engine speed, and on drag area changes, true airspeed, pressure altitude, and FAT. A drag area change table, showing the change due to each possible configuration change, shall be included.

h. Optimum cruise. When requested by contracting activity (6.2.) data shall be provided to determine the altitude for maximum range and maximum endurance as a function of gross weight and ambient temperature. Information shall also be provided for optimum rotor/propeller rpm for maximum range and endurance. Where optimum rpm is different from that presented for the (normal) cruise data, information shall be provided to correct fuel flow for the different rpm's. Optimum cruise speed (maximum range or endurance) presented on the cruise chart shall be referenced and used. Airspeed and power schedules for climb and descent to maximize total range or endurance shall be described. A means shall be provided for estimating ambient temperature at optimum altitude. Also, a means shall be provided for comparing the effects of varying winds with altitude with the change in aircraft performance with altitude. Data shall cover the range of gross weights and ambient temperatures presented on the cruise charts, and to the limits of altitude on the cruise charts (if required). Data shall be for the aircraft configuration and conditions of the cruise charts. If corrections to optimum altitude for configuration variation are significant and possible, this information shall be provided.

i. Climb-descent (figure 31). The climb-descent chart shall show the torque required above that required for level flight to obtain the desired rate of climb. The torque decrease for a desired rate of descent shall also be shown. Desired rate of climb or descent and gross weight shall be used to compute the torque change required.

j. Air data calibration (figure 32). An airspeed calibration chart which defines the relationship between pilot's indicated and calibrated airspeed for level flight, climb, and descent shall be provided. Instructions and examples shall be provided to allow the operator to determine the level flight indicated airspeed value which corresponds to known indicated airspeeds in climb and descent. Instructions and examples for determining calibrated airspeeds corresponding to known indicated airspeed shall also be provided. Altimeter correction charts which provide position error correction versus indicated airspeed shall be provided for all normal and emergency altimeter systems. Data shall be provided for all applicable flap settings or other variations in configuration. A temperature conversion/correction chart which provides true free air temperature (FAT) as a function of true airspeed and indicated temperature, and conversion from °C to °F shall also be provided. For those aircraft whose air data system position errors are insignificant, airspeed, altitude, and temperature calibration data may be omitted with approval of the contracting activity (6.2.).

3.2.9.3.2 Fixed wing chart content. Performance data charts for fixed wing aircraft presented within Chapter 7 shall conform to the following outlined criteria. Paragraph 3.2.9.1.11 contains chart sequence.

a. Crosswind — takeoff or landing. The crosswind chart shall show the takeoff or landing conditions under which a takeoff or landing is not recommended. Various wind velocities, runway wind angle, and rotation or touchdown airspeeds are shown. Additional charts to obtain required information shall be referenced. When more than one configuration is possible for the applicable aircraft, the differences shall be indicated and the charts adjusted appropriately (figure 33).

b. Idle fuel flow. The idle fuel flow chart shall show idle fuel flow, pounds per hour, at the airframe idle throttle position, at various altitudes and outside air temperatures. Additional charts, when applicable, depicting idle fuel flow at various idle conditions shall be shown. Differences between idle fuel flow with bleed air ON or OFF and similar conditions shall also be shown when applicable. The type of fuel used in computation shall be shown in the subheading of this chart (figure 25).

c. Torque available for takeoff. This chart shall show the torque available for takeoff, per engine for multi-engine aircraft, at various outside air temperatures and altitudes. Maximum torque limits shall be shown when applicable. When ram air (forward airspeed), prop rpm, operation of engine auxiliary systems (Electrical Control Unit etc.), or nonstandard fuels

affect the torque available readings obtained, the standards for which the chart was compiled will be shown in the heading and defined in the supporting text. Allowable tolerance for available torque shall be stated when applicable (figure 34).

d. Takeoff. The takeoff chart shall show the ground roll distance and total takeoff distance required to clear different obstacle heights at various temperatures, altitudes, and aircraft gross weights. Wind conditions, configuration, power requirements, runway surface condition, and other applicable information as required by the contracting activity (6.2.) shall be given in the subheading and explained in the text. Additional charts required to obtain information shall be referenced (figure 35). Each approved takeoff technique shall be covered on separate charts.

e. Rotation/takeoff airspeeds. These charts shall show the recommended normal rotation and takeoff airspeeds for the aircraft at various gross weights. Flap settings and other applicable information, as required by the contracting activity (6.2.), should be given in the subheading or explained in the text (figure 37). Each approved takeoff technique shall be covered on separate charts.

f. Acceleration check distance. This chart shall show the relationship between indicated airspeed and ground roll distance during takeoff. The actual indicated airspeed required at any distance traveled along the takeoff path shall be computable from this chart. Computations shall be based on the required takeoff airspeeds for various aircraft gross weights and the required ground roll distances for the aircraft gross weight being used. Additional charts shall be referenced when input conditions, i.e., airspeed and ground roll distance vs gross weight are required in computing the acceleration check airspeed at various predetermined distances. Conditions affecting acceleration check distance performance shall be indicated in the subheading and explained in the text (figure 37).

g. Accelerate — stop distance. This chart shall show the actual distance required to begin takeoff, accelerate to rotation speed, abort the takeoff, and bring aircraft to stop. Computations shall be based on ambient temperature, pressure altitude, and gross weight (figure 38).

h. Accelerate after lift-off. This chart shall show the actual distance required to clear an obstacle after takeoff. Computations shall be based on FAT, pressure altitude, takeoff weight, and velocity (figure 39).

i. Minimum single engine control air speed (Vmc). This chart is applicable to mult-engine aircraft and shall show the minimum controllable airspeed (Vmc) at various temperatures, altitudes, gross weights, for aircraft control following engine failure during takeoff. The chart shall be predicated on the operative engine(s) capability to produce full takeoff power and full takeoff power being applied during takeoff. The primary use of the chart shall be to provide Vmc at takeoff and not to provide single engine rate of climb information. All applicable limits, e.g., rudder limit, shall be shown and explained in the text when required by the contracting activity (6.2.). Applicable conditions such as flap setting, landing gear position, etc., shall be included in the subheading or explained in the text (figure 41). The effect of engine failure on takeoff, climb, and cruising performance, the effect of windmilling and feathered propellers on aircraft drag, etc., shall be described.

j. Single engine climb. This chart shall present single engine airspeeds and rate of climb data for various temperatures, altitudes, and aircraft gross weights. Single engine rate of climb shall be based on takeoff airspeeds to include gear-up and gear-down configurations. When alternate aircraft configurations change the validity of information being presented, additional single engine climb charts shall be prepared with an explanation of the alternate configuration provided in the subheading and within the text when necessary. Information indirectly obtained from the chart that would help in the determination of the best course of action to be taken shall also be included in the text. Charts related to single engine operations i.e., single engine cruise, single engine control airspeed, etc., shall be referenced in the text (figure 41).

k. Cruise climb. This chart shall present the time, fuel, and distance required to climb. Computations shall be based on initial and final FAT, initial and final pressure altitude, and initial gross weight (figure 43).

l. Cruise. The cruise chart shall show the obtainable airspeed, required engine shaft horsepower, engine torque pressure, shaft horsepower increase required due to increases in drag, fuel flow and optimum propeller RPM for maximum range during cruise flight at various aircraft gross weights, altitudes, and temperatures. The particular altitudes and temperatures at which cruise data are to be presented shall be specified by the contracting activity (6.2.). This information shall be presented

for each engine when performance data pertains to multi-engine aircraft. When fuel flow variations exist due to alternate engine operations such as ECU ON or OFF, fuel flow for each alternate operating condition shall be shown. Single engine data shall be placed on the same charts as multi-engine data for multi-engine aircraft unless otherwise approved by the contracting activity (6.2.). Cruise charts shall be prepared for altitude, temperature and configuration as specified by the contracting activity. Maximum performance, precautionary, and limits data shall be shown on each chart and explained in the text. Indicated and true airspeed for each altitude shall be shown. When an altitude limitation prevents safe single engine cruise for multi-engine aircraft, the single engine graph shall be omitted. Additional charts related to cruise performance shall be referenced in the text (figure 42).

m. Optimum cruise (figure 31). This chart shall be prepared in accordance with the requirements stated in 3.2.9.3.1.h.

n. Drag. The drag chart shall show additional shaft horsepower required at various airspeeds, altitudes, and temperatures due to drag increases caused by changes in the aircraft external configuration. Additional shaft horsepower shall be given per engine for multi-engine aircraft. Charts used in connection with the drag chart shall be referenced in the text. Tabular data presenting each drag item and the drag area change in square feet shall be included in the text (figure 29).

o. Climb/descent. The climb/descent chart shall show changes in torque and horsepower required to obtain a desired rate of climb or descent at a known gross weight and propeller rpm. For maximum rate of climb information, reference shall be made to the cruise charts. If the aircraft is other than clean, an increase in horsepower due to drag must be computed from the drag chart and added to the horsepower required per engine. Charts used in connection with the climb/descent charts shall be referenced in the text and the single engine climb chart (figure 43).

p. Approach speed. The approach speed chart shall present the recommended airspeeds during approach to landing for the full range of gross weights and flap settings for the aircraft. The chart shall be valid for all aircraft configurations unless otherwise specified by the contracting activity (6.2.). Charts used in connection with the approach speed chart shall be referenced in the text (figure 45).

q. Landing. The landing chart shall show the total ground roll distance for landing with no reverse thrust at known gross weight, pressure altitude, and outside air temperature. Landing distance shall be based on touching down at the approach speed obtained from the approach speed chart, full braking with 0- degrees and normal landing flap settings. The correct approach speed is obtained from the approach speed chart. Landing performance shall be based on a dry, level, hard surface runway. All data presented shall be based on calm wind conditions, because wind speed and direction cannot be predicted. This chart shall be valid for all stores configurations unless otherwise specified by the contracting activity (6.2.). Chart used in computing landing distances shall be noted in supporting text (figure 46).

r. Air data calibration (figure 32). These charts shall be prepared in accordance with the requirements stated in 3.2.9.3.1.j.

3.2.10 Chapter 8 — Normal procedures. This chapter shall contain the procedures (amplified checklists) from the time a flight is planned until the flight is completed and the aircraft is left properly parked and secured. The checklists shall include all steps necessary to ensure safe flight under normal, night and instrument conditions. Only the duties of the minimum crew necessary for the actual operation of the aircraft shall be included. Instructions for the operation of utility, avionics, mission equipment, and controls are contained in Chapters 2, 3, and 4 and shall be included in this chapter only if neglect of such operations as positioning of utility equipment of armament switches would affect safety or efficiency of the flight or cause damage to the equipment. (This does not preclude the inclusion of utility equipment checklists in chapters to which they pertain.) Only unique feel, characteristics, and reaction of the aircraft during the various specified phases of operation, and the techniques or procedures used for taxiing, takeoff, climb, etc., shall be described in detail. All precautions to be observed during the various operations shall be covered. Procedures for operation under all adverse environmental conditions shall be described. Instrument flight procedures shall be integrated with normal procedures as much as possible. For aircraft where no unique or abnormal techniques apply, refer to appropriate flight training publications, i.e., FM 1-203, FM 1-240.

3.2.10.1 Section I — Crew duties. Unique responsibilities which result from the specific characteristics of the aircraft shall be described.

3.2.10.2 Section II — Operating procedures and maneuvers. Section II shall contain the procedural steps to be followed from mission planning through walk around check. The following procedures, checks, etc., shall be contained in this section.

3.2.10.2.1 Procedures. Procedural steps shall be so designed that crewmembers are not required to retrace steps. Insofar as possible, checks shall be grouped to keep control manipulation and ground operating time at a minimum. Phases may be added or deleted to provide for special aircraft or special situations. However, the interpretation of the period of operation encompassed by a given phase shall be identical in all operator's manuals. The condition and response of a procedural step shall be separated by a long dash.

3.2.10.2.1.1 Sequence. Sequence of phases and actions shall be arranged chronologically.

3.2.10.2.1.2 Checks. All checks shall be made from left to right or top to bottom except where chronology must take precedence.

3.2.10.2.2 Symbols Definition. The following statements shall be included:

"Items which apply only to night or only to instrument flying shall have an N or an I, respectively, immediately preceding the check to which it is pertinent. The symbol O shall be used to indicate if installed or available. Those duties which are the responsibility of the copilot, will be indicated by a circle around the step number i.e., (4) STARTER and IGN SYS circuit breakers — In. The symbol star ★ indicates that a detailed procedure for the step is located in the performance section of the condensed checklist. The symbol asterisk * indicates that performance of step is mandatory for all thru-flights. In addition to thru-flight, the asterisked steps in this checklist may be used for combat/tactical operations when authorized by the commander. The asterisk applies only to checks performed prior to takeoff. Placarded items such as switch and controllables appear in boldface, capital letters."

3.2.10.2.3 Amplified checklist. The amplified checklist shall consist of numbered items supplemented where necessary by explanatory material. Where required for emphasis, the item shall contain a brief explanation of why it is required. These checklists are provided in the operator's manual for each aircraft. They are the basis of all operator's checklists and consist of the following:

a. The amplified normal checklist for the pilot, copilot, and flight engineer, shall be included as applicable.

b. The following paragraph shall be included only in the amplified checklist:

"Normal procedures are given primarily in checklist form and amplified as necessary in accompanying paragraph form when a detailed description of a procedure or maneuver is required. A condensed version of the amplified checklist, omitting all explanatory text, is contained in the Operator's Checklist, TM 1-XXXX-XXX-CL. To provide for easier cross referencing, the procedural steps are numbered to coincide with the corresponding numbered steps in this manual.

3.2.10.2.4 Amplified checklist format and style. Checklist format shall be as shown in figure 47. All checklist titles, such as BEFORE EXTERIOR CHECK, ENGINE-UP, etc., shall be bold face capital type. Checklist entries shall be all capital lettering. Checklist entries shall be listed numerically and will be blocked. Checklist entries that consist of two lines or more shall have the first letters of each line of type aligned as shown in figure 47. Placarded items shall be in boldface, capital letters. Procedural and technique paragraphs, usually consisting of subparagraphs, shall have type returned to the left margin. This is the same as the standard paragraphing used throughout the manual.

3.2.10.2.5 Preflight check. The amplified preflight check shall include a before exterior check, if required, and the exterior and interior checks.

3.2.10.2.6 Before exterior check. When required by the aircraft configuration, a check giving all necessary actions that must be performed prior to starting the exterior check shall be included. Emphasis shall be placed on items that affect safety during the inspections to follow. This shall include a check of the required aircraft publications, setting of trim tabs, landing gear handle position, and setting of required electrical switches, armament switches, and checking safety devices, as applicable.

3.2.10.2.7 Exterior check. Only those exterior points which significantly affect the flight shall be indicated, avoiding needless repetition of items which are the normal responsibility of the maintenance crew. The criteria on which these checks shall be based are safety of flight, items that have previously been a problem or that are anticipated to be a problem, and ease of accomplishing the check. Inspection usually shall proceed clockwise (as viewed from the top) around the aircraft.

3.2.10.2.8 Interior check. The complete interior check shall be described, including all necessary check items up to the point where the pilot actually straps or places himself in the seat. A requirement shall be included to ascertain that all necessary equipment (first aid kit, fire axes, pyrotechnic equipment, aircraft covers, tie downs, control locks, etc.), is stowed as required. A check of the headrest area of the ejection seat shall be included to determine that the face curtain handles are properly stowed, that the catapult pin is installed and connected to the removal mechanism, and that the catapult firing yoke is properly positioned and connected. Instructions shall be included to ensure that controls are positioned and connected. Instructions shall be included to ensure that controls are positioned as necessary to facilitate the exterior check (only for those aircraft where the interior check is performed before the exterior check). On large aircraft, it may be necessary to include an interior check diagram.

3.2.10.2.9 Crew/passenger briefing check. Instructions shall be provided to insure passenger briefing has been completed prior to starting engines.

3.2.10.2.10 Before starting engine(s). Precautions to be observed and checks to be accomplished before starting engine(s) shall be included. Such checks as should be accomplished before starting engine(s), but which could not be properly accomplished during the interior check (oxygen system, seats and pedals, safety belts and shoulder harnesses, parking brake, etc.), shall be included. Instructions for positioning of all important controls and checking of all important indicators shall be included. Insofar as practical, all controls shall be positioned as required for engine starting. Functional checks shall be included for all those systems that can be checked before engines are started. For those aircraft in which engine power is not necessary, a requirement that flight controls be checked for free and correct movement shall be included. Instructions shall be provided on the use of external power or auxiliary power unit and any necessary switching involved in its use.

3.2.10.2.11 Starting engine(s). The complete procedure for starting the engine(s) shall be provided, including order of starting for multi-engine aircraft. Except when significant differences in procedures are required on multi-engine aircraft, engine start procedures shall not be repeated. For jet and turbine powered aircraft, the means to avoid hot starts and procedures to follow when a hot start is experienced shall be included. Procedures for engaging rotors for rotary wing aircraft shall be given.

3.2.10.2.12 Engine ground operations. When required, warmup and ground operation power setting shall be specified. Any special precaution or limitation shall be stated. For rotary wing aircraft, if applicable, a requirement for flight control check before rotor is engaged shall be included.

3.2.10.2.13 Before taxiing. All checks to be accomplished before taxiing, such as check flight controls for free and correct movement (for those aircraft which require engine power to perform this check), windows and doors, control locks, hydraulic pressure checks, obtain clearance to taxi, advise crew, and check seat belt fastened shall be included.

3.2.10.2.14 Taxiing. Any unusual taxiing characteristics or techniques shall be described, including special instructions for engine cooling, reverse pitch, and use of brakes. A requirement that operation of flight instruments be checked during taxiing shall be included.

3.2.10.2.15 Engine runup. Instructions shall be given for checking engine propeller/rotor operation, including power, ignition, use of brakes, etc.

3.2.10.2.16 Before takeoff. All checks which must be accomplished prior to takeoff that have not been done previously shall be listed, such as trim setting, flap position, flight instruments set, doors secured, and crew ready for takeoff. A check for free movement of the flight controls shall be included. This check shall be located as near the end of the before takeoff checklist as is possible.

3.2.10.2.17 Lineup check. When aircraft configuration or mission requirements preclude performance of some of the takeoff checks before taxiing onto the active runway, a lineup check shall be provided. This may include activation of anti-icing/deicing system switches, transponder switches, setting or aligning gyros, or stabilizing power prior to starting takeoff.

3.2.10.2.18 Takeoff. Takeoff techniques that will be required to produce the results stated in the takeoff charts in Chapter 7 shall be covered in detail. Techniques for minimum run, obstacle clearance, crosswind shipboard, etc., takeoff shall be included, when appropriate. Manipulation of brakes and throttles/power levers, etc., shall be described. Detailed information shall be given regarding unique reactions of the aircraft during takeoff; whether nose wheel should be raised on takeoff run, whether aircraft must be pulled off the ground gently or firmly, corrective action to be taken for possible unfavorable tendencies, etc. Instructions for whether a takeoff should be continued or aborted under various circumstances shall be included. (Chapter 9 contains abort procedures.) Operational consideration and general rules contributing to hover capability and power availability shall be stated. Unique hover/taxi, sideward and rearward flight technique, and power check shall be included. The necessity for a prepared runway shall be discussed for various conditions of altitude and weight for aircraft which may be required to operate from temporary or unfinished runways.

3.2.10.2.19 After takeoff. All actions to be accomplished immediately after takeoff, such as braking wheels (if necessary), retracting flaps, switching off emergency fuel system, repositioning fuel switches as necessary, shutting down auxiliary power plant, and switching off landing and taxi lights, shall be listed. If flap retraction procedure differ under various conditions (heavy weight, weather, etc.), it shall be so stated. As applicable, minimum airspeed and altitude for retracting flaps shall be covered. If flaps should be brought up in small increments rather than in one steady movement, it shall be so stated. A minimum flap retraction airspeed chart shall be included for aircraft of highly variable gross weight. All actions that are required to establish the required climb shall be covered, including airspeed at which climb should be started.

3.2.10.2.20 Climb. A description of any unique climb technique that will be required to produce the results stated in the climb charts in Chapter 7 shall be included. Unusual characteristics of the aircraft in climb shall be indicated. Since the preceding paragraph includes the climb checklist, this paragraph shall contain discussion only.

3.2.10.2.21 Cruise. Explain all actions that must be taken when the transition from climb to cruise is made. Describe any particular matters that must be considered during cruise flight. Reference shall be made to Chapter 2 and 7 for fuel system management and any other matters that should be considered during flight. Actual procedures shall not be covered here; the reader shall simply be reminded of the actions that must be taken during cruising flight. Details of manual leaning, fuel system management, etc., shall be included by reference to the appropriate chapter of the manual.

3.2.10.2.22 Descent — Arrival. Both checklist and a discussion of this phase of operation shall be included as appropriate. The checklist shall include all checks which must be made immediately before and during a descent preparatory to landing. Special instructions regarding various types of descent, such as cruising and rapid, shall be included as applicable, including any special devices that may be provided to facilitate descent.

3.2.10.2.23 Before landing. All checks that must be made immediately before entering the traffic pattern until the landing is committed shall be covered. This shall include a check to ensure that the landing gear and fuel system is set for landing.

3.2.10.2.24 Landing. This paragraph shall be divided into two parts; a landing checklist and a narrative discussion of the landing problems and techniques. The landing checklist shall include all actions to be performed from the time the landing is committed until it is effected. Landing techniques required to produce the results stated in the landing charts in Chapter 7 shall be included. A statement to that effect shall be included. The exact techniques on which the charts are based for use of brakes, nose wheel on or off the runway, drag chute deployment, etc., shall be given. Heavy weight, crosswind, wet, and minimum run landings shall be covered, including instructions for use of brakes, reversible pitch propellers, and other devices that

may be used to accomplish the landing and/or the after-landing roll. Approach and landing airspeed corrections required to compensate for gusts shall be covered. In particular, the landing techniques from the viewpoint of recommended maximum and minimum approach and landing airspeeds as influenced by aircraft flight classification, aircraft strength, aircraft touchdown bounce characteristics, and other aircraft characteristics shall be included. Reference shall be made to Chapter 7 for supplemental information provided by landing and approach speed charts. Coverage of approach and landing should include cautions if applicable in the use of the engine during approach, performing a go-around, for the use of the angle of attack indicator in making an approach, etc. Shipboard landing techniques when applicable shall be included for rotary wing aircraft when unusual characteristics dictate.

3.2.10.2.25 Touch and go landings/Go-around. All instructions, such as trim changes and flap settings for executing go-around if the landing is not completed, shall be included. Proper throttle/power lever technique shall be emphasized, if applicable.

3.2.10.2.26 After landing. All checks and operations to be performed from immediately after landing until the parking area is reached shall be included.

3.2.10.2.27 Engine Shutdown. A checklist shall be provided covering proper procedures and precautions for stopping engines.

3.2.10.2.28 Before leaving the aircraft. Instructions for setting of all controls, control locks, and safety devices for securing the aircraft shall be provided for pilots and crew. The following shall be included regarding forms annotation by the flight crew.

> "In addition to established requirements for reporting any system defects, unusual and excessive operations such as hard landing, etc., the flight crew will also make entries on DA Form 2408-13, to indicate when any limits of the operator's manual have been exceeded."

3.2.10.2.29 The sequence within this section may be altered and specific checks deleted or added when approved by the contracting activity (6.2.).

3.2.10.3 Section III — Instrument flight. Unique qualities and capabilities of the aircraft under instrument flight conditions shall be briefly described. Only those procedures and techniques that are used for instrument flight that are different from normal procedures (Section XX) shall be discussed in this section.

3.2.10.3.1 Instrument takeoff. Characteristics of the aircraft on instrument takeoffs and initial climb shall be briefly stated, including effect of restriction to vision in poor visibility. Instructions shall be included regarding preparation, technique, power settings, wing flap settings, airspeeds, etc., if different from VFR instructions. (Reference shall be made to normal takeoff procedures). Time required for instruments to warm up, overloading of batteries when all instrument aids are on during taxiing, etc., shall be noted.

3.2.10.3.2 Instrument climb. Recommended technique for accomplishing climbs under instrument conditions shall be given. Any limitations, such as maximum bank in a climbing turn shall be covered, including slow airspeed and low rate climbs.

3.2.10.3.3 Instrument cruise. Coverage of precautions (if appropriate) and techniques to be observed during instrument cruising flight shall be included. Aircraft flight characteristics at high and low airspeeds during instrument flight shall be included. Desired airspeed range for instrument flight shall be stated with reasons.

3.2.10.3.4 Instrument descent. The qualities of the aircraft and the best techniques to employ during instrument descent up to the maximum rate of descent shall be included, together with any limitations. Fuel used and emergency penetration configuration shall be included.

3.2.10.3.5 Holding. Recommended power settings, airspeeds, and configuration for holding shall be stated. Any unusual holding characteristics and special precautions shall be covered.

3.2.10.3.6 Instrument approaches. The general qualities and capabilities of the aircraft on instrument approaches including aircraft control techniques shall be described. Preparations to be made prior to initiating an instrument approach shall be given.

3.2.10.3.7 Automatic approaches. Preparations and procedures to be followed in putting the aircraft under the control of the automatic approach equipment shall be described, including special precautions and techniques. Indications that would signify satisfactory or unsatisfactory approaches shall be covered, including procedure for breaking away from unsatisfactory automatic approach.

3.2.10.4 Section IV — Flight characteristics. This section shall describe unique flight characteristics of the particular aircraft. Emphasis shall be placed on advantageous flight characteristics as well as on any dangerous tendencies. The extent of coverage will depend principally on the type of aircraft being discussed. Extensive coverage will be required on aircraft having unusual flight characteristics.

3.2.10.4.1 Stalls. The power-off and power-on stalling characteristics of the airplane in the takeoff, landing, and cruise configurations shall be included. Stalling characteristics shall be included for the approach configuration if sufficiently different from landing. A definition of power-off and power-on as used in the discussion shall be included. Information about the stall warning shall also be included. Both normal and accelerated stalls shall be covered. Recommended procedures for accomplishing stalls shall be included. Stall recovery technique shall be emphasized. For helicopters, appropriate information shall be included on blade stalls.

3.2.10.4.2 Illustrations. Illustrations that may be required in Section III shall be in the same style and format required by 3.1.6 thru 3.1.6.3.19.

3.2.10.4.3 Stall chart. (Fixed Wing Only) Stalling airspeeds for airplanes for various configurations such as takeoff, landing, and cruise shall be presented showing the variation with bank angle and gross weight. Power-on or power-off shall be stated and these terms shall be defined as used in the chart. If power-on is covered, difference with power-off shall be stated; the reverse shall be accomplished if power-off is included in the chart.

3.2.10.4.4 Spins. (Fixed Wing Only) Spin characteristics and limitations shall be given, including details of any special technique recommended for recovery. Recovery technique shall be given whether or not spins are permitted. Altitude lost in effecting a recovery and minimum altitude at which bailout must be effected if aircraft has not been brought under control shall be stated.

3.2.10.4.5 Diving. The diving characteristics of the aircraft shall be described with particular emphasis on high speed diving and compressibility effects. Dive recovery technique and precautions shall be given, including any special information regarding power plant operation and trim changes. For highly maneuverable aircraft, dive recovery charts shall be included for various G pullouts.

3.2.10.4.6 Dive recovery charts. Dive recovery charts shall be included for various G pullouts for various combinations of altitude, airspeed, and angle of dive for aircraft required to perform tactical dives.

3.2.10.4.7 Maneuvering flight. Maneuvering flight shall be described, including characteristics under accelerated flight conditions. Stick forces shall be included, emphasizing conditions that may result in stick reversal.

3.2.10.4.8 Flight controls. Detailed coverage of the effectiveness and unusual reactions that may be encountered in the operation and use of the flight controls shall be included. All the various types of flight controls, such as ailerons, elevators, rudders, stabilators, trim tabs, speed brakes, slats, cyclic stick, and collective pitch shall be described. The text shall state when and how the various controls are used to achieve maximum benefits and what precautions must be observed. The capabilities and limitations of power-boosted systems when power boost is inoperative shall be covered.

3.2.10.4.9 Level flight characteristics under various speed conditions. The characteristics of the aircraft under conditions of slow flight, cruising flight, and high speed flight shall be included.

3.2.10.4.10 Flight with external loads. Changes in flight characteristics with external loads shall be described.

3.2.10.4.11 Flight with asymmetrical loads. As applicable, coverage of characteristics and techniques to be employed when operating with asymmetrical loads or configurations shall be included.

3.2.10.5 Section V — Adverse environmental conditions. This section shall provide information relative to operations that are unique to the specific aircraft under adverse environmental conditions (snow, ice, and rain, turbulent air flight, extreme cold and hot weather, desert operations, mountainous and altitude operations) at maximum gross weight, etc. This section shall be primarily narrative in nature. Checklists shall be avoided; they shall be used only to cover specific procedures that are characteristic of all weather operations, such as oil dilution or preparation for turbulent air flight. This section shall not include description of equipment since that information is covered elsewhere. An introductory paragraph shall be included explaining the function of this section, and that the checklists in Section II provide for adverse environmental operations.

3.2.10.5.1 Cold weather operation. A brief discussion of the general problems involved in maintaining satisfactory operation in extreme cold shall be included. The relationship of proper engine shutdown to subsequent engine starting shall be emphasized. Reference shall be made to icing conditions coverage elsewhere in this chapter. Any special problems resulting from operations where snow is present shall be included.

3.2.10.5.2 Preparation for flight. Special problems such as application of heat, removal of ice and snow (from the aircraft surfaces, fuel and oil tank vents, pilot tubes, props, etc.), and supply of external power shall be included.

3.2.10.5.3 Engine starting. Any special precautions that must be observed before starting the engines such as removal of oil immersion heaters, removal of ground heater ducts, priming, pulling through of propellers, and nacelle preheat for turboprop aircraft shall be included. Cold weather starting techniques shall be explained. The use of special fuels, carburetor heat, etc., shall be covered.

3.2.10.5.4 Warmup and ground tests. This shall include coverage of carburetor heat, cowl flap position, technique of switching from special starting fuel, etc. If oil dilution is available, the fuel boil-off procedure shall be covered, including a reference to the oil dilution table. The importance of ground testing of systems which may be adversely affected by cold weather shall be included.

3.2.10.5.5 Taxiing and hovering instructions. Unique techniques and precautions to be observed when taxiing on snow, ice, or slush-covered water where ice is suspected shall be explained. A requirement that wheels will be visually checked by operator/ground crew to ensure they are turning shall be included.

3.2.10.5.6 Before takeoff. A check for ice and snow buildup on the aircraft shall be included.

3.2.10.5.7 Takeoff. Unique techniques and precautions to be observed when taking off under cold weather conditions shall be included. The effect of snow- or ice-covered runways on takeoff, of extremely cold weather on engine and aircraft performance, etc, shall be covered.

3.2.10.5.8 During flight. Any special precautions that must be observed during flight in extreme cold, such as cycling propeller governing systems, shall be described.

3.2.10.5.9 Descent. Any special instructions regarding descent as may be applicable to cold weather operation shall be included, such as switching on the auxiliary power unit early to ensure that it is sufficiently warmed up prior to landing.

3.2.10.5.10 Landing. Unique techniques and precautions to be observed during landing in cold weather shall be included. The use of brakes and reverse pitch propellers when landing on snow- or ice-covered runways shall be covered. Any

restrictions regarding the use of landing or dive flaps when landing on snow- or slush-covered runways or slush-covered water where ice is suspected shall be included.

3.2.10.5.11 Engine shutdown. The proper method of shutting down the engine shall be given, including a table showing the required oil dilution time for various temperatures. The techniques and precautions to be observed in using oil dilution shall be covered. Operation of systems depending on engine oil (supercharger clutches, propeller governor, etc.) to ensure that these systems are supplied with diluted oil shall be included. Complete instructions for purging normal fuel from the system and filling the lines with special fuel shall be included. Time, speed or other requirement for turbine temperature stabilization prior to shutdown shall be stated.

3.2.10.5.12 Before leaving the aircraft. Coverage of duties to be accomplished before leaving the aircraft, such as leaving canopy slightly open, positioning of doors, battery care, and installing covers, shall be included.

3.2.10.5.13 Desert and hot weather operation. The same principles as outlined in cold weather operation (3.2.10.5.1), shall apply to the desert and hot weather operation section.

3.2.10.5.14 Turbulence and thunderstorm operation. Comments on the general qualities of the aircraft in turbulence and thunderstorms shall be included. A description of the technique to be used shall be given, and all preparations to be made before entering turbulence or thunderstorms shall be included.

3.2.10.5.15 Ice and rain. General coverage of the problem of ice and rain during each phase of flight, such as before takeoff, takeoff, climb, and cruise, shall be included and provisions for guarding against wing, rotor, propeller, carburetor, intercooler, etc., icing shall be mentioned. The effect of engine power, airspeed, etc., on performance of the ice and rain removal systems shall be mentioned. The temperature range and other conditions at which anti-icing/deicing systems are used shall be discussed

3.2.11 Chapter 9 — Emergency procedures. This chapter shall clearly and concisely describe the procedures to be followed in meeting an emergency that could reasonably be expected or encountered. Emergency procedure paragraph titles shall be based on how the pilot recognizes the emergency rather than what caused the emergency (for example, "Low RPM" not "GOVERNOR CONTROL FAILURE"). Complete coverage is required regarding the feel, characteristics, and reaction of the aircraft during various emergencies affecting flight, such as flight with one or more engines inoperative and ditching. All precautions (warnings, cautions and notes) to be observed in coping with and emergency shall be included. This chapter shall contain an emergency amplified checklist. This shall be developed from the material contained within this chapter and the applicable material contained in the chapters previously mentioned.

a. Emergency procedures in connection with the utility systems shall be described in Chapter 2, Section IX. Emergency operation of utility systems shall be included in this chapter insofar as it may affect safety of flight.

b. Within an emergency classification (e.g., engine, fire, etc.) emergencies that have identical corrective actions may be combined under one paragraph heading.

c. Those checks that must be performed immediately in an emergency procedure shall be underlined.

3.2.11.1 Section I — Aircraft systems. Section I shall contain emergency procedures to be taken in the event of an aircraft system malfunction under various conditions.

a. The following statement shall be included:

"Emergency operation of mission equipment is contained in this chapter insofar as its use affects safety of flight. Emergency procedures are given in checklist form when applicable. A condensed version of these procedures is contained in the condensed checklist TM 1-XXXX-XXX-CL.

NOTE

The urgency of certain emergencies requires immediate and instinctive action by the pilot. The most important single consideration is aircraft control. All procedures are subordinate to this requirement.

The term LAND AS SOON AS POSSIBLE is defined as landing at the nearest suitable landing area (e.g., open field) without delay. (The primary consideration is to ensure the survival of occupants.)

The term LAND AS SOON AS PRACTICABLE is defined as landing at a suitable landing area. (The primary consideration is the urgency of the emergency.)"

b. The following statement shall be included for helicopters only:

"The term AUTOROTATE is defined as adjusting the flight controls as necessary to establish an autorotational descent."

c. The following statement shall be included for rotary wing aircraft only:

"Other terms may be defined, as necessary, to simplify the procedural memory steps within the existing emergency procedures. The term can then be used as an emergency procedure step instead of the steps used to define it" EXAMPLE: The term EMER SHUTDOWN is defined as engine stoppage without delay and is accomplished as follows:

1. Throttle — off.
2. FUEL switches — OFF.
3. BAT switch — OFF.

3.2.11.1.1 Emergency exits and equipment. Emergency exists and equipment shall be illustrated. The following illustrations shall be presented, as applicable, in support of the text, aircraft design and equipment.

a. Emergency equipment. This shall be an illustration of the aircraft interior showing life support equipment, permanently installed in the aircraft such as fire axes, flares, pyrotechnic pistols, and hand fire extinguishers (figure 48). This illustration shall not include systems emergency equipment, such as emergency hydraulic controls, engine fire extinguishing systems, and emergency landing gear controls.

b. Emergency routes of escape and exits. If the aircraft is large enough to permit movement of personnel, emergency stations and routes of degrees to be followed in flight and after crash landing on land or water shall be indicated for all personnel. Coding shall be used to differentiate between routes and exits to be used in flight and those to be used after a crash landing (figure 48). This illustration shall be an interior view or as viewed by the occupants of the aircraft and may be combined with the emergency equipment diagram and the emergency entrance diagram, unless the resulting illustration would be confusing.

c. Emergency entrance. A diagram shall be included illustrating points at which emergency entrance can be affected into the aircraft after it has crash landed. This illustration may be combined with the routes of escape and exits diagram, unless the resulting illustration would be confusing (figure 48).

3.2.11.1.2 Engine. The necessary paragraphing shall be provided to set forth the emergency procedures to be taken in the event of an engine malfunction under the various conditions.

a. Flight characteristics under partial power conditions. A description of the characteristics and reactions of the aircraft when flying with one or more inoperative engines or with an engine having only partial power capability shall be included. Emphasis shall be given to any special precautions which must be observed and any dangerous tendencies of the aircraft. Information shall be included on how to determine which engine is inoperative. The problems of maintaining altitude, directional control, and any other special considerations shall be discussed.

b. Engine malfunction under specific conditions. Additional paragraphs shall be included as necessary to indicate action to be taken in the event of engine malfunction under various conditions. Partial engine malfunctions shall be described as well as complete engine failure. A complete checklist procedure to be followed in shutting down the malfunctioning engine and establishing continued flight shall be included. Insofar as possible, shutdown procedure shall be identical to that required in the event of engine fire. Recommended best techniques and procedures for crash landing while operating within avoidance areas (such as within the shaded areas of the height velocity diagram) shall be discussed.

c. Engine malfunction during takeoff and low altitude/low airspeed flight. This shall include possibilities of an abort during the takeoff run, immediately after liftoff and continued flight. Coverage shall be included for both complete engine failure and partial loss of power. For rotary wing aircraft, differentiation between engine malfunction while at a hover and engine malfunction after takeoff (in translational lift) shall be included. The description pertaining to these two types of malfunctions are not necessarily the same as the description of engine malfunction during cruise. Information shall be included concerning jettisoning external stores, landing gear retraction, pilot techniques, best airspeed for minimum power required (partial loss of power), etc. Reference shall be made to the paragraph in this chapter concerning runway barrier engagement (3.2.11.1.8b).

d. Engine malfunction during cruise. Reference shall be made to the chart data in Chapter 7 covering cruise control with one or more engines inoperative. The effect of loss of each engine on the various aircraft systems and equipment shall be included. For example, coverage shall be included for: increased time to extend landing gear and wing flaps when one engine is inoperative, fact that powered flight controls may become ineffective when speed brakes are extended with one engine inoperative, etc. Procedures to be followed in the event of partial power loss as well as for the complete engine failure shall be included, except that inclusion of information which is common knowledge to qualified aviators, such as maintaining aircraft control, and radio transmission, etc., shall not be required.

e. Engine malfunction during final approach. For multi-engine aircraft, procedures shall be provided for loss of one engine while on final approach in the landing configuration. Information shall be included concerning application of maximum controllable power, jettisoning external stores if applicable, landing gear position, use of flaps, pilot techniques and airspeed requirements.

f. Engine restart during flight. Instructions for proper means for restarting an engine in flight and resuming normal flight shall be presented, including such specific restart details as altitude, airspeed, rpm, etc. Special emphasis shall be placed on these criteria, and if considered advantageous, may be presented in chart form. A warning shall be included to the effect that the engine should not be restarted unless it can be determined that it will be reasonably safe to do so.

g. Maximum glide airplane. As applicable, this shall include glide requirements that will result in maximum range with no power available. This information is required for all single-engine and twin-engine aircraft. A graph, showing glide distance attainable from the service ceiling to sea level, shall be included (figure 49).

h. Autorotational descent helicopter. A chart which presents autorotational rate of descent versus indicated airspeed at normal rotor speed shall be provided (figure 50). The indicated airspeeds for minimum rate of descent and maximum glide distance shall be shown on the chart. Data and/or instructions for determining autorotational descent information for variations in aircraft configurations shall also be provided.

i. Landing with one or more engines inoperative. The recommended procedure shall be described, including important precautions. A brief discussion of any changes in the use of landing gear, wing flaps, slats, etc., during such landing shall be included. For single-engine and twin-engine aircraft, proper landing procedure with no power shall be emphasized. For rotary wing aircraft, reference shall be made to the height velocity diagram.

j. Go-around with one or more engines inoperative (fixed wing). Recommended procedures shall be described, including important precautions when different from go-around with engines fully operative.

k. Height velocity. This paragraph shall discuss the minimum height for safe landing following loss of power for both single or multi-engine helicopters. Additionally, initial engine failure for a multi-engine helicopter shall be discussed. Plots of height required for safe autorotational landing after loss of power and initial engine failure shall be included as applicable. For a multi-engine helicopter a recommended approach corridor with the critical engines inoperative shall be shown on the plot. Regions of caution, avoidance, and safe operation shall be shown (figure 51). The plots will be based on initiation of the necessary manual collective pitch control motion after at least a two-second delay following loss of power or as approved by the procuring activity (6.2.)

3.2.11.1.3 Propeller (or rotors, transmissions, and drive systems.)

a. Propeller failure. Instructions shall be given regarding recommended procedure in the event of runaway propeller and other types of propeller failure. Instructions shall be included regarding action to be taken if propeller does not feather properly.

b. Tail rotor failure and directional control malfunctions. Instructions shall be given regarding all modes of directional control malfunctions and tail rotor failures. Coverage shall include emergency procedures to be used in the event of failures during takeoff, while hovering, in flight, and while landing. Instructions for the possibility of maintaining powered flight as opposed to autorotation shall be included. Descriptions of malfunctions shall be in terms of pilot cues.

c. Malfunctions of main rotor transmissions and drive systems. This shall describe and differentiate between malfunctions within the transmission, malfunctions of the drive system between the engine and transmission, and malfunctions of the drive system between the transmission and main rotor. Actual and erroneous instrument/warning light indications shall be discussed, including procedures for specific malfunctions.

d. Other emergencies. Other emergencies such as ground resonance and mast bumping shall be described. Restrictions and preventive actions shall be described if applicable.

3.2.11.1.4 Fire. Instructions shall be included for aircraft fires as follows:

a. Engine fire. Instructions shall be included regarding the recommended method of dealing with engine fires on the ground and during flight. Insofar as possible, engine shutdown procedure shall be identical to that during engine failure.

b. Fuselage fire. Instructions shall be included regarding procedure to be followed when a fuselage fire breaks out. Warnings regarding dangers involved in using fire extinguishing agents shall be included.

c. Wing fires. Instructions shall be included on means of dealing with wing fires. Instructions shall be given to shut down systems which may be feeding the fire.

d. Electrical fire. Any special instructions regarding means of dealing with an electrical fire shall be included. If some of the aircraft fire extinguishers are not to be used for electrical fires, a statement shall be made to that effect.

e. Smoke and fume elimination. Instructions shall be given for most rapid means of dissipating smoke and toxic fumes.

3.2.11.1.5 Fuel system. Instructions shall be given for methods of dealing with fuel system failures and shall include a description of and differentiation between metering system failures (governor failures, etc.), fuel pump failures and control linkage failures (loss of fuel control with fuel input in a fixed position). Emergency procedures shall be included for each condition.

3.2.11.1.6 Electrical system. Instructions shall be given for methods of dealing with electrical system component failures under emergency conditions. Procedures shall be expressed in terms that indicate the action to be taken. If circuit breakers are push-pull type, procedures shall indicate in or out. In cases where circuit breakers are switch type, procedures shall indicate off or on.

3.2.11.1.7 Hydraulic system. Instructions shall be given for methods of dealing with hydraulic system component failures under emergency conditions.

3.2.11.1.8 Landing and ditching. Instructions shall be given regarding landing and ditching emergency procedures as follows:

a. Emergency descent. This shall describe means of accomplishing emergency descent as applicable. Emergency descent should not be confused with rapid descent which is described in Chapter 8. Rapid descent is a maximum performance effort with full consideration for all limits; emergency descent is a maximum effort in which damage to the aircraft or power plant must be considered secondary to getting the aircraft down.

b. Landing emergencies (except ditching). Preparation, warning signals to crew, approach, crew/passenger positions, harness locks, landing technique, routes and methods of crew exits, etc., shall be included for both hard and soft ground. Landings with one or more landing gears retracted, flat tire, no wing flaps, landing on unprepared runways, etc., shall be covered. Proper runway overrun barrier and barricade engagement technique shall be described. Information shall be included regarding pilot technique required for proper engagement, cautions regarding the pilot's head position in order to minimize injury in the event the barricade upper loading strap should enter the pilot's compartment, and any other pertinent information. Information regarding pilot techniques for forced landings in trees or wooded areas shall also be included.

c. Body positions. The body positions to be used by passengers and crew in emergency landings shall be illustrated.

d. Ditching. Instructions shall be included for ditching the aircraft. The ditching capabilities of the aircraft and the advantages of ditching versus bailout (or vice versa) shall be included. The following shall be described: preparation; warning signals to crew, approach; crew/passenger positions; ditching equipment, such as ditching belts and bulkheads; landing techniques; duties of each crewmember immediately after ditching, such as release of life raft and securing of necessary supplies; and methods of crew exits.

e. Ditching and crash landing stations. As applicable, an illustration shall be included showing the position of each crewmember during ditching and crash landing.

3.2.11.1.9 Flight controls. This section shall describe procedures to be employed in event of flight control failure.

3.2.11.1.10 Bailout or ejection. For all aircraft with established crew bailout or ejection procedures, the techniques, precautions, and warning signals for leaving the aircraft in flight shall be described, including instructions for separation from the seat. Bailout procedures to be used when seat ejection fails shall be included. The proper method of preparing the aircraft for bailout and method of jettisoning pilot's compartment enclosures and doors shall be indicated. A pictorial sequence of operations for ejection shall be provided, including alternate methods of removing safety pin where applicable.

3.2.11.1.11 Emergency jettisoning. All means of accomplishing emergency jettisoning of fuel, cargo, equipment, etc., shall be covered. Appropriate cautions relative to possible damage that may result, sudden shifting of center of gravity, etc., shall be included.

3.2.11.1.12 Other emergencies. Other emergency procedures may be added as required, e.g., doors open.

3.2.11.2 Section II — Mission equipment. Section II shall cover all mission equipment malfunctions that constitute a safety hazard during operation. Emergency procedures will be outlined as in Section I and shall include corrective action to be taken. Mission equipment shall include the following, as applicable:

a. Armament systems.

b. Chemical systems.

c. Avionic systems (special equipment).

d. Photographic systems.

e. Cargo systems.

3.2.12 Appendix A — References. This appendix shall be prepared in accordance with MIL-M-38784. Only those publications referenced in the text shall be listed in the appendix. Department of the Army blank forms and military specifications shall not be used.

3.2.13 Appendix B — Abbreviations and terms. A glossary of abbreviations and terms used throughout the text shall be prepared as double column, single spaced.

3.2.14 Index. An alphabetical index shall be prepared in accordance with MIL-M-38784. Index shall contain double column format for subject paragraph, figure, table, and page numbers.

3.3. Operator's Checklist (-CL). This manual shall provide a condensed version of the amplified checklist (3.2.10.2.3 and 3.2.11). Arrangement of the manual shall be as follows:

3.3.1 Standard Operator's Checklist. Unless otherwise specified by the contracting activity, the operator's checklist technical manual shall be prepared for publication as a 4 1/2″ by 8″ looseleaf technical manual and shall comply with the following requirements except those designated to apply to alternate operator's checklist only.

3.3.2 Alternate Operator's Checklist. The contracting activity has the option to specify that a one or two page 8 1/2″ by 11″ alternate operator's checklist be prepared (6.2.) instead of the standard operator's checklist. The alternate operator's checklist shall comply with the following requirements except those designated to apply to standard operator's checklists only.

3.3.2.1 Size and Binding. The standard operator's checklist shall be prepared for a final page size of 4 1/2 inches wide by 8 inches in length. The usable area for preparation of the standard operator's checklist shall be in accordance with figure 53. The alternate operator's checklist shall be prepared for a final page size of 11 inches wide by 8 1/2 inches in length. The usable area for preparation of the alternate operator's checklist shall be 10 1/2 inches wide by 8 inches in length.

3.3.2.2 Type style, size, and spacing. The standard operator's checklist type style, size and spacing shall be in accordance with figure 52. The alternate operator's checklist type style shall be a sanserif type such as futura. Type size and spacing shall be in accordance with figure 53.

3.3.2.3 Publication number assignment. The publication number for standard and alternate operator's checklist technical manuals will be assigned by the contracting activity (6.2.).

3.3.2.4 Marginal copy. Marginal copy for standard and alternate operator's checklist technical manuals shall consist of the publication number, page number, and change number (when applicable).

3.3.2.5 Publication number. The publication number for the standard operator's checklist technical manual shall appear in the center of the top margin as shown in figure 52. The publication number for the alternate operator's checklist technical manual shall appear at the right-hand side of the top margin of each printed page.

3.3.2.6 Page numbers. Page numbers in standard operator's checklist technical manuals shall consist of a capital letter separated from an Arabic numeral by a dash. The letter shall identify the part of the manual as follows: N for Normal E for Emergency, and P for Performance. Page numbers for basic manual pages shall be centered on the bottom of the page. Pages containing general information and scope shall be numbered with lower case Roman numerals; i, ii, etc. Page numbers in the alternate operator's checklist technical manual shall be one-part Arabic numerals and shall be placed at the center of the bottom margin of each page.

3.3.2.7 Change numbers and symbols. For standard operator's checklist technical manuals, each page containing changed material shall bear the appropriate change number (C1, C2), and shall be located adjacent to the page number. The change number shall be furnished by the contracting activity (6.2.) prior to preparation of reproduction copy. For alternate operator's checklist technical manuals only revisions shall be prepared, therefore change numbers and symbols do not apply.

3.3.2.8 Page arrangement. For standard operator's checklist technical manuals, all text shall be prepared in a single column page in accordance with the usable area of figure 52. The alternate operator's checklist technical manuals, all text shall be prepared in three columns equally spaced across the 10 inch horizontal usable area. When authorized by the contracting activity (6.2.), duplicate pages of the -CL may be prepared indicating configuration or equipment differences. The pages will be numbered identically, with difference indicated by the use of designator symbols (3.2.3.5) in the upper right corner of the page. The following statement shall be added to the General Information page of each -CL utilizing duplicate pages:

> "Duplicate pages have been provided indicating aircraft applicability on the upper right corner of -CL pages affected. Remove and discard pages which are not applicable to the assigned aircraft."

For alternate operator's checklist technical manuals, the following statement shall be added following the date or supersession notice and preceding the text:

> "This -CL applies only to the (model number) model of the (aircraft nomenclature)." or "Use only for the (model number) model of the (aircraft nomenclature)."

3.3.2.9 Splitting of procedures. For standard operator's checklist technical manuals, whenever possible, material for in-flight emergency procedures shall be so written that the procedure is contained in a single page. Performance data and procedures such as exterior, interior and before leaving aircraft inspections, which are performed while the aircraft is on the ground need not meet this requirement. Each classification of emergency procedures such as engine, fire, etc., shall begin on a right page.

For alternate operator's checklist technical manuals, procedures may be split between columns but shall not be split between pages.

3.3.2.10 Illustrations. Normal and emergency procedures for standard and alternate operator's checklist technical manuals require no illustrations.

3.3.2.11 Fold-out pages. No fold-out pages shall be used for standard and alternate operator's checklist technical manuals.

3.3.2.12 Table of contents. No table of contents shall be used for standard and alternate operator's checklist technical manuals.

3.3.2.13 Use of color. No color other than black is authorized for standard and alternate operator's checklist technical manuals.

3.3.2.14 Border for emergency pages. Page borders for pages with emergency procedures shall conform to requirements of MIL-M-38784. In alternate operator's checklists, page borders for pages with emergency procedures shall conform to MIL-M-38784, except that borders shall be placed in left and right margins only, instead of on three sides of the page.

3.3.3 Detailed requirements for standard operator's checklist technical manuals. Standard operator's checklist technical manuals shall be prepared in accordance with the following outline:

a. General information and scope.

b. Normal procedures.

c. Emergency procedures.

d. Performance.

NOTE

When required by the contracting activity (6.2.), pages titled "Crewmembers Duties" shall be prepared for normal and emergency procedures.

3.3.3.1 Detailed requirements for alternate operator's checklist technical manuals. Alternate operator's checklist technical manuals shall be prepared in accordance with the outline indicated below:

a. Normal procedures.

b. Emergency procedures.

3.3.4 Normal Procedures Pages. The contents of the normal procedures of this manual are a condensation of the amplified checklists appearing in the Normal Procedures or Crew Duties portion of the applicable operator's manual. A thru flight checklist is provided in this section and consists of asterisk "Thru Flight" items. In addition to thru flight, this checklist may be used for combat/tactical operations when authorized by the commander. Also procedures in the alternate checklist shall be highly abbreviated and shall use abbreviations which are defined in the operator's (-10) technical manual or which are commonly understood by the target audience.

3.3.4.1 Emergency Procedures Pages. The requirements of this section of the condensed checklist manual (CL) are identical to those for the normal procedures, except that the information is drawn from the amplified checks in the emergency procedures portion of the operator's manual. The emergency requirements are subdivided into 10 classifications as follows: engine; propeller/rotor (PROP or ROTOR); fire; fuel; electrical (ELECT); hydraulic (HYD); landing and ditching (LDG/DTCH); flight controls (FLT CONT); bail out or ejection (BAILOUT/EJECT), if applicable; and mission equipment (MSN/EQPT), as applicable. The underlined items are the steps that must be performed immediately without reference to the checklist. The alternate operator's checklist shall comply with the following additional requirements. Classifications which do not apply to the particular equipment shall be omitted. Procedures shall be highly abbreviated and shall use abbreviations which are defined in the operator's (-10) TM or which are commonly understood by the target audience.

3.3.4.2 Performance Pages. This section consists of charts, tables, and checklists for use during preflight, takeoff, cruise, landing, and shutdown.

3.3.4.3 Symbols Preceding Numbered Steps. The following symbols shall be used whenever they apply to a numbered step. In the standard operator's checklist only, the meaning of each symbol used shall be included and shall precede "Normal Procedures."

* — Indicates performance of steps is mandatory for all Thru Flights.

N — Means performance of step is mandatory for Night Flights.

★ — Indicates a detailed procedure for this step is included in the Performance Checks section, located at the back of the checklist.

I — Indicates mandatory check for Instrument Flights.

O — Indicates if installed or available.

Immediate action emergency items are underlined.

3.3.4.4 Reporting errors and recommending improvements. The following statement shall appear at the end of general information and scope for the standard operator's checklist only:

"REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) to Commander, US Army Aviation Systems Command, ATTN: AMSAV-MC, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished to you."

Types of comments that should be avoided on DA Form 2028 are those that: (1) Ask a question instead of giving an answer; (2) Are based on minor differences of opinion or wording; (3) Correct typographical errors, update references, terminology, or office symbols.

3.3.4.5 Normal procedures pages. The content of the normal procedures of the checklist manual shall be derived by condensing the amplified checklist appearing in the normal procedures or crew duties portion of the applicable operator's manual. The condensation shall be accomplished by omitting all explanatory material in the amplified checklist. Check items within this manual shall be numbered the same as the corresponding steps in the -10 manual. Before landing shall begin on the top of page (figure 55).

1. Collective — Down and locked.
2. Throttle — Closed.
3. SYS-IGN SOL circuit breaker — In.
4. STARTER REL circuit breaker — In.

The condensed checklist manual (CL) shall consist of a series of controls (or checks) and the required actions. The sequence of items (or checks) appearing in the condensed checklist manual shall be identical to those appearing in the operator's manual amplified checklist. In extremely unusual circumstances, explanatory material may be used in the condensed checklist manual in the form of warnings, cautions, and notes.

3.3.4.6 Emergency procedures pages. The requirements for this section of the condensed checklist manual (CL) are identical to those for the normal procedures, except that the information shall be drawn from the amplified checks in the emergency procedures portion of the operator's manual. The emergency requirements shall be subdivided as applicable into 10 classifications listed in paragraph 3.3.2.1. Placarded positions in the response shall be in upper case (figure 57).

3.3.4.7 Performance data pages. Performance data consists of performance checks.

3.3.4.8 Performance data charts. The contracting activity shall specify the use of performance data charts in the checklist and the format these charts must follow (6.2.). The data to be included in the performance data charts shall be the same data base as the charts appearing in the performance data portion of the operator's manual.

3.3.4.9 Performance checks. When applicable, detailed performance checks of selected procedures as indicated by the contracting activity (6.2.) shall follow performance data charts. The symbol shall precede those checks for which a detailed procedure is included in the performance data section.

3.3.4.10 Thru-flight checklist. A thru-flight checklist shall be included in the performance data section. It shall consist of all thru-flight (*) checks from the normal procedures section of the applicable operator's manual. The checks shall be numbered sequentially and shall begin on the first page of the performance section.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in (applicable test method document or applicable paragraph(s) in the specification).

4.3 Noncompliance. If a sample fails to pass inspection, the manufacturer shall notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured with essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the qualifying activity has been taken. After corrective action has been taken, the inspection shall be repeated at option of the qualifying activity. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.4 Performance data substantiation report. Contractors shall submit with the draft manual, required copies as stated by the contracting activity (6.2), of an aerodynamic report, illustrating the derivation of the data entered on the charts. Analysis leading to the establishment of lift and drag values used in the calculation, aircraft efficiency and compressibility correction factors, methods of computing power or thrust required and available, a discussion of duct loss and propeller efficiencies, and adequate references to appropriate wind tunnel or flight test data shall also be presented. Contractors are free to use calcula-

tion methods of their own selection but such methods shall be fully explained and a sample calculation given. Calculations shall be presented in sufficient detail to permit ready review and check of conclusions and to enable additional calculations to be made by the contracting activity. Revisions of the report, or additional reports, shall be submitted with the review copies of all revisions to the manual which affect data in this chapter.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with ASTMD 3951.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended Use. The operator's manual, and the operator's checklist technical manuals prepared in accordance with this specification provide the operators and crewmembers with operational procedures and a condensed checklist for both normal and emergency operations together with selected performance data.

6.2 Acquisition requirements. In addition to the requirements in MIL-M-38784, acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1).

c. Title and number of the technical manual, furnished by the contracting activity.

d. Specification tailoring by selection of optional requirements on the content/format selection summary (appendix).

6.3 Subject Term (Keyword) Listing.

Basis for data and graphics — (checklists & Manuals).

Design for layout and graphics.

Instruction and format, preparation of.

Preparation instructions.

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

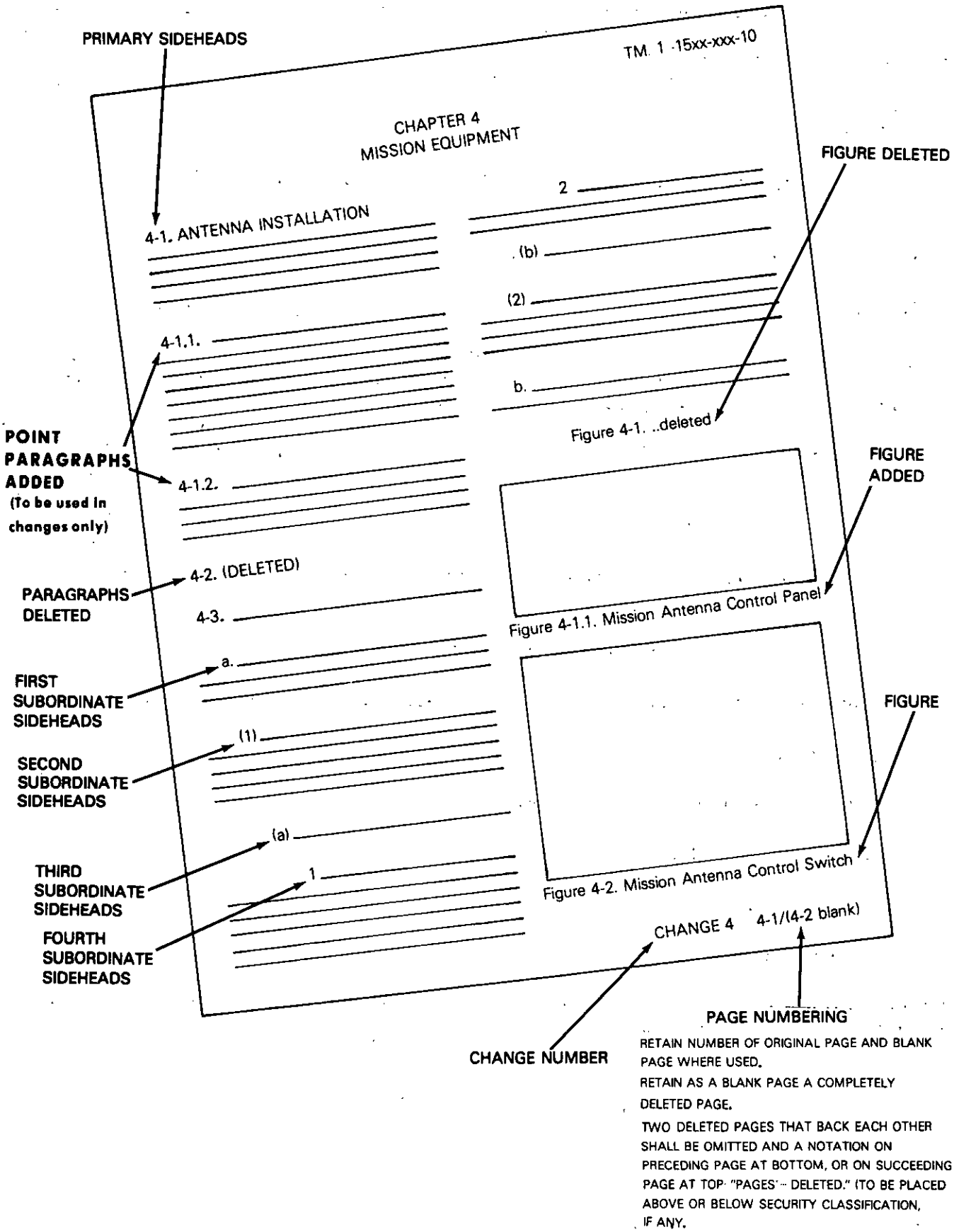
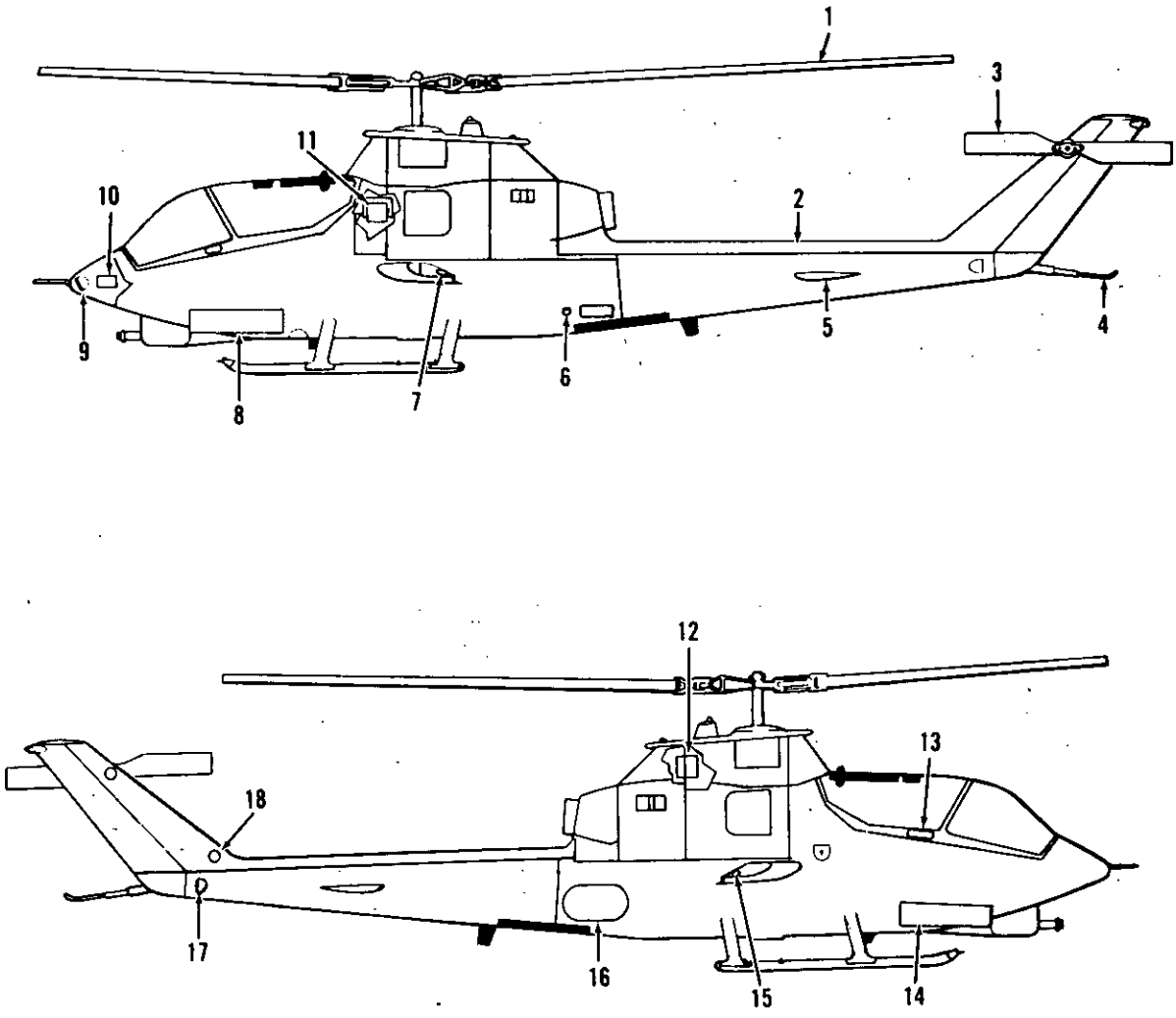
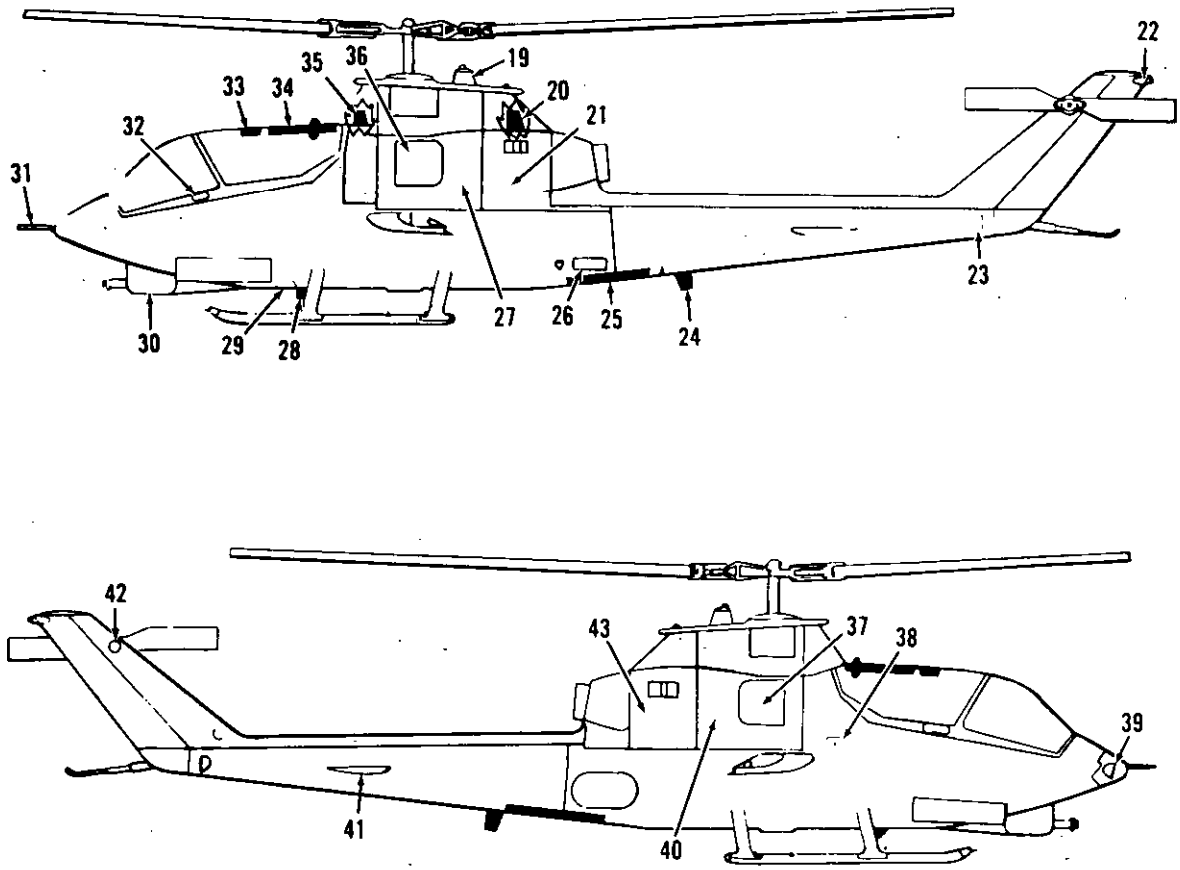


FIGURE 1. Numbering requirements



1. Main rotor blades and hub assembly
2. Tail rotor drive shaft cover
3. Tail rotor blades and hub assembly
4. Tail skid
5. Synchronized elevator (Left side)
6. Ground power unit (GPU) receptacle access door
7. Wing tip position light (Red)
8. Ammunition compartment access door (Left side)
9. Landing light (Left side)
10. Forward battery location
11. Hydraulic reservoirs and access doors
12. Engine oil tank and access door
13. Pilot compartment canopy latch
14. Ammunition compartment access door (Right side)
15. Wing tip position light (Green)
16. Electrical compartment door
17. Aft position light (White)
18. Intermediate gearbox (42°) oil level sight gauge

FIGURE 2. Sample aircraft general arrangement diagram



19. Anti-collision light
20. AN/ARC-54 communication antenna
21. Engine compartment access door (Left side)
22. Aft position light white
23. Aft position light (White)
24. AT-1108/ARC UHF-VHF communications antenna
25. AN/ARN ADF sense antenna
26. Aft battery location
27. Transmission compartment access door (Left side)
28. AT-884/APX antenna
29. Searchlight
30. XM-28 turret
31. Pitot tube
32. Gunner compartment canopy latch
33. AN/ARC-54 homing antenna
34. ARN-83 loop antenna
35. AN/ARC-54 communication antenna and AT-1108/ARC UHF-VHF communication antenna
36. Engine air inlet screen doors (Left side)
37. Engine air inlet screen doors (Right side)
38. Fuel filler cap
39. Landing light (Right side)
40. Transmission compartment access door (Right side)
41. Synchronized elevator (Right side)
42. Tail rotor gearbox (90°) oil level sight gauge
43. Engine compartment access door (Right side)

FIGURE 2. Sample aircraft general arrangement diagram - Continued

USE	STYLE AND SIZE[1]	LOCATION	REMARKS
1. Title	Universal Bold Condensed 12[2]	Centered, just below[3] publication number[4]	Includes model designator symbol only if applicable
2. Sub-Title	Universal Bold Condensed 10	Centered, 6 points below[3] title	Used only if required to distinguish similar graphs
3. Condition heading	Universal Bold 8[2]	Centered, 6 points below[3] title or subtitle	Separate conditions; one line desirable
4. NOTE:	Universal Bold 8	As required	Notes on graph page very undesirable - text preferred
5. Note information	Universal Medium 7	Following NOTE:	Use only if required to prevent misuse
6. EXAMPLE and number	Universal Bold Condensed 10	Centered over example text	Usually located near upper left of page
7. WANTED	Universal Bold 8	Indented 18 points; 12 points below EXAMPLE	
8. Wanted text	Universal Medium 7	Left margin justified; 6 points below WANTED	Parameter names only maximum of three
9. KNOWN and METHOD	Universal Bold 8	Indented 18 points; 6 points below preceeding text	
10. Known text	Universal Medium 7	Left margin justified; 6 points below KNOWN	Format: Parameter = Value, Units
11. Method Text	Universal Medium 7	Left margin justified; 6 points below METHOD	One line per step do not repeat konwn values
12. Primary scale values	Universal Bold 8	One minor grid division outside grid border	Oriented to read from bottom of page
13. Primary scale titles	Universal Bold 8	One minor grid division outside scale value numbers	Oriented to read from right (vertical scales) or bottom (horizontal scales) of page
14. Secondary scale values	Universal Medium 7	Two minor grid divisions outside grid border	Additional secondary scales may be added
15. Secondary scale titles	Universal Medium 7	One minor grid division outside scale values	
16. Primary data line labels	Universal Bold X X = 1 minor grid division	At mid point, 1 minor grid width to left or above lines	Parallel to data lines oriented to read from bottom.
17. Primary data line values	Universal Bold X X = 1 minor grid division	Interrupting data lines near mid-point	Alternate values staggered; if negative use (-) and (+)
18. Limit line labels	Universal Bold X X = 1 minor grid division	Parallel to limit line, near midpoint, in prohibited area	
19. Maximum Performance or Recommended operation	Universal Bold X X = 1 minor grid division	Location and orientation dependent on layout	
20. Time limited or restricted operation	Universal Bold X X = 1 minor grid division	Parallel to limit line, at midpoint in restricted area	
21. DATA BASIS:	Universal Bold 8	Left justified 6 points[3] above figure number	
22. Data basis text	Universal Medium 7 Initial[5] letter(s) only upper case	Following DATA BASIS:[3]	Includes data type, and source data document(s)
23. Figure number and title	Italic Medium 8 Initial[5] letter(s) only upper case	Centered, 6 points above[3] page number[4]	Includes figure number, title and if applicable sub-title and sht __ of __

NOTES:
[1] Size requirements apply to the final printed product. A 10% tolerance is allowed, however deviation on any page should be in the same direction.
[2] For independent sub-graphs on the same page, reduce heading type size by two points.
[3] Spacing is designed for heading information, Data Basis, and Figure information to be marginal copy to provide the full 7 by 9 inch area for the graph. If the full layout area is not required, or used, increase spacing to provide a balanced appearance.
[4] Publication and page number specifications are the same as for all other (non-graph) pages.
[5] Data basis text, figure number and figure title have first letter only upper case capitalization. All other types all upper case capitalization.

FIGURE 3. Graphical type standards

USE	COLOR	LENGTH	WEIGHT [1]	REMARKS
1. Primary Data	Black	To limits or operational range	1 0 00	Most even value Alternate lines Use if increments change
2. Grid Lines	Grey	Correspond to Primary scales	0 00	Major increments Minor increments
3. Transfer Grid	Grey	1/3 to 1 major grid	0.00	Direction of transfer only
4. Grid Border	Black	Primary scale length	1	Over outside grid
5. Primary Scale Tick Marks	Black	1/2 to 1 minor grid division	1	Inside grid border major grid only.
6. Secondary Scale Tick Marks	Black	1 minor grid 1/2 minor grid	0 (Major) 00 (Minor)	Outside grid border
7. Limit Lines	Black	As required	1	
8. Maximum Performance or Recommended Operation	Black	As required	1 0	Major lines Use if multiple lines
9. Restricted or Time Limited Operation	Grey	As required	00 (Border) shaded	Shaded area with black border line
10. Extrapolated Data	Black Dashed	As required	1,0,00	Use for data beyond source data conditions
11. Beyond Limit Data	Black Dotted	As required	1,0,00	Use for data beyond operating limits to aid interpolation

Line Definitions

Weight	Number [2]	Width: inches	millimeters
Very Fine	000	0.004	0.1
Fine	00	0.008	0.2
Medium	0	0.012	0.3
Heavy	1	0.016	0.4
Very heavy	2	0.020	0.5

Dashed: 5 to 10 x width line lengths, 3 to 5 x width gap space
Dotted: 1 to 2 x width line lengths, 2 to 3 x width gap space

NOTES: [1] Line weight requirements apply to the final printed product. A 20% deviation is allowed, however, deviation on any page should be in the same direction.
[2] Corresponds to rapidograph pen numbering system.

FIGURE 4. Graphical line standards

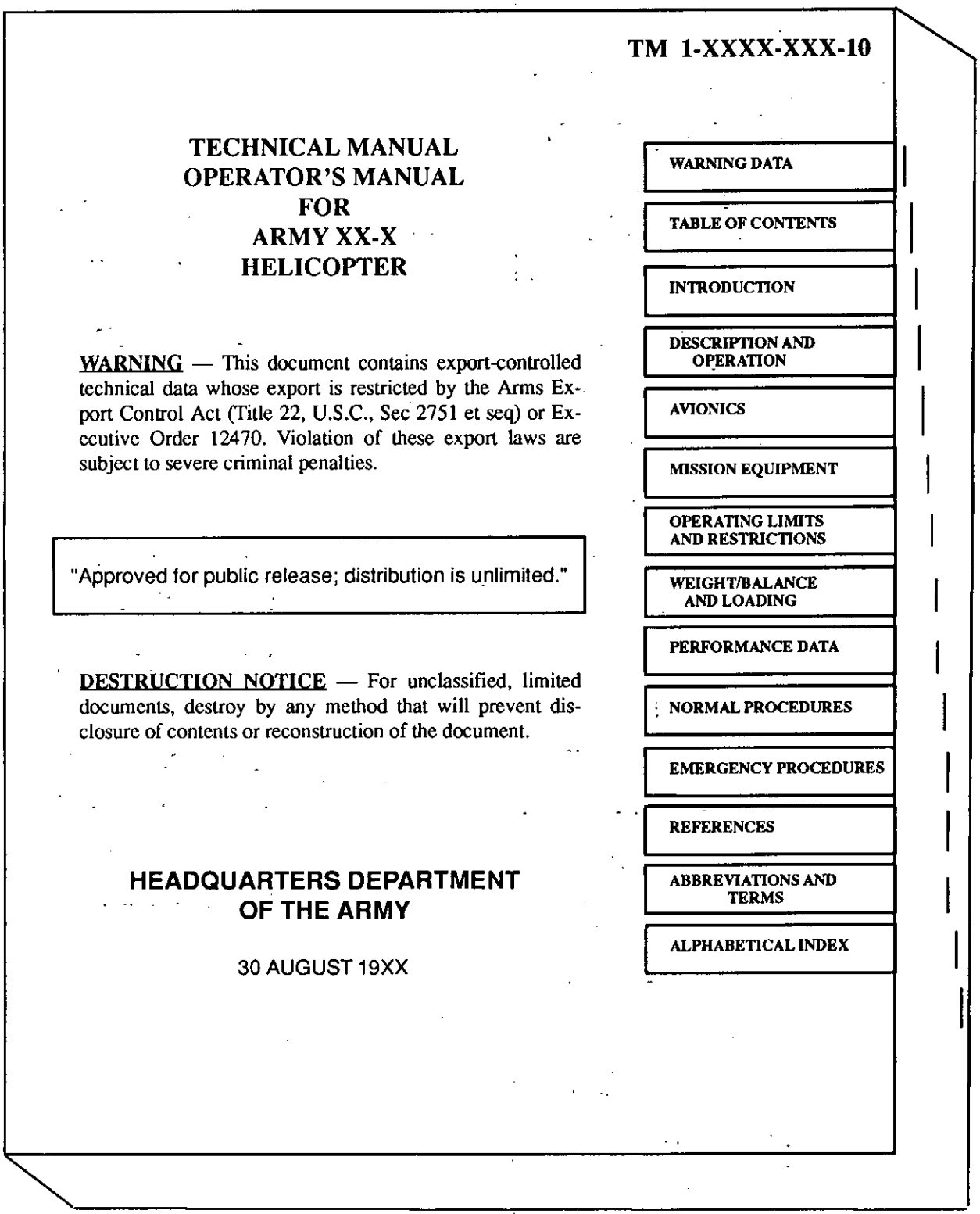


FIGURE 5. Example of front cover

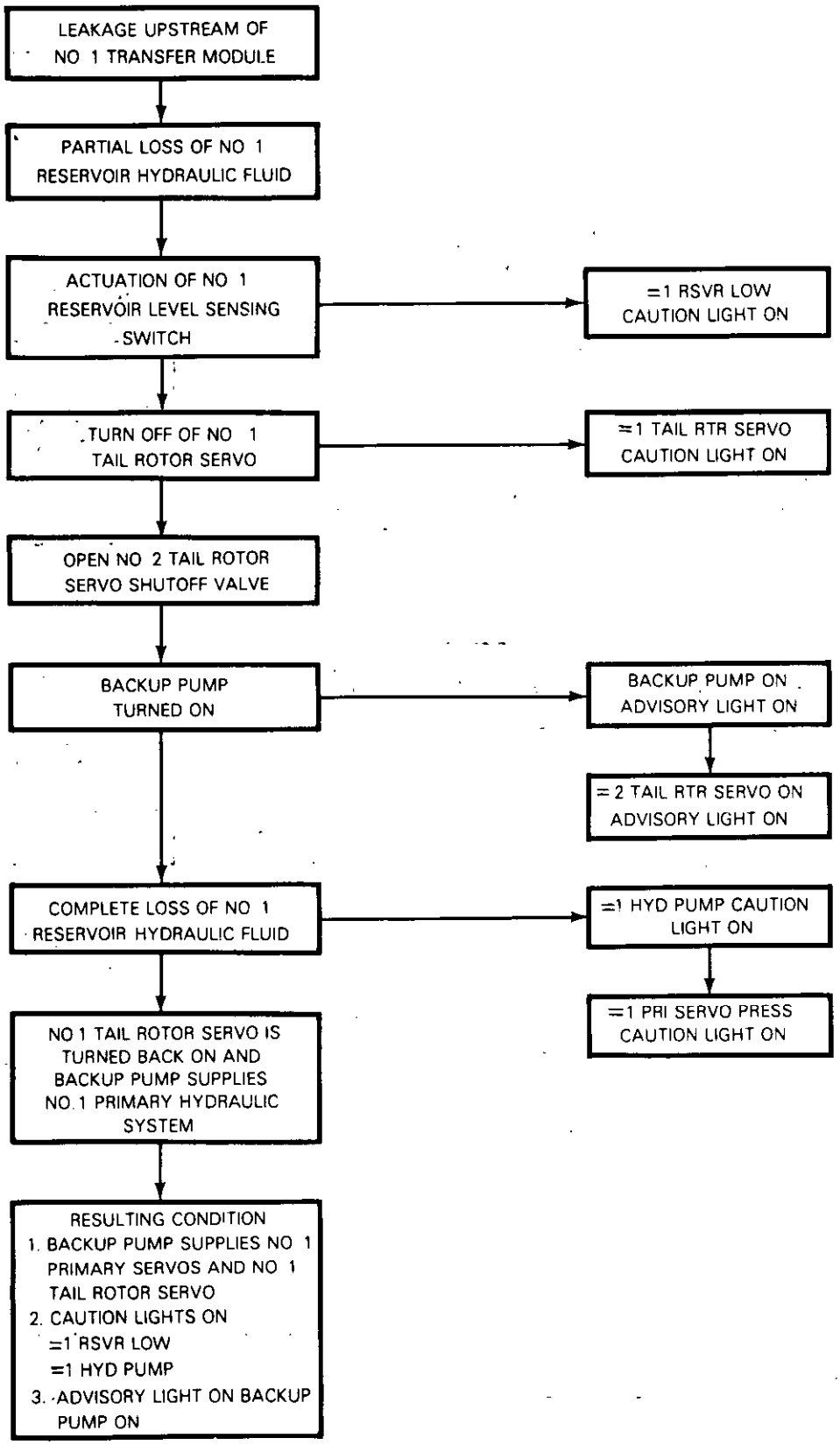


FIGURE 6. Example of flight crew oriented malfunction isolation chart

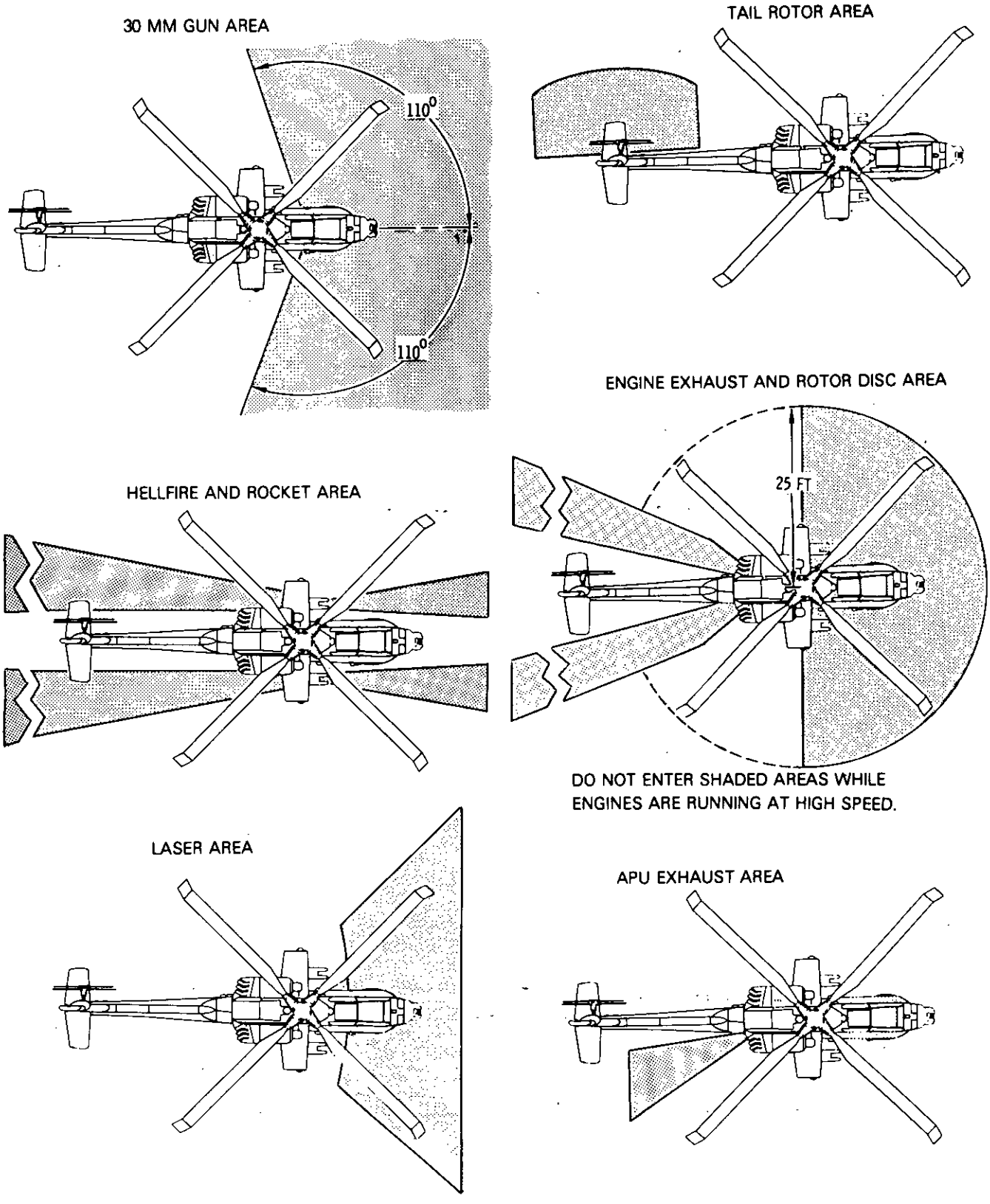


FIGURE 7. Example of danger area diagram

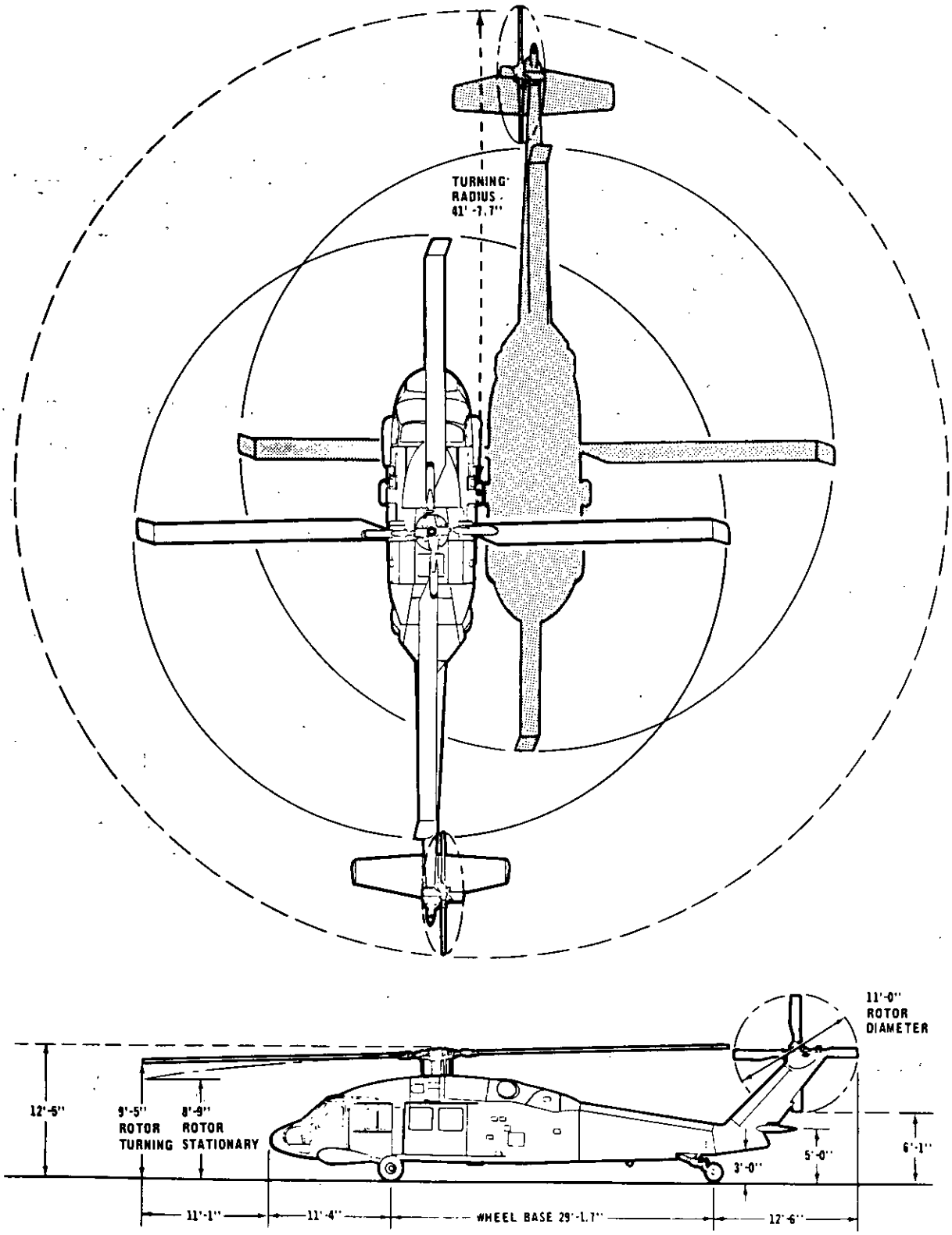


FIGURE 8. Example of turning radius, ground clearance, and dimensions diagram

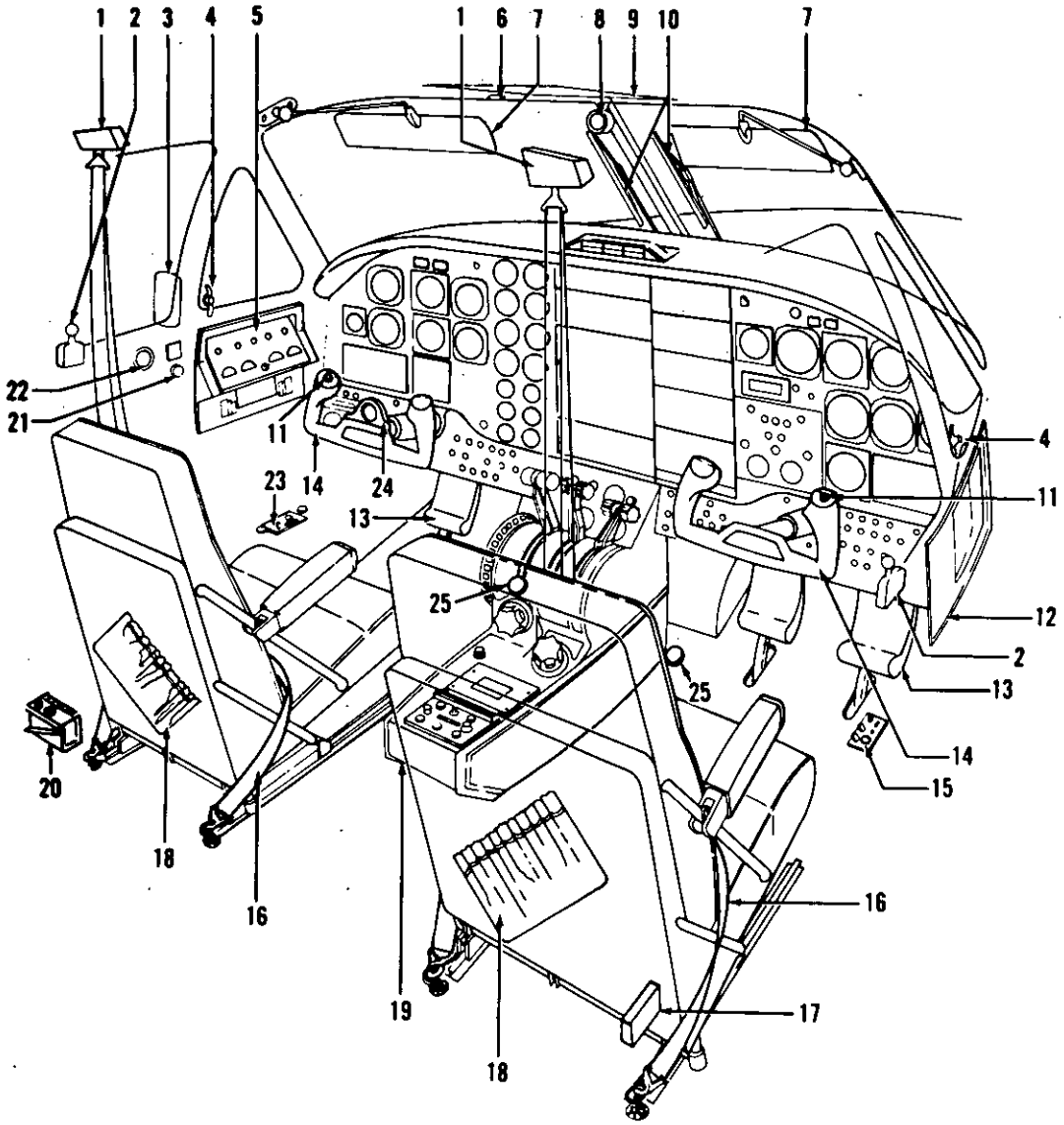
TM 1-15XX-XXX-10

Table 2-1. Main Differences

ITEM	RU-21E	RU-21H
Maximum takeoff gross weight	9,650 pounds Special equipment operators (2)	10,200 pounds
Maximum landing weight	9,168 pounds	9,700 pounds
Wing span	45 ft 10.5 in	50 ft 3 in
Minimum ground turning radius	29 ft 8.75 in	31 ft 11 in
Mission antennas	Fixed type	Fixed type plus two retractable belly mounted mission antennas
	None	Mission antennas deice boots
Fuel system	Four quantity indicator gages installed	Two quantity indicator gages installed
Emergency equipment	Four first aid kits installed	Two first aid kits installed
Oxygen system	Two 64 cubic foot cylinders servicing pilot, copilot and two operator stations	Four 64 cubic foot cylinders servicing pilot and copilot, and provisions for two personnel in cabin area
Communications	Audio control panel C-1611/AIC (four installed)	Audio control panels C-1611/AIC (two installed)
	FM liaison set AN/ARC-131 (two installed)	FM liaison set AN/ARC-131 (one installed)
	Voice security TSEC/KY-28 (two installed, one for pilot and copilot and one for mission operators)	Voice security TSEC/KY-28 (two installed, one used with FM and one with UHF)
	HF command set	Complete provisions only
Crew	Minimum crew normal mission; two pilots and two operators	Minimum crew normal mission; two pilots
Miscellaneous equipment	Plotting board behind pilot's seat	None
	Rack for five M-16 rifles	None
	Shock mounted racks both sides of cabin	Shock mounted racks on right side of cabin

FIGURE 9. Example of main differences table

TM 1-15XX-XXX-10



1. Shoulder harness inertia reel
2. Shoulder harness lock lever
3. External rear view mirror
4. Storm window lock
5. Fuel management panel
6. Free air temperature gage
7. Sun visor
8. Magnetic compass
9. Overhead control panel
10. Windshield wipers
11. Microphone switch
12. Copilot's circuit breaker panel
13. Rudder pedals
14. Control wheel
15. Oxygen regulator control panel
16. Seat belt
17. Vertical gyro circuit breaker box
18. Utility pocket
19. Control pedestal
20. Audio control panel
21. External mirror adjustment knob
22. Oxygen system gage
23. Oxygen system controls and regulator control panel
24. Eight-day clock
25. Foot microphone switch

FIGURE 10. Compartments

	CABIN PRESSURE ALTITUDE	CREW MASK CONDITION	TOTAL FLOW LPM-NTPD	DURATION IN MINUTES (1)
TWO MAN CREW	31,000	100%	8.4	384.0
	25,000	100%	11.8	273.3
	20,000	100%	15.2	212.2
	20,000	NORMAL	7.4	448.0
	15,000	100%	19.0	169.7
	15,000	NORMAL	10.2	316.2
	10,000	100%	23.8	135.5
	10,000	NORMAL	13.8	233.7
TWO MAN CREW PLUS ONE PASS	31,000	100%	12.1	266.6
	25,000	100%	15.5	208.1
	20,000	100%	18.9	170.0
	20,000	NORMAL	10.9	295.9
	15,000	100%	22.7	142.1
	15,000	NORMAL	13.9	232.1
	10,000	100%	27.5	117.3
	10,000	NORMAL	17.5	184.3

(1) For 100% capacity of useable oxygen, 3,226 L.

FIGURE 11. Example of oxygen duration table

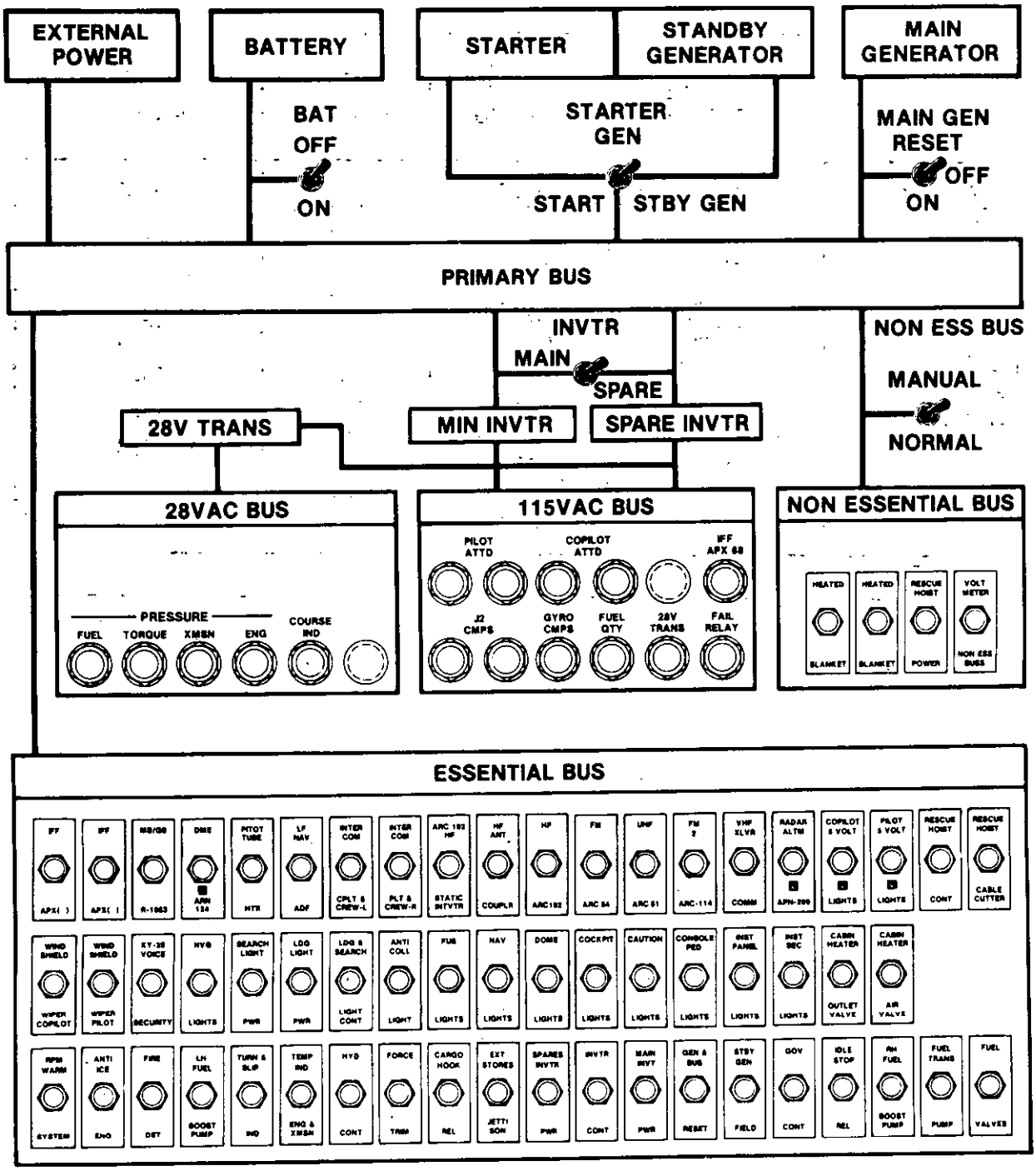


FIGURE 12. Example of electrical power supply and distribution system

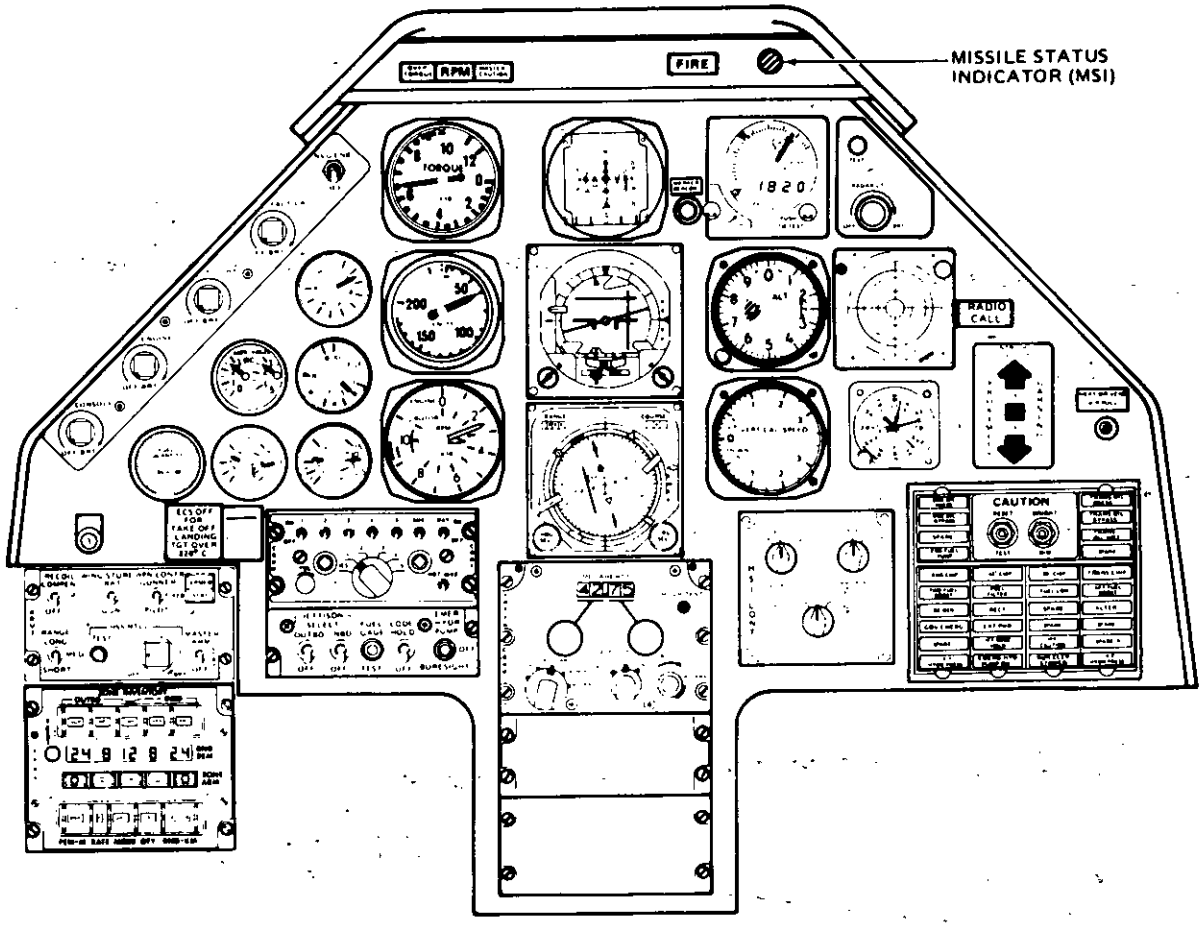
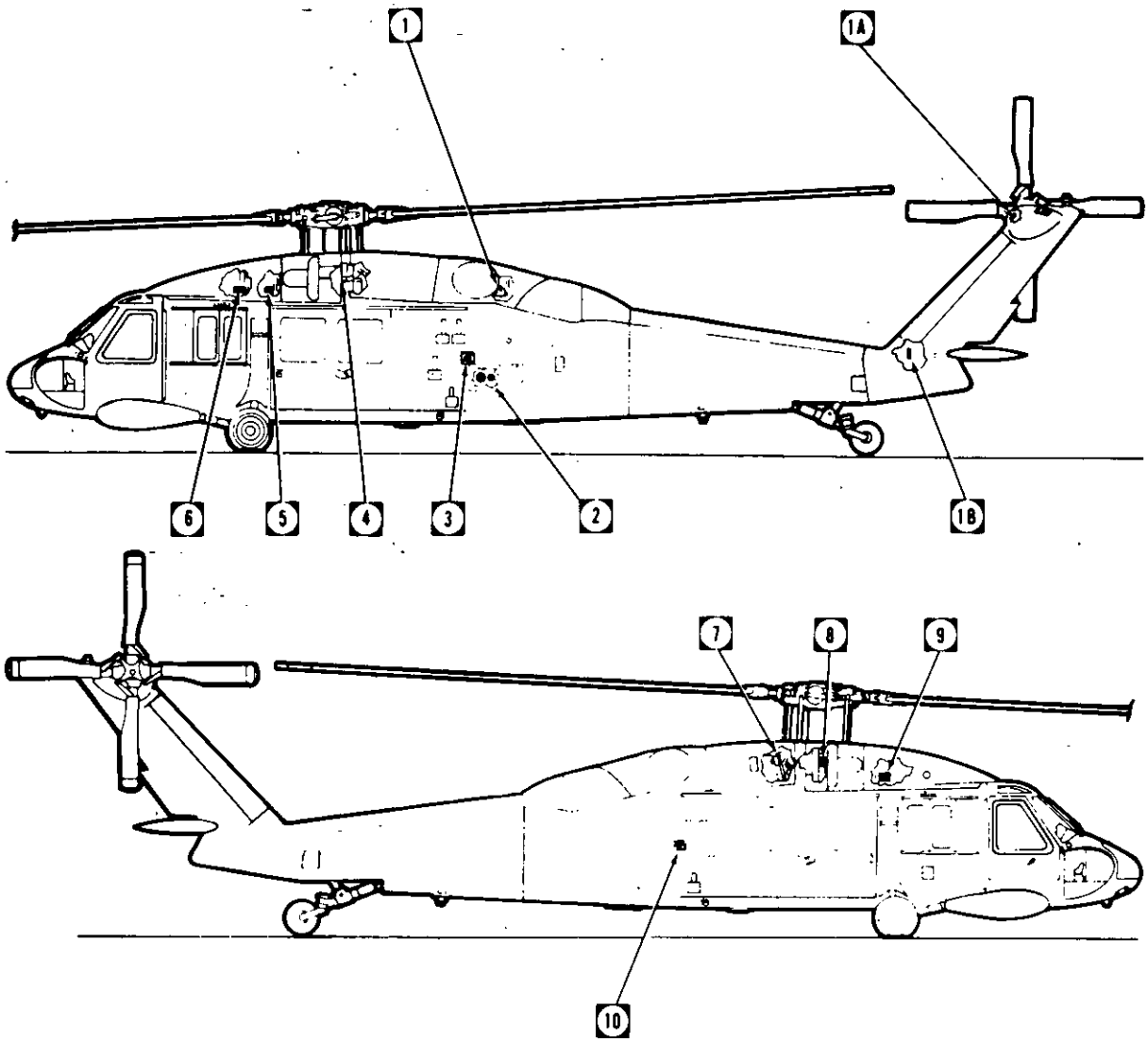


FIGURE 13. Instrument panel

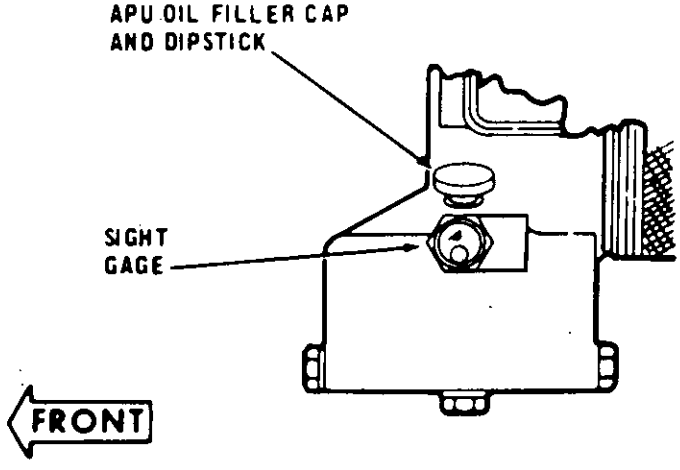
TM 1-15XX-XXX-10



1. AUXILIARY POWER UNIT
1A. TAIL ROTOR GEAR BOX OIL LEVEL SIGHT GAGE
1B. INTERMEDIATE GEAR BOX OIL LEVEL SIGHT GAGE
2. CLOSED CIRCUIT AND PRESSURE REFUELING PORTS
3. NO. 1 (LEFT) FUEL TANK GRAVITY REFUEL PORT
4. NO.1 ENGINE OIL LEVEL SIGHT GAGE
5. NO. 1 HYDRAULIC PUMP MODULE
6. BACKUP HYDRAULIC PUMP MODULE
7. MAIN TRANSMISSION OIL FILLER PORT AND DIP STICK
8. NO. 2 ENGINE OIL FILLER PORT AND SIGHT GAGE
9. NO. 2 HYDRAULIC PUMP MODULE AND PUMP MODULE FLUID FILLER PUMP
10. NO. 2 (RIGHT) FUEL TANK GRAVITY REFUEL PORT

FIGURE 14. Servicing diagram

TM 1-15XX-XXX-10



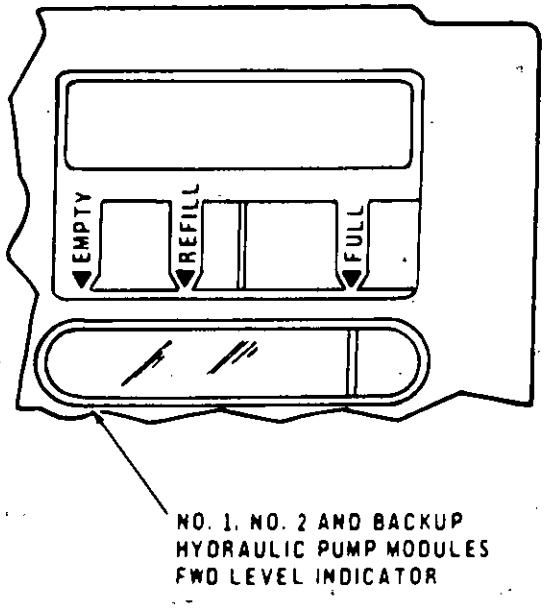


FIGURE 14. Servicing diagram - Continued

Servicing Table of Approved Fuels, Oils, and Fluids

System	Specification
Fuel	MIL-T-5624 (JP-4) [1]
Crashworthy System—	
Total: 208.5 U.S. gallons (789.2 liters).	
Usable: 206.5 U.S. gallons (781.6 liters)...	
Internal Auxiliary Tanks—	
Usable: 300 U.S. gallons (1135.5 liters)....	
Oil:	
Engine	MIL-L-23699 [2,4]
	*MIL-L-7808 [2,4]
Transmission	MIL-L-23699 [2,4]
	*MIL-L-7808 [2,4]
42° Gearbox	MIL-L-23699 [2,4]
	*MIL-L-7808 [2,4]
90° Gearbox	MIL-L-23699 [2,4]
	*MIL-L-7808 [2,4]
Hydraulic System	MIL-H-5606 [6,7]
	MIL-H-83282 [6,7]
Main Rotor Grip	MIL-L-46152 [8,9]
	MIL-L-23699 [2,4,9]
	*MIL-L-7808 [2,4]
	MIL-L-2104 [8,9]
	MIL-L-46167 [8,9]
Pillow Block Oil	MIL-L-23699 [2,4]
	*MIL-L-7808 [2,4]
	MIL-L-2104 [8,9]
	MIL-L-46152 [8,9]
	MIL-L-46167 [8,9]

Average Temp Range	Specification
+5°C and above	MIL-L-2104, Grade 40, NATO Code 0-230
−18°C to +5°C	MIL-L-2104, Grade 30, NATO Code 0-230 or MIL-L-46152, Grade 30
−29°C to −18°C	MIL-L-2104, Grade 10, NATO Code 0-230 or MIL-L-46152, Grade 10W30
−54°C to −20°C	MIL-L-46167, DEXRON II Automatic transmission fluid.

Approved domestic commercial fuels (spec. ASTM-D-1655-70): Manufacturers designation—

Jet B—JP4 Type	Jet A—JP5 Type	Jet A-1—JP8 Type
American JP-4	American Type A	
Aerojet B	Aerojet A	Aerojet A-1
	Richfield A	Richfield A-1
B.P.A.T.G.		B.P.A.T.K.
Caltex Jet B		Caltex Jet A-1
	CITGO A	
Conoco JP-4	Conoco Jet-50	Conoco Jet-60
Gulf Jet B	Gulf Jet A	Gulf Jet A-1
EXXON Turbo Fuel B	EXXON A	EXXON A-1
Mobil Jet B	Mobil Jet A	Mobil Jet A-1
Philjet JP-4	Philjet A-50	
Aeroshell JP-4	Aeroshell 640	Aeroshell 650
	Superjet A	Superjet A-1
	Jet A Kerosine	Jet A-1 Kerosine
Chevron B	Chevron A-50	Chevron A-1
Texaco Avjet B	Avjet A	Avjet A-1
Union JP-4	76 Turbine Fuel	

Approved foreign commercial fuels:

Country	F-40	F-44
Belgium	BA-PF-2B	
Canada	3GP-22F	3-6P-24e
Denmark	JP-4 MIL-T-5624	
France	Air 3407A	
Germany (West)	VTL-9130-006	UTL 9130-007/UTL 9130-010
Greece	JP-4 MIL-T-5624	
Italy	AA-M-C-1421	AMC-143
Netherlands	JP-4 MIL-T-5624	D. Eng Rd 2493
Norway	JP-4 MIL-T-5624	
Portugal	JP-4 MIL-T-5624	
Turkey	JP-4 MIL-T-5624	
United Kingdom (Britain)	D. Eng Rd 2454	E. Eng Rd 2498

NOTE: Anti-icing and Biocidal Additive for Commercial Turbine Engine Fuel—The fuel system icing inhibitor shall conform to MIL-I-27686. The additive provides anti-icing protection and also functions as a biocide to kill microbial growths in helicopter fuel systems. Icing inhibitor conforming to MIL-I-27686 shall be added to commercial fuel, not containing an icing inhibitor, during refueling operations, regardless of ambient temperatures. Refueling operations shall be accomplished in accordance with accepted commercial procedures. Commercial product "PRIST" conforms to MIL-I-27686.

Approved domestic commercial oils for Mil-L-7808: Manufacturers designation—
PQ Turbine Oil 8365
ESSO/ENCO Turbo Oil 2389
RM-184A/RM-201A

FOOTNOTES

[1] Army Standard fuel is MIL-T-5624 (JP-4) NATO code is F-40 Alternate fuels are MIL-T-5624 (JP-5) (NATO F-44) and MIL-T-83133 (JP-8) (NATO F-34). Emergency fuel is MIL-G-5572 (any AV gas) (NATO F-12, F-18, F-22). Refer to TM 55-9150-200-24.

The helicopter shall not be flown when emergency fuel has been used for a total cumulative time of 50 hours. (25 hours when TCP is used in fuel.)

CAUTION

* Lubrication oil made to MIL-L-7808 by Shell Oil Company under their part number 307, qualification number 7D-1 shall not be used in the engine or aircraft systems. It contains additives which are harmful to seals in the systems.

[2] * MIL-L-7808 NATO code is O-148. For use in ambient temperatures below minus 32°C/25°F. May be used when MIL-L-23699 oil is not available. Not for use in main rotor hub P/N 204-012-101-31.

CAUTION

Under no circumstances shall MIL-L-23699 oil be used in ambient temperatures below minus 32°C/25°F.

[3] MIL-L-23699 NATO code is O-156. For use in ambient temperatures above minus 32°C/25°F. Not for use in main rotor hub P/N 204-012-101-31.

[4] Do not mix MIL-L-2104, MIL-L-46152, MIL-L-46167, MIL-L-23699, and for MIL-L-7808 oils, except during an emergency. If the oils are mixed the system shall be flushed within six hours and filled with the proper oil. An entry on DA Form 2408-13 is required when the oils are mixed.

[6] MIL-H-5606 NATO code is H-515. For use in ambient temperatures below minus 35°C/30°F. (Refer to TB 55-1500-344-25.)

[7] For use in ambient temperatures above minus 35°C/30°F.

CAUTION

Prolonged contact with hydraulic fluid or its mist can irritate eyes and skin. After any prolonged contact with skin, immediately wash contacted area with soap and water. If liquid contacts eyes, flush immediately with clear water. If liquid is swallowed, do not induce vomiting; get immediate medical attention. When fluid is decomposed by heating, toxic gases are released.

[8] It is not advisable to mix MIL-H-5606 and MIL-83282 fluids, except during an emergency. An entry on DA Form 2408-13 is required when the fluids are mixed. When changing from MIL-H-5606 to MIL-H-83282, not more than two percent of MIL-H-5606 may be present in the system.

[9] Refer to stencil on grip assembly to determine proper lubrication requirements.

[9] MIL-L-2104, MIL-L-46152, and MIL-L-46167, must be used in hub P/N 204-012-101-31 as follows:

FIGURE 15. Example of servicing table of approved fuels, oils, and fluids

CAUTION

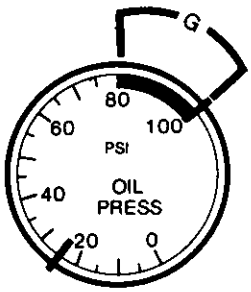
Do not use Shell Oil Co., part No. 307, qualification No. 7D-1 oil (MIL-L-7808). It can be harmful to seals made of silicone.

Approved domestic commercial oils for MIL-L-23699: Manufacturers designation—
PQ Turbine Lubricant 5247/6423/6700/7731/8878/9595
Brayco 899/899-G/899-S
Castrol 205
Jet Engine Oil 5
STO-21919/STO-21919A/STD-6530
HATCOL 3211/3611
Turbo Oil 2380 (WS-6000)/2395 (WS-6459)/2392/2393
Mobil Jet II RM-139A/Mobil Jet II RM-147A/Avrex S Turbo 260/Avrex S Turbo 265
Royco 899 (C-915)/899SC/Stauffer Jet II
Aeroshell Turbine Oil 500
Aeroshell Turbine Oil 550
Chevron Jet Engine Oil 5
Stauffer 6924/Jet II
SATO 7377/7730, TL-8090

Approved domestic commercial fluids for MIL-H-5606. Manufacturers designation—
"PO" 4226
Brayco 757B
Brayco 756C
Brayco 7561D
Hyspin A
Univis J41
Aero HFB
Petrofluid 5606B
Petrofluid 4607
Royco 756C/D
Royco 782
XSL 7828
PED 3565
PED 3337
TL-5874
Aero Hydroil 500
YT-283
FP-221
Approved domestic commercial fluids for MIL-H-83282:
Brayco Micronic 882
Hanover R-2
HF 832
XRM 230A
XRM 231A

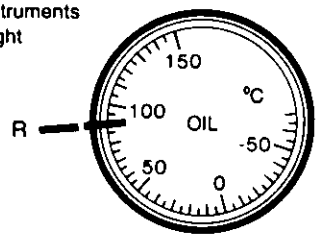
FIGURE 15. Example of servicing table of approved fuels, oils and fluids - Continued

COLOR MARKING CODES
W - White
R - Red
G - Green
NVG—Aircraft with Instruments Modified for Night Vision Goggles



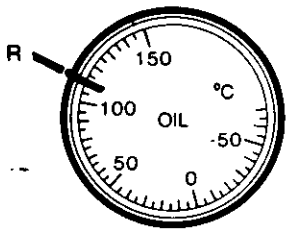
ENGINE OIL PRESSURE

R ■ 25 PSI Minimum—Engine Idle
G ■ 80 to 100 PSI Continuous
R ■ 100 PSI Maximum



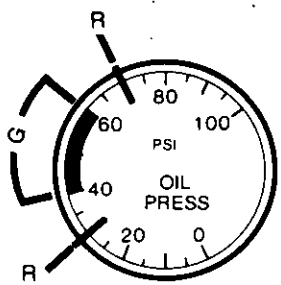
ENGINE OIL TEMPERATURE

R ■ 93°C Maximum Below 30°C FAT
93°C to 100°C Below 30°C FAT-10 Minute Limit
100°C Maximum At 30°C FAT and Above



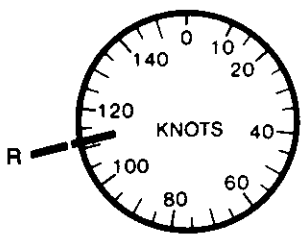
TRANSMISSION OIL TEMPERATURE

R ■ 110°C Maximum



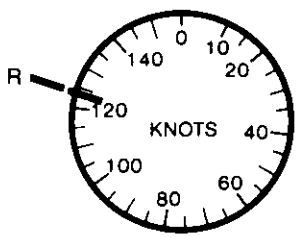
TRANSMISSION OIL PRESSURE

R ■ 30 PSI Minimum
G ■ 40 to 60 PSI Continuous
R ■ 70 PSI Maximum



AIRSPEED
NOSE MOUNTED PITOT TUBE

R ■ 112 Knots Maximum
Refer to Figure 5-2, Airspeed Operating Limits for Additional Limitations.



AIRSPEED
ROOF MOUNTED PITOT TUBE

R ■ 124 Knots Maximum
Refer to Figure 5-2, Airspeed Operating Limits for Additional Limitations.

FIGURE 16. Example of instrument operating ranges and markings

AIRSPEED OPERATING LIMITS

EXAMPLE

WANTED

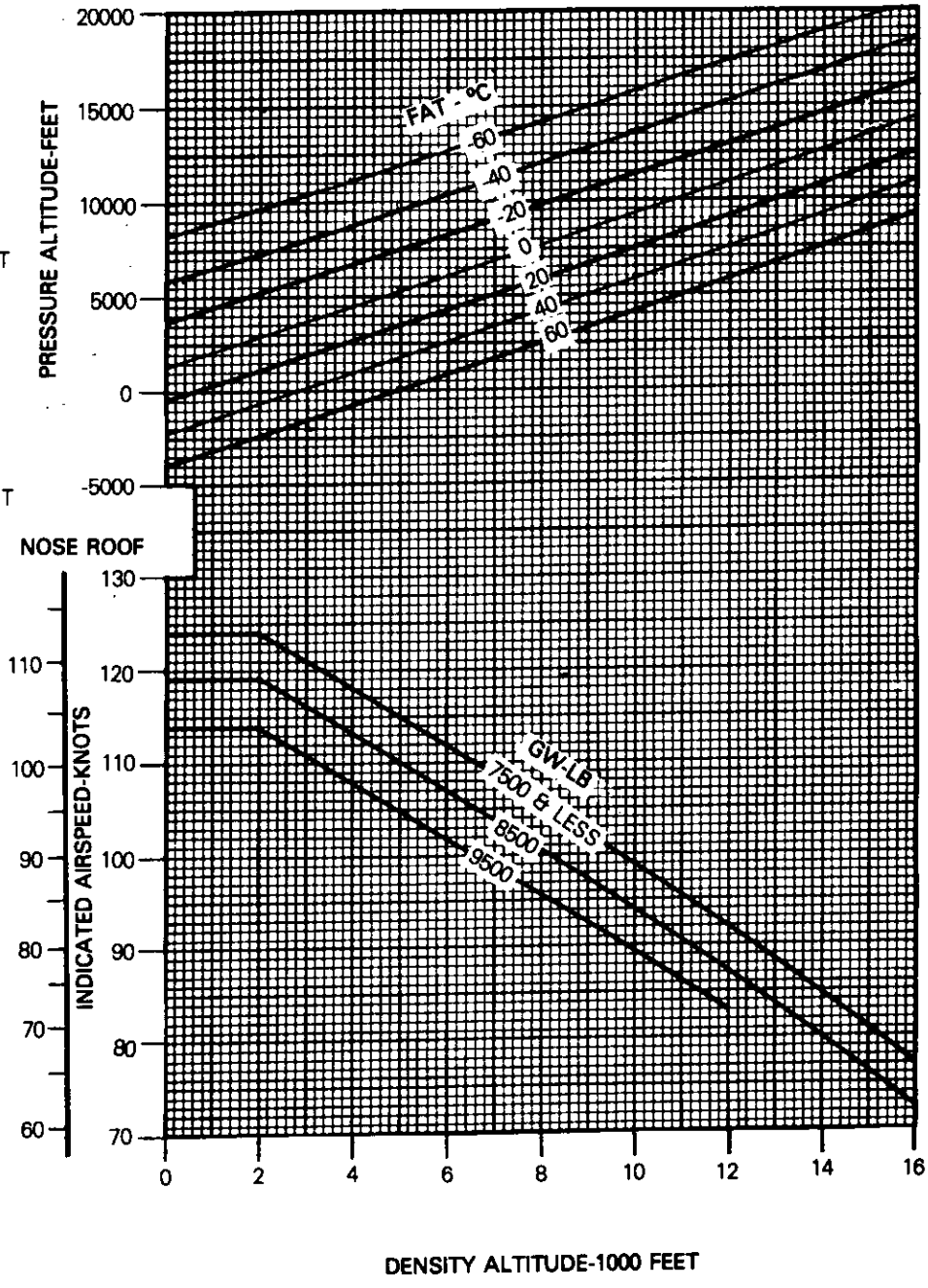
INDICATED AIRSPEED
AND DENSITY ALTITUDE

KNOWN

GROSS WEIGHT = 8500 LB
PRESSURE ALTITUDE = 7500 FEET
FAT = -20°C
ROOF MOUNTED SYSTEM

METHOD

ENTER PRESSURE ALTITUDE
MOVE RIGHT TO FAT
MOVE DOWN TO GROSS WEIGHT
MOVE LEFT, READ INDICATED
AIRSPEED = 110 KNOTS
REENTER PRESSURE ALTITUDE
MOVE DOWN, READ DENSITY
ALTITUDE = 5000 FEET



DATA BASIS: DERIVED FROM FLIGHT TEST

FIGURE 17. Airspeed operating limits chart

FLIGHT ENVELOPE

SEA LEVEL STANDARD DAY

17,650 LB

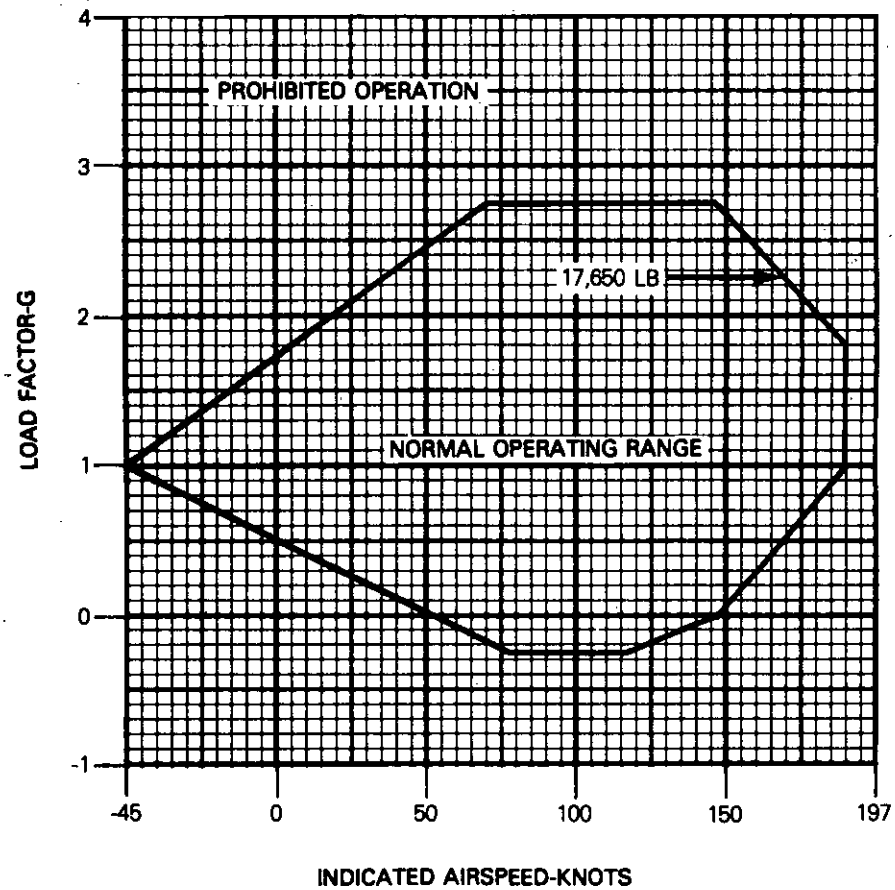
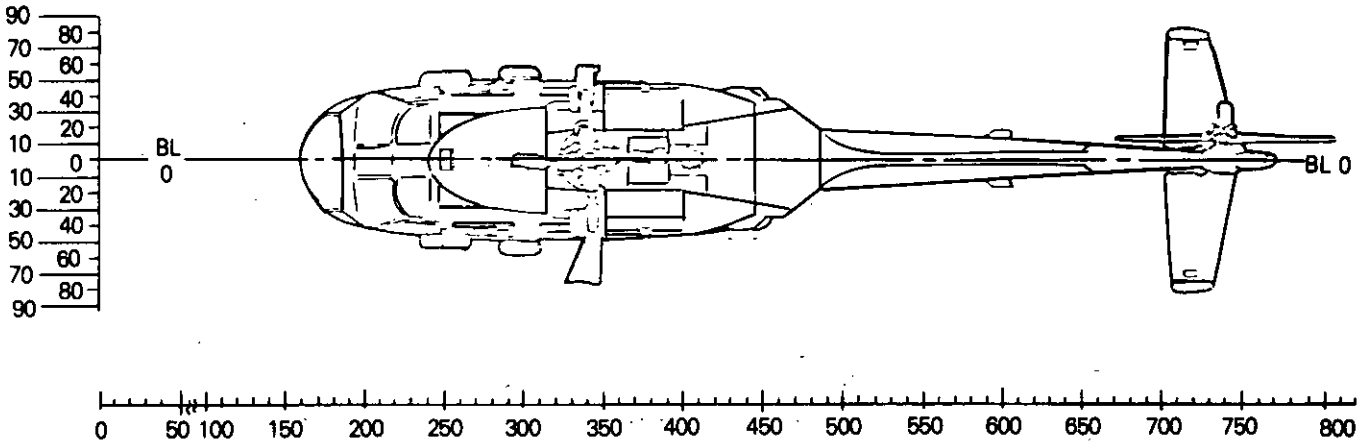


FIGURE 18. Flight envelope chart



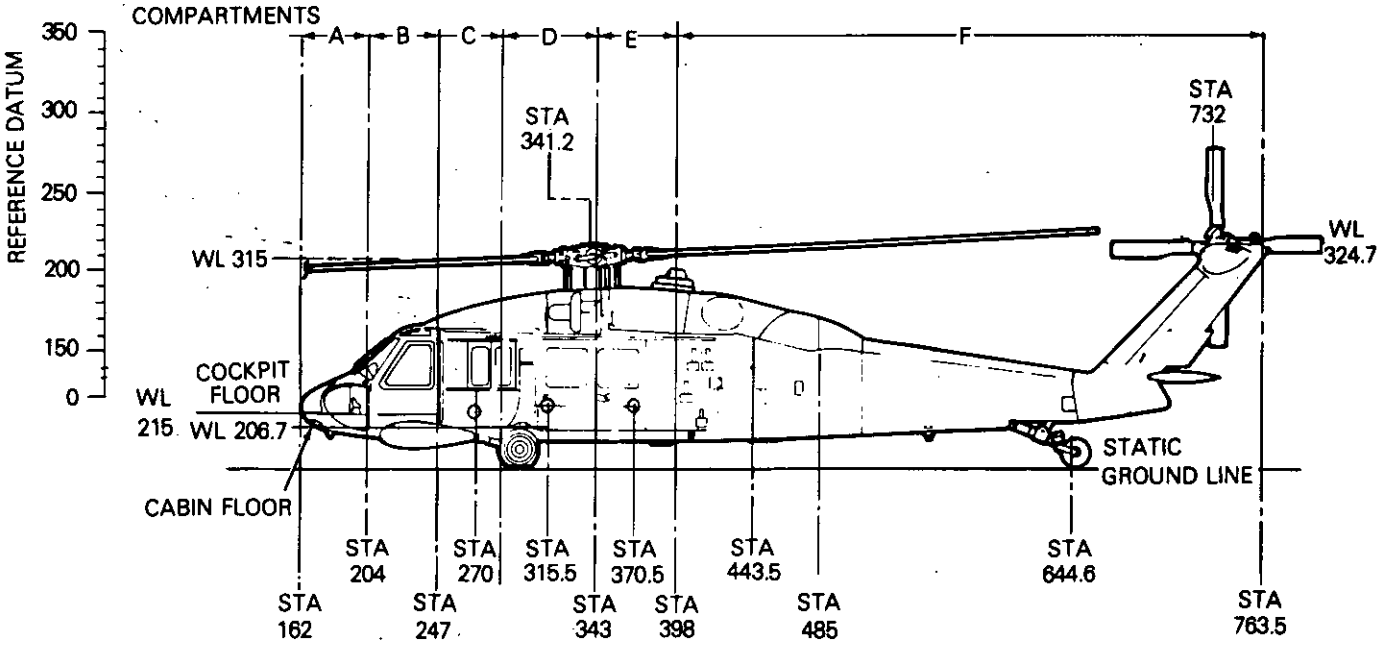
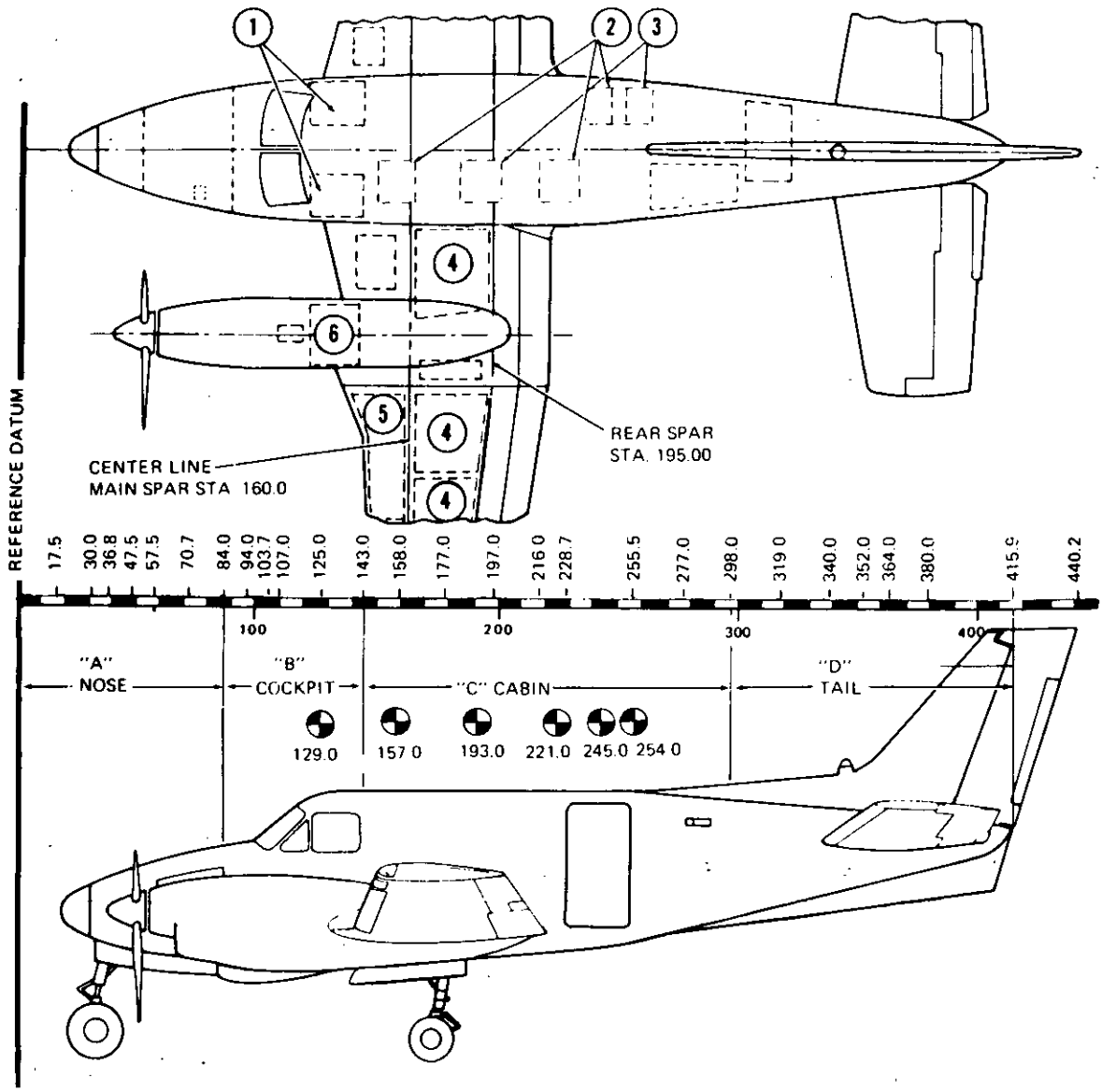


FIGURE 19. Aircraft compartment and station diagram



1. Pilot-Copilot Seats
2. Operator Seats (RU-21B)
3. Operator Seats (RU-21C)
4. Wing Fuel Tanks
5. Wing Fuel Tanks
6. Nacelle Fuel Tank

◔ Denotes Seating Centroids

FIGURE 19. Aircraft compartment and station - Continued

FUEL MOMENTS

EXAMPLE

WANTED

FUEL MOMENT

KNOWN

FUEL QUANTITY
MAIN 1700 POUNDS

METHOD

FOR MAIN TANK ENTER
AT 1700 POUNDS AND
MOVE RIGHT TO MAIN LINE.
MOVE DOWN. READ
MOMENT/1000 = 710

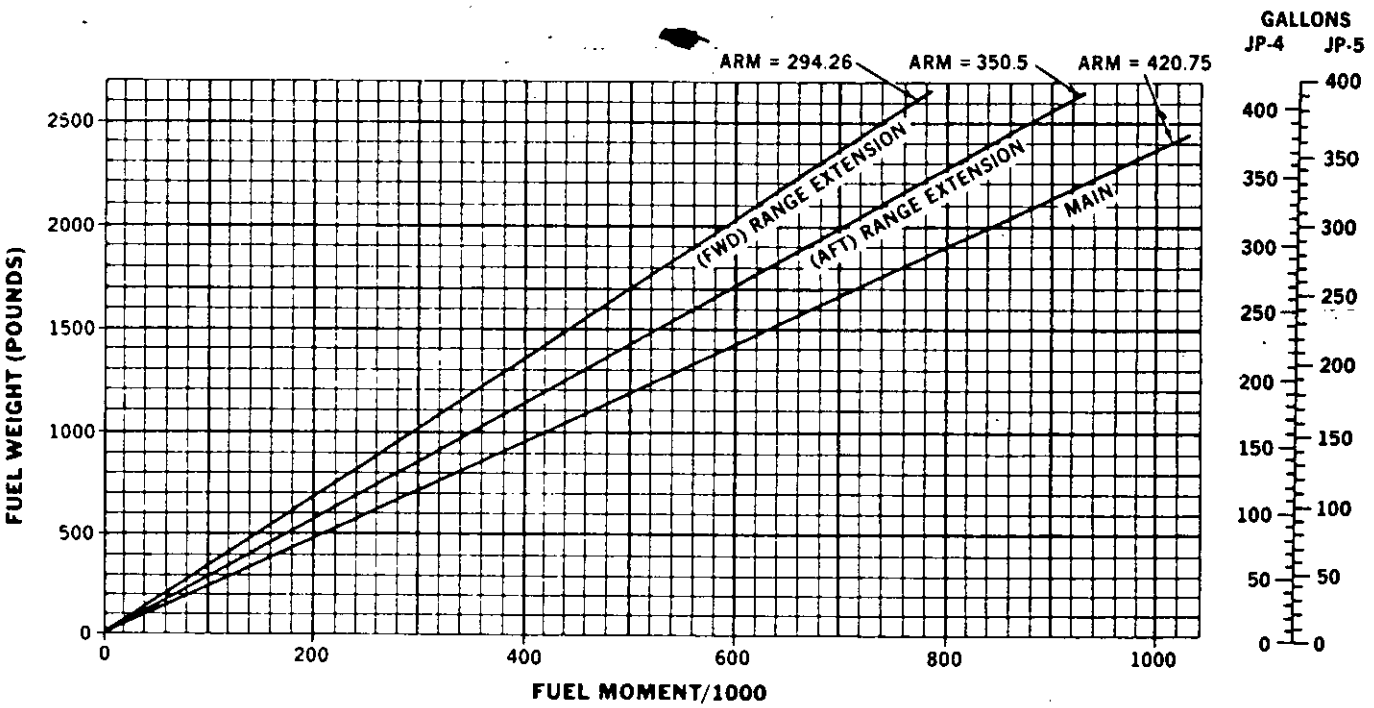


FIGURE 20. Fuel moment chart

PERSONNEL LOADING CHART

MOMENT FOR PERSONNEL

EXAMPLE

WANTED

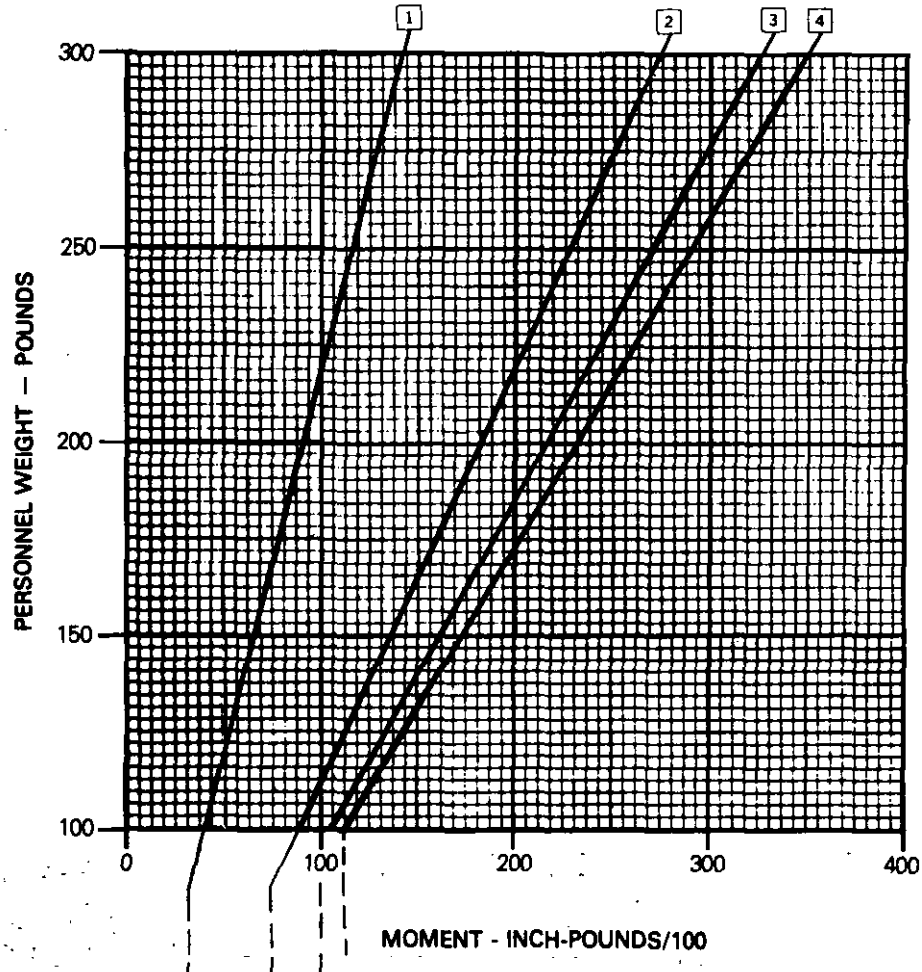
PERSONNEL MOMENT FOR A GIVEN WEIGHT AND LOCATION

KNOWN

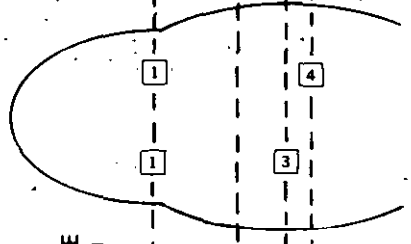
PERSONNEL WEIGHT OF 200 POUNDS AT F.S. 115.0 (ROW4)

METHOD

MOVE RIGHT FROM 200 LBS TO THE LINE CONNECTING WITH SEAT ROW 4
PROJECT DOWN TO READ 230 ON THE MOMENT/100 SCALE



E EB SEATING ARRANGEMENT



1 PILOT OR COPILOT
2 MISSION OPERATOR
3 MISSION OPERATOR
4 MISSION OPERATOR

FUSELAGE STATION
46.7
91.0
107.4
115.0

X SEATING ARRANGEMENT

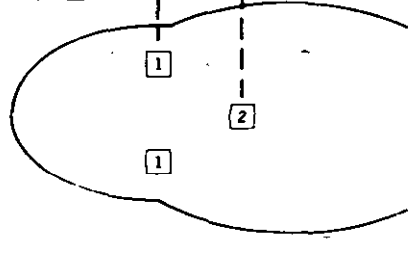


FIGURE 21. Personnel moments chart

Item	Qty	Inboard Station 2,3 or Outboard Station 1, 4	
		Accum Weight (lb)	Moment (in.-lb/100)
Missile	1	98.5	188
Missile	2	197.0	376
Missile	3	295.5	564
Missile	4	394.0	751

Item	Qty	Inboard Station 2,3 or OutboardStation 1, 4	
		Accum Weight (lb)	Moment (in.-lb/100)
H519 Rocket	1	20.6	41
Rocket	2	41.2	81
Rocket	3	61.8	122
Rocket	4	82.4	162
Rocket	5	103.0	203
Rocket	6	123.6	243
Rocket	7	144.2	284
Rocket	8	164.8	324
Rocket	9	185.4	365
Rocket	10	206.0	406
Rocket	11	226.6	446
Rocket	12	247.2	487
Rocket	13	267.8	527
Rocket	14	288.4	568
Rocket	15	309.0	608
Rocket	16	329.6	649
Rocket	17	350.2	690
Rocket	18	370.8	730
Rocket	19	391.4	771

FIGURE 22. Armament loading data chart

INTERNAL CARGO WEIGHT AND MOMENT

EXAMPLE

WANTED

CARGO MOMENT FOR A GIVEN CARGO WEIGHT AND FUSELAGE STATION

KNOWN

CARGO WEIGHT 1000 LBS
LOCATION FS105

METHOD

ENTER INTERNAL CARGO WEIGHT
MOVE RIGHT TO FS105
MOVE DOWN TO BASE-LINE AND
READ 1050 INCH POUNDS/100

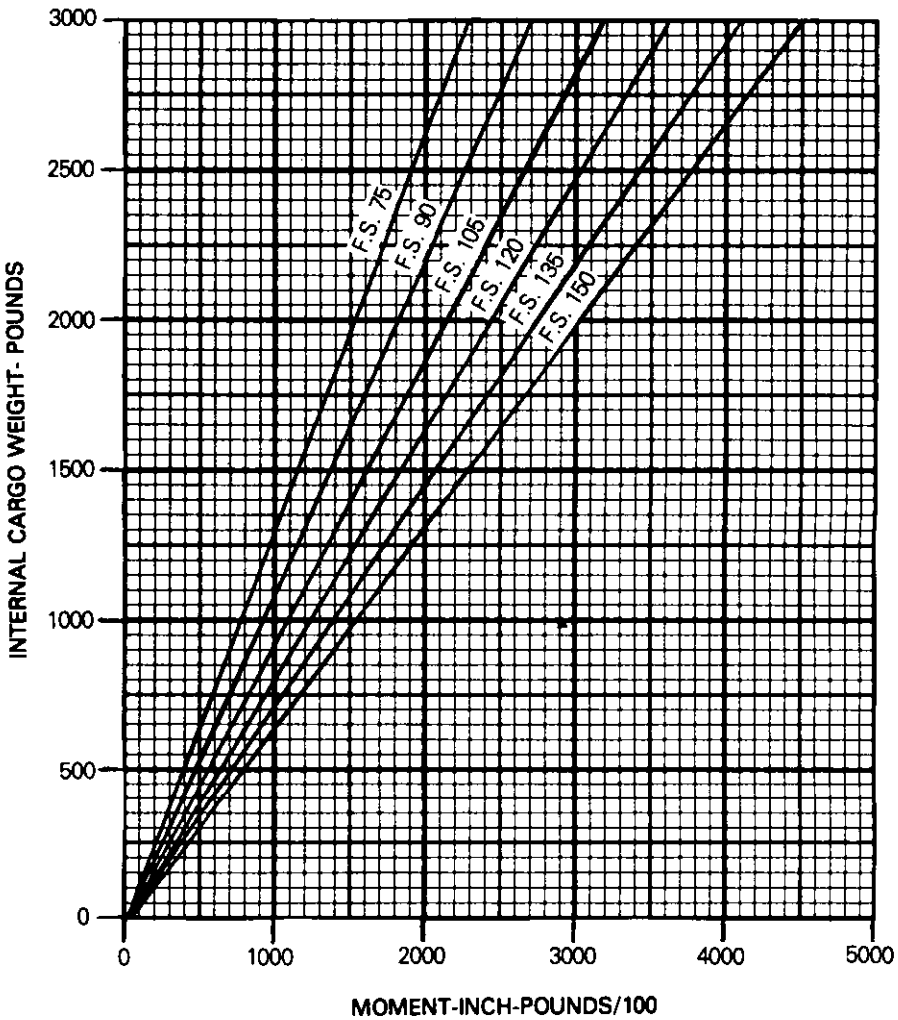


FIGURE 23. Cargo moments chart

CENTER OF GRAVITY LIMITS

EXAMPLE

WANTED

DETERMINE CENTER OF GRAVITY FOR KNOWN WEIGHT AND MOMENT

KNOWN

GROSS WEIGHT EQUALS 8460 POUNDS,MOMENT/100 EQUALS 11,900 INCH-POUNDS

METHOD

MOVE RIGHT FROM 8460 POUNDS TO A POINT APPROXIMATELY 1/2 OF THE DISTANCE BETWEEN 11,800 AND 12,000 INCH-POUND DIAGONAL LINES. FROM THIS POINT PROJECT DOWN TO READ 140.6 ON THE CENTER OF GRAVITY SCALE (FUSELAGE STATION IN INCHES).

NOTE

WHEN CG IS WITHIN SHADED AREA AFT OF STATION 140.0, APPROACHES SHOULD BE TERMINATED TO A 5-FOOT HOVER FOR ADEQUATE TAIL ROTOR CLEARANCE.

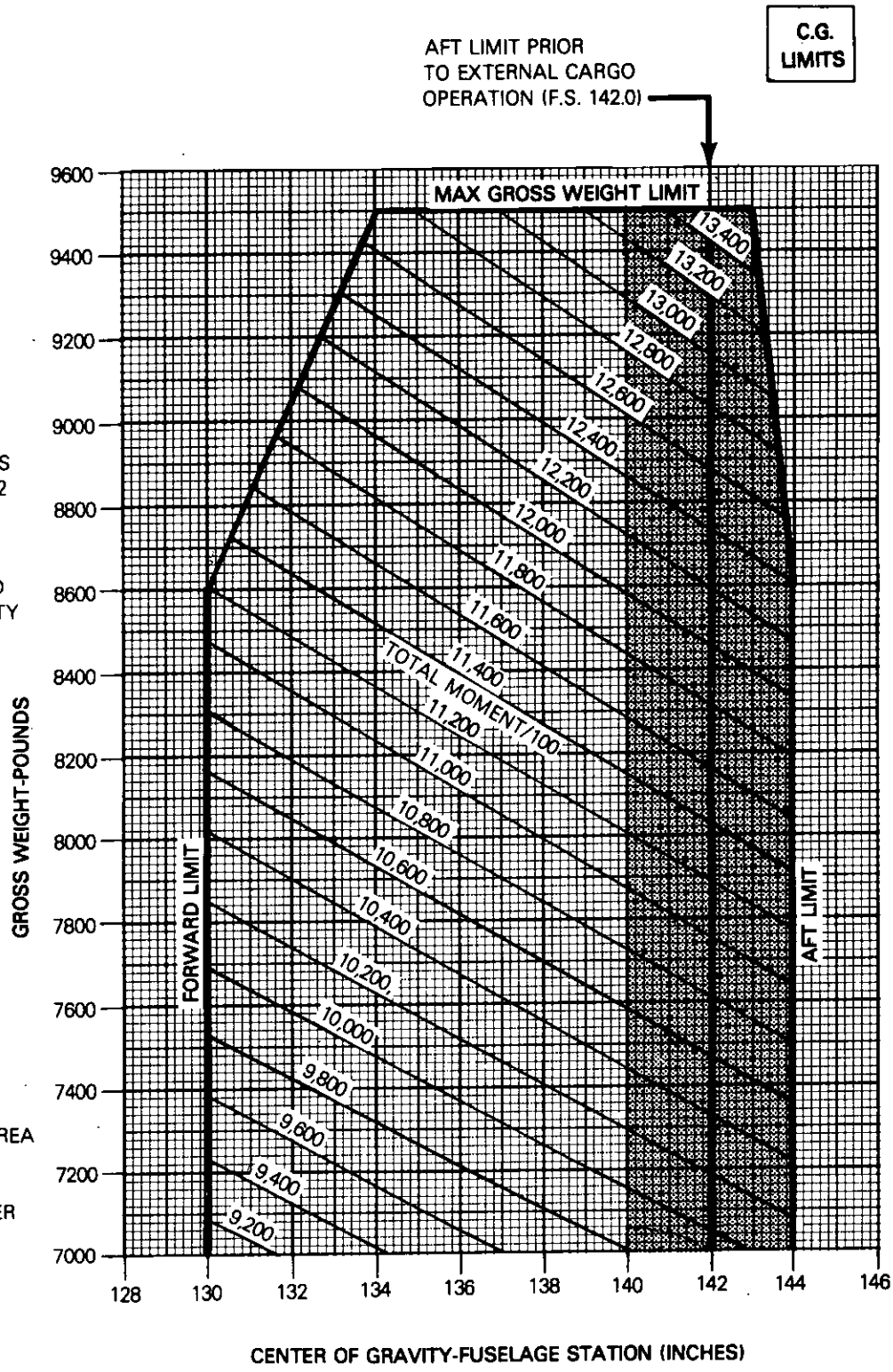


FIGURE 24. Center of gravity limits

CENTER OF GRAVITY LIMITS

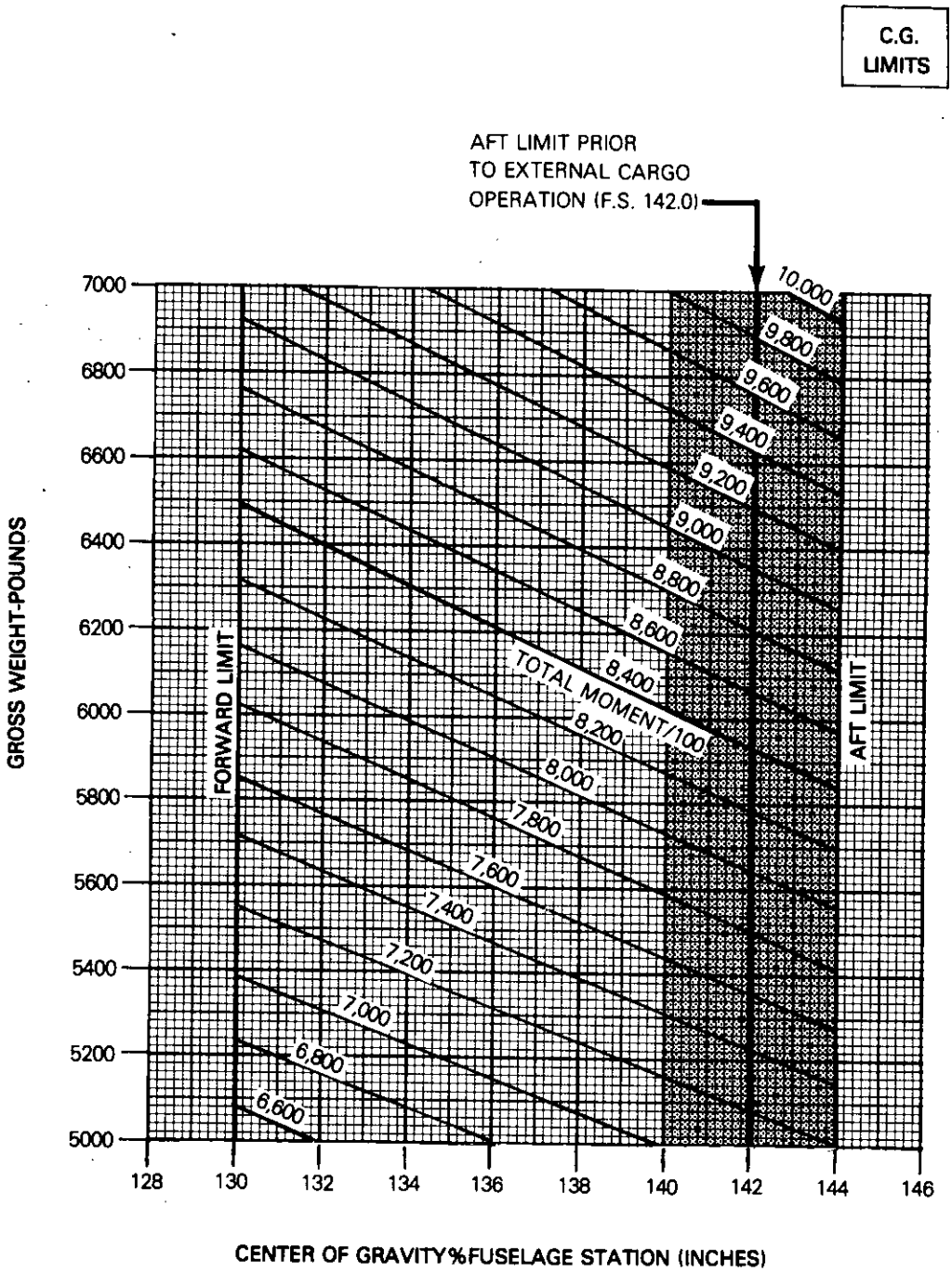


FIGURE 24. Center of gravity limits - Continued

EXAMPLE

WANTED

FUEL FLOW AT ENGINE IDLE AND AT 324 ROTOR/6600 ENGINE RPM WITH FLAT PITCH

KNOWN

PRESSURE ALTITUDE = 11000 FEET, FAT = 0°

METHOD

ENTER PRESSURE ALTITUDE
MOVE RIGHT TO (ENGINE IDLE) FAT
MOVE DOWN, REDA ENGINE IDLE
FUEL FLOW = 223 LB/HR
REENTER PRESSURE ALTITUDE
MOVE RIGHT TO (FLAT PITCH) FAT
MOVE DOWN, READ FLAT PITCH
FUEL FLOW = 265 LB/HR

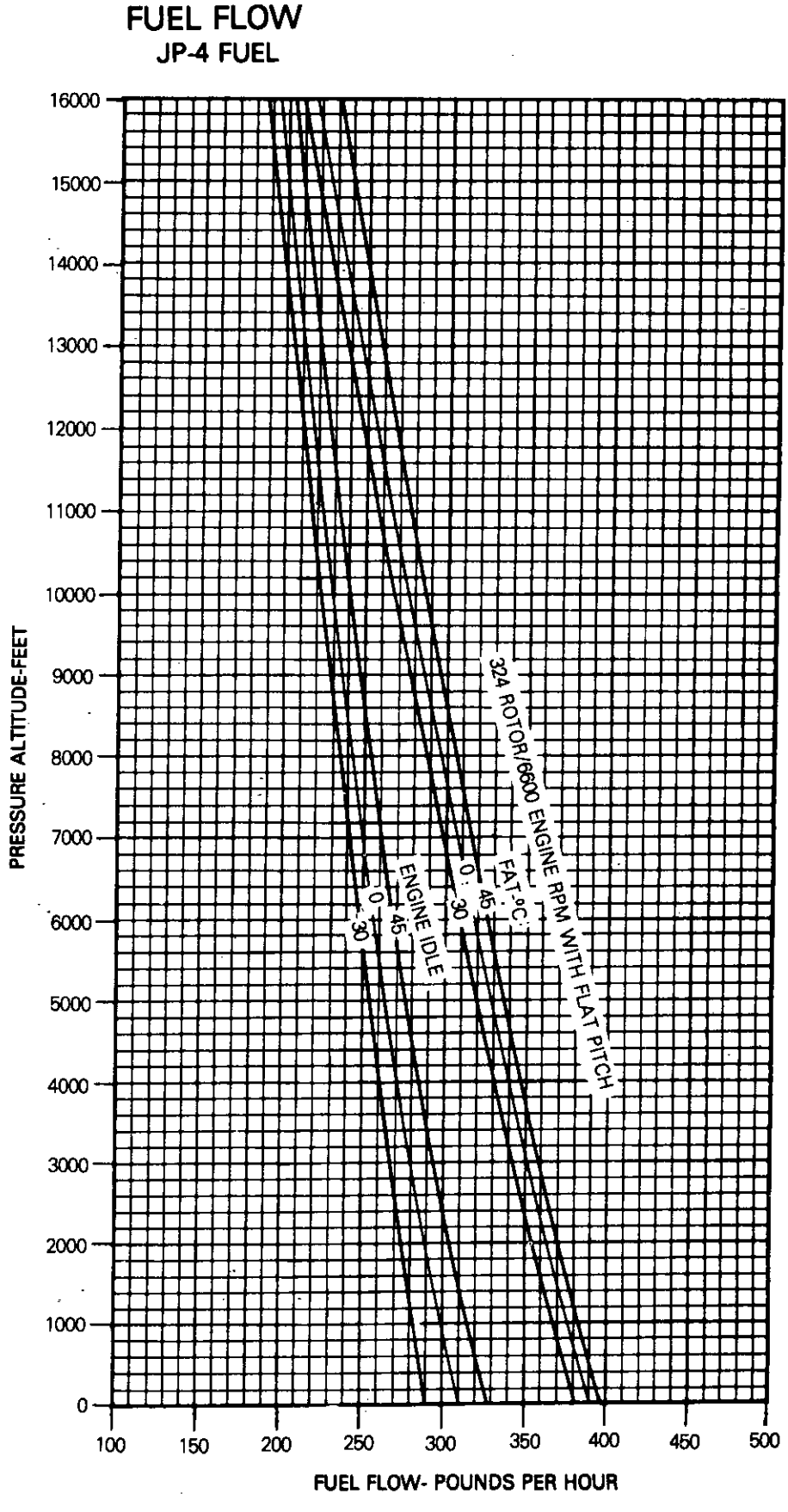


FIGURE 25. Fuel flow chart

MAXIMUM TORQUE AVAILABLE (30 MINUTE OPERATION)

ANTI-ICE OFF BLEED AIR HEATER OFF

324 ROTOR/ 6600 ENGINE RPM

EXAMPLE

WANTED

INDICATED TORQUE
CALIBRATED TORQUE

KNOWN

PRESSURE ALTITUDE=10,000 FT.
OAT=15°C
CALIBRATION FACTOR=66.0

METHOD

ENTER FAT
MOVE RIGHT TO PRESSURE ALTITUDE
MOVE DOWN TO CALIBRATION FACTOR
MOVE LEFT, READ INDICATED TORQUE=39 PSI
FOR CALIBRATED TORQUE CONTINUE DOWN THRU CALIBRATION FACTOR, READ CALIBRATED TORQUE=36.0 PSI

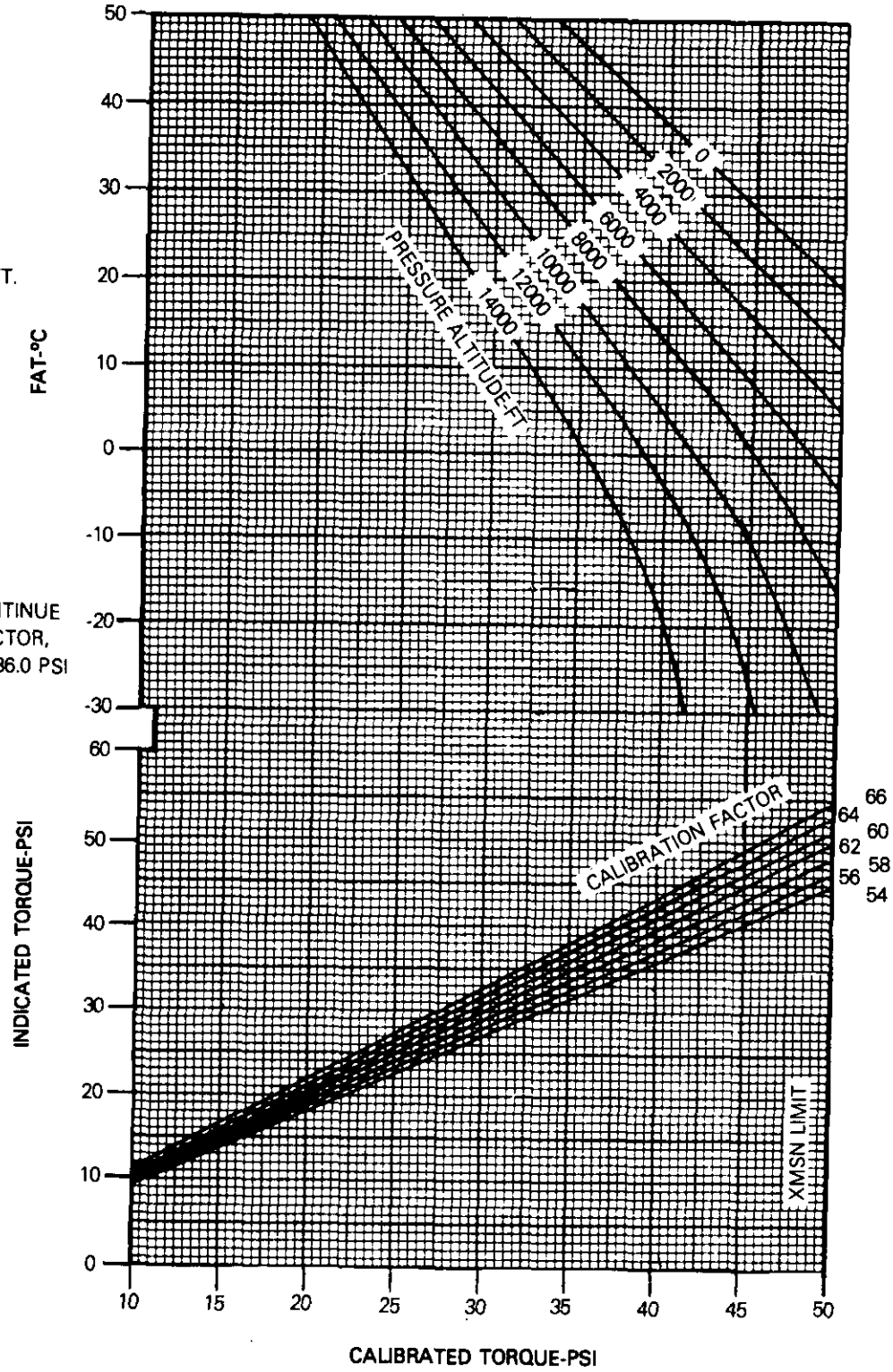


FIGURE 26. Maximum torque available (insert time) chart (RW)

HOVER CEILING

MAXIMUM TORQUE AVAILABLE (30 MINUTE OPERATION)

324 ROTOR/6600 ENGINE RPM

EXAMPLE

WANTED

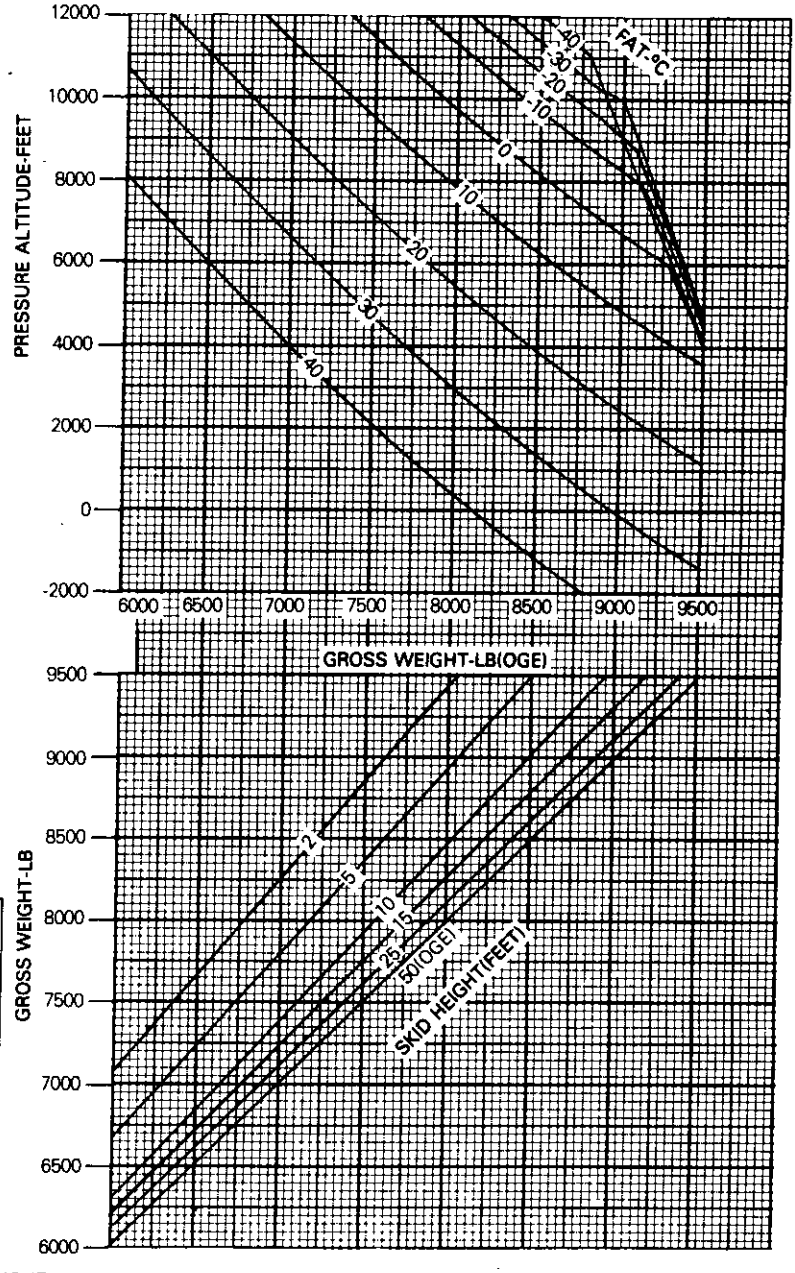
GROSS WEIGHT TO HOVER

KNOWN

PRESSURE ALTITUDE =10600 FEET
FAT=10°C
SKID HEIGHT =2 FEET

METHOD

ENTER PRESSURE ALTITUDE
MOVE RIGHT TO FAT
MOVE DOWN TO SKID HEIGHT
MOVE LEFT, READ GROSS WEIGHT
TO HOVER =8500 POUNDS



CORRECTION TABLE:

NOTE: WHEN OPERATING BELOW 20°C INCREASE TORQUE REQ'D BY:

PSI / FAT	20	30	40	50
0°C	.2	.3	.4	.5
-20°C	.4	.6	.8	.10
-40°C	1.4	2.1	2.8	3.5
-50°C	2.4	3.6	4.8	6.0
-60°C	4.0	6.0	8.0	10.0

DATA BASIS: DERIVED FROM YUH-1H FLIGHT TEST, ASTA-TDR 66-04 NOVEMBER 1970

FIGURE 27. Hover chart

HOVER POWER REQUIRED
LEVEL SURFACE CALM WIND
324 ROTOR/6600 ENGINE RPM

EXAMPLE

WANTED

TORQUE REQUIRED TO HOVER

KNOWN

PRESSURE ALTITUDE=2000 FEET
FAT=-40°C
GROSS WEIGHT=8500LB
DESIRED SKID HEIGHT 2 FEET

METHOD

ENTER PRESSURE ALTITUDE
MOVE RIGHT TO FAT
MOVE DOWN TO GROSS WEIGHT
MOVE LEFT TO SKID HEIGHT
MOVE DOWN, READ CALIBARTED TORQUE=31.5 PSI
FROM THE TABLE FOR FAT =-40°C AND 31.5 PSI TORQUE DETERMINE TORQUE CORRECTION OF 2.2 PSI
TORQUE REQUIRED TO HOVER IS 31.5+2.2=33.7 PSI

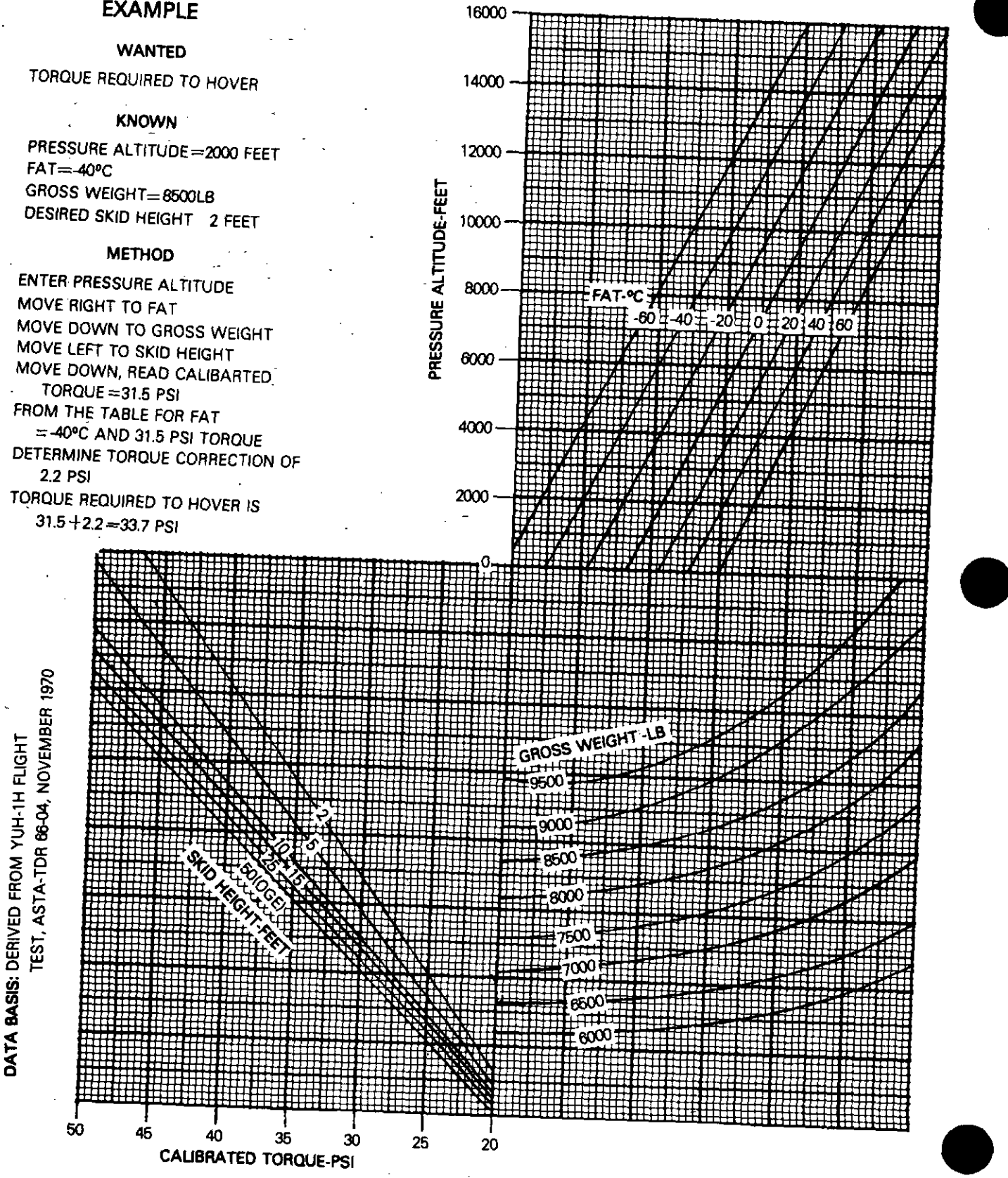


FIGURE 27. Hover chart - Continued

TAKEOFF

LEVEL ACCELERATION, 3 FT SKID HEIGHT
324 ROTOR/6600 ENGINE RPM MAXIMUM TORQUE AVAILABLE
CALM WIND LEVEL SURFACE ALL CONFIGURATIONS

EXAMPLE I

WANTED

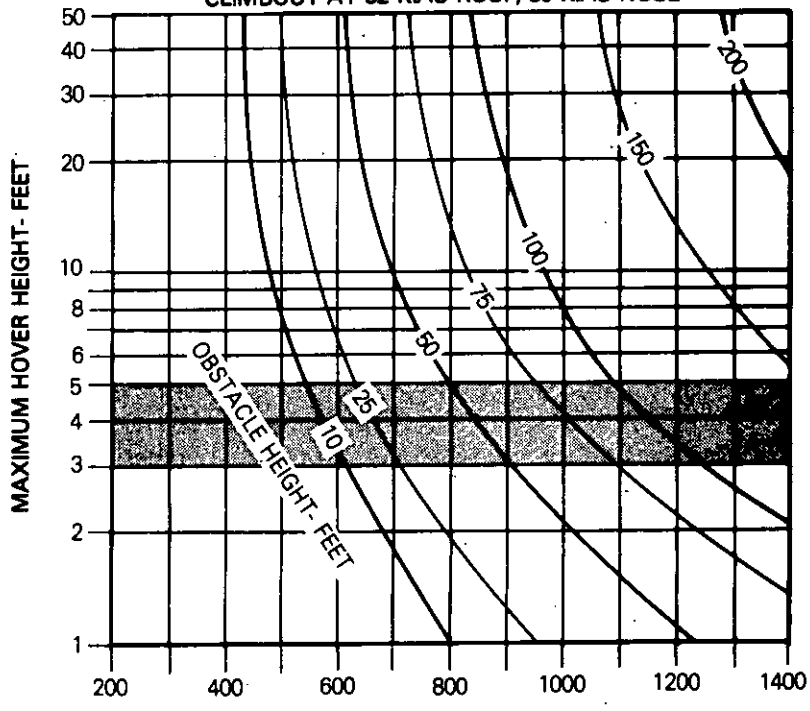
DISTANCE TO CLEAR OBSTACLE

KNOWN

MAXIMUM HOVER HEIGHT = 10 FEET
OBSTACLE HEIGHT = 50 FEET

METHOD

ENTER MAX HOVER HEIGHT
MOVE RIGHT TO OBSTACLE HEIGHT
MOVE DOWN, READ DISTANCE
TO CLEAR OBSTACLE = 700 FEET



EXAMPLE II

WANTED

DISTANCE TO CLEAR OBSTACLE

KNOWN

MAX HOVER HEIGHT = 8 FEET
OBSTACLE HEIGHT = 50 FEET
CLIMBOUT AIRSPEED = 40 KNOTS

METHOD

ENTER MAX HOVER HEIGHT
MOVE RIGHT TO CLIMBOUT TRUE AIRSPEED
MOVE DOWN TO OBSTACLE HEIGHT
MOVE LEFT READ DISTANCE
TO CLEAR OBSTACLE = 630 FEET

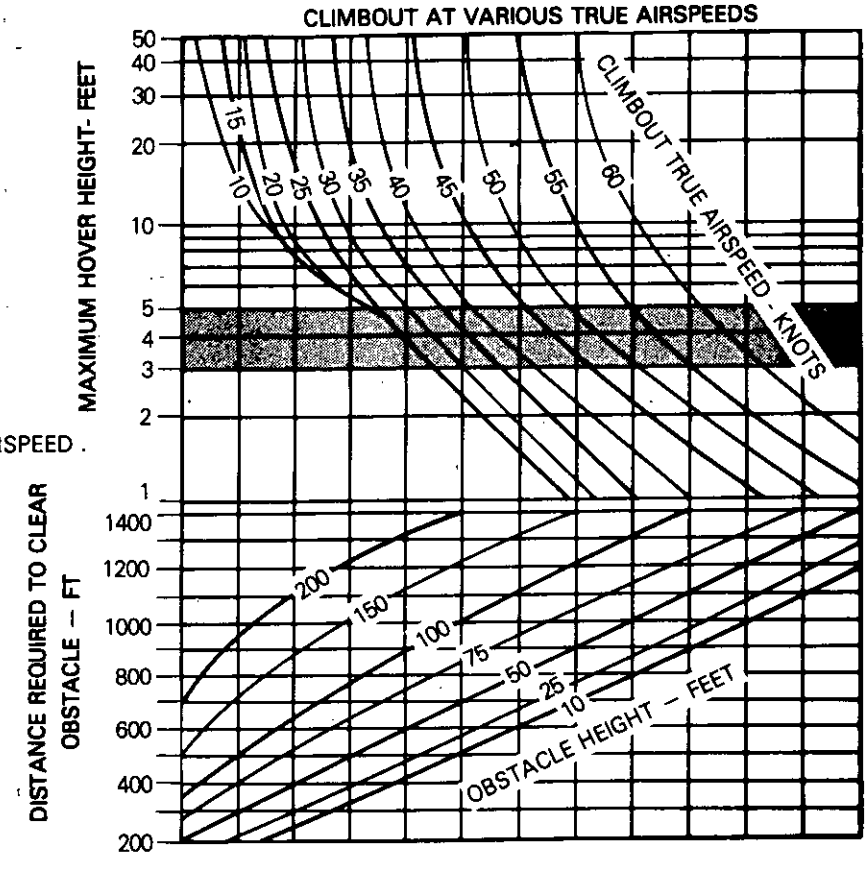


FIGURE 28. Takeoff chart

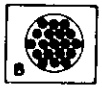
WING STORES		TURRET	WING STORES		REF	ΔF – SQ FT	
		A			1	4 TOW −3.5	8 TOW −6.5
F		A		F	2	4 TOW 0	8 TOW −3.0
F	B	A	B	F	3	+3	0
F	E	A	E	F	4	+1.3	−1.7
F	C	A	C	F	5	+1.5	−1.5
D		A		D	6	+3	0
D	B	A	B	D	7	+6	+3
D	E	A	E	D	8	+4	+1
D	C	A	C	D	9	+4.5	+1.5
C	C	A	C	C	10	−0.2	−3.2
C	B	A	B	C	11	+1.7	−1.3
B	C	A	C	B	12	+1.8	−1.2
B	B	A	B	B	13	+4.2	+1.2
B	E	A	E	B	14	+1.5	−1.5
C	E	A	E	C	15	−1.0	−4.0
	B	A	B		16	−0.4	−3.4
	E	A	E		17	−2.5	−5.5
C		A		C	18	−2.1	−5.1
B		A		B	19	−0.3	−3.3
	C	A	C		20	−2.2	−5.2

NOTE: ADD ΔF = 2.0 SQ. FT. FOR LOW REFLECTIVE IR PAINT TO ANY CONFIGURATION

A

TURRET – M28A1E2
(7.62 MM GUN/40 MM GRENADE)

B

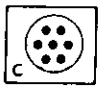


ROCKET LAUNCHER –
19 TUBE M200A1

CAUTION

The M200A1 is restricted to twelve (12) seventeen (17) pound warhead rockets when mounted on outboard pylons.

C



ROCKET LAUNCHER
7 TUBE M158A1

D

TOW MISSILE –
M65 – TWO LAUNCHERS
(FOUR MISSILES)

E

WING POD GUN – M18E1
(7.62 MM GUN)

F

TOW MISSILE –
M65 – ONE LAUNCHER
(TWO MISSILES)

DATA BASE: DERIVED FROM FLIGHT TEST USA ASAT 66-06, APRIL 1970 AND USA ASTA 72-43, JULY 1973

FIGURE 29. Drag chart

EXAMPLE A

WANTED

INCREASE IN DRAG AREA DUE TO EXTERNAL CARGO

KNOWN

SHAPE OF EXTERNAL LOAD = CYLINDER
FRONTAL AREA OF EXTERNAL LOAD = 6.8 SQ FT

METHOD

ENTER CHART AT SYMBOL FOR CYLINDER
MOVE DOWN TO 6.8 SQ FT
MOVE RIGHT AND READ INCREASED DRAG AREA = 4.0 SQ FT

EXAMPLE B

WANTED

CHANGE IN TORQUE REQUIRED DUE TO EQUIVALENT FLAT PLATE DRAG AREA CHANGE (ΔF) FROM CLEAN (BASELINE) CONFIGURATION TO AN EXTERNAL LOAD CONFIGURATION

KNOWN (FROM EXAMPLE A)

Δ F DRAG AREA CHANGE = 4.0 SQ FT
TRUE AIRSPEED = 110 KNOTS
PRESSURE ALTITUDE = SEA LEVEL
FAT = 0°C

METHOD

ENTER DRAG AREA CHANGE
MOVE RIGHT TO TRUE AIRSPEED
MOVE DOWN TO PRESSURE ALTITUDE
MOVE LEFT TO FREE AIR TEMPERATURE
MOVE DOWN, READ CHANGE IN TORQUE = 2.6 PSI

FIGURE 29. Drag chart - Continued

DRAG

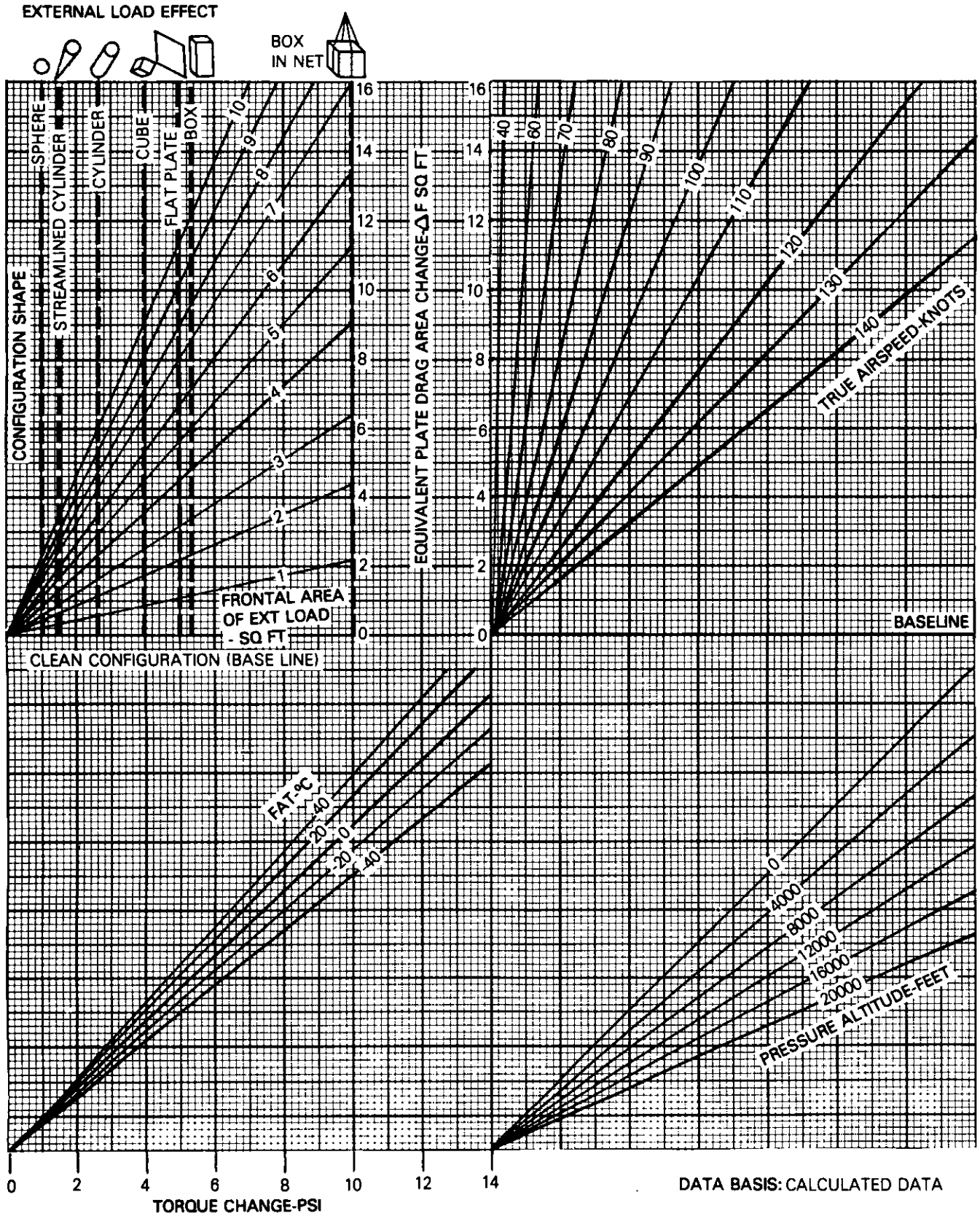


FIGURE 29. Drag chart - Continued

CRUISE

PRESSURE ALTITUDE SEA-LEVEL

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

EXAMPLE

WANTED

TORQUE REQUIRED AND FUEL FLOW FOR 76 ROCKET CONFIGUARTION

KNOWN

PRESSURE ALTITUDE=S.L., FAT=+10C, GW=14,000 LB, 4 LOADED ROCKET LAUNCHERS (76 ROCKETS) , IAS-150 KN

METHOD

FROM DRAG CHART (FIG 7-30) OBTAIN MULTIPLYING FACTOR=-0.42
ENTER CRUISE CHART AT IAS=150 KN
MOVE RIGHT TO BROKEN ΔQ LINE
MOVE UP TO READ ΔQ=12.8
MULTIPLY ΔQ BY MULTIPLYING FACTOR TO GET CHANGE IN TORQUE=-5.4%
RE-ENTER CRUISE CHART AT IAS=150 KN
MOVE RIGHT TO GW-14,000 LB
MOVE DOWN AND READ INDICATED TORQUE PER ENGINE=84.2 %
TORQUE REQUIRED=84.2-5.4=78.8%
RE-ENTER CRUISE CHART AT 78.8%
MOVE UP AND READ FUEL FLOW=1183 LB/HR

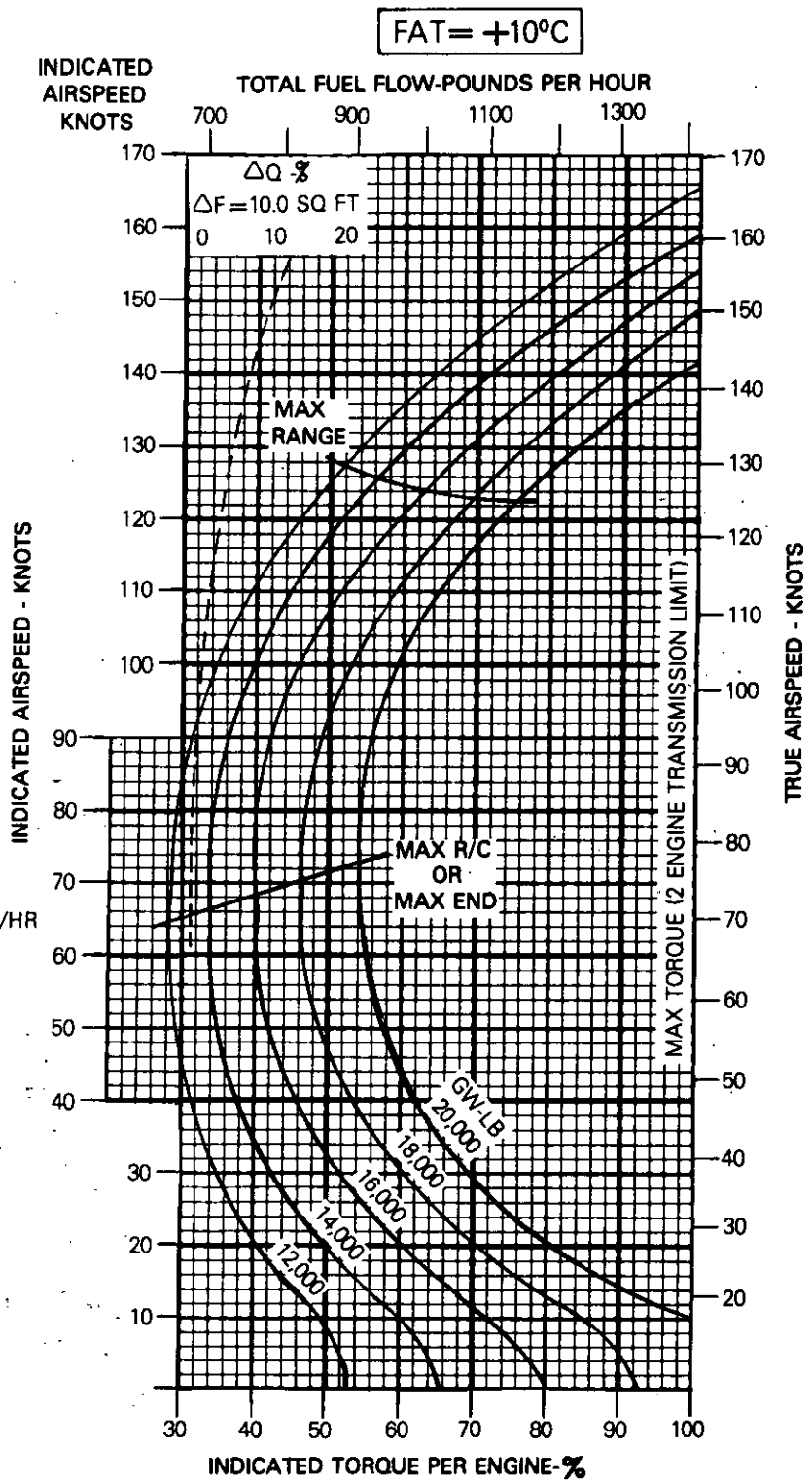
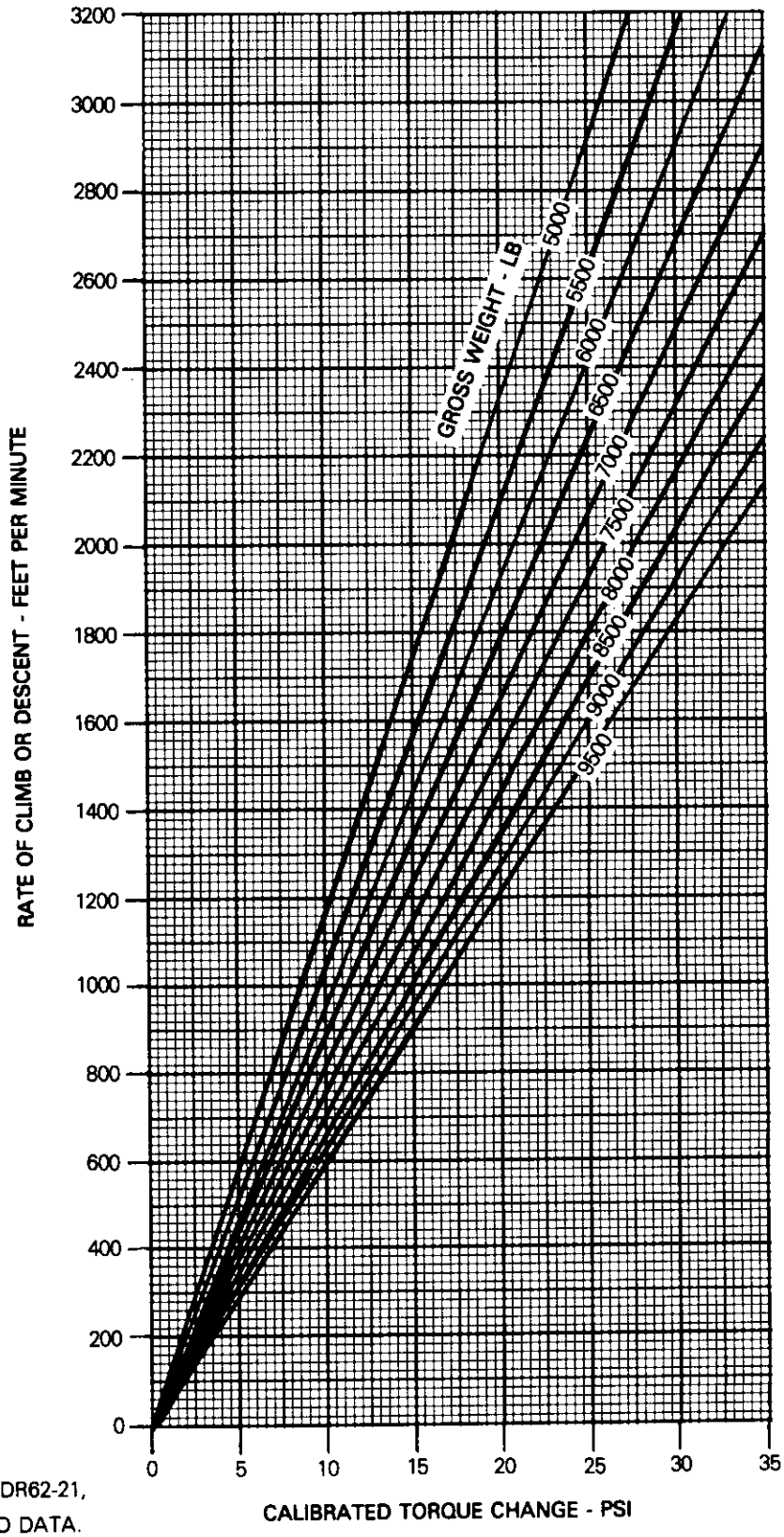


FIGURE 30. Cruise chart (RW)

CLIMB-DESCENT

314 ROTOR/8400 ENGINE RPM



EXAMPLE

WANTED

CALIBRATED TORQUE CHANGE
FOR DESIRED R/C OR R/D

KNOWN

GROSS WEIGHT = 6000 LB
DESIRED R/C = 1200 FT/MIN

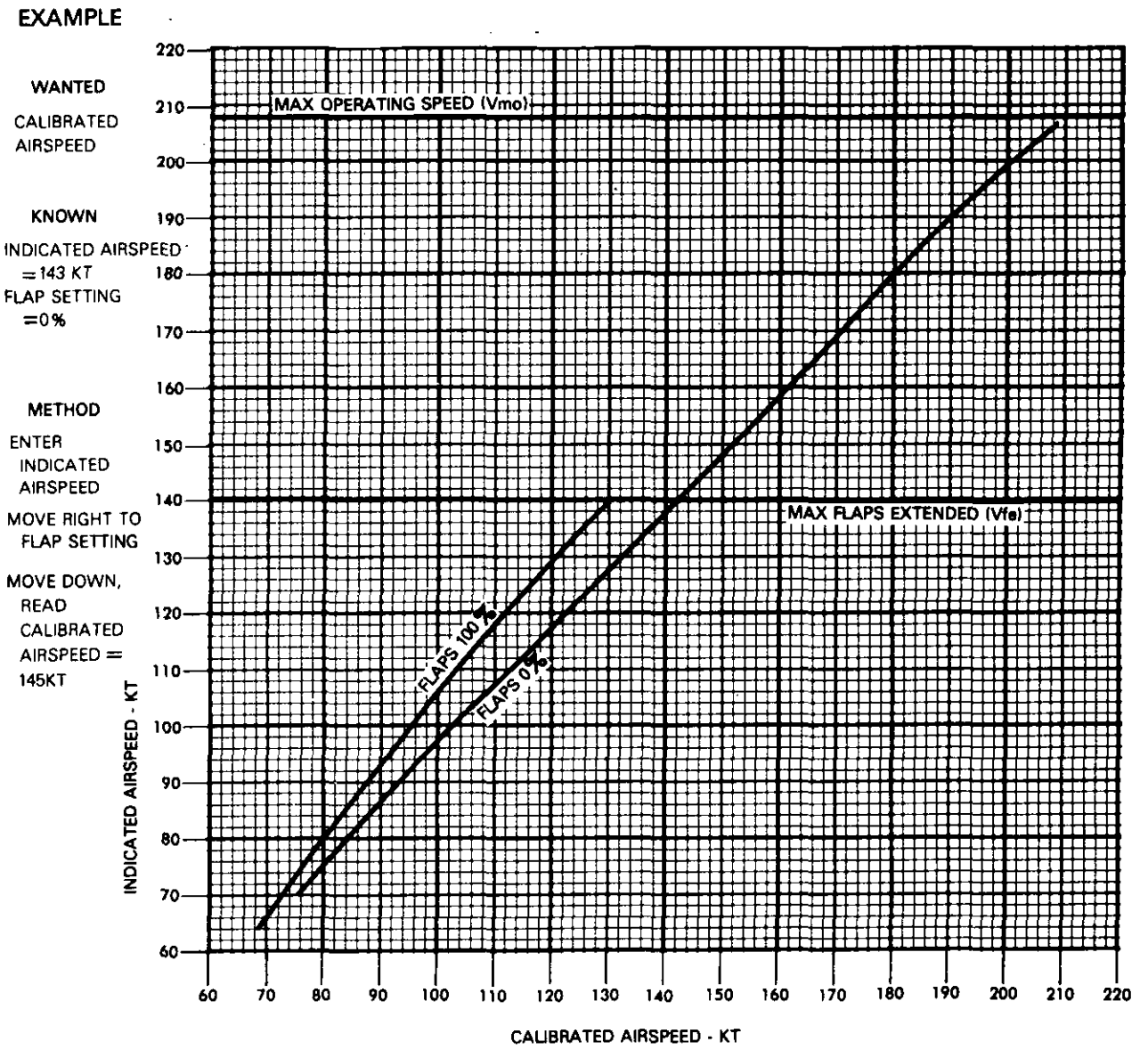
METHOD

ENTER R/C
MOVE RIGHT TO GROSS WEIGHT
MOVE DOWN, READ CALIBRATED
TORQUE CHANGE = 12.5 PSI

DATA BASIS: DERIVED FROM FLIGHT TEST FTC-TDR62-21, DECEMBER 1962, AND CALCULATED DATA.

FIGURE 31. Climb-descent chart

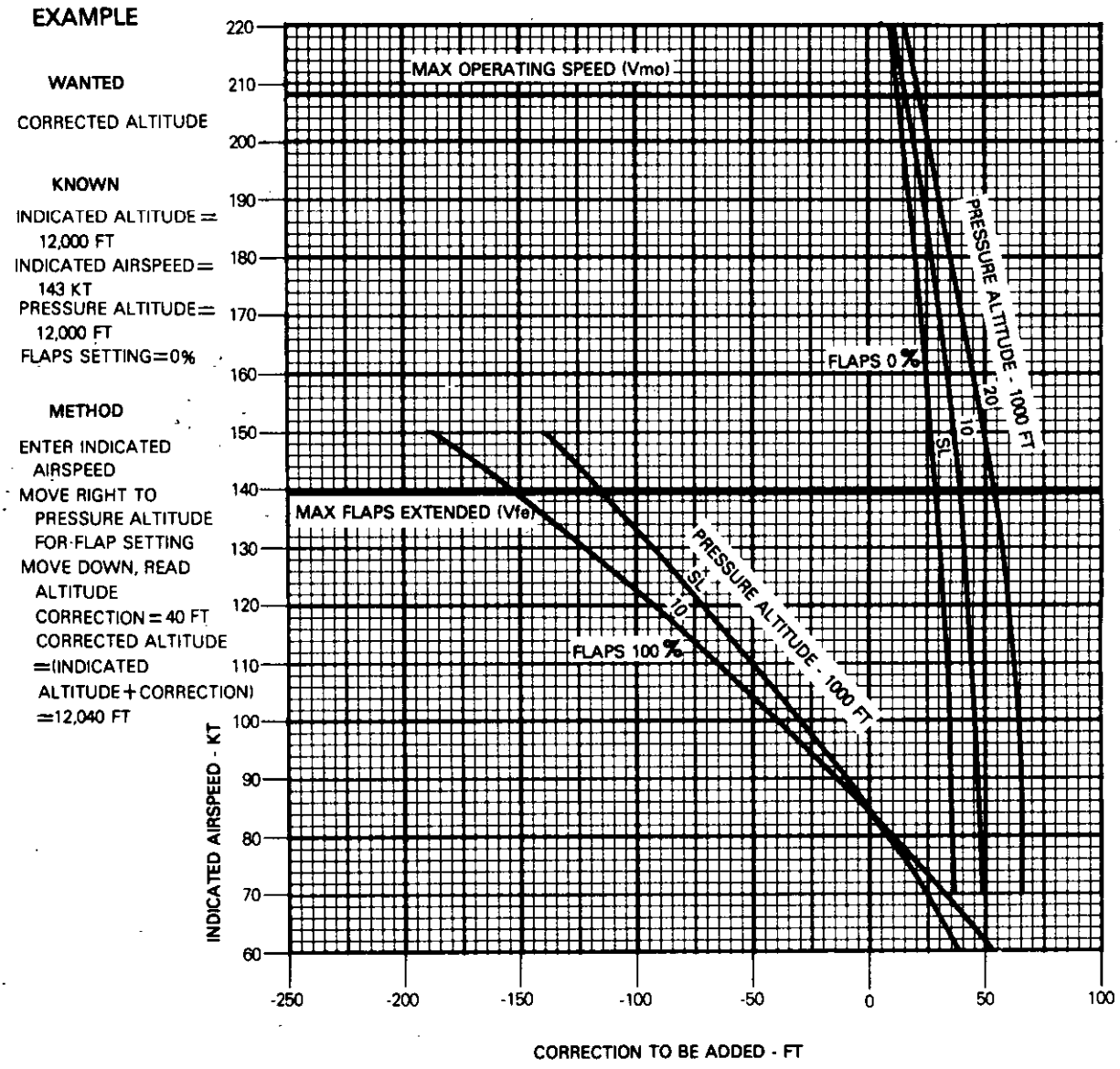
AIRSPEED CALIBRATION - NORMAL SYSTEM



DATA BASIS: DERIVED FROM FLIGHT TEST

FIGURE 32. Air data calibration chart (airspeed calibration)

ALTIMETER CORRECTION - NORMAL SYSTEM



DATA BASIS: DERIVED FROM FLIGHT TEST

FIGURE 32. Air data calibration chart (airspeed calibration) — Continued

TEMPERATURE CONVERSION CHART

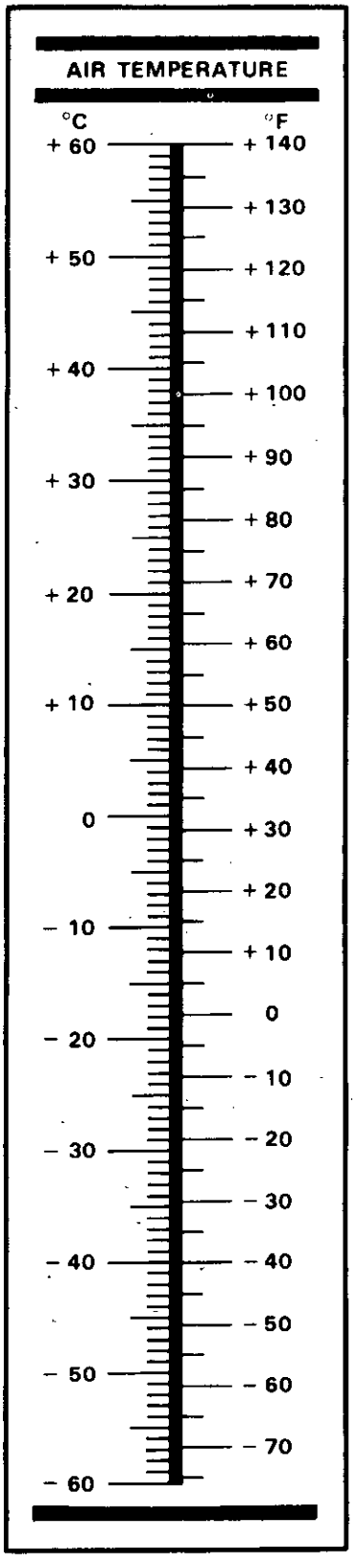


FIGURE 32. Air data calibration chart (airspeed calibration) — Continued

CROSSWIND - TAKEOFF OR LANDING

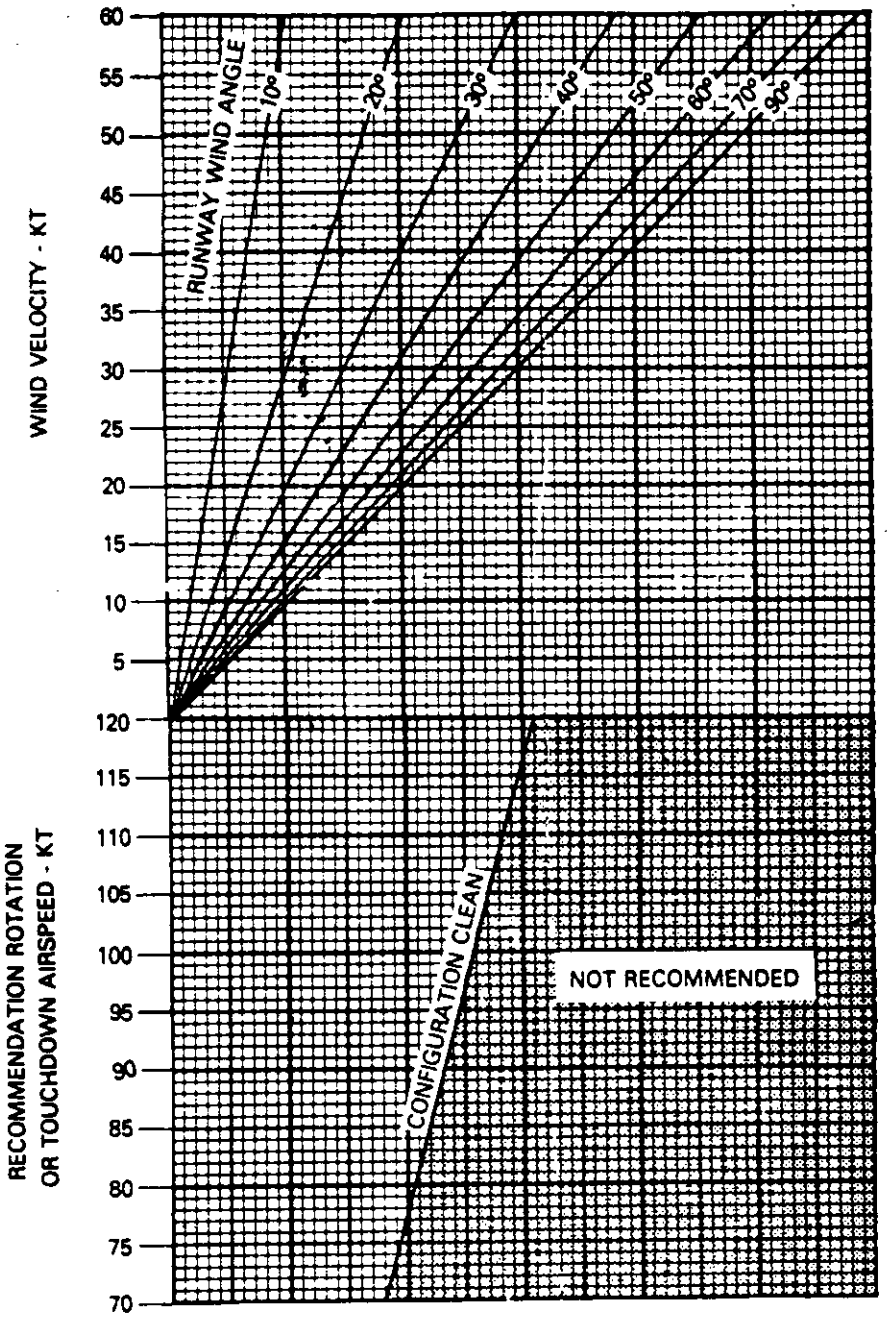
EXAMPLE

KNOWN

CLEAN CONFIGURATION
RUNWAY 21
WIND VELOCITY = 23KT
WIND DIRECTION = 190°
NORMAL ROTATION AIRSPEED = 93KT

METHOD

DETERMINE RUNWAY WIND ANGLE,
210° - 190° = 20°
ENTER WIND VELOCITY
MOVE RIGHT TO RUNWAY WIND ANGLE = 20°
MOVE DOWN TO NORMAL ROTATION AIRSPEED LINE = 93 KTS
THE INTERSECTION FALLS WITHIN THE RECOMMENDED AREA



DATA BASIS: FLIGHT TEST

FIGURE 33. Crosswind-takeoff or landing chart (FW)

TORQUE AVAILABLE FOR TAKEOFF

PROP SPEED 2200 RPM
FUEL JP-4 AIRSPEED 0 KNOTS

EXAMPLE

WANTED

TORQUE AVAILABLE FOR TAKEOFF

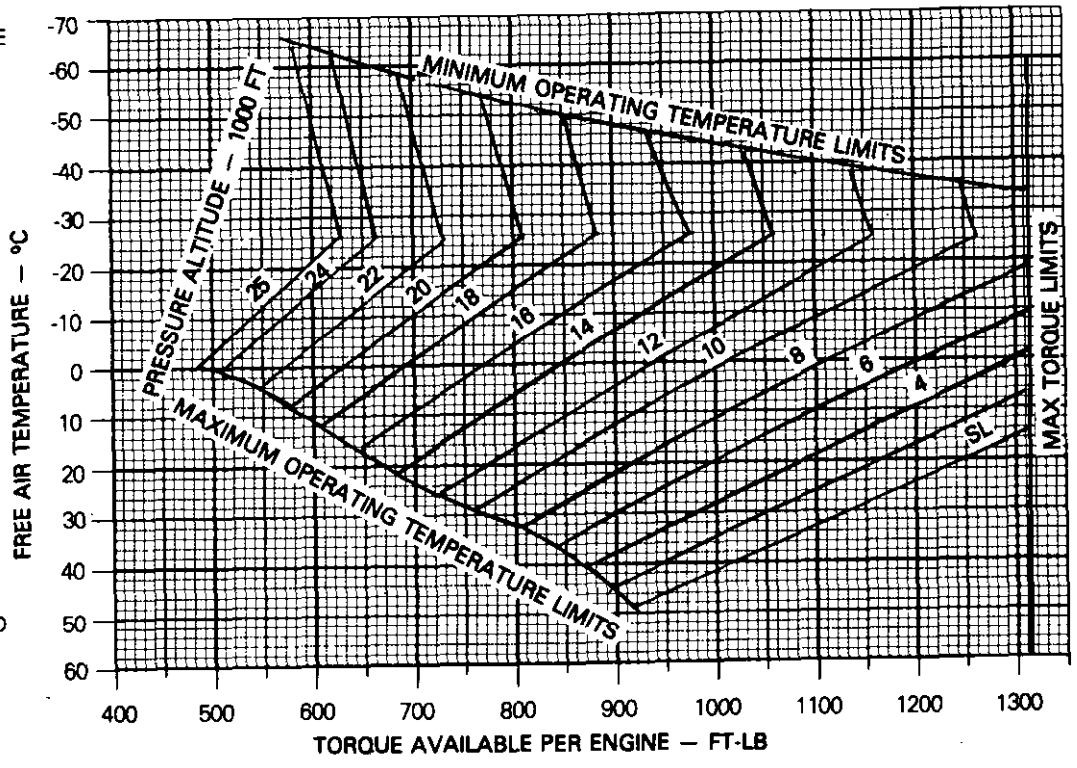
KNOWN

FAT=12°C
PRESSURE ALTITUDE=4307FT

METHOD

ENTER FAT
MOVE RIGHT TO PRESSURE ALTITUDE=4307 FT

MOVE DOWN, READ TORQUE AVAILBLE PER ENGINE=1159 FT-LB



DATA BASIS: CALCULATED FROM ENGINE MODEL SPEC

FIGURE 34. Torque available for takeoff chart (FW)

TAKEOFF - NORMAL

CALM WINDS FLAPS 0 PERCENT POWER - TAKEOFF

LEVEL HARD SURFACE

EXAMPLE

WANTED

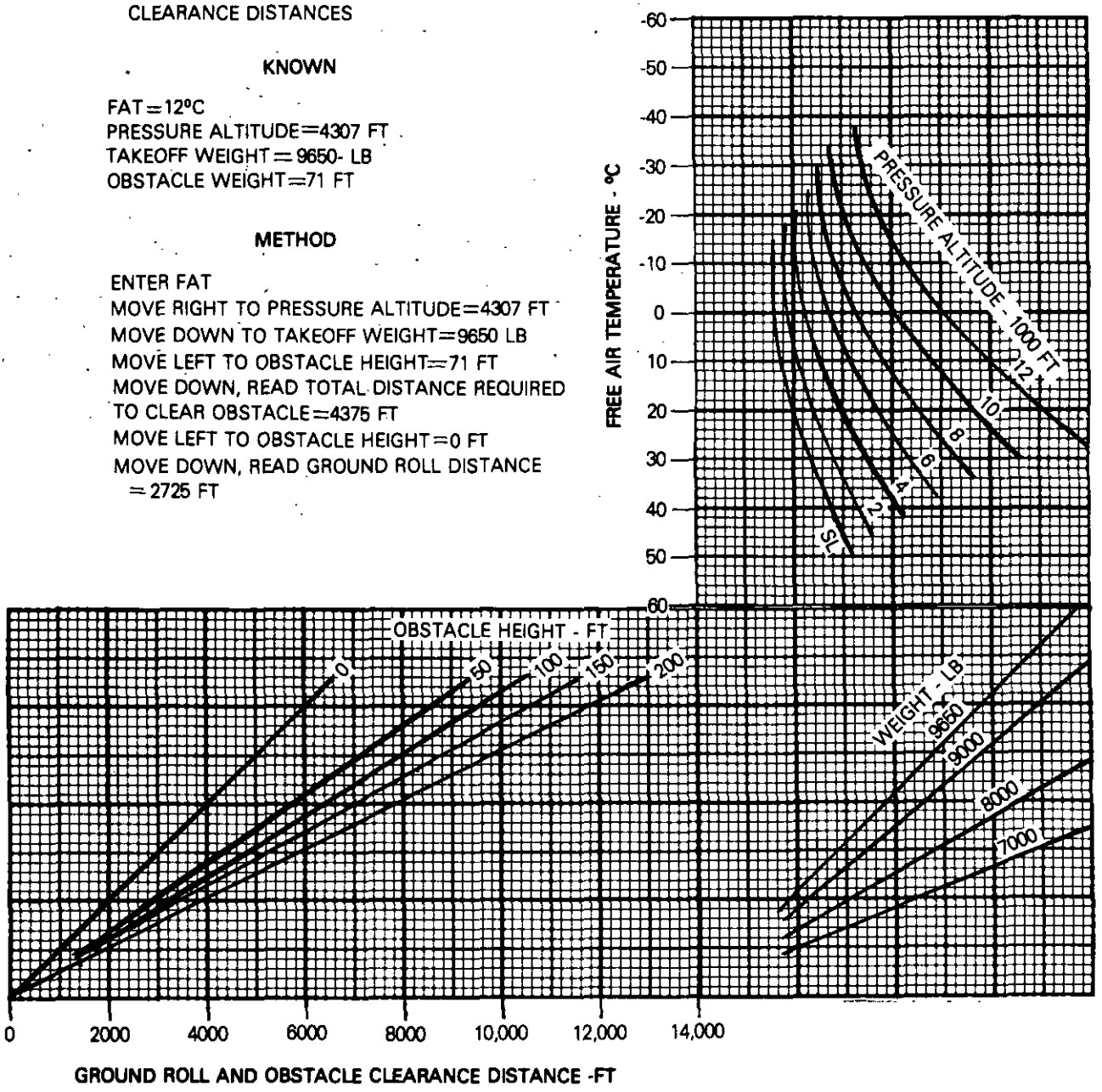
REQUIRED GROUND ROLL AND OBSTACLE CLEARANCE DISTANCES

KNOWN

FAT=12°C
PRESSURE ALTITUDE=4307 FT
TAKEOFF WEIGHT=9650- LB
OBSTACLE WEIGHT=71 FT

METHOD

ENTER FAT
MOVE RIGHT TO PRESSURE ALTITUDE=4307 FT
MOVE DOWN TO TAKEOFF WEIGHT=9650 LB
MOVE LEFT TO OBSTACLE HEIGHT=71 FT
MOVE DOWN, READ TOTAL DISTANCE REQUIRED TO CLEAR OBSTACLE=4375 FT
MOVE LEFT TO OBSTACLE HEIGHT=0 FT
MOVE DOWN, READ GROUND ROLL DISTANCE =2725 FT



DATA BASIS: CALCULATED

FIGURE 35. Takeoff-normal chart (FW)

NORMAL ROTATION/TAKEOFF AIRSPEED

FLAPS 0 PERCENT

EXAMPLE

WANTED

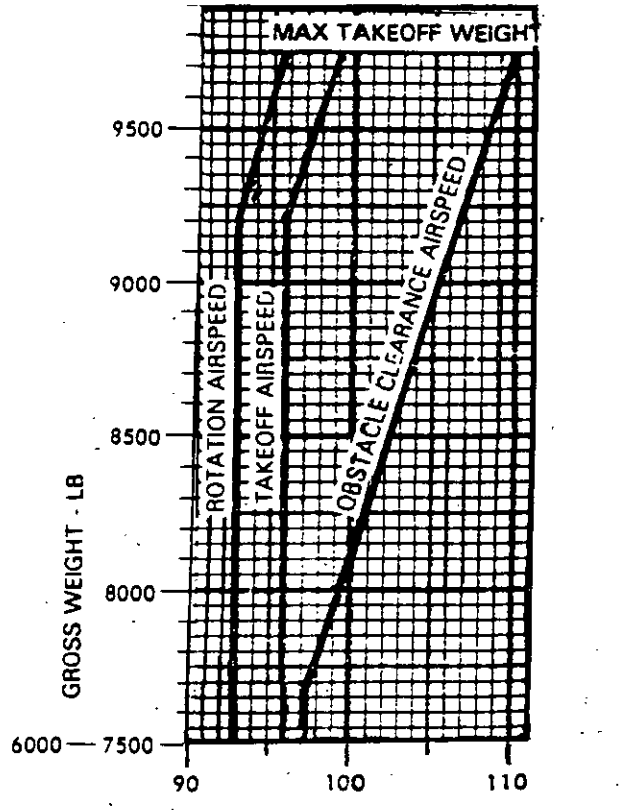
NORMAL ROTATION, TAKEOFF, AND OBSTACLE CLEARANCE AIRSPEEDS FOR KNOWN TAKEOFF WEIGHT

KNOWN

TAKEOFF WEIGHT = 9650 LBM

METHOD

ENTER TAKEOFF WEIGHT
MOVE RIGHT TO ROTATION AIRSPEED. TAKEOFF AIRSPEED AND OBSTACLE CLEARANCE AIRSPEED LINES
MOVE DOWN FROM ROTATION AIRSPEED LINE READ INDICATED AIRSPEED FOR ROTATION 96 KT
MOVE DOWN FROM TAKEOFF AIRSPEED LINE, READ INDICATED AIRSPEED FOR TAKEOFF 99 KT
MOVE DOWN FROM OBSTACLE CLEARANCE AIRSPEED LINE, READ INDICATED AIRSPEED FOR OBSTACLE CLEARANCE 110 KT



DATA BASIS: FLIGHT TEST

FIGURE 36. Normal rotation/takeoff airspeed chart (FW)

ACCELERATION CHECK
U-21A
T74-CP-700

ACCELERATION CHECK

POWER – TAKEOFF CALM WINDS
FLAPS 0 PERCENT LEVEL HARD SURFACE

EXAMPLE

WANTED

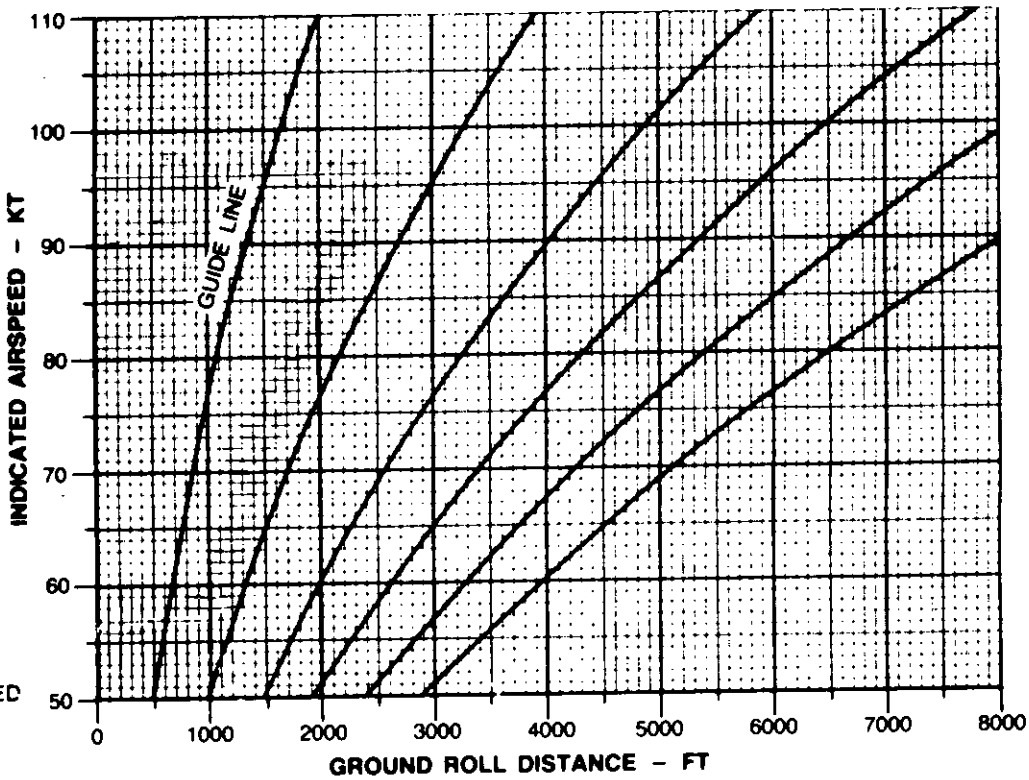
AIRSPEED REQUIRED AT VARIOUS ACCELERATION CHECK POINTS

KNOWN

TAKEOFF AIRSPEED FOR KNOWN GROSS WEIGHT OF 9,650 LB = 96 KT
GROUND ROLL DISTANCE = 2500 FT

METHOD

ENTER INDICATED AIR SPEED
MOVE RIGHT TO GROUND ROLL DISTANCE LINE = 2500 FT
MOVE DOWN THE GUIDE LINE TO THE 1000 FT GROUND ROLL DISTANCE LINE
MOVE LEFT, READ INDICATED AIRSPEED REQUIRED AT 1000 FT MARKER = 57 KT



DATA BASIS: ESTIMATED

FIGURE 37. Acceleration check distance chart (FW)

ACCELERATE-STOP DISTANCE

HARD SURFACE RUNWAY WIND CALM FLAPS 0 PERCENT

TAKEOFF POWER FOLLOWED BY IDLE POWER AND MAX BRAKING

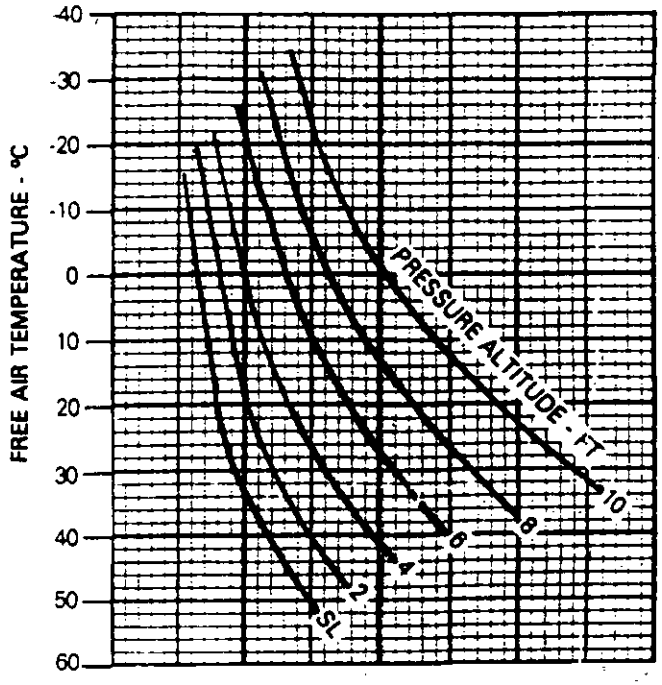
EXAMPLE

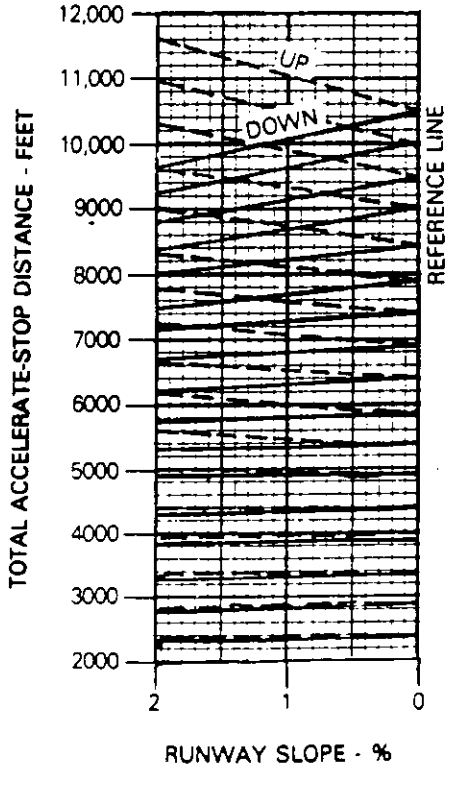
KNOWN

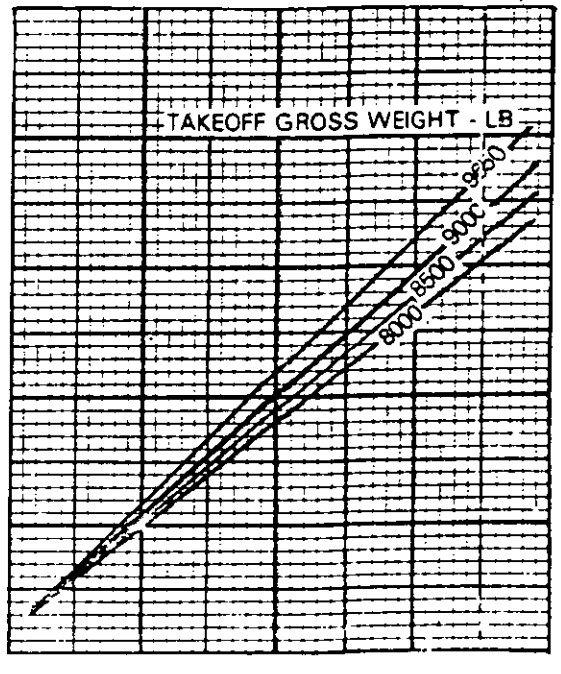
FREE AIR TEMPERATURE = 12°C
PRESSURE ALTITUDE = 4307 FT
TAKEOFF WEIGHT = 9650 LB
RUNWAY SLOPE = 0.0%

METHOD

ENTER FAT
MOVE RIGHT TO PRESSURE ALTITUDE = 4307 FT
MOVE DOWN TO TAKEOFF WEIGHT = 9650 LB
MOVE LEFT TO REFERENCE LINE
FOLLOW GUIDE LINES TO RUNWAY SLOPE = 0 %
MOVE LEFT TO ACCELERATE-STOP DISTANCE = 5000 FT







DATA BASIS: ESTIMATED

FIGURE 38. Accelerate-stop distance chart (FW)

Accelerate After Lift-Off
Flaps 40°
Power 100%

EXAMPLE

WANTED

GROUND ROLL DISTANCE AND
TOTAL DISTANCE OVER 50 FT,
OBSTACLE.

KNOWN

FREE AIR TEMPERATURE — 25°C
PRESSURE ALTITUDE — 3966 FT.
HEADWIND COMPONENT — 9.5 KTS
GROSS WEIGHT — 12500 LBS.

METHOD

ENTER AT FAT
MOVE RIGHT TO PRESSURE ALTITUDE
MOVE DOWN TO 1ST REF. LINE
FOLLOW GUIDE LINE TO GROSS WEIGHT
MOVE DOWN TO 2ND REF. LINE
FOLLOW GUIDE LINE TO WIND SPEED
MOVE DOWN TO 3RD REF. LINE
CONTINUE STRAIGHT DOWN
READ GROUND ROLL EQUAL 3300 FT.
FOLLOW GUIDE LINE TO 50 FT
READ TOTAL DISTANCE EQUAL 8550 FT.

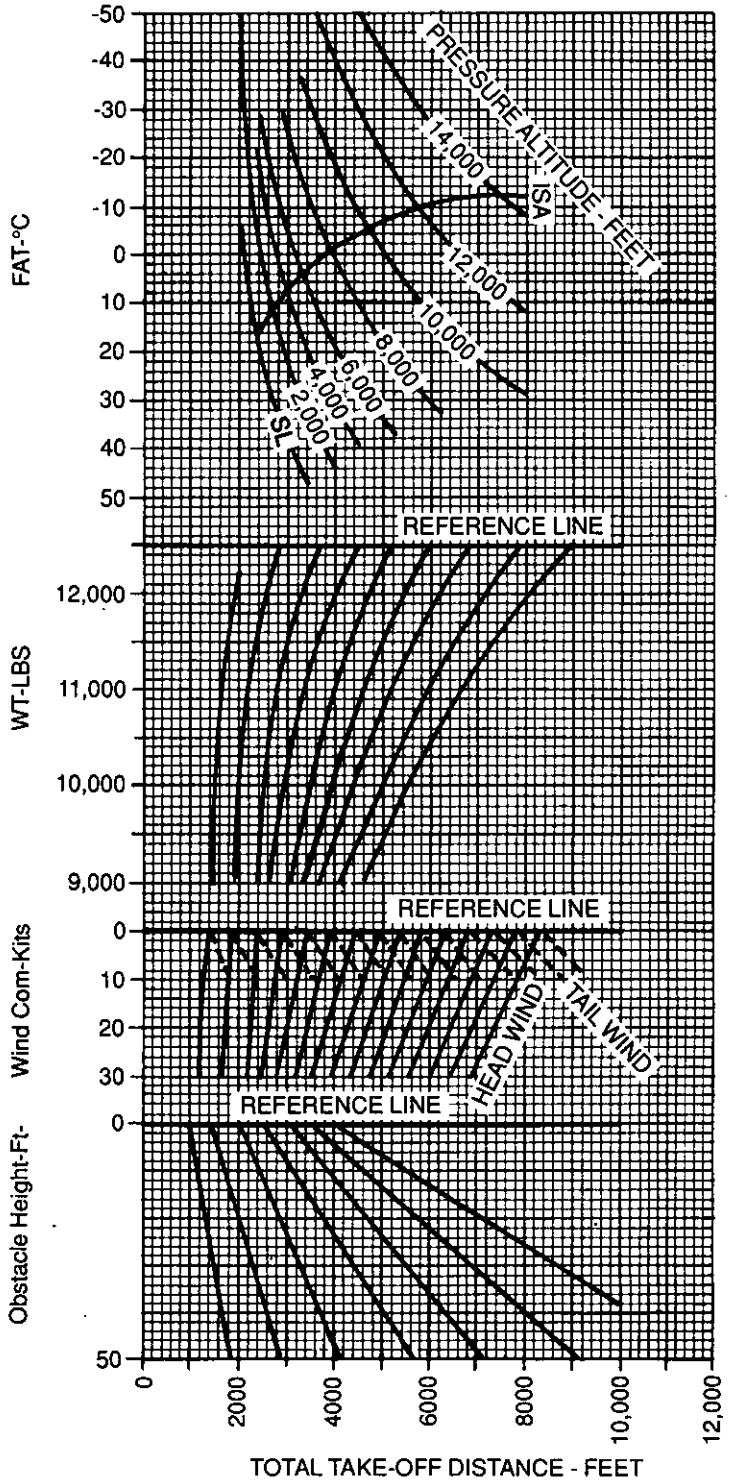


FIGURE 39. Accelerate after lift-off chart (FW)

MINIMUM SINGLE ENGINE CONTROL AIRSPEED (Vmc)

POWER — TAKEOFF GEAR DOWN
FLAPS 0 PERCENT PROP FEATHERED

EXAMPLE

WANTED

MINIMUM SINGLE ENGINE CONTROL AIRSPEED AT A GIVEN FAT AND PRESSURE ALTITUDE

KNOWN

FAT = 12°C
PRESSURE ALTITUDE = 4307 FT

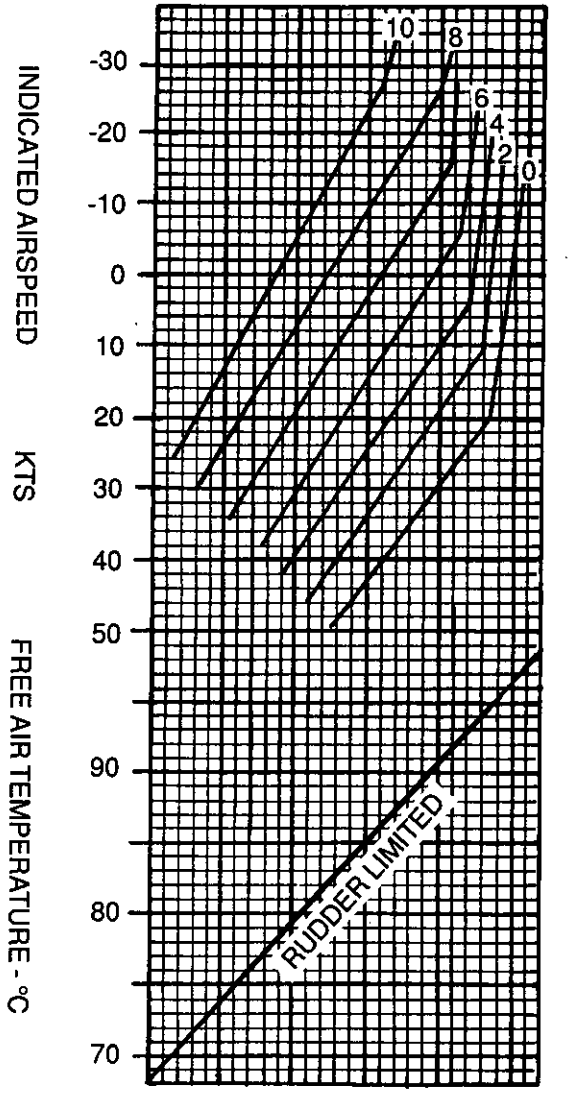
METHOD

ENTER FAT HERE
MOVE RIGHT TO PRESSURE ALTITUDE 4307 FT
MOVE DOWN TO RUDDER LIMITED LINE
MOVE LEFT, READ MINIMUM CONTROL INDICATED AIRSPEED = 84 KNOTS

NOTE

AT SOME WEIGHTS A STALL CONDITION CAN OCCUR AT AIRSPEEDS HIGHER THAN THE RUDDER LIMITED Vmc

MINIMUM SINGLE ENGINE
CONTROL AIRSPEED
U-21A
T74-CP-700



DATA BASIS: FLIGHT TEST

FIGURE 40. Minimum single engine control airspeed (Vmc) chart (FW)

Single Engine Gradient of Climb
Flaps 40%
Power - 100%
Landing Gear-Up

EXAMPLE

WANTED

GRADIENT OF CLIMB

KNOWN

FREE AIR TEMPERATURE — 25°C
PRESSURE ALTITUDE — 3966 FT.
GROSS WEIGHT — 12150 LBS

METHOD

ENTER AT FAT
MOVE RIGHT TO PRESSURE ALTITUDE
MOVE DOWN TO REFERENCE LINE
FOLLOW GUIDE LINE TO GROSS WEIGHT
MOVE DOWN READ GRADIENT OF CLIMB
EQUAL 2.4%

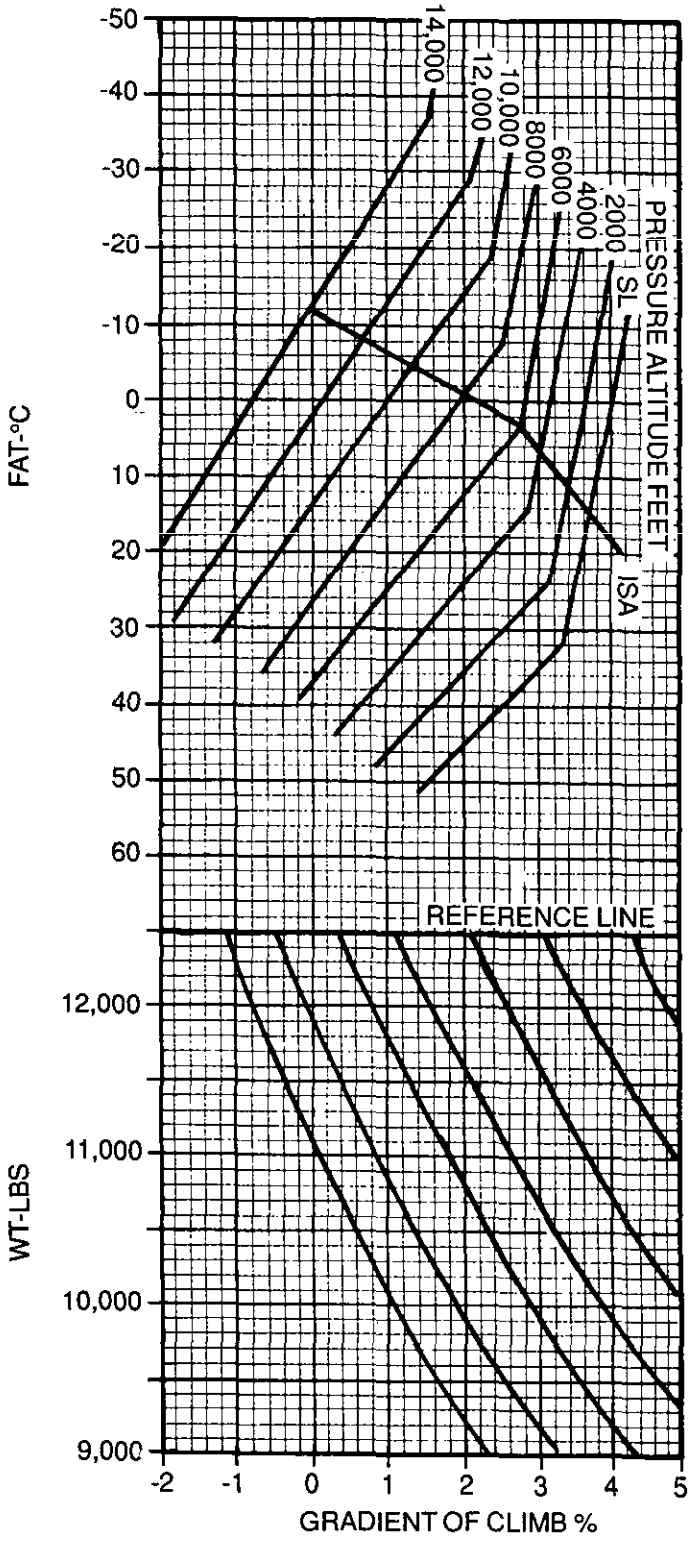


FIGURE 41. Single engine climb chart (FW)

SINGLE ENGINE CLIMB

TAKEOFF CONFIGURATION

FLAPS 0 PERCENT PROP FEATHERED POWER — TAKEOFF

EXAMPLE

WANTED

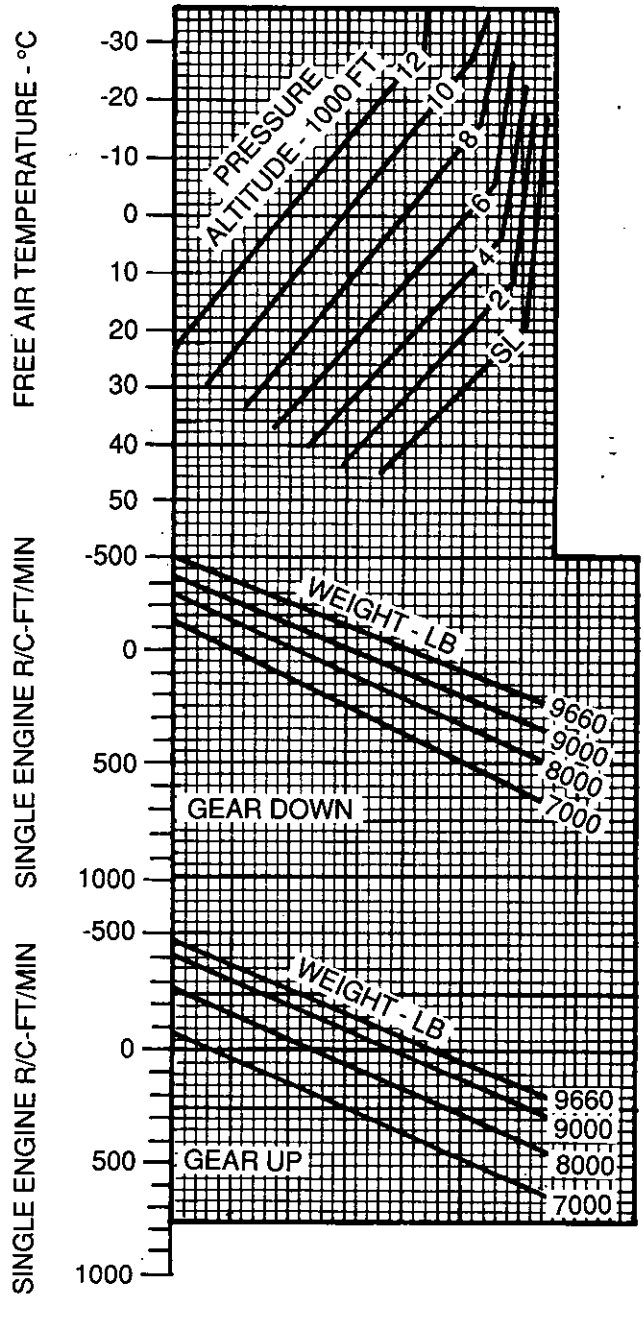
WEIGHT TO OBTAIN A POSITIVE SINGLE ENGINE R/C AT LIFTOFF AND SINGLE ENGINE R/C AFTER GEAR IS RETRACTED.

KNOWN

FAT = 12°C
PRESSURE ALTITUDE = 4307 FT.

METHOD

ENTER FAT
MOVE RIGHT TO PRESSURE ALTITUDE = 4307 FT
MOVE DOWN TO 0 FT/MIN R/C FOR GEAR DOWN
READ WEIGHT TO OBTAIN POSITIVE R/C AT LIFTOFF = 9650 LBS. THE MAXIMUM TAKEOFF WEIGHT
MOVE DOWN TO WEIGHT = 9650 LBS FOR GEAR UP CLIMB
MOVE LEFT, READ SINGLE ENGINE R/C AFTER GEAR RETRACTION = 280 FT/MIN



DATA BASIS: FLIGHT TEST

FIGURE 41. Single engine climb chart (FW) — Continued

CRUSIE CLIMB

GEAR UP FLAPS 0 PERCENT CALM WIND

POWER - CRUISE CLIMB

140 KIAS

EXAMPLE

WANTED

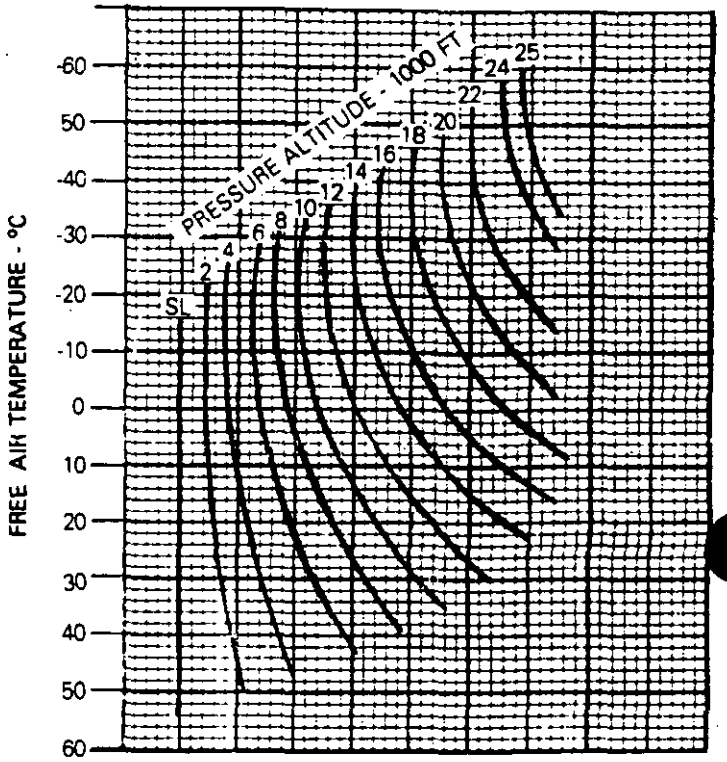
TIME, FUEL, AND DISTANCE REQUIRED TO CLIMB

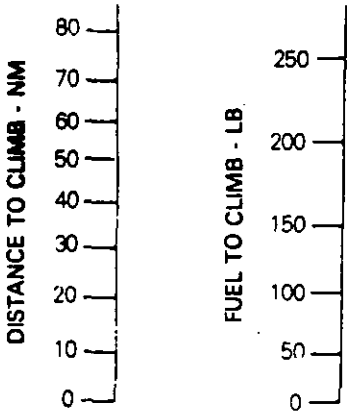
KNOWN

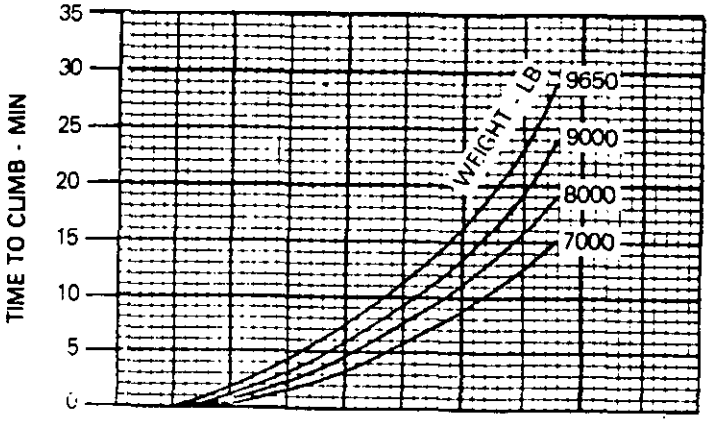
INITIAL FAT=12°C
INITIAL PRESSURE ALTITUDE=4307 FT
INITIAL WEIGHT=9650 LBS
FINAL FAT=-5°C
FINAL PRESSURE ALTITUDE=12,000 FT

METHOD

ENTER FAT
MOVE RIGHT TO PRESSURE ALTITUDE
MOVE DOWN TO INITIAL WEIGHT
MOVE LEFT, READ TIME, FUEL AND DISTANCE
READ GRAPH FOR INITIAL CONDITIONS AND SECOND READ FOR FINAL CONDITIONS WITH INITIAL WEIGHT.
DIFFERENCE BETWEEN READINGS IS TIME, FUEL AND DISTANCE TO CLIMB.
TIME TO CLIMB (9-3)=6 MIN
FUEL TO CLIMB (90-37)=53 LB
DISTANCE TO CLIMB (19-7)=12 NM







DATA BASIS: FLIGHT TEST

FIGURE 42. Cruise climb chart (FW)

CLIMB/DESCENT
GEAR UP FLAPS 0 PERCENT

EXAMPLE *I*

WANTED

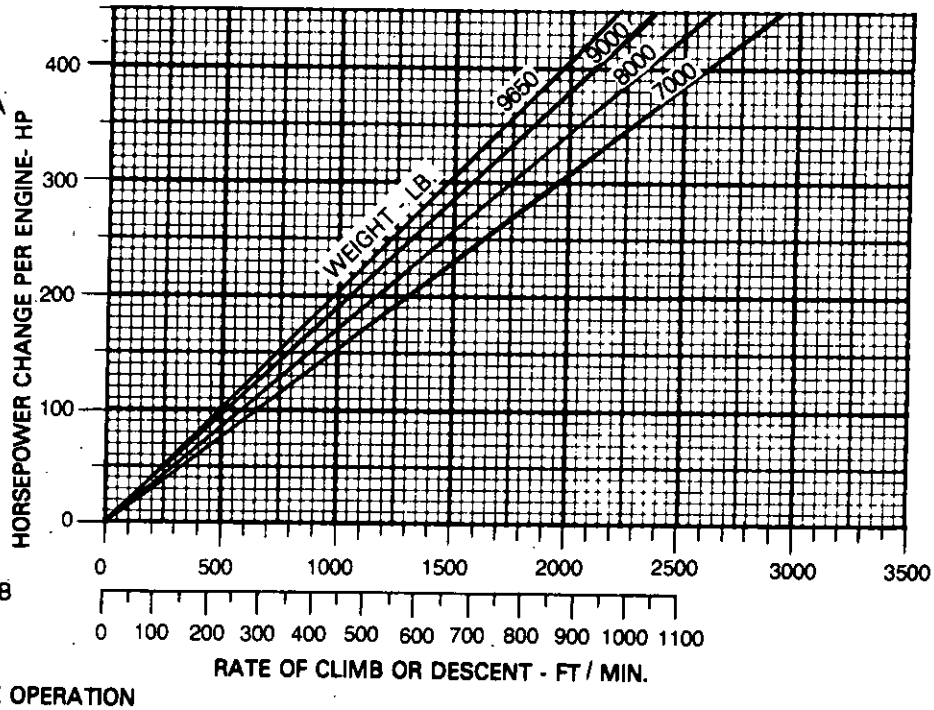
RATE OF CLIMB OR DESCENT AS A RESULT OF CHANGE IN HORSEPOWER

KNOWN

CHANGE = 200 HP
WEIGHT = 9000 LB

METHOD

ENTER HORSEPOWER CHANGE
MOVE RIGHT TO WEIGHT = 9000 LB
MOVE DOWN, READ RATE OF CLIMB OR DESCENT = 1050 FT. / MIN.



TWO ENGINE OPERATION

SINGLE ENGINE OPERATION

EXAMPLE *II*

WANTED

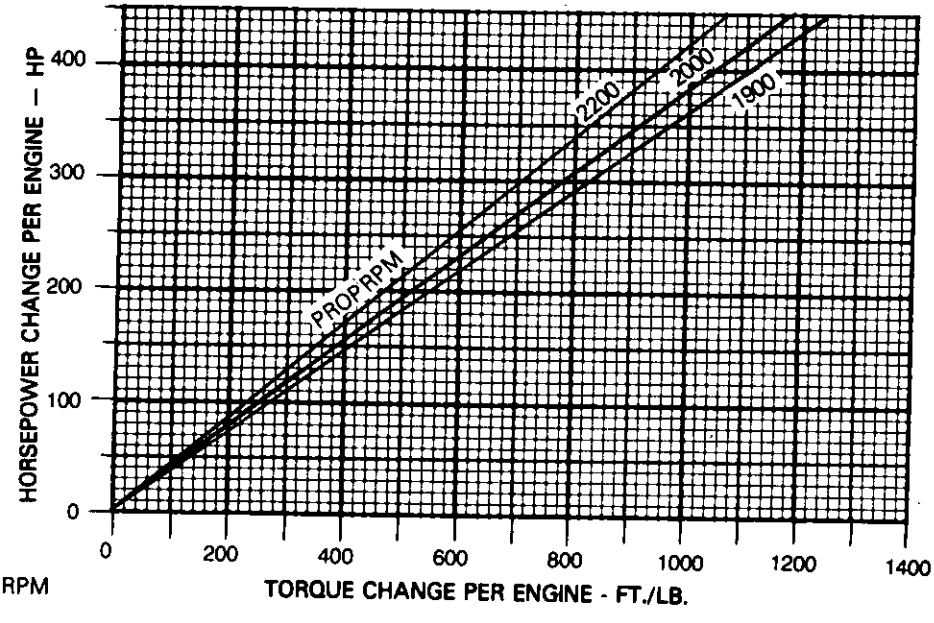
TORQUE CHANGE FOR CLIMB OR DESCENT AS A RESULT OF CHANGE IN HORSEPOWER OR PRM

KNOWN

HORSEPOWER CHANGE = 200HP
PROP RPM = 1900 RPM

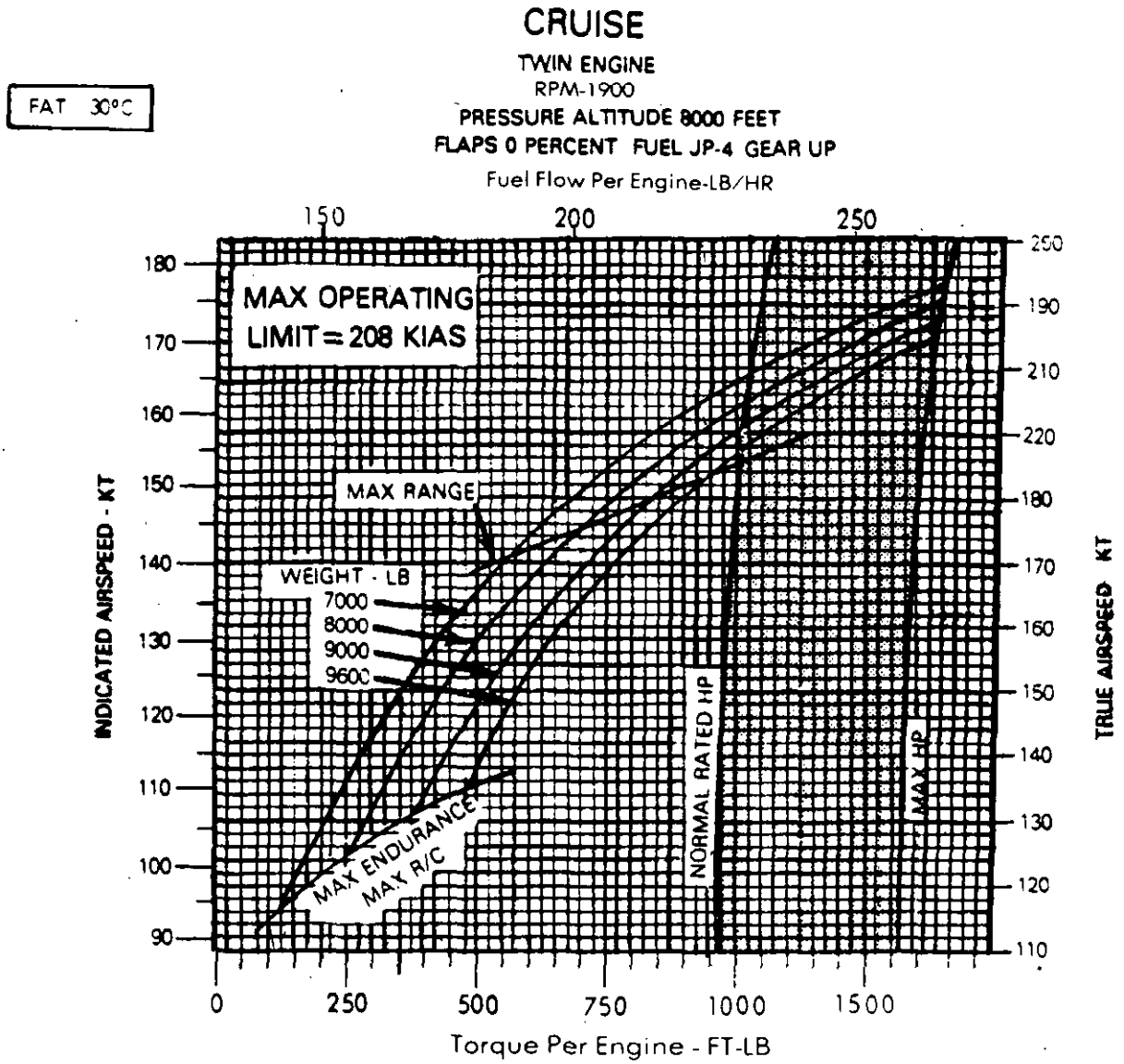
METHOD

ENTER HORSEPOWER CHANGE
HERE MOVE RIGHT TO RPM = 1900 RPM
MOVE DOWN, READ TORQUE CHANGE PER ENGINE = 560 FT. LB.



DATA BASIS: CALCULATED

FIGURE 43. Climb/descent chart (FW)



DATA BASIS: ESTIMATED

FIGURE 44. Cruise chart (FW)

APPROACH SPEED

GEAR DOWN

EXAMPLE

WANTED

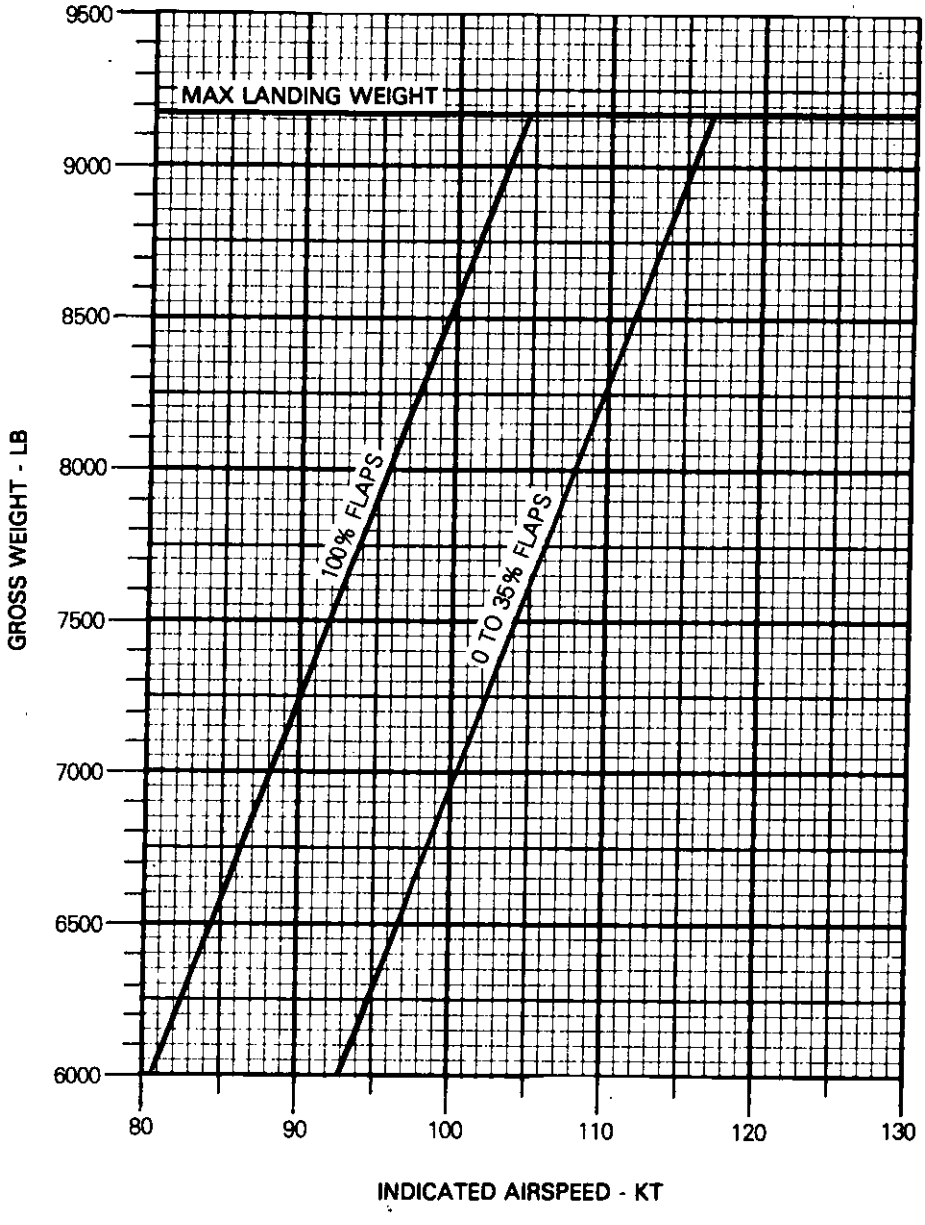
RECOMMENDED APPROACH SPEED FOR KNOWN WEIGHT

KNOWN

WEIGHT=8855 LB
FLAP SETTING=DOWN

METHOD

ENTER WEIGHT
MOVE RIGHT TO APPROACH SPEED LINE, FLAPS DOWN
MOVE DOWN, READ INDICATED AIRSPEED=103 KT



DATA BASIS: FLIGHT TEST

FIGURE 45. Approach speed chart (FW)

LANDING

CALM WINDS LEVEL, DRY, HARD SURFACE
MAX BRAKING AND IDLE POWER ON RUNWAY

EXAMPLE

WANTED

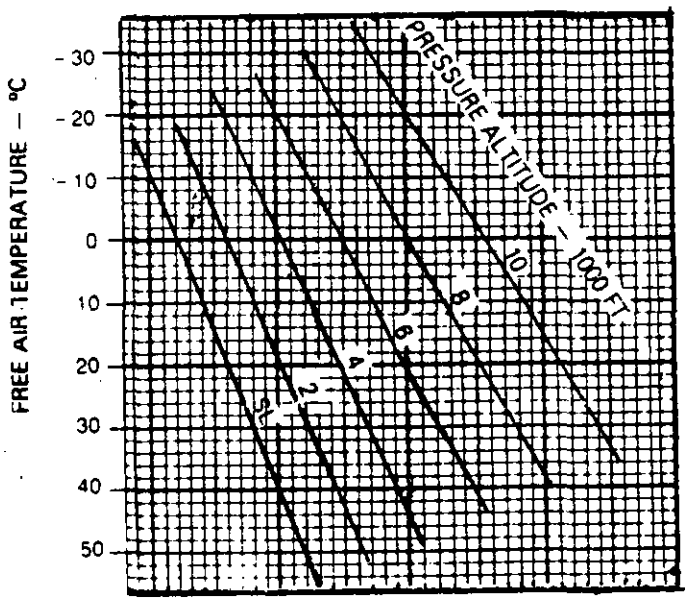
LANDING DISTANCE

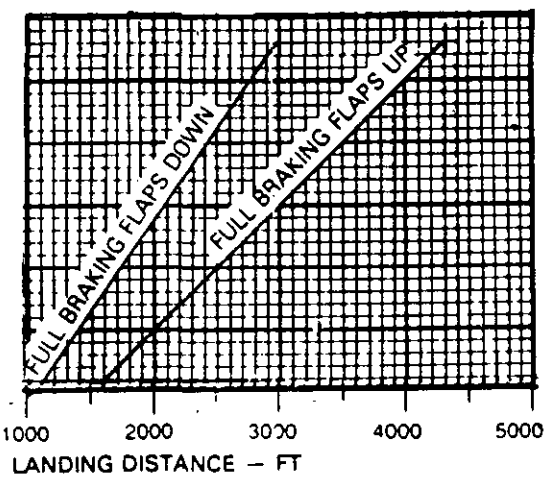
KNOWN

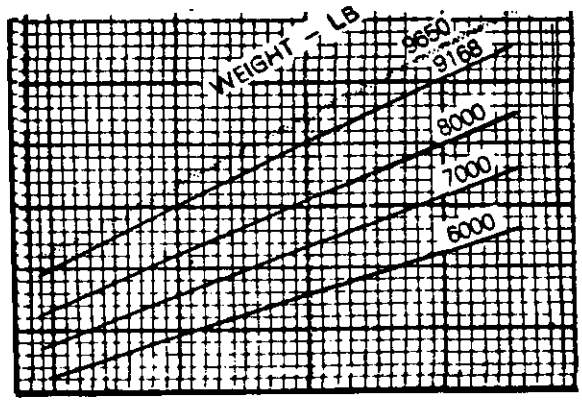
WEIGHT – 8855 LB
PRESSURE ALTITUDE – 4484 FT
FAT – 18°C
FLAPS DOWN

METHOD

ENTER FAT
MOVE RIGHT TO PRESSURE ALTITUDE – 4484 FT
MOVE DOWN TO WEIGHT – 8855 LB
MOVE LEFT TO FULL BRAKING WITH FLAPS DOWN
MOVE STRAIGHT DOWN, READ LANDING DISTANCE – 2150 FT







DATA BASIS: CALCULATED

FIGURE 46. Landing chart (FW)

8-20. ENGINE RUN-UP.

CAUTION

Minimize movement of the cyclic during ground run-up, to preclude damage to the input quill seal and the main drive shaft.

*1. Gas producer - 70 to 72 percent rpm.

NOTE

This check should be made while holding throttle lightly against engine idle stop.

*2. Engine oil pressure - 25 psi minimum at engine idle.

*3. Transmission oil pressure - Check.

*4. Master caution light - OFF.

*5. SCAS power switch - ON. Check No-Go lights illuminated.

CAUTION

If fuel quantity gage does not coincide with the visual inspection of fuel quantity, the possibility exists that fuel is restricted from flowing to the aft cell by malfunction or improper installation of the flapper check valve. If this condition does exist, it presents a serious center of gravity hazard and should be thoroughly investigated by maintenance before flight.

*6. Fuel quantity - Press to test.

*7. Avionics - ON.

★8. Force Trim Switch - ON. Check force gradients as follows: Press cyclic momentary interrupt switch (pilot then gunner) ensuring magnetic brakes release.

0 (9.) Force Trim Switch - ON. Check force gradients operational. Press cyclic momentary interrupt switch (pilot then gunner) ensuring magnetic brakes release.

FIGURE 47. Example of amplified checklist format and style

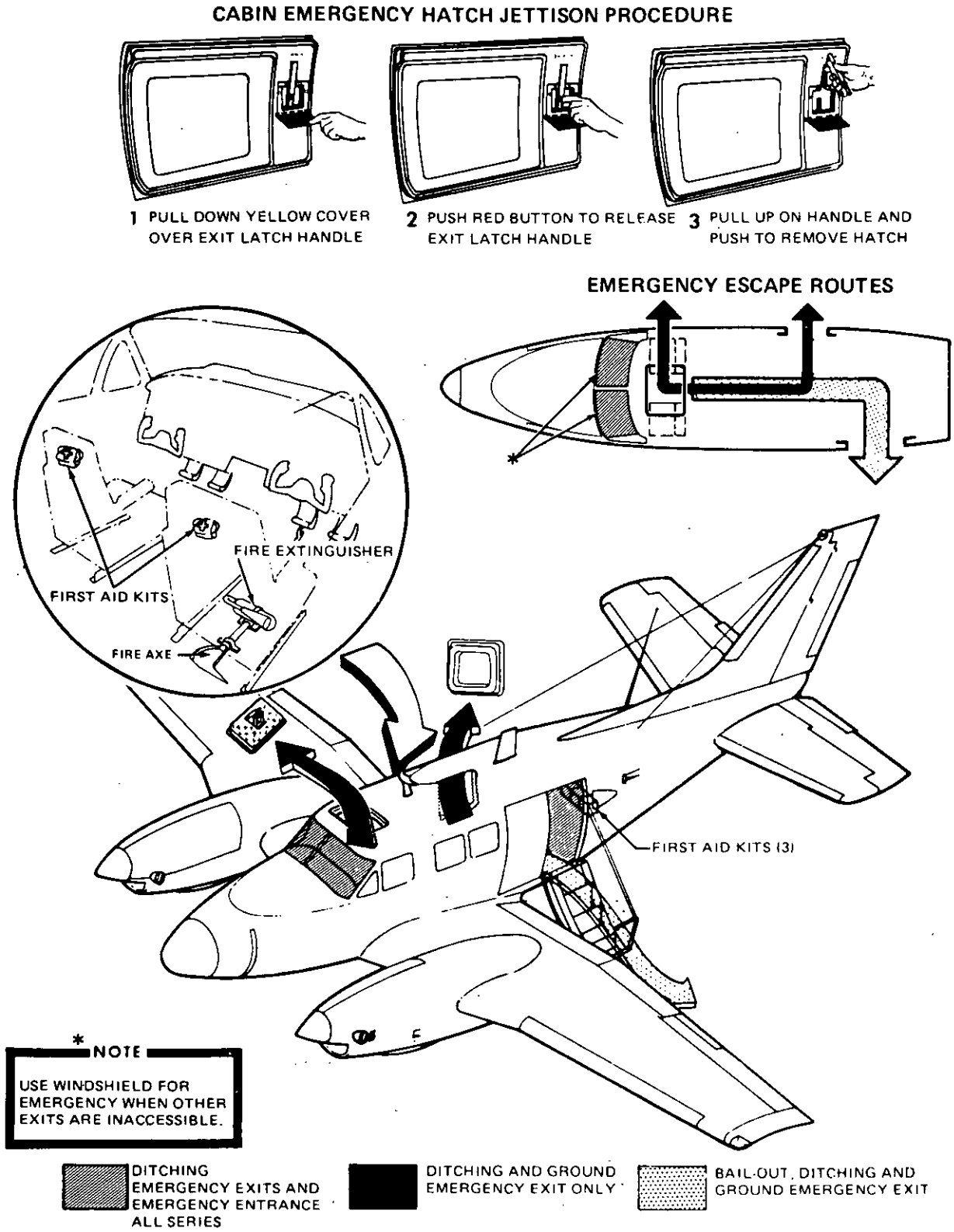


FIGURE 48. Emergency equipment and emergency exit diagram

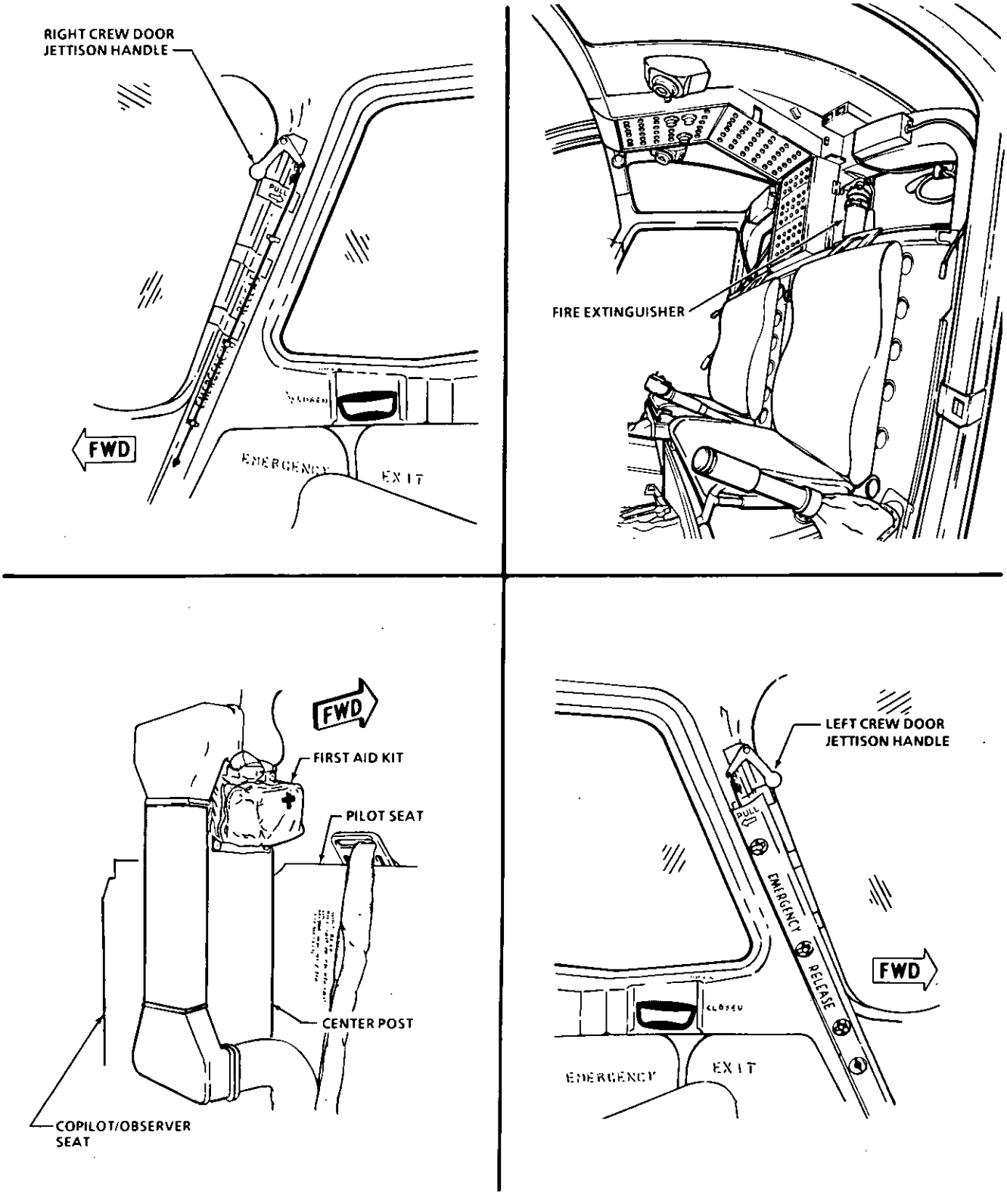


FIGURE 48. Emergency equipment and emergency exit diagram — Continued

MAXIMUM GLIDE DISTANCE

POWER OFF (PROPELLERS FEATHERED)
GEAR AND FLAPS UP ZERO WIND

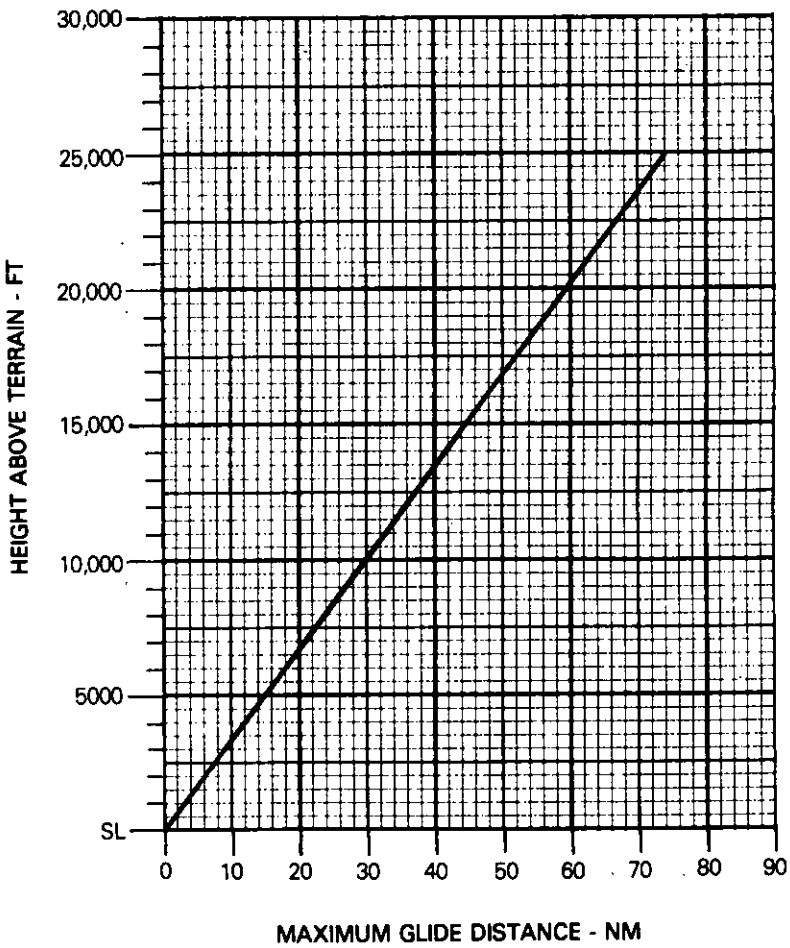
WEIGHT - LBS.	BEST GLIDE SPEED KIAS
9650	112
9000	108
8000	102
7000	94
6000	87

EXAMPLE

WANTED
MAXIMUM GLIDE DISTANCE

KNOWN
HEIGHT ABOVE TERRAIN =7400 FT

METHOD
ENTER HEIGHT ABOVE TERRAIN
MOVE RIGHT TO MAXIMUM GLIDE DISTANCE LINE
MOVE DOWN, READ MAXIMUM GLIDE DISTANCE=22NM



DATA BASIS: ESTIMATED

FIGURE 49. Maximum glide distance (FW)

AUTOROTATIONAL GLIDE CHARACTERISTICS
POWER OFF

EXAMPLE

WANTED

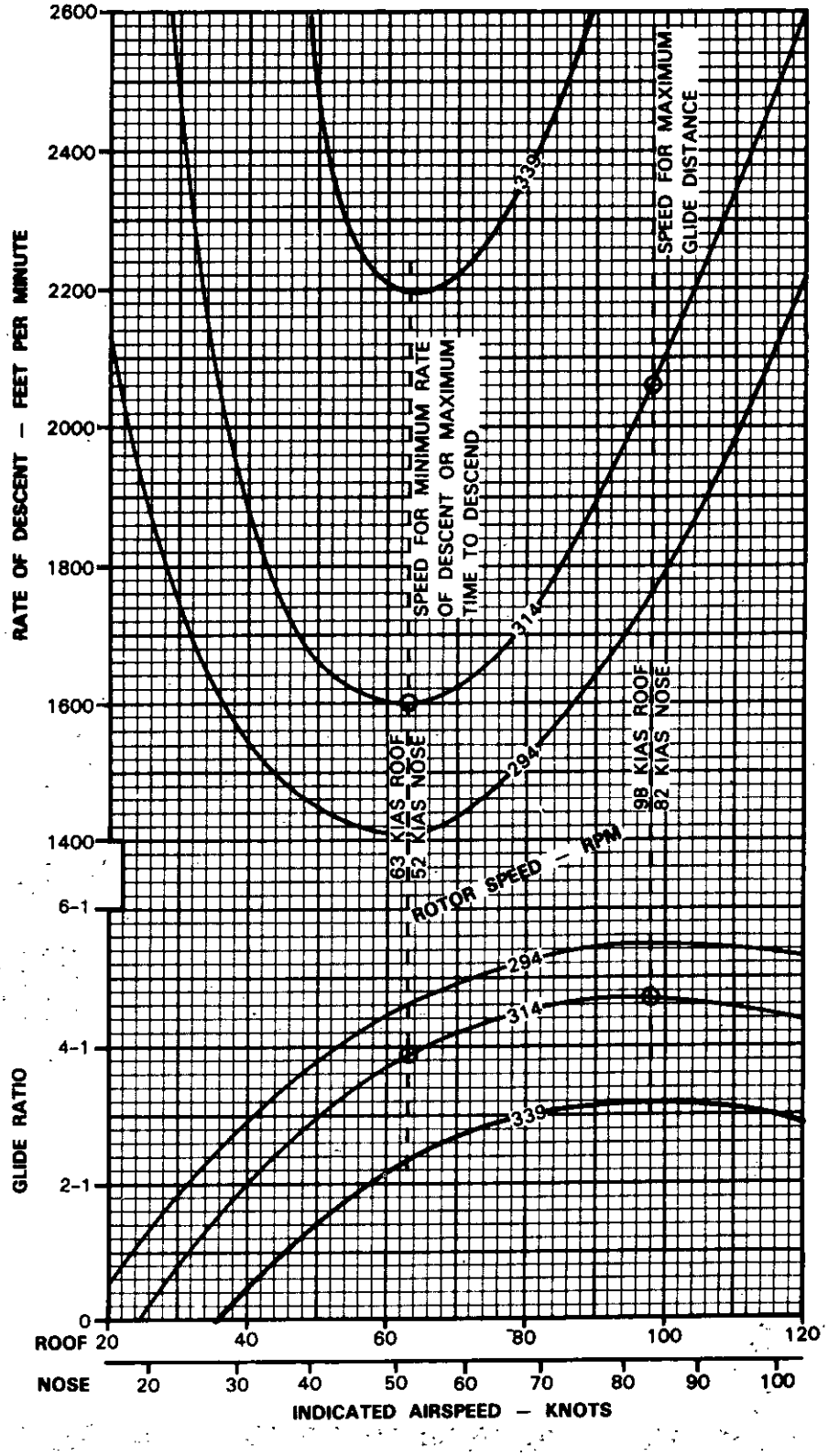
GLIDE RATIO AND RATE OF DESCENT

KNOWN

AIRSPEED – 80 KIAS ROOF
ROTOR RPM – 314

METHOD

ENTER INDICATED AIRSPEED
MOVE UP TO 314 ROTOR RPM LINE
MOVE LEFT, READ GLIDE RATIO – 4.5
CONTINUE UP 80 KIAS TO 314 ROTOR RPM LINE ON UPPER GRAPH. MOVE LEFT, READ RATE OF DESCENT – 1725 FPM

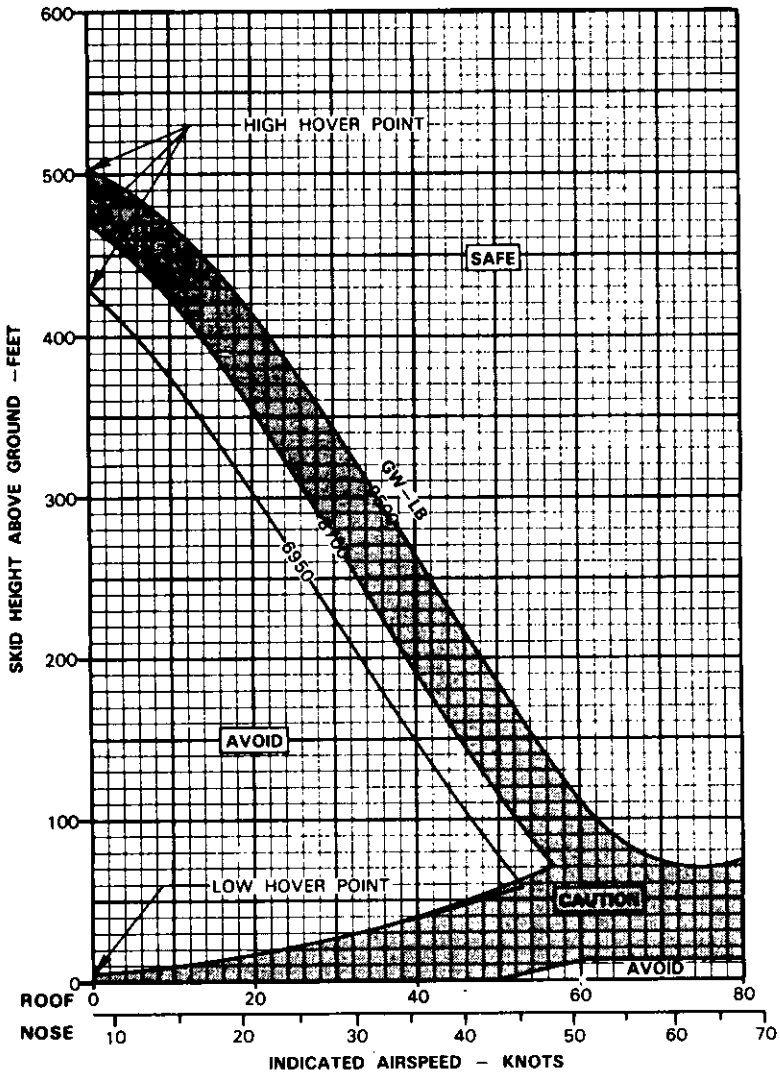


DATA BASIS: CALCULATED DATA

FIGURE 50. Autorotational descent

HEIGHT VELOCITY DIAGRAM

324 ROTOR RPM



DATA BASIS: DERIVED FROM FLIGHT TEST FTC-TDR 67-27, NOVEMBER 1964

FIGURE 51. High velocity diagram

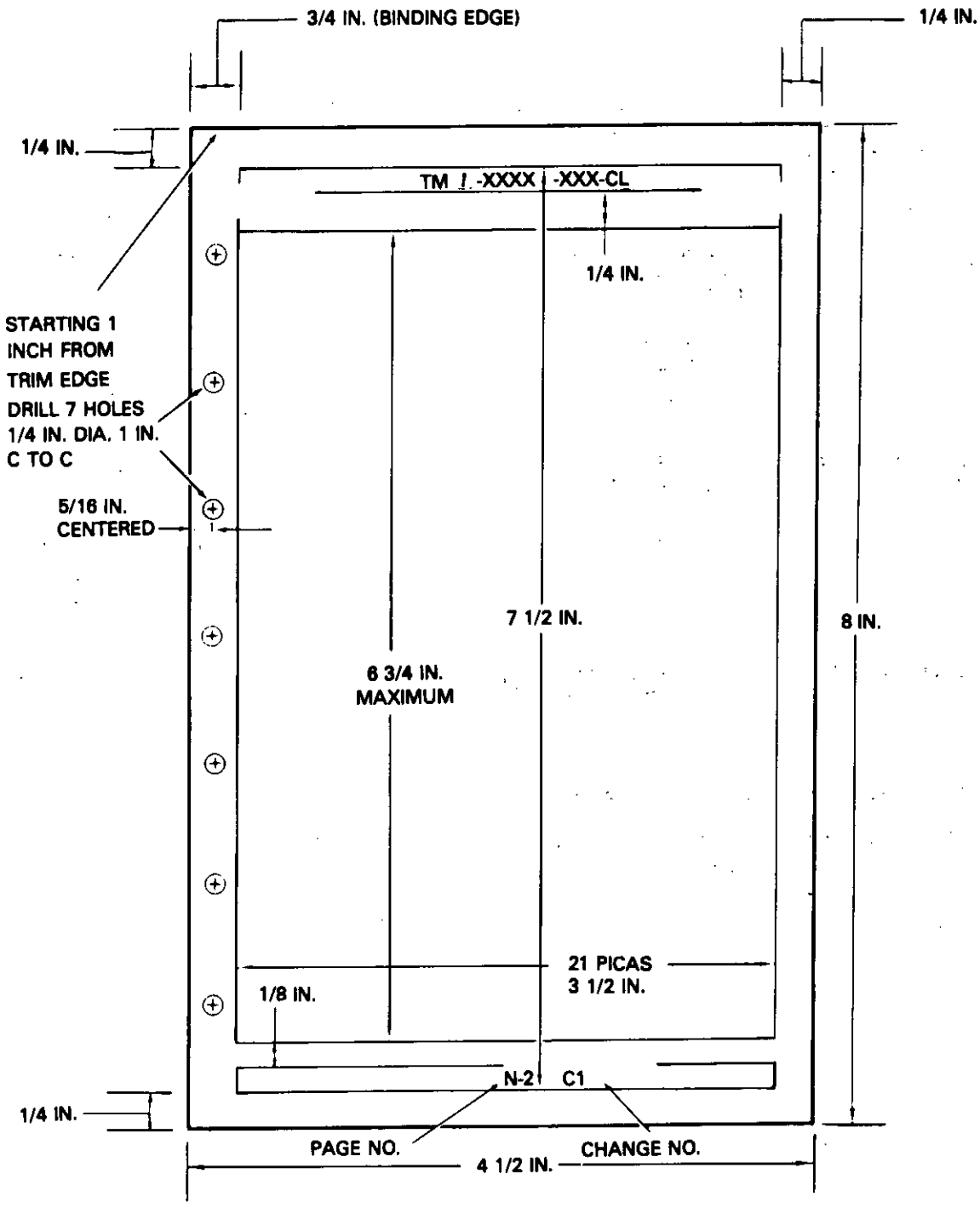


FIGURE 52. Dimensions for reproducible page (CL)

USE	TYPE STYLE AND SIZE	CAPITALIZATION	SPACING
1. GENERAL INFORMATION AND SCOPE	10 PT MEDIUM		
2. MARGINAL COPY	10 PT BOLD	CAPITALS	SEE FIGURES 61 AND 62.
3. NORMAL AND EMERGENCY CHECKLIST TEXT*	(a) PRIMARY HEADINGS 14 PT BOLD AND SUBORDINATE HEADINGS 12 BOLD. (b) ITEM TO BE CHECKED 10 PT MEDIUM. (c) ACTION TO BE TAKEN 10 PT MEDIUM.		1 PICA BETWEEN PRIMARY AND SUBORDINATE HEADINGS, BETWEEN SUBORDINATE HEADING AND CHECKS, OR BETWEEN CHECKS AND NEXT PRIMARY OR SUBORDINATE. HEADING.
4. IMMEDIATE ACTION TEXT	10 PT MEDIUM UNDERLINED		1 PICA BETWEEN PRIMARY AND SUBORDINATE HEADINGS, BETWEEN SUBORDINATE HEADING AND CHECKS, OR BETWEEN CHECKS AND NEXT PRIMARY OR SUBORDINATE HEADING.
5. PERFORMANCE DATA	NO LARGER THAN 12 PT AND NO SMALLER THAN 8 PT BOLD	CAPITALS	

*INDENTIONS SHALL BE 1 EM AND 2 EMS AS NEEDED.

(TYPE STYLES OTHER THAN THOSE LISTED ABOVE SHALL HAVE PRIOR APPROVAL IN WRITING OF THE PROCURING ACTIVITY-6.2.)

FIGURE 53. Standard Operator's Checklist — Type style and spacing requirements (CL)

USE	TYPE STYLE AND SIZE	CAPITALIZATION	SPACING
1. MARGINAL COPY	10 PT BOLD	CAPITALS	4¼ PICAS (¾ in) FROM EDGE OF PAPER
2. NORMAL AND EMERGENCY CHECKLIST TEXT*	PRIMARY HEADINGS – 10 PT BOLD SUBORDINATE HEADINGS – 10 PT MEDIUM ITEM TO BE CHECKED AND ACTION TO BE TAKEN – 8 PT MEDIUM	CAPITALS CAPITALS	¼ PICA (6 POINTS ABOVE AND BELOW HEADINGS
3. IMMEDIATE ACTION TEXT	8 PT MEDIUM UNDERLINED		¼ PICA (6 POINTS) SPACE ABOVE AND BELOW HEADINGS

*INDENTIONS SHALL BE 1 EM AND 2 EMS AS NEEDED.

FIGURE 54. Alternate Operator's Checklist — Type style and spacing requirements

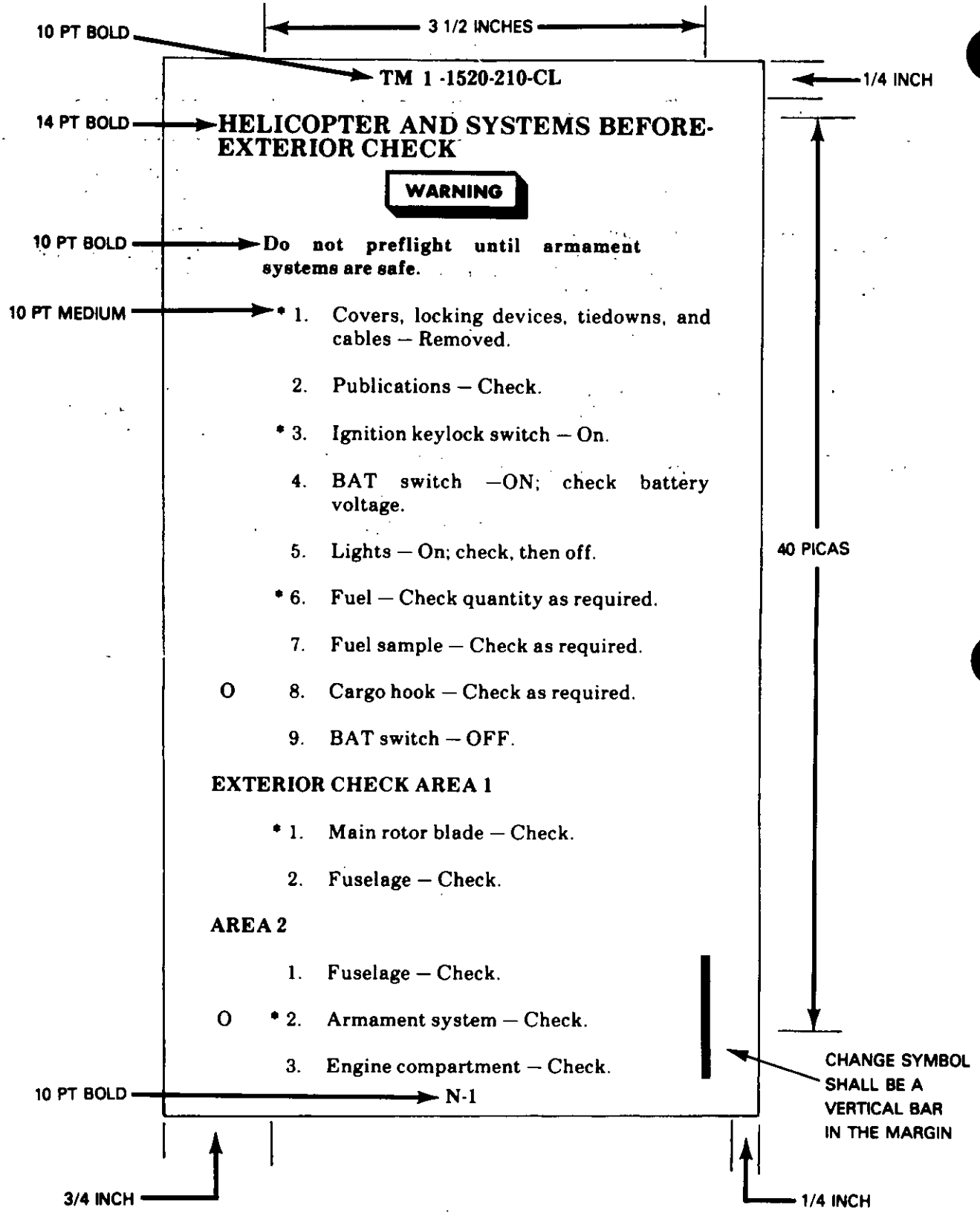


FIGURE 55. Example of normal procedures page (CL)

GENERAL INFORMATION AND SCOPE

SCOPE. This checklist contains the checks to be accomplished during normal and emergency operations. Performance data pertinent to normal operation of the helicopter is provided in the performance data section of this checklist.

GENERAL INFORMATION. The checklist consists of three parts: normal procedures, emergency procedures, and performance data.

NOTE

This checklist does not replace the amplified version of the procedures in the operator's manual (TM 55-1520-210-10), but is a condensed version of each procedure.

Normal Procedures Pages. The contents of the normal procedures of this manual are a condensation of the amplified checklists appearing in TM 55-1520-210-10 Emergency Procedures pages. The requirements of this section of the condensed checklist manual (CL) are identical to those for the normal procedures, except that the information is drawn from the amplified checks in the emergency procedures portion of the operator's manual. The emergency requirements are subdivided into 12 classifications as follows: engine, rotor/transmission/drive system, fire, fuel, electrical, hydraulic, landing and ditching, flight controls, bailout, and mission equipment, as applicable.

Performance Data pages. This section consists of charts, tables, and checklists for use during preflight, takeoff, cruise, landing, and shutdown.

(FRONT)

Symbols preceding numbered steps:

* —Indicates performance of steps is mandatory for all thru flights.

N —Indicates performance of step is mandatory for night flights.

★ —Indicates a detailed procedure for this step is included in the Performance Checks section located in the back of the checklist.

I —Indicates mandatory check for instrument flights.

O —Indicates if installed.

Underlined items: Immediate action emergency procedure items which are underlined must be performed without reference to checklist.

Through-flight checklist. A through-flight checklist is provided in the Performance Section and consists of asterisk "Thru Flight" items. In addition to thru flight, this checklist may be used for combat/tactical operations when authorized by the commander.

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 through your commander to Commander, US Army Aviation Systems Command, ATTN: AMSAV-MC, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798.

(REVERSE)

FIGURE 56. Example of general information and scope page (CL)

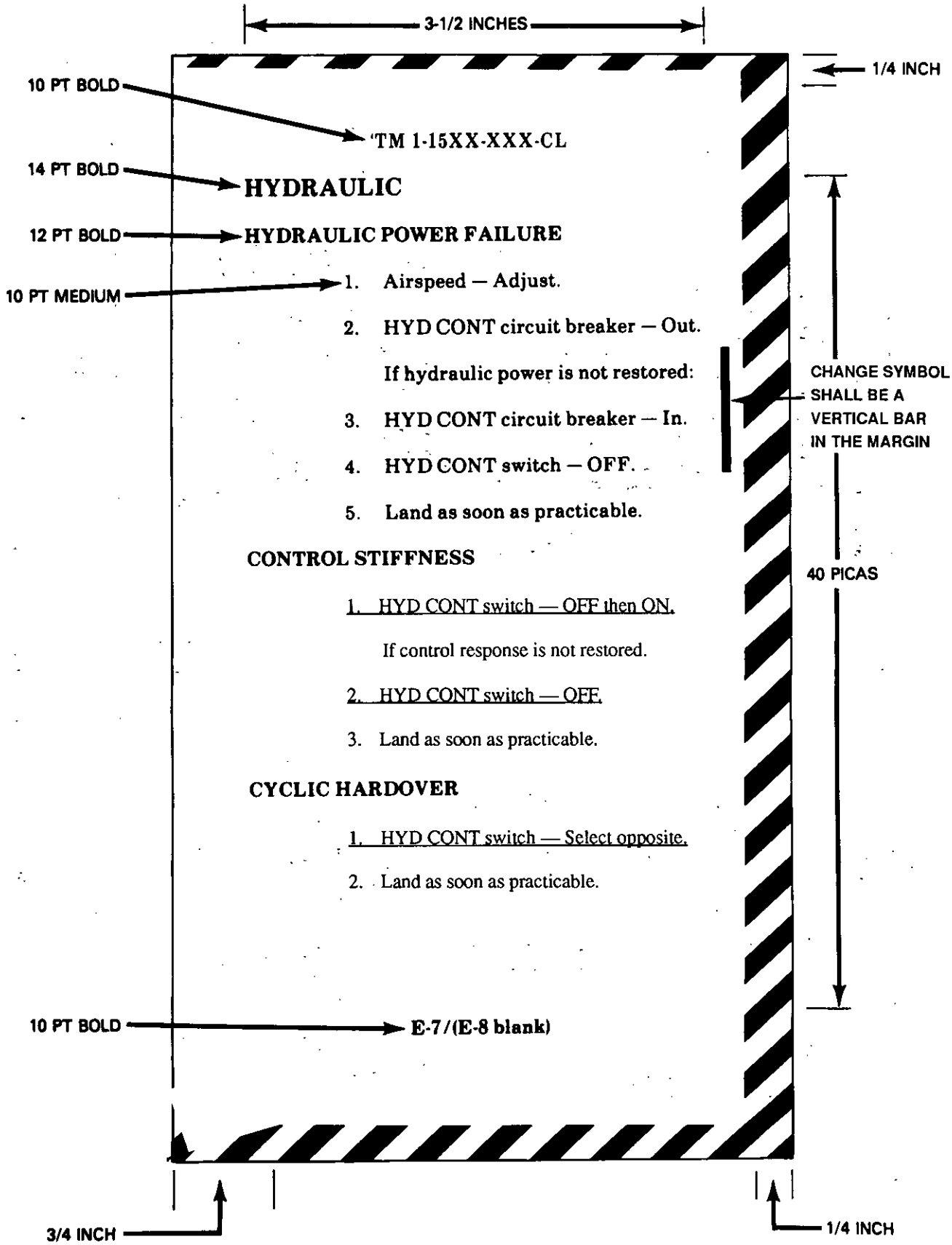


FIGURE 57. Example of emergency procedures page (CL)

APPENDIX

PROCEDURE FOR CONTENT/FORMAT SELECTION

10. SCOPE

10.1 Scope. This appendix details the content/format selection summary provided by the contracting activity as part of a contract statement of work. Manual content will be determined as checked next to the applicable item in the CONTENT/OPTION column. The applicable chapter/section for locating the item selected is entered in the MANUAL LOCATION column. This appendix is a mandatory part of the specification. The information contained herein is intended for guidance.

MANUAL ELEMENT	ITEM	MIL-M-63029 PARA REF	CONTENTS/OPTIONS/REMARK	CONTENT/ OPTION	MANUAL LOCATION
THROUGH-OUT	ILLUSTRATIONS	3.1.5 3.1.6	LINE DRAWINGS		
			PHOTOGRAPHS		
			BROADSIDES		
			GRAPHICAL PRESENTATION (other than specified)		
			ORDER OF PRIORITIES (other than specified)		
			SCALING (other than specified)		
	CHAPTER, SECTION, AND APPENDIX REQUIREMENTS	3.1.1 3.1.2	Additional sections		
			Additional Appendixes		
	MANUFACTURER'S NAMES	3.1.8	Use of manufacturer's names		
	PAGE ARRANGEMENT	3.2.1.8	Duplicate pages		

MANUAL ELEMENT	ITEM	MIL-M-63029 PARAGRAPH REFERENCE	CONTENTS/OPTIONS/REMARKS	CONTENT/ OPTION	MANUAL LOCATION
Chapter 1- Introduction	Introductory Material	3.2.3.4	Include additional special information		
Chapter 2- Aircraft and Systems Description and Operation	Malfunction Isolation Charts	3.2.4	Include flight crew oriented malfunction isolation charts.		
	Fuel System Illustrations	3.2.4.6.4	Schematic diagrams.		
	Approved Fuels	3.2.4.17.3	Include additional fuels in addition to those listed in TB 55-9150-200-24.		
Chapter 3- Avionics	Section Requirements	3.2.5.2	Add additional sections		
	Operation	3.2.5.2.3	Government furnished standard operational avionics data.		
			Contractor prepared operational avionics data.		
Chapter 4- Mission Equipment	Mission Avionics	3.2.6.1	Prepare appendix for mission avionics equipment.		
Chapter 5- Operating Limits and Restrictions	Instrument Operating Ranges and Markings	3.2.7.2.1	Include other instrument markings in addition to those specified.		
	Airspeed Limits Maximum and Minimum	3.2.7.5	Other than specified		
	Additional Sections	3.2.7.8	Include additional sections.		
Chapter 6- Weight/Balance and Loading	Oil data	3.2.8.3.1	Include statement of usable oil capacity		
Chapter 7- Performance Data	Configuration	3.2.9.1.5	Other than specified		
	Fuel	3.2.9.1.5	Additional charts for alternate fuels.		
	Atmospheric Conditions	3.2.9.1.5	Other than specified.		
	Rotary Wing Performance Data	3.2.9.1.10	Other than specified		
			Additional Charts		

MANUAL ELEMENT	ITEM	MIL-M-63029 PARAGRAPH REFERENCE	CONTENTS/OPTIONS/REMARKS	CONTENT/ OPTION	MANUAL LOCATION
	Fixed Wing Performance Data	3.2.9.1.11	Other than specified		
			Additional Charts		
	Use of Charts	3.2.9.2.5	Include additional discussion		
			Include additional problems		
			Include additional illustrations		
	Rotary Wing Chart Content	3.2.9.3.1	Additional fuel flow data for alternate or emergency fuels		
			Additional charts for all approved takeoff techniques.		
			Depict alternate total configuration(s) on drag charts (special line coding).		
			Omit airspeed, altitude, and/or temperature calibration data		
	Fixed Wing Chart Content	3.2.9.3.2	Approach speed other than specified		
			Landing chart validity other than specified		
Chapter 8 - Normal Procedures	Section II - Operating Procedures and Maneuvers	3.2.10.2.31	Alter sequence		
			Delete specific checks		
			Add specific checks		
Chapter 9 - Emergency Procedures	Engine	3.2.11.1.2	Height velocity plots other than specified.		

MANUAL ELEMENT	ITEM	MIL-M-63029 PARAGRAPH REFERENCE	CONTENTS/OPTIONS/REMARKS	CONTENT/ OPTION	MANUAL LOCATION
Operator's Checklist (-CL)	Type Style, Size and Spacing	3.3.2.2	Other than specified in n figure 52.		
	Detail Requirements	3.3.3	Prepare pages titled "Crew-members Duties" for nor-mal and emergency pro-cedures		
	Performance Data Charts	3.3.4.8	Prepare performance charts (specify format)		

CONCLUDING MATERIAL

Custodian:
ARMY-TM

Preparing Activity:
Army-AV

Review activities:
ARMY-SC, SL

PROJECT NUMBER TMSS-A 197

*U.S. GOVERNMENT PRINTING OFFICE: 1991--504-034/50246

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-M-63029C(AV)	20 March 1991

3. DOCUMENT TITLE
Manuals, Technical: Requirements for Operator's Manuals and Checklist for Aircraft

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON
c. ADDRESS (Include Zip Code)	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340