NOT MEASUREMENT SENSITIVE

MIL-PRF-63029F (AV)

28 FEBRUARY 2005
SUPERSEDING
MIL-PRF-63029E (AV)
31 January 2002

TECHNICAL MANUAL SPECIFICATION

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

This specification is approved for use by U.S. Army Research, Development and Engineering Command, 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 establishes the requirements needed to prepare digital technical manuals (TMs) describing operating procedures, checklists, and maintenance test flight (MTF) manuals for operators of Army aircraft.

1.2 Classification. The TMs to be prepared in accordance with this specification include:

-10 - Operator's Manual
-CL - Operator's and Crewmember’s Checklist
-MTF - Maintenance Test Flight Manual

Comments, suggestions, or questions on this document should be addressed to U.S. Army Research, Development and Engineering Command, ATTN: AMSRD-AMR-SE-TD, Redstone Arsenal, AL 35898-5000. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

AMSC A6038 AREA TMSS

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

1.3 Figures. In the event of a conflict between the text and the illustrations, the text of this document takes precedence over the figures.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 3 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARD

MIL-STD-40051-2	Preparation of Digital Technical Information for Page-Based Technical Manuals

DEPARTMENT OF DEFENSE HANDBOOK

MIL-HDBK-310	Global Climatic Data for Developing Military Products

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/or http://assist.daps. dla.mil. /or Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 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 or contract.

FM-1-203	Fundamentals of Flight
FM-1-240	Instrument Flying and Navigation for Army Aviators
TB 55-9150-200-24	Engine and Transmission Oils, Fuels, and Additives for Army Aircraft

TM 1-1500-328-23	Aeronautical Equipment Maintenance Management Policies and Procedures
TM 55-1500-342-23	Army Aviation Maintenance Engineering Manual for Weight and Balance
TM 750-244-1-5	Procedures for the Destruction of Aircraft and Associated Equipment to Prevent Enemy Use

(Copies of these publications are available from the U.S. Army Publishing Directorate, Distributions Operations Facility, 1655 Woodston Road, St. Louis, MO 63114-6181.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation.

American Society of Mechanical Engineers (ASME)

ASME Y14.38M	Abbreviations and Acronyms

(Application for copies of ASME publications should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017-2393.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. This section provides the technical content requirements for the operator's manuals, checklists and MTF manuals. Technical content requirements (3.2 through 3.4) shall deal with the specific technical data aspects of operator's manuals, checklists and MTF manuals. The style and format requirements for the development of operator's manuals, checklists and MTF manuals are provided in Appendix A through Appendix D of this specification.

3.2 Operator's manual (-10).

3.2.1 General. The operator's 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, operational procedures, and checks necessary for the pilot to safely and efficiently operate the aircraft, aircraft systems, and mission equipment during flight

and ground operation. Each operator's manual prepared in accordance with this specification shall be divided into the following sections:

Front Matter

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

References

Abbreviations and Terms

Index

Authentication Page

DA Form 2028

Foldouts (if included)

3.2.2 Front Matter.

3.2.2.1 Cover. Covers shall be prepared in accordance with Figure 1 (note the distribution statement). Following the TM title and any additional required subtitles, the following notices shall be provided in the order listed below, as applicable.

a. Volume notice.

b. Supersedure notice.

c. Disclosure notice.

d. Distribution statement.

e. Export control notice.

f. Destruction notice.

3.2.2.1.1 Supersedure notice. Unless otherwise specified (6.2), the supersedure notice shall be placed on the cover/abbreviated title page when the manual/revision/rapid action change (RAC) under preparation supersedes all of other manuals/changes/revisions. When specified, the notice of supersession shall include a list of all currently superseded supplements and RACs. Superseded supplements/RACs shall normally be listed individually, but when several alphabetically/numerically sequenced supplements/RACs are superseded, they shall be grouped. The applicable portions of the following notice shall be used:

This manual supersedes (applicable manual number) dated (date of superseded document), including all changes.

3.2.2.2 Warning page. When specified (6.2), a warning page(s) shall include each general type of warning and warning symbol used within the TM. The warning page shall not include a word-for-word repetition of all the warnings in the TM. It shall be limited to alerting the user of the different types of hazards in general terms including general hazardous subject data such as radiation, chemicals, high voltage, gas pressure, laser light, etc. that will be encountered in operating and maintaining the aircraft or equipment. The warning page shall also include first aid data. The warning page (Figure 2) shall start on a right-hand page immediately following the cover. As applicable, the warning page shall consist of the following in the order specified below:

a. First aid data.

b. Warning icons.

c. Warning description.

d. Hazardous materials icons.

e. Hazardous materials descriptions.

3.2.2.3 Change transmittal page. A change transmittal page shall be provided. The change transmittal page shall provide the information shown in Figure 3. In addition when the manual has been reviewed for the presence of environmental and hazardous material information, the ODC statement provided on the abbreviated title page shall be repeated (3.2.2.5.1).

3.2.2.4 List of effective pages. The list of effective pages (Figure 4) shall be a complete list of all manual pages, including abbreviated title page, list of effective pages currently in effect, verification status pages, table of contents pages, warning pages, blank pages, deleted pages, added pages, and foldout pages. The list of effective pages shall include a statement of the total number of pages in the manual. The list of effective pages shall be updated for each change or revision. The listing shall be held to a minimum by grouping numbers where applicable. The page numbers for a blank page and the printed side of the sheet shall be listed as separate numbers even though a double number shall appear on the printed side of the sheet. Appropriate change numbers shall be indicated for each page that is changed. As appropriate, the words "Deleted," "Blank," or “Added” shall be placed beside the page number that is affected.

3.2.2.5 Abbreviated title page. A TM shall have an abbreviated title page (Figure 5). The abbreviated title page shall follow the list of effective pages. An applicable reporting errors and recommending improvements statement shall be included. The reporting errors and recommending improvements statement shall be provided by the acquiring activity since this statement is subject to change either due to an address change or statement tailoring by a specific acquiring activity. The abbreviated title page shall contain the same statements and notices as provided on the cover (3.2.2.1). The statements/notices shall follow the reporting errors and recommending improvements statement. Space permitting, the table of contents (TOC) shall immediately follow the abbreviated title page information (3.2.2.6).

3.2.2.5.1 Environmental/hazardous material information. When the manual has been reviewed for the presence of environmental and/or hazardous material information, a statement similar to the following ODC and/or Hazardous Materials statement shall be provided on the abbreviated title page:

OZONE DEPLETING CHEMICALS INFORMATION

This document has been reviewed for the presence of Class I Ozone Depleting Chemicals. As of *provided date*, the status is: All references to Class I Ozone Depleting Chemicals have been removed from this document by substitution with chemicals that do not cause atmospheric ozone depletion.

HAZARDOUS MATERIALS INFORMATION

This document has been reviewed for the presence of Solvents used as cleaning solutions containing hazardous materials as defined by EPCRA 302 and 313 lists by the engineering, environment and logistics oversight office. As of the base document dated *provided date*, all references to cleaning solvents containing hazardous materials have been removed from this document by substitution with non—hazardous or less hazardous materials where possible.

3.2.2.6 Table of contents. The table of contents (TOC) shall list all chapters and sections in the same order and with the same title used in the text. If space allows, the TOC (Figure 5) shall be placed on the abbreviated title page, or begin on the first right-hand page following the abbreviated title page. The first volume of a multi-volume paper manual shall contain a master TOC for all volumes. Each of the remaining volumes shall have its own TOC. Refer to MIL-STD-40051-2 for the preparation requirements for a multi-volume TOC.

3.2.3 Chapter 1 – Introduction. This chapter shall consist, at a minimum, of introductory material that applies to the manual as a whole.

3.2.3.1 General. A brief summary of the contents of the manual shall be provided.

3.2.3.2 Explanation of warnings, cautions, and notes. An explanation of the use of warnings, cautions, and notes that the operators will find in the TM and the importance of observing these safety alerts shall be provided. The following shall be included:

WARNINGS, CAUTIONS, AND NOTES. Warnings, cautions, and notes are used to emphasize important and critical instructions and are used for the following conditions.

WARNING

Identifies and highlights an essential operating or maintenance procedure, practice, condition, statement, etc. which if not strictly observed, could result in injury to, or death of, personnel or long term health hazards to the person performing that procedure.

CAUTION

Identifies and highlights an essential operating or maintenance procedure, practice, condition, statement, etc. which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

NOTE

Highlights an essential operating or maintenance procedure, condition, or statement.

3.2.3.3 Description. A succinct summary of the aircraft's description and primary mission, omitting any extraneous mission capabilities statements, shall be provided. The statement similar to the following 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 adherence to procedures is mandatory except when modifications are 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 Army aviation safety program. The following statement shall be provided. “Reports necessary to comply with the Army Aviation Safety Program are prescribed in AR 385-40”.

3.2.3.5 Destruction of Army materiel. Information on procedures for destroying Army materiel to prevent enemy use shall be included. Reference shall be made to TM 750-244-1-5.

3.2.3.6 Forms and records. Flight records and aircraft maintenance records which are used by the operators and crewmembers shall be described. References shall be made to DA Pam 738-751 and TM 55-1500-342-23.

3.2.3.7 Explanation of change symbols. An explanation of the use of change symbols shall be included. An example of this explanation shall be as follows:

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 bar in the outer margin, 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 instructive information and procedures.

d. Blank spaces resulting from the deletion of text, an illustration, or a table.

3.2.3.8 Designator symbols. An explanation of designator symbols, along with a table of symbols used in the TM shall be provided.

3.2.3.9 Explanation of the use of shall, should, and may. A statement similar to the following shall be included in the introduction:

> Within this TM use "shall" whenever a TM expresses a mandatory requirement. “Will” may be used to express a declaration of purpose or procedural result. Use "should" to indicate a non-mandatory but preferred method of accomplishment. The word "may" shall be used to indicate an acceptable method of accomplishment.

3.2.3.10 Additional introductory information. Any additional introductory information that may be required such as explanatory information for appendices or indices shall be provided, as applicable.

3.2.4 Chapter 2 - Aircraft and Systems Description and Operation.

3.2.4.1 General. A description of the airframe and all aircraft systems and controls shall be provided. Individual sections (as noted in 3.2.4.2 through 3.2.4.16) shall be developed for the description and operation of the aircraft and each aircraft system. The title of the sections shall include the nomenclature of the system(s). The description of each system and associated controls and equipment shall be brief and concise. Illustrations shall be used to identify and locate the systems controls and equipments.

For aircraft equipped with interactive displays, such as a multifunction display (MFD), the data management system, including the interactive display, shall be described in this chapter. For each section within this chapter that describes a subsystem, the appropriate top page of the interactive display, including each button, shall be fully described and explained. In addition each page following the top page shall be briefly described. When needed for clarity, illustrations of representative items displayed on the interactive display shall be included throughout the TM.

3.2.4.1.1 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. When feasible, a separate paragraph and illustration shall be devoted to each control. It shall be preferable to divide the control description into two portions, normal controls and emergency controls, if emergency capabilities exist.

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

3.2.4.2 Section I - Aircraft. This section shall provide a complete but concise description of the aircraft. At a minimum, the following subjects and illustrations shall be included.

3.2.4.2.1 General. A description of the airframe shall be included. Major assemblies such as fuselage, wings, and tail boom shall be described. Each compartment of the aircraft such as cockpits and cabins shall be described and illustrated as required.

3.2.4.2.2 Illustrations and tables. The following illustrations and tables shall be included in Section I.

a. The aircraft's general arrangement shall depict all access openings that will be checked during preflight of the aircraft (Figure 6). The general arrangement shall be placed as near to the beginning of Section I as practicable. These diagrams shall not include individual controls or aircraft systems. Diagrams that are needed for clarity shall be used. Two or more of these illustrations, such as crew movement diagrams and compartment diagrams, may be combined into one.

b. Illustrations showing minimum turning radius, ground clearance, dimensions and danger areas shall be included (Figures 7 and 8). The minimum turn shall be based on a turn permitted on one wheel (tire hub), with and without power steering assist. Minimum ground clearance shall also be shown. The turning radius for skid equipped aircraft shall 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. 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 also be depicted.

c. Significant differences in design and operation between each aircraft series included in the manual shall be provided. Special emphasis shall be placed on features that will affect recognition and operation of the various series. This information shall be contained in a table (Figure 9).

d. Each major compartment, such as cockpit or cabin (Figure 10), that can carry payload or that can be entered by personnel shall be illustrated and identified.

3.2.4.2.3 Landing gear system. Information describing the landing gear system shall be presented in detail for the operator's use. The following shall also be included.

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

b. The brake system, including all emergency provisions, shall be described. Brake provisions for aircraft equipped with floats shall be described as well.

3.2.4.2.4 Instruments, panels and consoles. All instruments, panels, and consoles shall be described and illustrated. Several configurations may be covered by one illustration labeled typical. 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 shall be shown more than once when major changes in configuration are involved.

3.2.4.2.5 Canopies. The canopies shall be described and illustrated. 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.

3.2.4.2.6 Doors. All doors to include ramps, hatches, etc., controls for normal and emergency operations, and their sources of power shall be described.

3.2.4.2.7 Seats. Pilot and other flight compartment seat controls shall be described and illustrated. Emergency and ejection seat controls, inertia reels, harnesses, and seat belts shall be described and illustrated in detail, emphasizing how they are affected by other systems.

3.2.4.3 Section II - Emergency equipment. All emergency equipment, except that which forms part of a complete system, shall be described. For example, emergency landing gear controls shall be treated under the landing gear system and emergency fuel pumps under the fuel system. Emergency equipment in this section shall include, but shall not be limited to, hand fire extinguishers, engine fire extinguishers, emergency alarms, pyrotechnic equipment, axes, emergency hatches, signal lamps, ditching jackets, first aid kits, and survival kits. Emergency procedures shall be described only in Chapter 9.

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

3.2.4.4 Section III - Engines and related systems. The engine and its related controls, as outlined in the following paragraphs shall be described.

3.2.4.4.1 Engines. The most important characteristics and special features of the engine shall be described. Model designation shall be included for all engines used in the subject aircraft. The following engine systems shall be described:

a. Cooling system and controls such as cowl flaps and engine cooling fans.

b. Engine/engine inlet anti-icing/deicing system.

c. The engine fuel control system, which applies to jet and turbine powered aircraft and extends from the engine fuel control unit through the burner ring or combustor section. Where applicable, special emphasis shall be placed on the emergency fuel

control systems. Any special or unusual characteristics of the system shall also be described. Theory of operation shall not be included. Discussion of the throttle/power lever shall be included, as well as all systems affected by throttle/power lever operation.

d. Information on all controls affecting the oil system.

e. Ignition system controls.

f. Starter controls.

g. Infrared suppression system.

h. Engine instruments and indicators. For the purpose of the operator's manual, the fuel and oil supply systems shall be treated as ending at the point where they deliver the fluid to the carburetor, fuel control unit, or the engine-driven oil pump.

3.2.4.5 Section IV - Fuel system. A full description of the fuel system shall be given. Coverage of drop tank release controls shall be included. Reference shall be made to fuel grades and specifications in Section XV, Servicing. Diagrams of the typical courses of fuel flow, including fuel system control positions for takeoff, cruising, landing, and emergency operation shall be included.

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

3.2.4.5.2 Fuel system management. The fuel system management process shall be described, including auxiliary fuel, booster pump use, fuel transfer procedures, 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. The sequence in which fuel tanks must be used shall be stated with corresponding reasons (strength or balance). When 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 (CG) shall be described in detail. Remarks shall also be included regarding control of the aircraft if the transfer system fails and results in an unbalanced condition because of improper fuel distribution.

3.2.4.6 Section V - Flight control system. The flight control system and its location in the aircraft shall be described in its entirety. Flight controls, indicators, trim tabs, force trim, control locks, etc. shall be discussed as stated in paragraphs 3.2.4.1.1 and 3.2.4.1.2. In addition, all other controls located on the control sticks, wheels, yokes, pedals, cyclic and collective, shall be discussed. 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.

3.2.4.6.1 Automatic flight control system. Detailed coverage of automatic stabilization equipment, stability augmentation control system, and autopilot shall be provided. All modes of operation 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 for conditions of partial or temporary electrical power failure, manual override, etc. When applicable, reference shall be made to navigation equipment descriptions and operations contained in Chapter 3.

3.2.4.7 Section VI - Hydraulic and pneumatic systems. A description of all hydraulic and pneumatic systems shall be provided. At a minimum, test switches, indicators and gauges, caution/warning lights, and controls shall be discussed.

3.2.4.8 Section VII - Power train system. The power train system shall be described in detail to include the transmission and gearbox systems, drive shafting, system controls, and indicators.

3.2.4.9 Section VIII - Rotors or propellers. The propellers or rotors, as applicable, and their functions shall be described, including a detailed description of operation.

3.2.4.10 Section IX - Utility systems. A description of the defrosting, antiicing/deicing, pressurization, oxygen, and rain removal systems and miscellaneous equipment shall be provided. Coverage shall be brief and shall focus on the location of the equipment and its controls, source of power, illustration of the controls (if not covered previously), and a brief discussion of function and operation. Control/switch panels that control several different utility systems shall only be illustrated once, if feasible. Information shall be included on all non-emergency equipment which is not part of a system. All miscellaneous equipment and normal and emergency operation procedures shall be included. Miscellaneous equipment shall include, but shall not be limited to, seats (other than pilot and flight engineer), hatches, heated blanket provisions, data case, beaching gear, night flying curtains, ladders, relief equipment, food warmers, water containers, and tool kits. Items covered as aircraft loading equipment in Chapter 6 shall not be included here. Items dealing with aircraft servicing and ground handling shall be contained in servicing, parking, and mooring, Section XV.

3.2.4.11 Section X - Heating, ventilation, cooling, and environmental control systems. The heating, ventilation, cooling, and environmental control systems shall be described. The description, normal operation, and emergency operation for each of these systems shall be discussed under separate paragraphs, as applicable.

3.2.4.12 Section XI - Electrical power supply and distribution systems. The electrical power supply and distribution systems and controls shall each be described and illustrated (Figure 11). Where pertinent, reference shall be made to auxiliary power systems that are described elsewhere. The external power source and the interaction between the auxiliary power plant and the electrical system shall be described.

General arrangement and order of the primary system shall be covered first, followed by the secondary system.

3.2.4.12.1 DC power supply system. DC power supply systems shall include battery; starter-generators, generators, alternators and converters; indicators, gauges, and controls; circuit breaker and junction boxes; auxiliary power; and ground power.

3.2.4.12.2 AC power supply system. These systems shall include inverters and alternators; indicators, gauges, and controls; AC circuit breaker and junction box diagram; auxiliary power; and ground power.

3.2.4.12.3 Breakers. 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) that 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.

3.2.4.13 Section XII - Auxiliary power unit. A description of the auxiliary power unit, controls, and its interaction with other systems shall be provided. Starting, stopping, and in-flight operating procedures shall be contained in Chapter 8 and emergency procedures in Chapter 9.

3.2.4.14 Section XIII - Lighting. Information shall be provided for, but shall not be limited to, formation, landing, fuselage, cabin, instruments, wheel well, taxi, navigation, and anti-collision lights. Coverage shall concern itself largely with locations, controls, power sources, and a discussion of functions. Illustrations may be used if equipment is not depicted in Chapter 2 or elsewhere.

3.2.4.15 Section XIV - Flight instruments. All flight instruments, indicators, gauges, and miscellaneous instruments and systems shall be described. Miscellaneous instruments and systems shall include such items as master caution systems, rpm high/low warning systems, trainer instrument panel, and clocks. Special problems, such as erroneous readings of the airspeed indicating system resulting from installation error or hovering, shall be included with references to correction charts, when applicable. Complex display systems shall be included under a separate primary heading. Line drawings shall be provided for all instruments. Each indicator, gauge, and control shall be shown (Figure 12). Each item shall be indexed or posted and references or links shall be used within the text as appropriate.

3.2.4.16 Section XV - Servicing, parking, and mooring. Servicing shall include, but shall not be limited to, flight crew oriented instructions for normal and closed circuit refueling and for replenishment of fuel, oil, hydraulic fluid, other fluids, and air in tires. Servicing shall also include all other such items involved in servicing the aircraft that a crew could be expected to perform while away from military maintenance support. Safety precautions to observe in servicing a particular tank or reservoir, such as grounding and prevention of fire hazards, shall be stated clearly. 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 data in other parts of the manual pertinent to servicing, such as tire pressure versus gross takeoff weight.

3.2.4.16.1 Servicing diagram. The servicing diagram shall depict each servicing point, including, but not limited to, tanks, reservoirs, filler caps, receptacles, oxygen bottles, and accumulators and shall be shown as viewed (Figure 13). Illustrations of site gauges and other indicators shall clearly depict proper servicing levels.

3.2.4.16.2 Servicing information. Servicing data shall be in tabular form as shown in Figure 14. Each item of equipment including, but not limited to, engine, transmission, gearboxes, reservoirs (hydraulic, anti-icing), auxiliary power unit, and oxygen systems shall be listed under "System." Under the heading of "Specification," the military specification for the fuel, oil, fluid, or lubricant shall be listed, including references to any notes on temperature ranges, mixing of oil, etc. Fuel capacities shall also be listed to include total, servicing capacity, and usable capacity in U.S. measurements to the nearest tenth of a gallon, and metric equivalents.

3.2.4.16.3 Approved fuels. A tabular listing of primary, alternate, and emergency fuels shall be included, to include NATO and commercial brand names authorized for use in the aircraft for which this manual applies. Warnings and cautions regarding additives shall be presented in the table. Also, restrictions on the use of any fuels shall be stated. The fuels contained in this listing shall only be those authorized for use by TB 55-9150-200-24 and by the acquiring activity (6.2). This information shall not be repeated in the manual.

3.2.4.16.4 Additional servicing instructions. Information shall include a listing of acceptable commercial engine oils as indicated in TB 55-9150-200-24 and as authorized for use in the aircraft (Figure 14).

3.2.4.16.5 Ground handling. Instructions and necessary precautions for ground handling of the aircraft shall be provided, including any information needed in extreme cold, heat, humidity, and dust. A description and instructions for operating any ground handling equipment involved shall also be provided. Left and right turning limits while towing (with or without external stores) shall be listed. Aircraft ground handling procedures relating to electronics equipment shall be stated when applicable.

3.2.4.16.6 Parking and mooring. Instructions for parking and mooring and the installation and stowage of aircraft covers, control locks, chocks, and tie down devices shall be described and illustrated. If feasible, ground handling, parking, and mooring may be shown on a single page illustration.

3.2.5 Chapter 3 – Avionics.

3.2.5.1 Section I - General. Except for mission avionics, a general overall description covering the avionics equipment configurations installed on a specific aircraft shall be provided. It shall include a brief description of the avionics equipment, its technical characteristics, capabilities, and locations. Mission avionics equipment shall be covered in Chapter 4.

3.2.5.2 Sections II through IV. For each item of avionics equipment contained within Sections II, III, and IV, the following information shall be included, as applicable. Additional sections shall be added by the acquiring activity when required (6.2).

a. Description.

b. Controls and functions.

c. Operation.

d. Emergency operation (if applicable).

e. Power source (if applicable).

3.2.5.2.1 Description. Avionics equipment shall be described in detail, including controls, indicators, instruments (if applicable), jacks, switches, and control panels, etc. Antenna locations shall be shown on appropriate illustrations. Antenna arrangement illustrations shall be included in Section I and referenced or linked when required or may be included in the applicable section where discussed. The proper techniques and procedures to be employed when operating the equipment shall also be described.

3.2.5.2.2 Controls and functions.

a. The location and function of each control, including built-in test capability, contributing to the operation of the avionics equipment shall be listed. Each control panel shall be discussed separately. Reference or links shall be made to illustrations in Chapter 2 regarding controls and control panels.

b. A tabular listing (**standard table**) shall be included for each control panel. The table (Figure 15) shall be divided into two columns, titled "Control/Indicator" and "Function,". Each control or indicator shall be listed and its function defined in terms of what the operator of the control shall see, hear, or do as a result of the control setting. Terms of simple, immediate, and 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.

c. When applicable, a tabular listing (**standard table**) shall be included for each control display unit. The table (Figure 16) shall include a header "**CONTROL DISPLAY UNIT**" and shall be divided into 2 columns, titled "KEY" and "FUNCTION". Each key that must be pressed shall be listed and a description of the function shall be included in the table.

3.2.5.2.3 Operation. A description of the operating details for each item of avionics equipment shall be provided. Whenever standard operational avionics data exist within the government, such data shall be furnished by the acquiring activity. Complete operating procedures shall be included as follows:

a. When separate modes of operation are available, i.e., when the equipment may serve two or more systems, each mode shall be described. These shall be listed as modes of operation and each shall be briefly described.

b. The sequence of settings and the position to which the controls should be set to ensure proper results each time the equipment is energized shall be explained. Instructions shall be provided to prevent the possibility of damage through improper settings or sequence of operations. When appropriate, operating tolerances shall be called out. When operation of a unit is related to 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. 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 shall be covered by a reference to the previous procedure.

3.2.5.2.4 Emergency operations. When applicable, settings and operations of avionics equipment during emergency operations shall be described.

3.2.5.2.5 Power source. When applicable, a brief description of the power sources for avionics equipment shall be provided, including any special procedures or limitations using, but not limited to, external power and battery power.

3.2.5.3 Section II - Communications. Information for communications equipment installed in the aircraft shall be developed.

3.2.5.4 Section III - Navigation. All navigation systems and indicators information, as applicable, shall be developed. 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. A suitable reference shall be made in the manual to aid the operator in locating the material. The following systems and indicators shall be described:

a. Automatic direction finder (ADF)

b. Gyro compass and magnetic indicators

c. Marker beacon

d. Flight director

e. (VHF) OMNI directional range

f. Tactical Air Navigation (TACAN)

g. Instrument landing system

h. Doppler

i. Inertial navigation system (INS)

j. Autopilot

k. Other

3.2.5.5 Section IV - Transponder and radar. All information for transponders, collision warning systems, and radar systems and indicators, as applicable, shall be provided.

3.2.6 Chapter 4 - Mission Equipment.

3.2.6.1 General. A description of all standard mission equipment that may be utilized with the aircraft shall be provided. Coverage shall include description, controls and function, operating procedures, power sources, and illustrations. Controls, functions, and operating procedures shall be prepared as detailed in 3.2.5.2.2 through 3.2.5.2.5, as applicable.

3.2.6.2 Section I - Mission avionics. Unclassified information regarding mission avionics equipment that is not a part of the standard flight communication, navigation, transponder, or radar equipment shall be provided. It includes 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 including, but not limited to, types of cameras, control stations, camera doors, and capabilities of the equipment. Gun camera equipment shall also be covered. Mission avionics equipment that requires extensive explanation of operating procedures shall be covered in this section or separately. An appendix for mission avionics equipment shall be included only if authorized by the acquiring activity (6.2). Classified information on mission avionics equipment shall be covered in a separate classified supplement to the manual.

3.2.6.3 Section II - Armament. The description of gunnery, rocket, tow target, control, and computer equipment and their interrelations when installed shall be provided. Armor protection shall be discussed along with the individual item that is being protected. Precautions and safety considerations shall also be included.

3.2.6.3.1 Armament control system. Description and operating instructions for the armament control system shall be provided, if applicable. Also, information such as presentation on the scope or sight, when applicable, shall be included. Warm-up time and preflight, in-flight before landing and after landing checks shall be listed. Checklist format and style shall be in accordance with Appendix B.

3.2.6.3.2 Gunnery equipment. Information shall be included on all guns and turrets, including quantity of ammunition that can be carried for each gun. When describing remote controlled turrets, the manual shall include, but shall not be limited to, the station from which the turret is operated, method of gaining control of the turret, and method of transferring control. All gunnery controls shall be covered, including gun sight and gun heater.

3.2.6.3.3 Rocket equipment. Information shall be provided regarding the firing procedures, description and capability, controls, and types and number of rockets that can be carried. Typical combinations of rockets and firing order shall be covered. Special precautions, if any, shall be listed.

3.2.6.3.4 Missiles. Information shall be provided regarding the firing procedures, description and capability, controls, and types and number of missiles that can be carried. Special precautions, if any, shall be listed.

3.2.6.4 Section III - Cargo handling. Descriptions and procedures for cargo handling systems and equipment to include hoists, winches, and cargo hooks shall be provided.

3.2.6.5 Section IV - Passive defense. Passive defense equipment shall be described, procedures outlined, and controls and precautions listed. Employment methods shall also be discussed.

3.2.6.6 Additional system coverage. Additional sections shall be used as required, to describe systems not covered in other sections.

3.2.7 Chapter 5 - Operating Limits and Restrictions.

3.2.7.1 General. All important operating limits and restrictions that shall be observed during ground and flight operations shall be provided. Special emphasis shall be placed on any unusual restrictions which are particularly characteristic of the aircraft. All time limited operations shall include a time limit and the upper and lower boundaries.

3.2.7.2 Section I - General. General information on aircraft limits and restrictions, including decals and placards shall be provided. The following statements shall be included:

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

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

c. Exceeding operational limits. Any time an operational limit is exceeded, an appropriate entry shall be made on DA Form 2408-13-1. The 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.

d. Minimum crew requirements. The minimum crew required for flight is (fill in proper number). Additional crew members, as required, will be added at the discretion of the commander in accordance with pertinent DA regulations.

3.2.7.3 Section II - System limits. All aircraft system limits not covered elsewhere in this chapter that may restrict operation shall be provided.

3.2.7.3.1 Instrument, interactive display, or display operating ranges and markings. Each instrument, interactive display, or display that indicates an operating limit(s) shall be illustrated and accurately reflect the actual markings/displays on the instrument, interactive display, or display (Figure 17). The information appearing on the illustration depicting markings or displays shall not be repeated in the text or table. The color coded markings/displays or interactive display graphic symbols shall be fully explained. If the instrument, interactive display, or display limits cannot be adequately explained in the space provided for the captions, explanations shall be included under the appropriate paragraph heading. The text shall state or describe all limit ranges, including gaps that may be shown in range markings.

3.2.7.3.2 Propeller limitations. Propeller limitations shall be discussed including, but not limited to, reverse pitch and restricted revolutions per minute (rpm).

3.2.7.3.3 Rotor limitations. For rotary wing aircraft, rotor limitations during both flight and ground operation shall be discussed, covering such points as restricted rpm, auto-rotational rpm, limitations for startup and shutdown during high winds, and wind gust spread.

3.2.7.3.4 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.

3.2.7.4 Section III - Power limits. Power limits shall include engine and drive train and idle limitations. Limitations that must be observed when alternate fuel grades are used shall be included. Acceleration limits and restrictions that apply to the engine shall be covered. Limits shall be expressed in terms of observable indications that are available to the flight crew; e.g., 360°C, 46 lb., 10 psi. Terms such as military power or takeoff power shall not be used.

3.2.7.5 Section IV - Loading limits. Loading limits pertaining to the aircraft shall be discussed in detail.

3.2.7.5.1 Center-of-gravity limitations. Longitudinal limitations shall be described. Lateral limitations shall be described when specified by the acquiring activity (6.2). Also, a statement similar to the following shall be included:

> CG limits for the aircraft to which this manual applies and appropriate charts for computation of the CG are contained in Chapter 6.

3.2.7.5.2 Weight limitations. All minimum/maximum aircraft weight limitations including parking, towing, taxing, and 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. References or links shall be made to fuel management in Chapter 2, as necessary.

3.2.7.5.3 Turbulence. Restrictions regarding flying in all levels of turbulence shall be discussed and limitations shall be covered.

3.2.7.5.4 Other limitations. Other types of limitations that affect operations shall be covered, including the following:

a. Additional restrictions to be observed when carrying stores. For aircraft equipped to carry a variety of external stores, information concerning the stores 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 that are to be observed when carrying internal cargo.

d. Restrictions on jettisoning external stores and sling loads.

3.2.7.6 Section V - Maximum and minimum airspeed limits. Airspeed limitations shall be discussed, including 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 knots indicated airspeed (KIAS), unless otherwise specified by the acquiring activity (6.2).

3.2.7.6.1 Airspeed operating limits chart. This chart shall present operating limits for forward flight at various gross weights, pressure altitudes, free air temperature (FAT), and KIAS (Figure 18).

3.2.7.7 Section VI - Maneuvering limits. Maneuvering flight limitations to include acrobatic flight, if applicable, shall be described. Acceleration limitations shall also be covered, including maximum acceleration with tip tanks and maximum bank angle at high gross weight. Maximum permissible accelerations under various flight conditions at specific gross weights and fuel weights shall be detailed. For aircraft not equipped with G meters, G forces shall be expressed in terms that are recognizable by the pilot, such as airspeed and bank angle. Restrictions on control movements shall be listed. Material shall be presented on permissible bank angles and side slip. Prohibited maneuvers shall be listed as appropriate.

3.2.7.7.1 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 a function of load limit factors, shall be presented (Figure 19). When changes in configuration result in variations in airspeed position error, separate airspeed scales shall be shown. Where direct reading Mach meters are provided, charts for both indicated airspeed (IAS) and indicated Mach number (IMN) shall be provided.

3.2.7.8 Section VII - Environmental restrictions. As applicable, altitude, temperature, rain, snow, ice, hail, and oxygen limits shall be provided. Material on maximum wind velocity and gust spread, maximum wind velocity for crosswind operations, wind from the critical azimuth, and normal operation shall be included. Operations under wind azimuth direction and wind velocity conditions that should be avoided shall be discussed. Where appropriate, charts shall be used to depict the preceding conditions.

3.2.7.8.1 Flight under instrument meteorological conditions (IMC). The definition of IMC and the criteria for such flights shall be provided. In addition, when applicable, information on when a particular aircraft is qualified for operation in instrument meteorological conditions, and when a certain aircraft is restricted to visual flight conditions shall be included.

3.2.7.9 Additional sections. When specified by the acquiring activity (6.2), additional sections may be used to allow for added limits or restrictions to fit specific aircraft.

3.2.8 Chapter 6 - Weight/balance and loading.

3.2.8.1 Section I - General. General statements about the importance of weight and balance calculations shall be provided. In addition, a note that Chapter 6 contains sufficient instructions and data so that an aviator, given the proper data, can compute any combination of weight and balance shall be included. When weight and balance computers/calculators are provided for the aircraft, instructions and examples of their use shall be based on gear down configurations, with supplementary data for gear up conditions (when required). A statement similar to the following statement shall be included:

> 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 95-1.

3.2.8.1.1 Aircraft compartment and station diagram. A general description of the aircraft compartments and a supporting diagram shall be provided. The diagram shall show the reference datum line, stations, butt lines, and water lines in inches (Figure 20).

3.2.8.2 Section II - Weight and balance. Information necessary for the computation of weight and balance for loading of specific aircraft shall be provided. Instructions for completion of weight and balance forms (DD Form 365 series) shall not be provided in the manual; however, TM 55-1500-342-23 which provides these instructions shall be referenced. Sufficient information shall be provided 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, ordnance 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 21). The names of the tanks on the charts 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 that 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 of fuel. 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. When specified by the acquiring activity (6.2), a statement of usable oil capacity, equivalent in pounds, total moments, and fuselage station number shall be provided. Aircraft that have a large usable oil capacity shall have a tabular

listing if oil loading computation is critical. It shall be noted that the weight shall be based on specific gravity at standard day temperature.

3.2.8.4 Section IV - Personnel. All essential information and instructions for preparation, loading, and unloading of personnel, including airborne troops shall be provided.

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, shall be provided. In addition, a description shall be provided of any critical dimensions which limit full use of the personnel compartment.

3.2.8.4.2 Personnel loading and unloading. Personnel loading and unloading shall include, but shall 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 harness.

c. A check of comfort and emergency provisions.

d. Instructions for troop loading and unloading procedure.

3.2.8.4.3 Personnel weight. When aircraft are operated at critical gross weights, the exact weight of each individual occupant, including the weight of the equipment shall be provided. In addition, if weighing facilities are not available, or if the tactical situation dictates otherwise, loads shall be included and computed as follows:

a. Combat equipped soldiers - 240 pounds per individual.

b. Combat equipped paratroopers - 260 pounds per individual.

c. Litter and patient’s weight - 265 pounds per patient.

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

3.2.8.4.4 Personnel moments. Personnel moments charts for personnel in any position shall be provided (Figure 22).

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 shall be listed. Items that are part of the basic weight shall not be part of this listing. Data shall be provided for all applicable mission system loads including, but not

limited to, armament, avionics, sling, hoist, and litters. Listings shall provide weights and moments of required pylons and launchers. Tabular listing of rockets shall be inclusive for maximum capacity of launchers. Since rockets vary in weight by type, separate listings shall be required (Figure 23).

3.2.8.6 Section VI - Cargo loading. Detailed information on cargo loading shall be provided.

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

a. A plan view showing dimensions of cargo floor, designation, location, and strength of tie-down fittings, and 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. A suitable view of litter provisions showing location shall be presented.

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

d. A list and description of all cargo loading aids, unloading aids, cargo securing equipment (including, but not limited to, ramps, hoists, winching provisions, and tie-downs), and stowage provisions shall be provided.

3.2.8.6.2 Equipment loading and unloading. Procedures and a checklist for loading and unloading vehicles and equipment shall be provided, as follows:

a. Assembly of equipment needed for loading.

b. Preparation of cargo compartment and floor and installation of fittings.

c. Preparation of the aerial delivery system, when applicable.

d. Including, but not limited to, operation of cargo doors, ramps, load assist devices, and aircraft support jacks, including installation and operation, as applicable. Instructions for checking landing gear shall be included, when appropriate.

e. Assembly and checking of unloading aids and releasing of cargo tie-down devices.

3.2.8.6.3 Preparation of general cargo. Pre-loading information shall be presented as follows:

a. Instructions that loading personnel should assemble prior to loading data, such as weights, dimensions, CG locations, and contact areas of equipment for use in positioning the load shall be included.

b. Reference or a link shall be made to the weight and balance computations in Section II, and the balance computer, if furnished, for the computation of final load positions in the aircraft.

3.2.8.6.4 Loading, securing, and unloading cargo. General methods of loading, safe lashing, and unloading of cargo, vehicles, and equipment shall be provided. Rigging of cargo for aerial delivery shall be included, when applicable. The information shall be detailed enough 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. A chart shall be provided (Figure 24) showing approximate allowable cargo CGs versus known weights which may be used for planning purposes for various cargo loads. The chart shall be based on a range of aircraft basic weights and center of gravity locations to allow for anticipated variations in these values. The chart shall state that these data are for planning purposes only, that the results are approximate, and final loading must be checked for the particular aircraft using weight and balance computations and the balance computer, if furnished.

3.2.8.6.6 Loading procedure. A checklist of the actions required from the time the aircraft is prepared for loading until it is ready for flight shall be provided. It shall include instructions and notes on loading equipment into the aircraft, checking items with CG markings and items 10 feet or longer and placing them in position, determining the amount of shoring required for flight conditions, and general instructions for loading and lashing miscellaneous cargo. Reference shall be made to the appropriate regulations regarding handling of hazardous equipment.

3.2.8.6.7 Securing loads. The following items shall be described.

a. Approved restraint criteria including fore, aft, sideward and vertical restraints.

b. Detailed tie-down instructions shall be provided only for equipment or cargo that is unique to a specific aircraft.

3.2.8.6.8 Unloading procedures. Procedures for unloading the aircraft and stowing associated equipment shall be provided.

3.2.8.7 Section VII - Center-of-gravity. Longitudinal CG limitations shall be included, and lateral CG limits shall be shown as specified by the acquiring activity (6.2).

a. 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. All charts shall be in the style and format as shown in Figure 25.

b. Explanatory text shall explain the purpose and components of the charts; illustrate the use of the charts; emphasize that charts are designed to illustrate degree of risk involved at various weights and CGs; and establish limitations.

c. The chart shall be based on gross weight that is defined as the total weight of the aircraft and its contents. It shall include, but not be limited to, operating weight plus fuel, cargo, ammunition, missiles, and external auxiliary fuel tanks. 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.

d. At least one example to illustrate the application of the chart shall be included.

3.2.9 Chapter 7 - Performance Data.

3.2.9.1 General. All the performance data charts required for the completion of preflight and in-flight mission planning shall be provided. The data presented shall cover the maximum range of conditions and performances for which the aircraft is qualified. Explanatory text applicable to the use of data presented shall be included for each model of aircraft. Performance data charts shall appear in the initial issue of the manual.

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. Each section shall include an explanation of all applicable charts and a synopsis of pertinent terms used with each chart.

3.2.9.1.1 Data basis. Unless otherwise specified by the acquiring activity (6.2), the preparation of performance data charts shall be derived from flight test reports, when available. Exceptions to this may be authorized by the acquiring activity for new aircraft, provided adequate flight tests have been completed for the prototype. However, for these exceptions, an evaluation of all changes that affect performance shall be obtained by additional flight tests. The basis for data 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 such. Conservative estimates shall be used until verified by flight test data. Data that are not based strictly on the particular aircraft shall be explained in detail.

3.2.9.1.2 Identification. Each chart shall be marked in the following manner:

a. Titles shall be centered above the chart. The name of each chart shall define the type of information to be obtained from that particular chart.

b. Condition headings (Appendix D, D.3.2.4.2) shall be centered below the title and, when required, shall contain the following types of information, when applicable:

(1) Pressure altitude.

(2) Situation to which chart applies (takeoff, landing, sling load takeoff).

(3) Conditions of auxiliary equipment (ECU, bleed air, etc.).

(4) Configuration.

(5) Wing flap position.

(6) Rotor or prop rpm.

(7) Engine rpm.

(8) Fuel type.

(9) Hovering condition (in ground effect (IGE) or out of ground effect (OGE)).

(10) Power requirements.

(11) Runway conditions.

(12) Wind conditions.

(13) Gear up/down.

(14) Power required.

c. Titles of figures shall match the title shown at the top of each chart.

3.2.9.1.3 Factors affecting data. Conditions that 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 these factors shall be included in the text that describes that chart.

3.2.9.1.4 Configuration. Unless otherwise specified by the acquiring activity (6.2), the baseline configuration for all presented data shall be the most probable combat configuration. This baseline configuration shall be labeled and presented as a

condition on applicable charts. The baseline configuration shall be completely defined in the "Drag" section. Where inherent configuration variations exist (including, but not limited to, antenna variations, IR suppressers, and engine inlet configurations), the data shall be based on the most conservative configuration combination (highest drag, lowest power/thrust available, highest fuel consumption, etc.). The effects of altering these items shall be discussed in each section, as applicable.

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

3.2.9.1.6 Atmospheric conditions. Where data are presented incrementally, they shall be presented to the next increment beyond the range of probable operating atmospheric conditions as found in MIL-HDBK-310, for guidance only, to permit interpolation. Unless otherwise specified by the acquiring activity (6.2), standard day, standard conditions, standard temperature, or density altitude shall not be mentioned or presented. The following formulas for converting pressure altitude (H_p) to static air pressure (P), and vice versa, shall be used:

$$P \text{ (in. Hg)} = 29.92125(1 - H_p/145{,}442.1)^{5.255376}$$

$$H_p \text{ (ft.)} = 145{,}442.1(1 - P/29.92125)^{.1902632}$$

3.2.9.1.7 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 increased allowance of five percent shall be made for fuel consumption data only when data are based on estimates; however, this shall not be stated in the TM.

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

3.2.9.1.9 Definitions. Definition of terms used including, but not limited to, takeoff speed, takeoff distance, and rotation speed shall be included in abbreviations and terms (3.2.13).

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

a. Fuel flow (Figure 26).

b. Maximum torque available (insert condition/time) (Figure 27).

c. Hover (Figure 28).

d. Takeoff (Figure 29).

e. Drag (Figure 30).

f. Cruise (Figure 31).

g. Climb-descent (Figure 32).

h. Airspeed calibration (Figures 33 and 34).

Additional charts peculiar to certain aircraft, such as multi-engine, shall be included as specified by the acquiring activity. These charts, if required, shall completely define the operation or restrictions of the aircraft.

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

a. Crosswinds - takeoff and landing (Figure 35).

b. Idle fuel flow (Figure 26).

c. Torque available for takeoff (Figure 36).

d. Takeoff - normal (Figure 37).

e. Normal rotation/takeoff airspeed (Figure 38).

f. Acceleration check distance (Figure 39).

g. Accelerate-stop distance (Figure 40).

h. Accelerate after lift off (Figure 41).

i. Minimum single engine control airspeed (Figure 42) (flaps down and up, if applicable).

j. Single engine climb (Figure 43).

k. Cruise climb (Figure 44).

l. Drag (Figure 30).

m. Cruise (Figure 45).

n. Climb/descent (Figure 46).

o. Approach speed (Figure 47).

p. Landing (Figure 48).

q. Airspeed calibration (Figures 33 and 34).

3.2.9.2 Section I - Introduction. An explanation of the performance data including the purpose, scope, limits, uses, and conditions shall be provided.

3.2.9.2.1 Purpose. The following paragraph shall be included:

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 Standard Operating Procedures (SOPs), including pilot aid cards, and to inform ground commanders of performance/risk tradeoffs.

3.2.9.2.2 General. This paragraph shall contain a statement similar to the following:

> The data presented cover 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. Over-limit operation can decrease performance, cause immediate failure, or failure on a subsequent flight.

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 2408-13-1 so proper maintenance action can be taken. Exceeding operating limits can cause permanent damage to critical components. Overlimit operations can decrease performance, cause immediate failure, or failure on a subsequent flight.

3.2.9.2.3 Use of charts. This paragraph shall contain a sample problem typical of a normal mission accomplished by the aircraft. The sample shall be included on or precede the first chart. Additional examples shall 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. Additional discussion, sample problems, or illustrations may be used throughout the chapter to clarify the usage of charts.

The TM shall point out that the use of a straight edge (ruler or page edge) and a hard fine point pencil is recommended to avoid cumulative errors. 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 shall be shown by noting that although the hover chart is primarily arranged to find torque required, maximum skid height or maximum gross weight can also be found. The TM shall note that in general, any single variable can be found if all other variables are known. Also, the tradeoffs between two variables can be found.

3.2.9.2.4 Data basis. This paragraph shall contain a statement similar to the following statements and definitions:

The source 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 are based on one of the following categories.

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

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

c. Estimated data are data based on estimates using aerodynamic theory or other means not verified by flight testing.

3.2.9.2.5 Specific conditions. This paragraph shall contain a statement similar to the following:

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

3.2.9.2.6 General conditions. General conditions, in addition to specific conditions listed on each chart, shall be included. Examples of general conditions which might affect performance of the aircraft shall include, but shall not be limited to, rigging, pilot technique, sideslip, aircraft variation, engine variation, and instrument variation. Information shall be included which defines what effect the general conditions listed shall have on the performance data of the aircraft.

3.2.9.2.7 Performance discrepancies. A statement similar to the following shall be included in the TM:

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

3.2.9.3 Section II and subsequent sections. A separate section shall be created for each chart listed in 3.2.9.1.10 or 3.2.9.1.11, as applicable. The sections shall be titled using the applicable performance data chart title. In addition to the chart itself, each section shall contain, as a minimum, the following:

a. Description. A description of the performance data including those parameters obtainable from the chart and information relative to any peculiarity of data presented shall be provided.

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 acquiring activity (6.2). Reference shall be made to related charts that may be used in conjunction with the chart and all information relative to peculiarities of data presented on the chart.

c. Conditions. Each condition that 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 charts for rotary wing aircraft shall conform to the requirements detailed in the following paragraphs.

3.2.9.3.1.1 Fuel flow chart. The fuel flow chart (Figure 26) 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 configurations, e.g. 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 that present fuel flow data at cruise conditions. Fuel flow data shall be based on the primary fuel type. 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 operating engine rpm.

3.2.9.3.1.2 Maximum torque available chart. The charts for maximum torque available (Figure 27) 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. 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 they are 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 suppressers, 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.

3.2.9.3.1.3 Hover chart. The hover chart (Figure 28) 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 shall be presented and safe limits presented to better clarify the use of the data. Basic IGE hover data shall be based on hovering over a level surface. If IGE hover data are 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 as shown on Figure 28.

3.2.9.3.1.4 Critical data chart. 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.

3.2.9.3.1.5 Takeoff chart. The takeoff chart shall consist of all takeoff data required to clear various obstacle heights and shall be based on all the parameters shown on Figure 29. All approved techniques such as level acceleration, coordinated climb, and

sling load techniques shall be covered on additional charts as required by the acquiring activity (6.2). The primary parameters used for takeoff 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.

3.2.9.3.1.6 Drag chart. The baseline configuration for drag (Figure 30) shall be completely defined. Inherent or basic equipment variations, existing or anticipated, and any external stores included in the baseline configuration shall be provided. 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. These data shall be prepared in tabular form or shall be conveyed in a manner more suitable for interactive viewing. Negative drag increments from baseline configurations shall be permissible. The drag data shall fall into one of these major categories: (1) inherent or basic aircraft modifications or basic equipment chances; (2) external stores and store combinations; (3) crew alterable configurations; 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 are not provided. Information to determine the change in maximum range or long range cruise to chart the airspeed with drag variations shall be provided. A supplementary graph on the cruise chart depicting torque/horsepower change for drag 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 shall be depicted on these sub-graphs using special line coding with approval of the acquiring activity (6.2). If alternate configurations are depicted, they shall be completely defined using separate charts, as applicable.

3.2.9.3.1.7 Cruise chart. Cruise charts (Figure 31) 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 acquiring 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 operations. 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. Velocity never exceeded (V_{ne}) 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 pertain 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 related to the cruise charts shall be referenced. All cruise data shall be based on normal operational rotor and engine speed, 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.

3.2.9.3.1.8 Climb-descent chart. The climb-descent chart (Figure 32) shall show the torque required in excess of that needed 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.

3.2.9.3.1.9 Airspeed calibration chart. An airspeed calibration chart (Figures 33 and 34), which defines the relationship between the pilot's indicated and calibrated airspeed for level flight, climb, and descent, shall be provided. Instructions and examples shall be provided to show the operator how 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 that 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 that provides true FAT as a function of true airspeed and indicated temperature shall also be provided for aircraft capable of significant airspeeds. For those aircraft whose air data system position errors are insignificant, calibration data for airspeed, altitude, and temperature shall be omitted, with approval of the acquiring activity (6.2).

3.2.9.3.1.10 Optimum cruise. When requested by the acquiring 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 rpms. 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 the limits of altitude on the cruise charts (if required). If corrections to optimum altitude for configuration variations are significant and capable of being done, this information shall be provided.

3.2.9.3.2 Fixed wing chart content. Performance data charts for fixed wing aircraft shall conform to the requirements in the following paragraphs.

3.2.9.3.2.1 Crosswind chart. The crosswind chart (Figure 35) shall show the takeoff or landing conditions under which a takeoff or landing is or is not recommended.

Various wind velocities, runway wind angle, and rotation or touchdown airspeeds shall be 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 or separate charts may be provided for each configuration.

3.2.9.3.2.2 Idle fuel flow chart. The idle fuel flow chart (Figure 26) shall show idle fuel flow pounds per hour at the airframe idle throttle position at various altitudes and ambient air temperatures. Additional charts, when applicable, depicting idle fuel flow at various idle conditions shall be included. 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.

3.2.9.3.2.3 Torque available for takeoff chart. This chart (Figure 36) shall show the torque available for takeoff, per engine for multi-engine aircraft, at various ambient air temperatures and altitudes. Maximum torque limits shall be shown when applicable. The standards for which the chart was compiled shall be shown in the heading and defined in the supporting text. Allowable tolerances for available torque shall be stated when applicable.

3.2.9.3.2.4 Takeoff chart. The takeoff chart (Figure 37) 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, aircraft configuration, power requirements, runway surface conditions, and other applicable information shall be given in the subheading and explained in the text. Additional charts required to obtain information shall be referenced. Each approved takeoff technique shall be covered on separate charts.

3.2.9.3.2.5 Rotation/takeoff airspeed chart. The chart (Figure 38) 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 acquiring activity (6.2), shall be given in the subheading or explained in the text. Each approved takeoff technique shall be covered on separate charts.

3.2.9.3.2.6 Acceleration check distance chart. This chart (Figure 39) 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 airspeeds for various aircraft gross weights and the required ground roll distances for the aircraft shall be provided.

3.2.9.3.2.7 Accelerate-stop distance chart. The accelerate-stop distance chart (Figure 40) shall show the actual distance required to begin takeoff, accelerate to rotation speed, abort the takeoff, and bring the aircraft to a stop. Variables shall include ambient air temperature, pressure altitude, runway conditions, and gross weight.

3.2.9.3.2.8 Accelerate after takeoff chart. The chart (Figure 41) shall show the actual distance required to clear an obstacle after takeoff. Parameters shall include FAT, pressure altitude, takeoff weight, and velocity.

3.2.9.3.2.9 Minimum single engine control airspeed chart. This chart (Figure 42) is applicable to multi-engine aircraft and shall show the minimum controllable airspeed (V_{mc}), with parameters of FAT, pressure altitude, and gross weight, following engine failure during takeoff. The chart shall be based on the operating engine's capability to produce full takeoff power. The primary use of the chart shall be to provide V_{mc} at takeoff, not to provide single engine rate of climb information. All applicable limits shall be shown and explained in the text. Conditions such as flap setting, landing gear position, etc. shall be included in the subheading or explained in the text. The effect of engine failure on takeoff, climb, and cruising performance, the effect of wind-milling and feathered propellers on aircraft drag, and other adverse factors shall be described.

3.2.9.3.2.10 Single engine climb chart. This chart (Figure 43) shall present single engine airspeeds and rate of climb data for various temperatures, altitudes, and 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 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. Reference shall be made to other charts related to single engine operations.

3.2.9.3.2.11 Cruise climb chart. The cruise climb chart (Figure 44) shall be used to find the time, fuel, and distance required to climb. Parameters shall include initial and final FAT, initial and final pressure altitude, and initial gross weight.

3.2.9.3.2.12 Drag chart. The drag chart (Figure 30) shall show additional shaft horsepower required at various airspeeds, altitudes, and temperatures due to drag increases caused by changes in 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.

3.2.9.3.2.13 Cruise chart. The cruise chart (Figure 45) 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, configurations, and temperatures at which cruise data are to be presented shall be specified by the acquiring activity (6.2). This information shall be presented for each engine when performance data pertain to multi-engine aircraft. When fuel flow variations exist due to alternate engine operations, fuel flow for each alternate condition shall be shown. Single engine data

shall be placed on the same charts as multi-engine data only when approved by the acquiring activity (6.2). 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.

3.2.9.3.2.14 Climb-descent chart. The climb-descent chart (Figure 46) 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 baseline configuration, an increase in horsepower due to drag shall 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 in the single engine climb chart.

3.2.9.3.2.15 Approach speed chart. The approach speed chart (Figure 47) 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 acquiring activity (6.2). Charts used in connection with the approach speed chart shall be referenced in the text.

3.2.9.3.2.16 Landing chart. The landing chart (Figure 48) shall show the total ground roll distance for landing with no reverse thrust at known gross weight, pressure altitude, and ambient 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 and calm wind conditions. This chart shall be valid for all stores configurations unless otherwise specified by the acquiring activity (6.2). The chart used in computing landing distances shall be described in the text.

3.2.9.3.2.17 Airspeed calibration chart. An airspeed calibration chart (Figures 33 and 34) that defines the relationship between the pilot's indicated and calibrated airspeed for level flight, climb, and descent shall be provided. Instructions and examples shall be provided to show the operator how to determine the level flight indicated airspeed value that 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 that 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 that provides true FAT as a function of true airspeed and indicated temperature shall also be provided. For those aircraft whose air data system position errors are insignificant, airspeed, altitude, and temperature calibration data shall be omitted, with approval of the acquiring activity (6.2).

3.2.9.3.2.18 Optimum cruise. When requested by the acquiring 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. 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 the limits of altitude on the cruise charts (if required). If corrections to optimum altitude for configuration variations are significant and capable of being done, this information shall be provided.

3.2.10 Chapter 8 - Normal procedures.

3.2.10.1 General. Procedures (amplified checklists) from the time a flight is planned until the flight is completed and the aircraft is properly parked and secured shall be provided. 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, avionic, mission equipment and controls are contained in Chapters 2, 3, and 4 and shall be included in this chapter only if neglect 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 operating the aircraft 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, reference shall be made to appropriate flight training publications.

3.2.10.2 Section I - Crew duties. Unique crew responsibilities that result from the specific characteristics of the aircraft shall be described. When applicable, a description of mission planning shall also be included.

3.2.10.3 Section II - Operating procedures and maneuvers. Normal procedures including all steps necessary to ensure safe and efficient operation of the aircraft from the time preflight begins until the flight is completed and the aircraft is parked and secured shall be provided. Where applicable, performance charts provided in

Chapter 7 that are required to carry out specific flight procedures or maneuvers shall be referenced or linked as necessary.

3.2.10.3.1 Procedures. Procedural steps shall be written so that crewmembers shall not be required to retrace steps. Insofar as possible, checks shall be grouped to keep control manipulation and ground operating time at a minimum. Phases shall 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. In the checklists, the condition and response of a procedural step shall be separated by a long dash.

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

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

3.2.10.3.2 Symbols definition. The following symbols shall be used in the checklist to identify certain conditions or duties:

a. The symbol "O", which shall precede the step, shall be used to indicate if equipment is installed or available.

b. Those duties that are the responsibility of the pilot (not on the controls) shall be indicated by a circle around the step number, "4".

c. A “star” symbol that shall precede a step shall indicate that a detailed procedure for the step is located in the performance section of the condensed checklist.

d. The asterisk symbol “*”, which shall precede the step, shall indicate that performance of the step is mandatory for all through-flights. The asterisked steps in this checklist shall be used for combat/tactical operations when authorized by the commander. The asterisk shall apply only to checks performed prior to takeoff.

e. The letter “N” shall indicate the performance of a step that is mandatory for night flights.

f. The letter “T” shall indicate a task or step required by the operator’s manual.

g. The letter “F” shall indicate a task or step that requires a flight engineer function or response.

3.2.10.3.3 Amplified checklist. The amplified checklist (Figure 49) shall consist of numbered items supplemented where necessary by explanatory material. Where required for emphasis, a brief explanation shall be provided as to why it is required. These checklists shall be provided in the operator's manual for each aircraft, and they

shall be the basis of all operators' checklists. An amplified normal checklist shall be included for the pilot, pilot (not on the controls), and flight engineer, as applicable. A statement similar to the following 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 including warnings, cautions, and notes, is contained in the Operator's Checklist, TM 1-XXXX-XXX-CL. The procedural steps are numbered to coincide with the corresponding numbered steps in this manual.

3.2.10.3.4 Preflight check. The amplified preflight check shall include a before exterior check, if required, and the exterior and interior checks. The amplified checklist shall emphasize that the preflight is not intended to be a detailed mechanical inspection and that the order is a recommended sequence only. In addition the expanded sub-steps shall not need to be memorized or accomplished in a certain order. The preflight may be made as comprehensive as conditions warrant at the discretion of the pilot.

3.2.10.3.5 Before exterior check. When required by the aircraft configuration, 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.

3.2.10.3.6 Exterior check. Only those exterior points that significantly affect the flight shall be included 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. Inspections usually should proceed counter-clockwise (as viewed from the top) around the aircraft.

3.2.10.3.7 Interior check. The complete interior check shall be described, including all necessary check items up to the point where the pilot is strapped in the seat. All necessary equipment including, but not limited to, a first aid kit, fire axes, pyrotechnic equipment, aircraft covers, tie downs, and control locks shall be stowed. 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.

3.2.10.3.8 Crew/passenger briefing check. Instructions shall be provided to insure that crew and passenger briefings have been completed prior to starting engines.

3.2.10.3.9 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 shall be included. Instructions for positioning important controls and checking important indicators shall be included. Insofar as is practicable, all controls shall be positioned as required for engine starting. Functional checks shall be included for those systems that can be checked before the engines are started. For those aircraft in which engine power is not necessary, flight controls shall be checked for free and correct movement. Instructions shall be provided on the use of external power or auxiliary power units and any necessary switching involved in its use.

3.2.10.3.10 Starting engine(s). The complete procedure for starting the engine(s) shall be provided, including the order of starting for multi-engine aircraft. Except when significant differences in procedures are required for 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.

3.2.10.3.11 Engine ground operations. When required, warm-up and ground operation power setting shall be specified. Any special precaution or limitation shall be stated. For rotary wind aircraft a requirement for flight control checks before the rotor is engaged shall be included, if applicable.

3.2.10.3.12 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, and hydraulic pressure checks shall be included.

3.2.10.3.13 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 flight instruments be checked during taxiing shall be included.

3.2.10.3.14 Engine runup. Instructions shall include, but shall not be limited to, checking engine propeller/rotor operation, including power, ignition, and use of brakes.

3.2.10.3.15 Before takeoff. All checks, which must be accomplished immediately prior to takeoff/departure, shall be listed.

3.2.10.3.16 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, and stabilizing power prior to starting takeoff.

3.2.10.3.17 Takeoff. Takeoff techniques required to produce the results shown on the takeoff charts in Chapter 7 shall be covered in detail. 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. Criteria for continuing a takeoff or aborting under various circumstances shall be included. Operational consideration and general rules contributing to hovering capability and power availability shall be stated. Unique hover/taxi, sideward and rearward flight techniques and power check shall be included. The necessity for a prepared runway shall be discussed for various conditions of altitude and weight of aircraft that may be required to operate from temporary or unfinished runways.

3.2.10.3.18 After takeoff. All actions and techniques to be accomplished immediately after takeoff shall be listed. If flap retraction procedures differ under various conditions including, but not limited to, heavy weight and weather, it shall be so stated. When applicable, minimum airspeed and altitude for retracting flaps shall be covered. A minimum flap retraction airspeed chart shall be included for aircraft of highly variable gross weight. All actions needed to establish the required climb shall be covered, including the airspeed at which the climb should be started.

3.2.10.3.19 Climb. A description of unique climb techniques 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 described. Since the preceding paragraph includes the climb checklist, this paragraph shall contain discussion only.

3.2.10.3.20 Cruise. An explanation shall be provided for all actions that must be performed when the transition from climb to cruise is made. Any particular matters that must be considered during cruise flight shall be described. Reference shall be made to Chapters 2 and 7 concerning fuel system management and other actions that should be considered during flight. Actual procedures shall not be covered here.

3.2.10.3.21 Descent-arrival. A checklist and discussion of this phase of operation shall be included as appropriate. The checklist shall include all checks that must be made immediately before and during a descent preparatory to landing. Special instructions regarding various types of descent shall be included as applicable, including any special devices that may be provided to facilitate descent.

3.2.10.3.22 Before landing. All checks that must be made immediately before entering the traffic pattern until the aircraft is committed to landing shall be covered.

3.2.10.3.23 Landing. A landing checklist and a narrative discussion of the landing problems and techniques shall be provided. 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. Braking techniques and devices used during the landing and after-landing roll shall be described. Approach and landing airspeed corrections required to compensate for gusts shall be covered. In addition, landing techniques

from the viewpoint of recommended maximum and minimum approach and landing airspeeds as related to 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 shall include cautions, when 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.

3.2.10.3.24 Touch and go landings/go-around. All instructions including, but not limited to, trim changes and flap settings for executing these procedures shall be included. Proper throttle/power lever technique shall be emphasized, when applicable.

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

3.2.10.3.26 Engine shutdown. A checklist shall be provided covering proper procedures and precautions for stopping engines.

3.2.10.3.27 Before leaving the aircraft. A checklist of settings of all controls, control locks, and safety devices for securing the aircraft shall be provided for pilots and crew. A statement similar to the following shall be included:

> In addition to established requirements for reporting any system defects or unusual and excessive operations such as hard landings, the flight crew shall also make entries on DA Form 2408-13-1 to indicate when any limits of the operator's manual have been exceeded.

3.2.10.3.28 Checklist changes. The specific checks described above may be deleted or new checks added when approved by the acquiring activity (6.2).

3.2.10.4 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 in FM 1-240 shall be discussed. Instrument flight conditions to be considered shall include instrument takeoff, climb, cruise, descent, and approaches; holding; and automatic approaches.

3.2.10.5 Section IV - Flight characteristics. Detailed unique flight characteristics of the particular aircraft that may be different from FM 1-203 shall be provided. Emphasis shall be placed on advantageous flight characteristics as well as on any dangerous tendencies. The extent of coverage shall depend principally on the type of aircraft being discussed.

3.2.10.5.1 Stalls. The power-off and power-on stalling characteristics of the airplane in the takeoff, landing, and cruise configurations shall be described. Stalling characteristics shall also 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. Normal and accelerated stalls shall be covered, and recommended procedures for initiating stalls shall be included. Stall recovery technique shall be emphasized. For helicopters, appropriate information shall be included on blade stalls.

3.2.10.5.2 Stall chart (fixed wing only). Stalling airspeeds (with power-on and power-off configurations) for takeoff, landing, and cruise shall be presented showing the variations of bank angle and gross weight.

3.2.10.5.3 Spins (fixed wing only). Spin characteristics and limitations shall be given, including details of any special techniques recommended for recovery. Recovery techniques 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.

3.2.10.5.4 Diving. The diving characteristics of the aircraft shall be described with particular emphasis on high speed diving and compressibility effects. Dive recovery techniques 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 given varying parameters of altitude, airspeed, and dive angle.

3.2.10.5.5 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.

3.2.10.5.6 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.

3.2.10.5.7 Level flight. Characteristics of level flight under slow, cruising, and high speed conditions shall be described.

3.2.10.5.8 External loads. Changes in flight characteristics due to external loads shall be described.

3.2.10.5.9 Asymmetrical loads. Coverage of characteristics and techniques to be employed when operating with asymmetrical loads or configurations shall be presented.

3.2.10.6 Section V - Adverse environmental conditions. Information relative to operations that are unique to the specific aircraft under adverse environmental conditions (snow, ice, rain, turbulent air flight, extreme cold and hot weather, desert operations, and high altitude operations) for parameters including, but not limited to, gross weight and aircraft configuration shall be provided. The information presented 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. A description of equipment shall not be included. An introductory paragraph shall be included explaining the function of this section. In addition coverage of duties to be accomplished before leaving the aircraft, including, but not limited to, leaving the canopy slightly open, positioning of doors, battery care, and installing covers shall be included for applicable environmental conditions.

3.2.10.6.1 Cold weather operations. A brief discussion of the general problems involved in maintaining satisfactory operations in extreme cold shall be included. The relationship of proper engine shutdown to subsequent engine starting shall be emphasized, and operations under icing conditions shall be covered. Any special problems resulting from operations when snow is present shall be included.

3.2.10.6.2 Preparation for flight. Special problems including, but not limited to, application of heat, removal of ice and snow from the aircraft surfaces, fuel and oil tank vents, pitot tubes, props, and supplying external power shall be addressed.

3.2.10.6.3 Engine starting. Any special precautions that must be observed before starting the engines shall be included. Cold weather starting techniques shall be explained including the use of special fuels and carburetor heat.

3.2.10.6.4 Warm-up and ground testing. This shall include, but shall not be limited to, coverage of carburetor heat, cowl flap position, and technique of switching from a special starting fuel. 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 that may be adversely affected by cold weather shall be included.

3.2.10.6.5 Taxiing and hovering instructions. The unique techniques and precautions to be observed when taxiing on snow, ice, or slush covered water shall be explained, as well as, instructions for operator/ground crew to visually check wheels to ensure they are turning.

3.2.10.6.6 Before takeoff. Checks for ice and snow buildup on the aircraft shall be included.

3.2.10.6.7 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.

3.2.10.6.8 During flight. Any special precautions that must be observed during flight in extreme cold, such as cycling propeller governing systems, shall be described; procedures for dealing with in-flight icing shall be described.

3.2.10.6.9 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.

3.2.10.6.10 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.

3.2.10.6.11 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, and the techniques and precautions to be observed in using oil dilution shall be covered. Operation of systems depending on engine oil (including, but not limited to, supercharger clutch and propeller governor), to ensure that these systems are supplied with diluted oil, shall be included. Complete instructions for purging normal fuel from the system and replacing with special fuel shall be included. Time, speed or other requirements for turbine temperature stabilization prior to shutdown shall be stated.

3.2.10.6.12 Desert and hot weather operations. The same requirements and procedures outlined in cold weather operations (3.2.10.6.1) shall apply to desert and hot weather operation.

3.2.10.6.13 Turbulence and thunderstorm operations. A discussion on the general qualities of the aircraft in turbulence and thunderstorms shall be included. A description of the techniques to be used shall be given and all preparations to be made before entering turbulence or thunderstorms shall be included.

3.2.10.6.14 Rain. General coverage of the problem of rain during each phase of flight, including before takeoff, takeoff, climb, and cruise, shall be included. Performance of the rain removal systems shall be described.

3.2.11 Chapter 9 -Emergency Procedures.

3.2.11.1 General. Procedures to be followed in dealing with emergencies that could reasonably be encountered shall be provided. Minor malfunctions that do not

adversely affect the continued safe operation of the aircraft and compound or multiple failure emergency procedures shall not be included. Emergency procedure 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 shall be required regarding the feel, characteristics, and reaction of the aircraft during various emergencies affecting flight. All precautions to be observed in coping with an emergency shall be included. An emergency amplified checklist shall be included. Emergency procedures in connection with the utility systems shall be described in Chapter 2, Section IX. Emergency operation of utility systems shall be included only insofar as it may affect safety of flight. Emergencies shall be divided into the following ten categories:

a. Engine

b. Propeller/rotor

c. Fire

d. Fuel

e. Electrical

f. Hydraulic

g. Landing and ditching

h. Flight controls

i. Bailout/ejection

j. Mission equipment (when applicable)

Within an emergency classification, emergencies that have identical corrective actions may be combined under one paragraph heading. Those checks that must be performed immediately in an emergency procedure shall be underlined, and a statement that such underlined steps must be performed immediately without reference to the checklist shall be included.

3.2.11.2 Section I - Aircraft systems. Emergency procedures to be performed in the event of an aircraft system malfunction under various conditions shall be provided.

a. A statement similar to the one provided below shall be included:

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

b. A note similar to the one provided below shall be included:

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.

c. A statement similar to the one provided below shall also be included:

Terms may be defined as necessary to simplify the procedural memory steps within the existing emergency procedures. Each term shall be used as an emergency procedure step instead of listing the individual steps used to define the term. For example, the term "EMER ENG SHUTDOWN" is defined as engine stoppage without delay and is accomplished as follows:

1. Throttle - off.

2. **FUEL** switches -**OFF.**

3. **BAT** switch - **OFF.**

For rotary wing aircraft**,** the definitions of emergency terms shall be included near the beginning of Chapter 9.

d. The following definitions shall be included:

(1) LAND WITHOUT DELAY is defined as a landing in which the primary consideration is continued control of the aircraft and survival of the occupants. It is meant to be more urgent than LAND AS SOON AS POSSIBLE. The situation may not permit the aircrew to maneuver the aircraft to a suitable landing area (e.g., open field). If maneuvering to an open area is not practical, then the crew must make a decision to land in an area that will have the least amount of negative impact on crew survivability. (Over dense forest, select an area with the smallest trees; in the mountainous area, choose an area with the least amount of slope.)

(2) 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.

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

(4) AUTOROTATE is defined as adjusting the flight controls as necessary to establish an autorotational descent and landing.

3.2.11.2.1 Emergency equipment and exits. The following emergency equipment and exits shall be illustrated.

a. The aircraft interior shall be illustrated showing life support equipment permanently installed in the aircraft including, but not limited to, fire axes, flares, pyrotechnic pistols, and hand fire extinguishers (Figure 50).

b. If the aircraft is large enough to permit movement of personnel, emergency stations and routes of egress 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 50). This illustration shall be an interior view or as viewed by the occupants of the aircraft. It may be combined with the emergency equipment diagram and the emergency entrance diagram, unless the resulting illustration would be confusing.

c. A diagram shall be included to show points at which emergency personnel can enter 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.

3.2.11.2.2 Engine. Emergency procedures shall be described in the event of an engine malfunction under a variety of conditions.

3.2.11.2.2.1 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 that 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.

3.2.11.2.2.2 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 as well as complete engine failure shall be described. 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 shall be discussed.

3.2.11.2.2.3 Engine malfunction during takeoff and low altitude/low airspeed flight. This shall include 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. Information shall be included, but not limited to, jettisoning external stores, landing gear retraction, pilot techniques, and best airspeed for minimum power required (partial loss of power).

3.2.11.2.2.4 Engine malfunction during cruise. Reference shall be made to the performance 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. Procedures to be followed in the event of partial power loss as well as for the complete engine failure shall be included.

3.2.11.2.2.5 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.

3.2.11.2.2.6 Engine restart during flight. Instructions for proper means for restarting an engine in flight and resuming normal flight shall be presented. Special emphasis shall be placed on parameters such as altitude, airspeed, and rpm. If considered advantageous, they may be presented in chart form. A warning shall be included that the engine should not be restarted unless it can be determined that it would be reasonably safe to do so.

3.2.11.2.2.7 Maximum glide. Glide requirements that shall result in maximum range with no power available shall be provided. 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 51).

3.2.11.2.2.8 Autorotational descent. A chart that presents autorotational rate of descent versus indicated airspeed at normal rotor speed shall be provided (Figure 52). 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.

3.2.11.2.2.9 Landing with one or more engines inoperative. The recommended procedure shall be described, including important precautions. A brief discussion of any changes that include, but are not limited to, the use of landing gear, wing flaps, and slats during such landing shall be included. For single-engine and twin-engine aircraft, proper landing procedures with no power shall be emphasized. For rotary wing aircraft, reference shall be made to the height velocity diagram.

3.2.11.2.2.10 Go-around with one or more engines inoperative (fixed wing). Recommended procedures shall be described, including important precautions.

3.2.11.2.2.11 Height velocity. The minimum height for safe landing following loss of power for both single and multi-engine helicopters shall be provided. Plots of height required for safe auto-rotational 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 53). The plots shall 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 acquiring activity (6.2).

3.2.11.2.3 Propeller/ rotor, transmissions, and drive systems. Emergency procedures shall be described in the event of propeller/rotor, transmission, or drive system failure.

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

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

3.2.11.2.3.3 Malfunctions of main rotor transmission and drive systems. Differentiation between malfunctions with the drive system between the engine and transmission, and malfunctions of the drive system between the transmission and main rotor shall be included. Actual and erroneous instrument/warning light indications shall be discussed, including procedures for specific malfunctions.

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

3.2.11.2.4 Fire. Emergency procedures shall be included for aircraft fires as directed in the following paragraphs.

3.2.11.2.4.1 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 procedures shall be identical to those used during engine failure.

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

3.2.11.2.4.3 Wing fire. Instructions shall be included on means of dealing with wing fires, including shutting down systems which may be feeding the fire.

3.2.11.2.4.4 Electrical fire. Instructions for dealing with an electrical fire shall be included. If certain aircraft fire extinguishers are not to be used for electrical fires, that information shall be included.

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

3.2.11.2.5 Fuel system. Procedures shall be given for dealing with fuel system failures and shall include a description of metering system failures, 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.

3.2.11.2.6 Electrical system. Instructions shall be given for methods of dealing with electrical system failures. Procedures shall be expressed as actions to be taken involving circuit breakers. For push-pull types, procedures shall indicate in or out. Where the circuit breakers are a switch type, procedures shall indicate off or on.

3.2.11.2.7 Hydraulic system. Instructions shall be given for dealing with hydraulic system component failures.

3.2.11.2.8 Landing and ditching. Instructions shall be given regarding landing and ditching emergency procedures as described in the following paragraphs.

3.2.11.2.8.1 Emergency descent. The means of accomplishing an emergency descent shall be provided. Emergency descent is a maximum effort in which damage to the aircraft or power plant is considered secondary to getting the aircraft on the ground.

3.2.11.2.8.2 Landing emergencies. Preparation, warning signals to crew, approach, crew/passenger positions, harness locks, landing technique, routes, and methods of crew exits shall be included for both hard and soft ground. Landings with one or more landing gears retracted, flat tires, no wing flaps, and landing on unprepared runways

shall also be covered. Information regarding pilot techniques for forced landings in trees or wooded areas shall also be included.

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

3.2.11.2.8.4 Ditching. Instructions shall be included for ditching the aircraft. The ditching capabilities of the aircraft and the advantages of ditching versus bailout 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; and methods of crew exits. As applicable, an illustration shall be included showing the position of each crewmember during ditching and crash landing.

3.2.11.2.9 Flight controls. Procedures to be employed in event of flight control failure shall be provided.

3.2.11.2.10 Bailout/eject. 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 described. A pictorial sequence of operations for ejection shall be provided, including alternate methods of removing safety pins where applicable.

3.2.11.3 Section II - Mission equipment. Emergency procedures shall be outlined for malfunctioning mission equipment that constitutes a safety hazard.

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

3.2.12 References. A listing of official publications cited within the manual applicable to flight crews shall be provided. The listing shall contain only those publications referenced in the manual, and shall not contain blank forms. The list of references shall be provided as Appendix A (3.5.1.16).

3.2.13 Abbreviations and terms. Definitions of all abbreviations and terms used throughout the manual shall be provided. The definition list shall be provided as Appendix B (Appendix A, A.3.10).

3.2.14 Index. The index shall list in alphabetical order, every titled paragraph, figure, and table contained in the TM (Appendix A, A.3.17).

3.2.15 Authentication page. An authentication page (Figure 54) shall be placed immediately preceding the back cover.

3.2.16 DA Form 2028. DA Form 2028 (Figure 55) shall be provided in the back of the manual immediately following the alphabetical index. Instructions for sending an electronic DA Form 2028 shall also be included (Figure 55).

3.2.17 Foldouts. When foldouts are provided they shall be placed at the end of the Operator’s Manual immediately following DA Form 2028. Refer to Appendix D for identification and numbering of foldout figures and foldout pages.

3.3 Operator's checklist (-CL).

3.3.1 General. The operator’s checklist (-CL) is a condensed version of Chapter 8 and 9 of the operator’s manual which consist of a series of controls (or checks) and the required actions. The sequence of items (or checks) appearing in the operator’s checklist shall be identical to those appearing in the amplified checklist of the operator's manual. In unusual circumstances, explanatory material shall be used in the operator’s checklist in the form of warnings, cautions, and notes, only if specified by the acquiring activity (6.2). The contents of the -CL shall be as described in the paragraphs below.

3.3.1.1 Standard operator's checklist. Unless otherwise specified by the acquiring activity (6.2), the operator's checklist shall comply with the following requirements, except those which are designated as applying specifically to alternate operator's checklists (3.3.3).

3.3.2 Detailed requirements for standard operator's checklists. Operator's standard checklists shall be prepared in accordance with the following outline indicated below:

a. Cover

b. Change transmittal page

c. General information and scope

d. Normal procedures

e. Emergency procedures

f. Performance data

g. Authentication Page

When required by the acquiring activity (6.2), a list of crewmembers' duties shall be prepared for normal and emergency procedures.

3.3.2.1 Cover. The cover (Figure 56) shall comply with the requirements of 3.2.2.1.

3.3.2.2 Change transmittal page. A change transmittal page shall be provided. The change transmittal page shall provide the information shown in Figure 57. In addition when the manual has been reviewed for the presence of environmental and hazardous material information, the ODC statement and hazardous materials statement provided on the abbreviated title page shall be repeated (3.2.2.5.1).

3.3.2.3 General information and scope. The general information and scope shall indicate the purpose of the checklist, how and when it is to be used, and scope, including an explanation of the content of the normal and emergency procedures that appear in the checklist. Information for reporting errors and making recommendations shall be included (3.2.2.5). DA Form 2028s shall not be included. An explanation of the symbols (3.2.10.3.2) used throughout the procedures shall also be provided. When applicable, information that a review for hazardous materials and ozone depleting chemicals has been done and non-hazardous materials and chemicals have been substituted when possible shall also be included.

3.3.2.4 Normal procedures. A condensed version of the normal procedures or crew duties portion of the applicable operator’s manual (-10) shall be developed (Figure 58). A through-flight checklist (3.3.2.7) shall be provided and consist of items marked by an asterisk. In addition to through-flight, this checklist shall be used for combat/tactical operations when authorized by the commander. Procedures shall be highly abbreviated and shall use abbreviations that are defined in the operator’s TM.

3.3.2.5 Emergency procedures. A condensed version of the emergency procedures or crew duties portion of the applicable operator’s manual (-10) shall be developed (Figure A-3). The emergency requirements of the condensed checklist (CL) shall be identical to those for the normal procedures (3.3.2.4), 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 into 10 classifications as listed in 3.2.11.1. The underlined items shall be the steps that must be performed immediately without reference to the checklist. Procedures shall be highly abbreviated and shall use abbreviations that are defined in the operator’s (-10) TM.

3.3.2.6 Performance data. Charts, tables, and checklists used during preflight, takeoff, cruise, landing, and shutdown shall be included.

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

3.3.2.6.2 Performance checks. When applicable, detailed performance checks of selected procedures, as indicated by the acquiring activity (6.2), shall precede the performance data charts. Performance checks provided in Chapter 8 of the Operator's manual that have the star symbol (★) preceding those checks shall be included in the performance data section. When applicable, performance checks for mission equipment shall follow the detailed performance checks. The detailed performance checks shall appear in the same order/sequence as they appear in the Chapter 8 checklist.

3.3.2.7 Through-flight checklist. If a through-flight checklist is required, it shall be included in normal procedures (3.3.2.4) following the abbreviated checklist. It shall consist of all through-flight checks from the normal procedures section of the applicable operator's manual. The checks shall be numbered sequentially.

3.3.2.8 Authentication page. An authentication page (Figure 54) shall be placed immediately preceding the back cover.

3.3.3 Alternate operator's checklist. The acquiring activity (6.2) shall have the option to specify that a one or two page alternate operator's checklist (Figure 59) be prepared instead of the standard operator's checklist.

3.3.3.1 Detailed requirements for alternate operator's checklists. Alternate operator's checklists shall include normal and emergency procedures. The procedures shall be written in the same manner as 3.3.2.4 and 3.3.2.5.

3.4 Maintenance test flight manual (-MTF).

3.4.1 Detailed requirements for maintenance test flight manual. An MTF manual shall be prepared in accordance with the following outline indicated below:

a. Front matter.

b. Section 1. Introduction.

c. Section 2. Maintenance test flight manual.

d. Section 3. Troubleshooting guides.

e. Section 4. Special/detailed procedures.

f. Section 5. Charts and forms.

g. Authentication Page

3.4.2 Front matter.

3.4.2.1. Cover. The cover shall conform to Figure 60. The title shall identify the type, model, and series of subject aircraft.

3.4.2.2 Warning page. The warning page shall contain a warning statement similar to the following:

"WARNING"

"A maintenance test flight is an exceptionally demanding operation and requires a thorough flight readiness inspection (pre-flight). The flight readiness inspection is prescribed in TM 1-XXXX-XXX-10 (operator's manual) and must be completed prior to each MTF. Emergency procedures are found in the applicable operator's manual (-10) and checklist (-CL) and are not duplicated in this publication. Prior to each maintenance test flight, the pilot shall contact maintenance/quality control personnel to determine the maintenance that has been performed. This manual should be used only by qualified maintenance test flight pilots as required by AR 95-1."

3.4.2.3 Change transmittal page. A change transmittal page shall be provided. The change transmittal page shall provide the information shown in Figure 61. In addition, when the MTF has been reviewed for the presence of environmental and hazardous material information, the ODC statement and hazardous materials statement provided on the abbreviated title page shall be repeated (3.2.2.5.1).

3.4.2.4 Abbreviated title page/table of contents. Information for reporting errors and making recommendations shall be placed at the beginning of the abbreviated title page/table of contents. When applicable, information that a review for hazardous materials and ozone depleting chemicals has been done and non-hazardous materials and chemicals have been substituted when possible shall also be included. The procedures in 3.2.2.5 shall be followed; however, referral to DA Form 2028's shall be directed to the Operator's Manual. The table of contents shall list the chapters and main paragraphs in the same order and with the exact titles used in the text, shall be placed after the reporting of errors (Figure 62).

3.4.3 Section I - Introduction.

3.4.3.1 General. Information of a general nature including the definition of an MTF, the purpose, and instructions specific to the checklist shall be provided.

3.4.3.2 Purpose. The purpose of the MTF manual shall be to provide complete instructions for performing an MTF for a specific model, type, and series aircraft. For the specific criteria which require a general or limited MTF, reference shall be made to TM 1-1500-328-23 and the applicable aviation unit and intermediate maintenance manuals.

3.4.3.3 Definitions. The following definitions shall be included.

a. Maintenance test flight. A flight for which the primary mission is to determine airworthiness, i.e., that the airframe, power plant accessories and items of equipment are functioning in accordance with predetermined requirements in the intended operational environment.

b. Warnings, cautions, and notes. Warnings, cautions, and notes are used to emphasize important and critical instructions and are used for the following conditions.

WARNING

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc. which if not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

CAUTION

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc. which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

NOTE

Highlights an essential operating or maintenance procedure, condition, or statement.

3.4.3.4 General Information. The following information shall be provided.

a. This manual shall cover only MTFs of aircraft (insert type, model, and series) and in no way supersedes any information contained in TM 1-XXXX-XXX-10 or-CL, but is to be used in conjunction with the -10 or -CL. For the purpose of MTFs only, the MTF manual shall satisfy all of the requirements of the -CL from Interior Check through Engine Shutdown.

b. Crew requirements shall be as specified in TM 1-1500-328-23 and TM 1-XXXX-XXX-10.

c. The duration of a general or limited test flight shall be in accordance with the requirements of TM 1-1500-328-23.

3.4.3.5 Special instructions. The following special items of interest shall be included.

a. Cargo and passengers shall be prohibited on MTFs.

b. Forms and records shall be checked prior to the MTF to determine what maintenance has been performed and the type of MTF required (i.e., general or limited).

c. The configuration of the aircraft shall be established prior to each MTF in order to determine performance parameters.

d. A thorough post test flight inspection shall be performed to the extent necessary to ensure that deficiencies that may have developed as a result of the MTF are detected.

e. When an MTF is required to ensure proper operation of a specific system(s), references shall be made to the applicable maintenance manuals for the limits of that system.

f. The symbols identified and described in 3.2.10.3.2 shall be used in the checklist to identify certain conditions or duties.

g. A check sheet (Figure 63) shall be developed for recording the results of test flights. When a test flight is performed to determine if specific equipment or systems are operating property, completion of only that portion of the MTF check sheet applicable to the specific equipment or system being tested shall be required. Continuation sheets may be used when necessary. Items that prove to be unsatisfactory during the test flight and require corrective action shall be listed in the remarks block during flight and transferred to DA Form 2408-13-1 immediately after termination of the flight. The sheet shall be attached to the DA Form 2408-13-1 upon completion. After accumulation of two or more sheets, the data shall be reviewed to determine if trends are developing.

3.4.4 Section 2 - MTF checklist.

3.4.4.1 General. MTF requirements for specific Army aircraft shall be provided. Criteria for performing MTFs shall be in accordance with TM 1-1500-328-23. Requirements shall ensure a thorough inspection of the aircraft before flight, during flight, and upon completion of the MTF. Unless otherwise specified by the acquiring activity (6.2), checklist items shall include those that are contained in the applicable aircraft operator's checklist, plus those MTF checks peculiar to the aircraft in question.

3.4.5 Section 3 - Troubleshooting Guides.

3.4.5.1 General. A statement that troubleshooting information is provided in the applicable maintenance manual shall be provided.

3.4.6 Section 4 - Special/Detailed Procedures. Those special/detailed procedures that are referenced in Section 2 shall be included. Complete instructions for each procedure shall be listed. Examples of special/detailed procedures shall include rotor smoothing techniques, speed trim checks, engine conditioning, engine starting, etc. (Figure 64). The special/detailed procedures shall be specified by the acquiring activity (6.2).

3.4.7 Section 5 - Charts and Forms.

3.4.7.1 General. Forms and charts (Figure 65), shall be prepared, as necessary, to help perform and record MTFs. Charts shall be prepared that shall include, but not be limited to, bleed band opening envelope, turbine entire analysis check, and power adjusting. A list of required charts, including the contents, size, and format, shall be provided by the acquiring activity (6.2). The number of foldouts shall be kept to a minimum. Fold-up charts shall not be used. Placement and identification of foldouts are provided in Appendix D. The forms shall be used to record readings, pressures, rpm, etc. obtained during MTFs.

3.4.7.2 List of charts. A complete list of charts shall be provided. The figure number, title, and page number shall be included. The charts shall be listed in order of their appearance.

3.4.7.3 Maintenance test flight check sheets. A check sheet, similar to the one in Figure 63, shall be provided for use by the person(s) conducting the checks.

3.4.7.4 Metric conversion chart. A chart, similar to the chart shown in Figure 66, shall be included at the back of the manual.

3.4.7.5 Appendices. Appendices shall immediately follow the last chapter of the manual. Appendixes shall be included when specified by the acquiring activity (6.2).

3.4.7.6 Authentication page. An authentication page (Figure 55) shall be placed immediately preceding the back cover.

4. VERIFICATION

4.1 General. This section shall include all activities to be performed to determine that the TM conforms to the requirements in Section 3 of the specification. The requirements shall be verified by following the procedures detailed in the TM to determine if the desired results can be achieved.

4.1.1 Validation. A 100 percent validation of the procedures outlined in the TM shall be performed for technical accuracy and adequacy of content. Validation shall include, but shall not be limited to actual operating procedures. It also shall include a review of instructions and associated checklists and technical accuracy and adequacy.

Transitions from, references to, and sequences of tasks/task segments, shall be validated in the final DEP product as a whole.

a. Tasks in the DEP shall be validated at any time. There shall be no requirement that they be done together. The only requirement shall be that the task selected for validation be performed completely, so that the task can be evaluated for technical adequacy. No task segment that stops short of achieving the task goal shall be considered validated.

b. When the source file for the manual or checklist shall be required to be delivered, the XML source file shall be tagged to the level and depth required by the applicable DTD and the content requirements contained in this specification (see 6.2).

c. When the manual or checklist is to be delivered in a intelligent PDF format, all information in the manual or checklist including the operation, maintenance, and troubleshooting information shall be accessed from the table of contents. All references shall be linked and the links shall provide access to the correct data.

4.1.1.1 Performance. The DEP shall be reviewed for:

a. Conformance to applicable requirements of the governing documents. This task shall include editorial review of the manuscript.

b. Technical accuracy and adequacy of the content. This shall include the actual performance of all of the procedures to operate the applicable aircraft under all conditions and to properly perform the proper checks. It shall also include, but shall not be limited to, a review of the essential need and adequacy of illustrations in the text and the adequacy of references cited.

4.1.2 Verification. All procedures outlined in the TM are subject to verification unless specifically excluded in contract documents. Verification shall be accomplished using one or more of the methods listed in paragraphs a through c below. The methods listed are in addition to reviewing the publication for conformance to the requirements of the governing documents. Verification shall be accomplished by the following:

a. Performing 100 percent of the operating procedures in the TM by using military operator personnel of the type and qualifications of those expected to operate the aircraft. Each procedure shall be performed successfully at least once. All performances shall be monitored by a subject matter expert and a master copy of the publication being verified shall be updated and given a final desk review. The desk review shall include a check of those portions of the publication not subject to hands-on performance, such as index, content, proper style, format, and adequacy of writing. When resources and time constraints limit the feasibility of performing a validation and verification as separate entities, these requirements may be combined.

b. Reviewing the technical content of the publication by personnel performing the operating instructions specified.

c. Witnessing the validation.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES
This section contains information of a general or explanatory nature which may be helpful but is not mandatory.

6.1 Intended Use. This specification is to be used for information and guidance in writing technical manuals for operator's manuals, checklists and MTF manuals for Army aircraft.

6.2 Acquisition requirements. Acquisition documents shall specify the following:

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

b. Omit date from the cover page (see 3.2.2.1).

c. Inclusion of a warning page (see 3.2.2.2).

d. Supersession notice will be placed other than as specified (see 3.2.2.1.1).

e. Provide a list of primary, alternate, and emergency fuels (see 3.2.4.16.3).

f. Add sections describing avionics equipment to Chapter 3 (see 3.2.5.2).

g. Whether standard operational avionics data exist. (see 3.2.5.2.3).

h. Include an appendix for mission avionics equipment (see 3.2.6.2).

i. Describe lateral CG limitations (see 3.2.7.5.1).

j. Expression for airspeeds if other than as specified (see 3.2.7.6).

k. Add sections to allow for added limits or restrictions for specific aircraft (see 3.2.7.9).

l. Include a statement about usable oil capacity (see 3.2.8.3.1).

m. Lateral CG limits (see 3.2.8.7).

n. The basis for performance data charts if other than as specified (see 3.2.9.1.1).

o. A configuration that is other than as specified (see 3.2.9.1.4).

p. Add data charts for alternate fuels (see 3.2.9.1.5).

q. Whether standard day, standard conditions, standard temperature, or density altitude should be mentioned (see 3.2.9.1.6).

r. Create rotary wing performance data charts other than as specified (see 3.2.9.1.10).

s. Create fixed wing performance data charts other than as specified (see 3.2.9.1.11).

t. If additional use of performance data charts may be included (see 3.2.9.3b).

u. Add charts to supplement the takeoff chart (see 3.2.9.3.1.5).

v. Alternate aircraft configurations for drag chart (see 3.2.9.3.1.6).

w. Provide particular altitudes, configurations, and temperatures for cruise chart (see 3.2.9.3.1.7).

x. For airspeed calibration chart, calibration data for airspeed, altitude, and temperature may be omitted (see 3.2.9.3.1.9).

y. If data are needed for an optimum cruise chart (see 3.2.9.3.1.10).

z. Flap settings and other applicable information will be provided for the rotation/takeoff airspeed chart (see 3.2.9.3.2.5).

aa. Provide particular altitudes, configurations, and temperatures for cruise chart (see 3.2.9.3.2.13).

ab. If single engine data are to be placed on cruise charts for multi-engine aircraft (see 3.2.9.3.2.13).

ac. Flap settings and other aircraft configurations for the approach speed chart (see 3.2.9.3.2.15).

ad. Indicate if the landing chart will be valid for stores configurations other than as specified (see 3.2.9.3.2.16).

ae. For airspeed calibration chart, calibration data for airspeed, altitude, and temperature may be omitted (see 3.2.9.3.2.17).

af. If data are needed for an optimum cruise chart (see 3.2.9.3.2.18).

ag. Indicate if specific checks are to be added to or deleted from the operating procedures and maneuvers section (see 3.2.10.3.28).

ah. State time delay period before initiation of collective pitch control motion following a loss of power (see 3.2.11.2.2.11).

ai. Inclusion of warnings, cautions, and notes (see 3.3.1).

aj Standard operator’s checklist requirements if other than as specified (see 3.3.1.1).

ak. Prepare a list of crewmembers' duties (see 3.3.2).

al. Use of performance data charts and the form of the charts (see 3.3.2.6.1).

am. Select detailed performance checks (see 3.3.2.6.2).

an. The operator’s alternate checklist should be prepared instead of the operator’s standard checklist (see 3.3.3).

ao. Select checklist items other than as specified (see 3.4.4.1).

ap. List of special/detailed procedures (see 3.4.6).

aq. List of required charts and format (see 3.4.7.1).

ar. Include appendices (see 3.4.7.5).

as. Front matter will be other than as specified (see A.3.1).

at. The TM number (see A.3.5).

au. The publication date (see A.3.7).

av. Dimensional data are other than as specified (see A.3.12).

aw. Use of manufacturers' names in the operator’s manual or checklist (see A.3.13).

ax. Include an index if other than as specified (see A.3.17).

ay. Use of photographic illustrations (see D.3.1.1).

az. Use of more than three variables if other than as specified (see D.3.2.1).

ba. Priorities for preparing graphical data that are other than as specified (see D.3.2.3).

bb. Use of four division scale grids for graphical data presentation (see D.3.2.4.7).

bc. Minimal minor grid spacing if other than as specified (see D.3.2.4.7).

bd. Data range is other than as specified (see D.3.2.4.9).

be. The type of revision (see A.3.22).

bf. Use of new change symbols (see A.3.22.2).

bg. Do not prepare a change record (see A.3.23).

bh. Arrange operator’s manuals in single column format (see A.3.3.2).

bi. Operator’s checklist style and format that are other than as specified (see B.2).

bj. Delivery manual or checklist source file to the government (see 4.1.1b).

bk. Submission, along with the draft TM, of an aerodynamic report illustrating the derivation of the data entered on the charts included in the TM. The report should include an analysis leading to the establishment of lift and drag values used in the calculations, 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. Calculation methods need to be fully explained and a sample calculation given. The calculations should be presented in sufficient detail to permit ready review and check of conclusions and to enable additional calculations to be made.

bl. Packaging requirements (see 5.1).

6.3 Technical Manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, specifications and standards that have been cleared and listed in DoD 5010.12-L,

Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

6.4 Definitions.

6.4.1 Changes/Revisions. When updates to technical manuals are ordered the deliverable product shall be change pages or a complete revision of the TM. The acquiring activity shall determine the type of update required.

6.4.2 Complete revision. A complete revision requires rewrite and reorganization of the technical content of the data. All existing changes to the basic manual shall be merged. All change dates and change symbols shall be removed, and, if necessary, all work packages shall be assigned new WP sequence numbers in consecutive order. The total number of pages in the TM (i.e., warning page, TOC, etc.) is counted when determining the total number of pages in the proposed change and applying the percentage rule.

a. Bound publications. Bound publications shall be revised when a proposed change to a publication would alter 25 percent or more of its printed pages or would alter 50 percent or more of its printed paragraphs. If the publication is eight or fewer pages, it shall always be revised.

b. Loose-leaf publications. Loose-leaf publications, which have 32 or fewer printed pages including changes, shall be revised when a proposed change would replace 50 percent or more of those pages. Loose-leaf publications, which have more than 32 printed pages including changes, shall be revised when a proposed change would replace 75 percent or more of those pages.

6.4.3 Final draft equipment publication (FDEP). The FDEP is the final document with illustrations, ready for transmittal to the US Army Publication and Printing Command for printing and publication as an authenticated DA equipment publication. It includes all necessary changes and final resolutions of all comments and recommendations made as a result of technical and user testing, if conducted, service test, validation/verification, user coordination, and maintenance literature conference.

6.4.4 Nonsuperseding revision. A revision which does not supersede the preceding edition. When a new manual is needed to cover a different configuration of a system or equipment for which there is a high degree of commonality, a nonsuperseding revision can be published to minimize cost. A nonsuperseding revision shall stand on its own and shall be identified by a unique TM identification number.

6.4.5 Draft equipment publication (DEP). Those publications prepared during the development phase of the equipment which are used for validation and early technical

and user testing. The DEP shall conform to format requirements of the applicable specification when provided in the form of printed books or manuscript.

6.4.6 Revision. A revision is comprised of corrected, updated, or additional pages or work packages to the current edition of a manual. It consists of replacement work packages that contain new or updated technical information, or improves, clarifies or corrects existing information in the current edition of the manual.

6.4.7 Standard table . A table designated as a **"standard table"** in the technical content requirements have no deviations to the number of columns and the titles in the column headings. The format and table headings are automatically generated by the applicable DTD and style sheet used for the functional information.

6.5 Subject term (key word) listing.

Avionics
Center-of-gravity (CG)
Checklist, alternate
Checklist, standard
Condition heading
Cover
Data, graphical
Data, performance
Diagram, moment
Equipment, mission
Instruments, flight
Limits, operating
Number, publication
Page, warning
Procedures, emergency
Procedures, normal
Statement, distribution
Symbol, designator
System, flight control
System, hydraulic
System, power train
System, utility
Test flight, maintenance
Through-flight
Weight and balance

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

CUSTODIANS:
Army-AV

REVIEW ACTIVITIES:
Army CR, TM

PREPARING ACTIVITY
Army-AV

(Project TMSS-A389)

NOTE: The activities listed above were in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.

TM 1-XXXX-XXX-10

TECHNICAL MANUAL
OPERATOR'S MANUAL
FOR
ARMY
HELICOPTER
(EIC:)

Volume Notice (If Applicable)
Supersedure Notice (If Applicable)
Disclosure Notice (If Applicable)
Distribution Statement (If Applicable)
Export Warning (If Applicable)
Destruction Notice (If Applicable)

HEADQUARTERS, DEPARTMENT OF
THE ARMY
Day Month Year

FIGURE 1. Example of front cover

TM 1-XXXX-XXX-10

WARNING

Personnel performing operations, procedures, and practices which are included or implied in this technical manual shall observe the following warnings. Disregard of these warnings and precautionary information can cause serious injury or death.

WARNING

STARTING ENGINES

Coordinate all cockpit actions with ground observer. Insure that wheels are chocked (if applicable), rotor and blast areas are clear, and fire guard is posted.

WARNING

GROUND OPERATION

Engines will be started and operated only by authorized personnel.

WARNING

ROTOR BLADES

Beware of moving rotor blades, particularly the blades of the forward rotor system.

WARNING

HIGH VOLTAGE

All ground handling personnel must be informed of high voltage hazards when making external cargo hook–ups.

WARNING

FIRE EXTINGUISHER

Exposure to high concentrations of fire extinguishing agents or decomposition products should be avoided. The liquid should not contact the skin. It may cause frostbite or low temperature burns.

WARNING

ARMAMENT

Loaded weapons or weapons being loaded or unloaded, shall be pointed in a direction which offers the least exposure to personnel or property in the event of accidental firing. Personnel shall remain clear of the hazardous area of all loaded weapons.

WARNING

VERTIGO

Turn the anti–collision lights off during flight through clouds. This will eliminate light reflections from the clouds, which could cause vertigo.

a

FIGURE 2. Example of a warning page

URGENT

TM 1-XXXX-XXX-10

CHANGE

NO. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 10 May 2004

OPERATOR'S MANUAL

FOR

ARMY MODEL

HELICOPTERS

(EIC:)

Distribution Statement:

ENVIRONMENTAL/HAZARDOUS MATERIAL INFORMATION

This document has been reviewed for the presence of Class I Ozone Depleting Chemicals. As of 14 June 1995, the status is: All references to Class I Ozone Depleting Chemicals have been removed from this document by substitution with chemicals that do not cause atmospheric ozone depletion.

TM 1-XXXX-XXX-10, dated 31 January 2003, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
A – B	A – B
2-15 – 2-16	2-15 – 2-16
3-5 – 3-18	. . . . .
5-5 – 5-6	5-5 – 5-6
. . . . .	8-10.1 – 8-10.6

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

DISTRIBUTION:
To be distributed in accordance with Initial Distribution (IDN XXXXXX), requirements for TM 1-XXXX-XXX-10.

FIGURE 3. Example of a change transmittal page

TM 1-XXXX-XXX-10

LIST OF EFFECTIVE PAGES

Insert latest changed pages; dispose of superseded pages in accordance with regulations.

N0TE: On a changed page, the portion of the text affected by the latest change is indicated by a vertical line, or other change symbol, in the outer margin of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Dates of issue for original and changed pages are:

Original ..... 30 April 1992
Change 1 .... 29 October 1993
Change 2 ..... 1 March 1994
Change 3 .... 30 September 1994

Total number of pages in this publication is 574, consisting of thhe following:

Page No.	*Change No.	Page No.	*Change No.
Title	0	2-96 Blank	0
a — b	3	3-1 — 3-80	0
A — B	3	4-1 — 4-2.	1
i — ii	2	4-3 — 4-8	2
iii — iii	3	4-9 — 4-45	0
iv Blank Deleted	3	5-1 — 5-18	0
1-1 — 1-2	0	6-1 — 6-38	0
2-1 — 2-2	2	7-1 — 7-116	0
2-3 — 2-4	0	8-1 — 8-28	0
2-5 — 2-10	3	9-1 — 9-2	0
2-10.1 — 2-10.2 Added	3	9-3	1
2-11 — 2-12	3	9-4 — 9-24	0
2-13 — 2-95	0	Index 1 — Index 8	0

*Zero in this column indicates an original page.

A Change 3

FIGURE 4. List of effective pages

TM X-XXXX-XXX-10

TECHNICAL MANUAL
NO. 1-XXXX-XXX-10

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 1 NOVEMBER 2002

TECHNICAL MANUAL
OPERATOR'S MANUAL
FOR

ARMY MODEL HELICOPTER

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) located in the back of this manual directly to: Commander, US Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5230. You may also submit your recommended changes by E-Mail directly to 2028@redstone.army.mil or by fax (256) 842-6546/DSN 788-6546. A reply will be furnished directly to you. Instruction for sending an electronic 2028 may be found at the back of this manual immediately preceding the hard copy 2028.

OZONE DEPLETING CHEMICALS INFORMATION

This document has been reviewed for the presence of Class I Ozone Depleting Chemicals. As of *provided date*, the status is: All references to Class I Ozone Depleting Chemicals have been removed from this document by substitution with chemicals that do not cause atmospheric ozone depletion.

HAZARDOUS MATERIALS INFORMATION

This document has been reviewed for the presence of Solvents used as cleaning solutions containing hazardous materials as defined by EPCRA 302 and 313 lists by the engineering, environment and logistics oversight office. As of base document *provided date*, all references to cleaning solvents containing hazardous materials have been removed from this document by substitution with non-hazardous or less hazardous materials where possible.

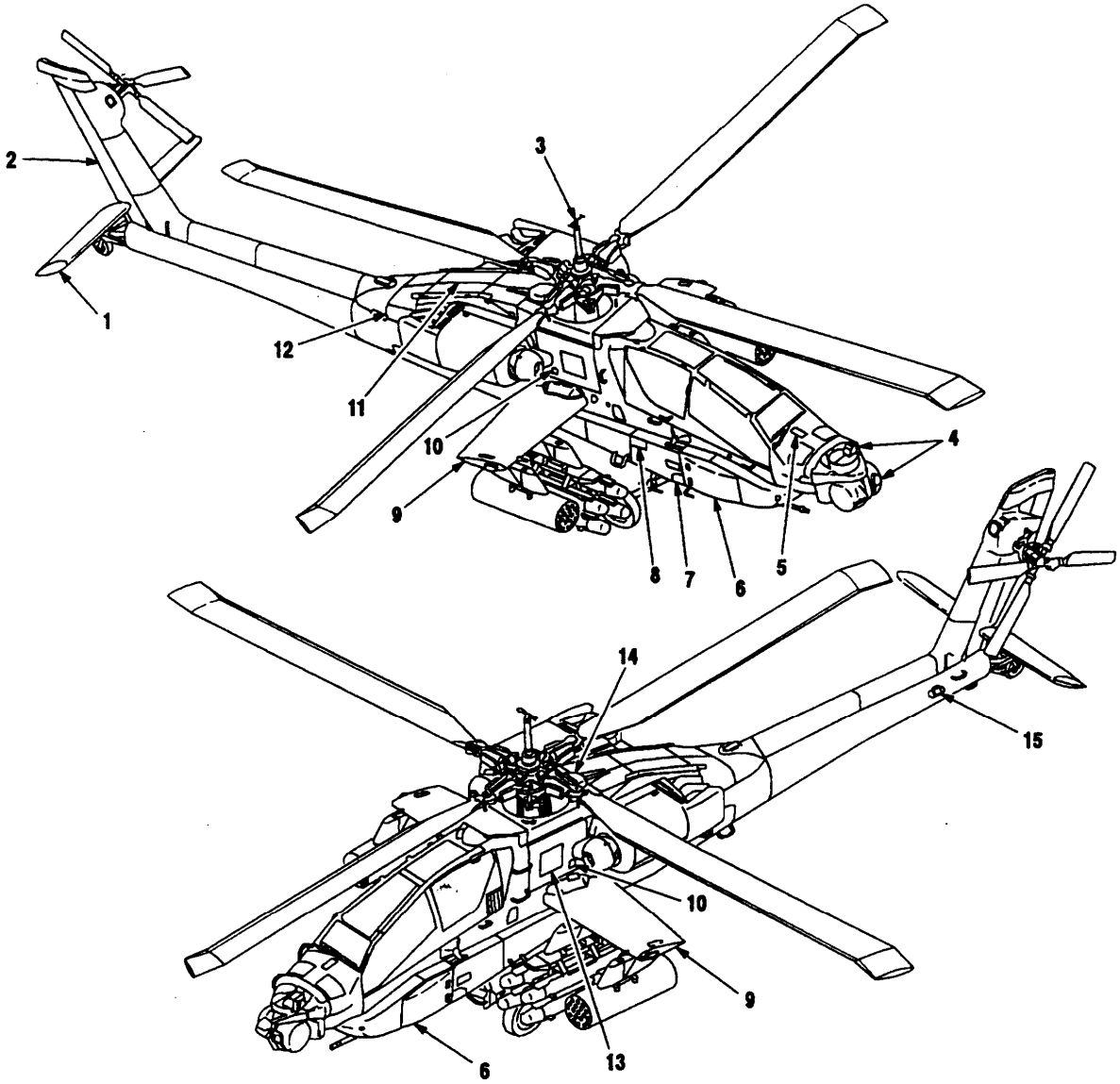
DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

TABLE OF CONTENTS

Chapter/Section	Page
CHAPTER 1 INTRODUCTION	1-1
SECTION I. INTRODUCTION	1-1
CHAPTER 2 AIRCRAFT AND SYSTEMS DESCRIPTION AND OPERATION	2-1
SECTION I. HELICOPTER	2-1
SECTION II. EMERGENCY EQUIPMENT	2-1
SECTION III. ENGINES AND RELATED SYSTEMS	2-1
SECTION IV. FUEL SYSTEM	2-1

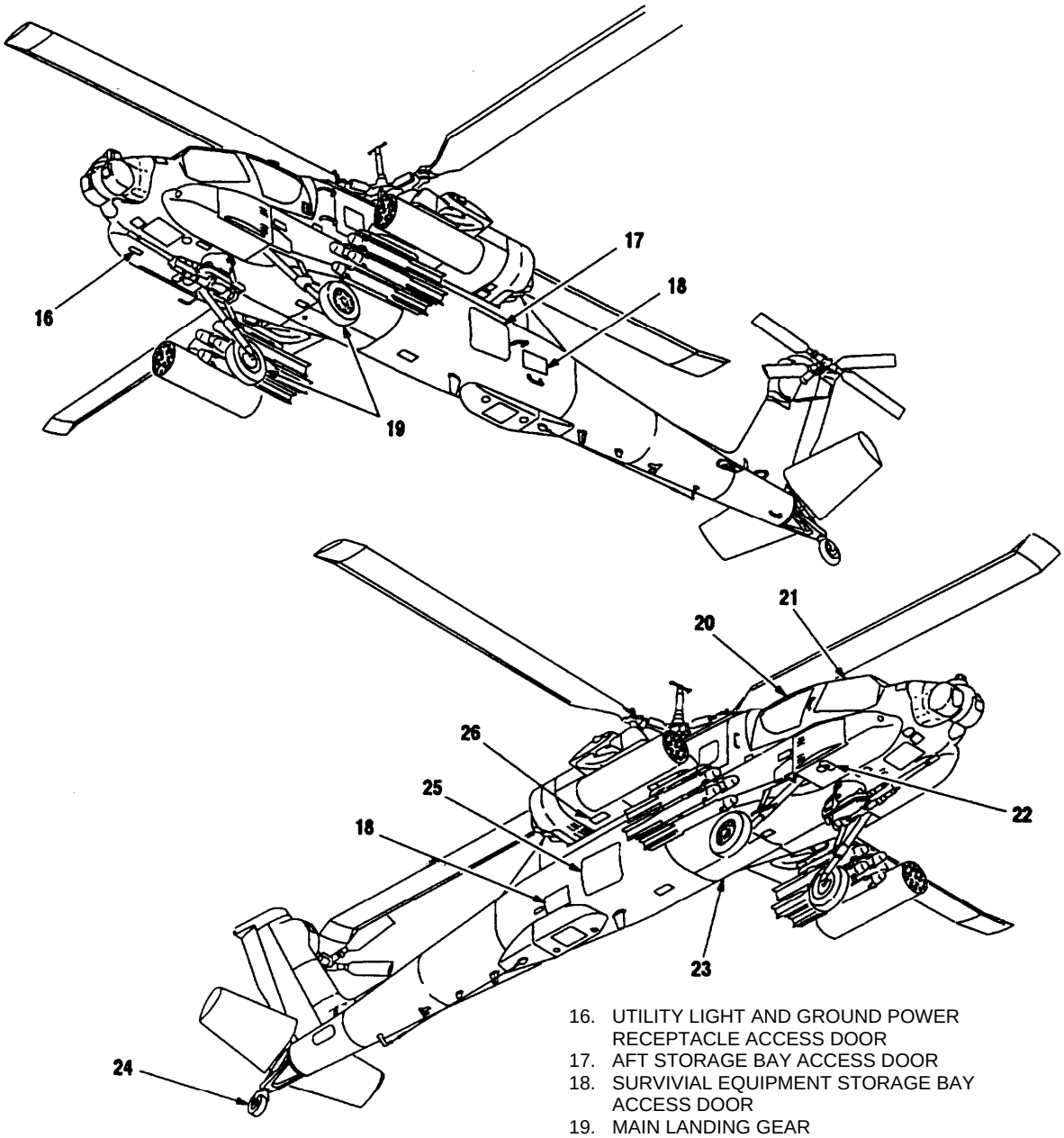
i

FIGURE 5. Abbreviated title page w/table of contents



1. STABILATOR
2. VERTICAL STABILIZER
3. AIR DATA SENSOR
4. TADS & PNVS TURRETS
5. CANOPY JETTISON HANDLE DOOR ACCESS DOOR
6. FORWARD AVIONICS BAY ACCESS DOOR
7. MOORING LUG ACCESS DOOR
8. FIRE EXTINGUISHER ACCESS DOOR
9. INTERCOMM ACCESS DOOR
10. MAIN TRANSMISSION OIL LEVEL SIGHT GAGE ACCESS DOOR
11. AFT EQUIPMENT BAY (CATWALK AREA) ACCESS DOORS
12. HYDRQULIC GROUND SERVICE PANEL ACCESS DOOR
13. HYDRAULIC OIL LEVEL SIGHT GAGE ACCESS DOOR
14. INFRARED COUNTERMEASURE DEVICE MOUNT
15. CHAFF PAYLOAD MODULE MOUNT

FIGURE 6. Aircraft general arrangement diagram (sheet 1 of 2)



16. UTILITY LIGHT AND GROUND POWER RECEPTACLE ACCESS DOOR
17. AFT STORAGE BAY ACCESS DOOR
18. SURVIVIAL EQUIPMENT STORAGE BAY ACCESS DOOR
19. MAIN LANDING GEAR
20. PILOT DOOR
21. CPG DOOR
22. SEARCHLIGHT
23. AMMUNITION BAY ACCESS DOOR
24. TAIL LANDING GEAR
25. AFT AVIONICS BAY ACCESS DOOR
26. APU OIL LEVEL SIGHT GAGE ACCESS DOOR

FIGURE 6. Aircraft general arrangement diagram (sheet 2 of 2)

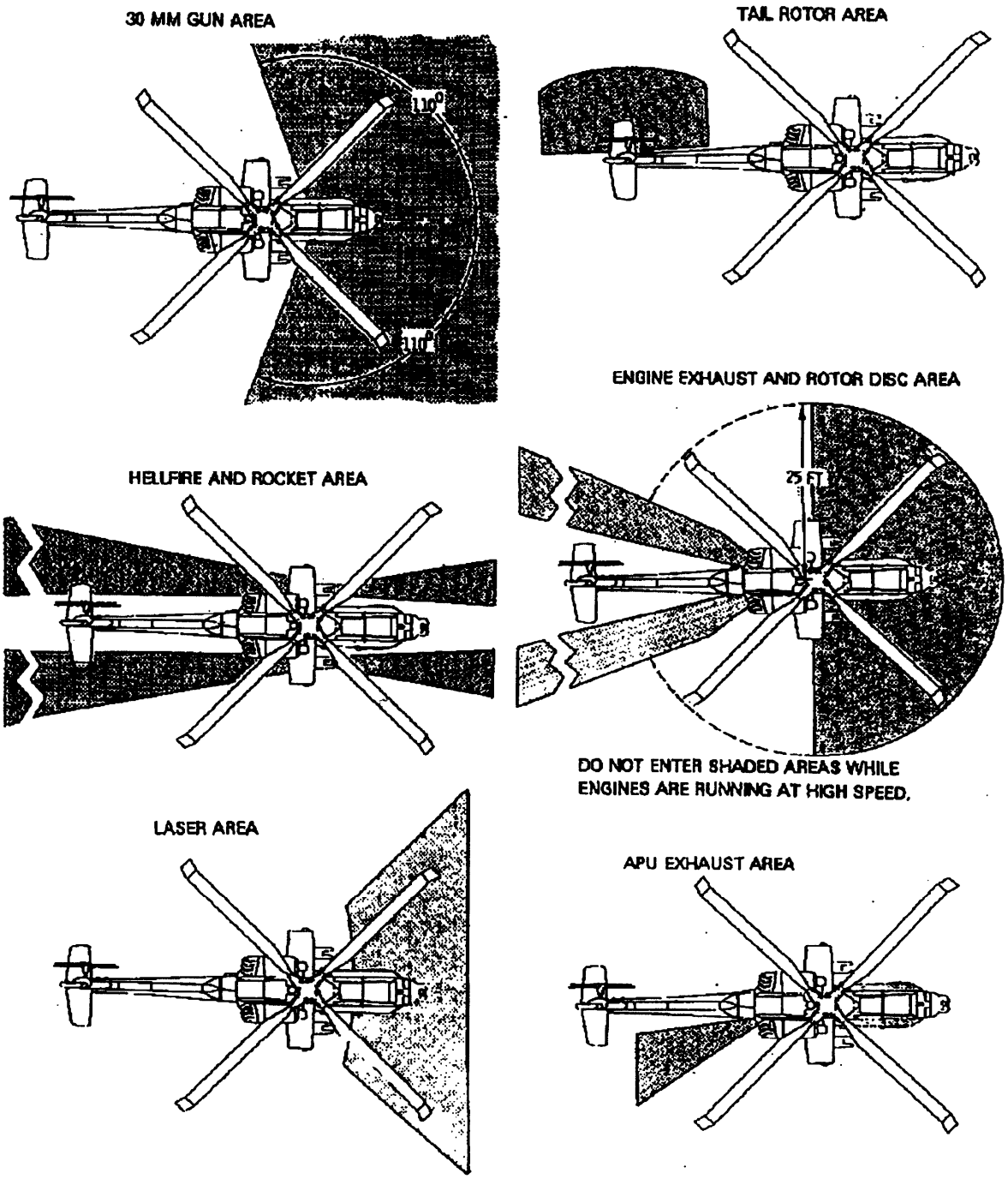


FIGURE 7. Example of danger area diagram

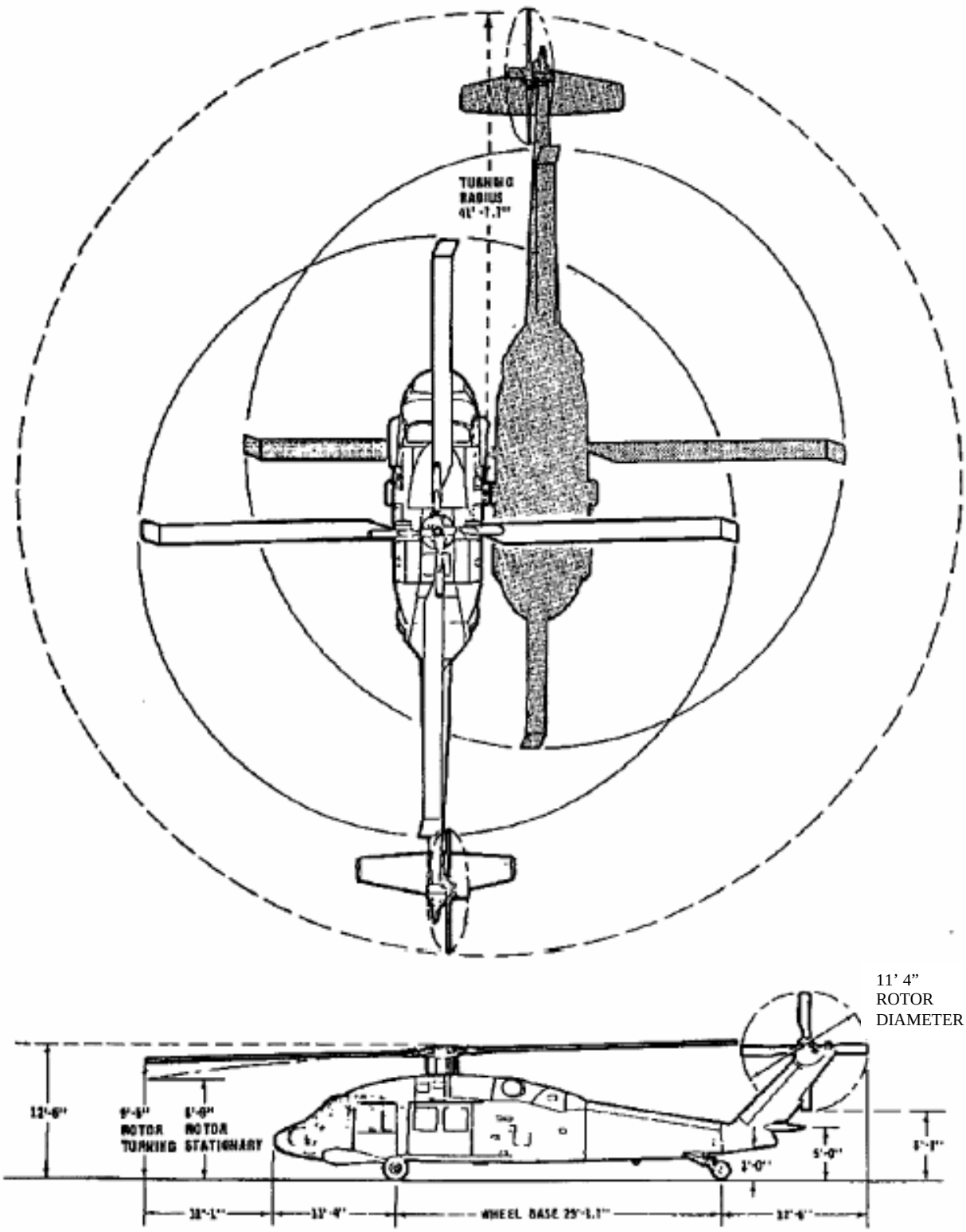
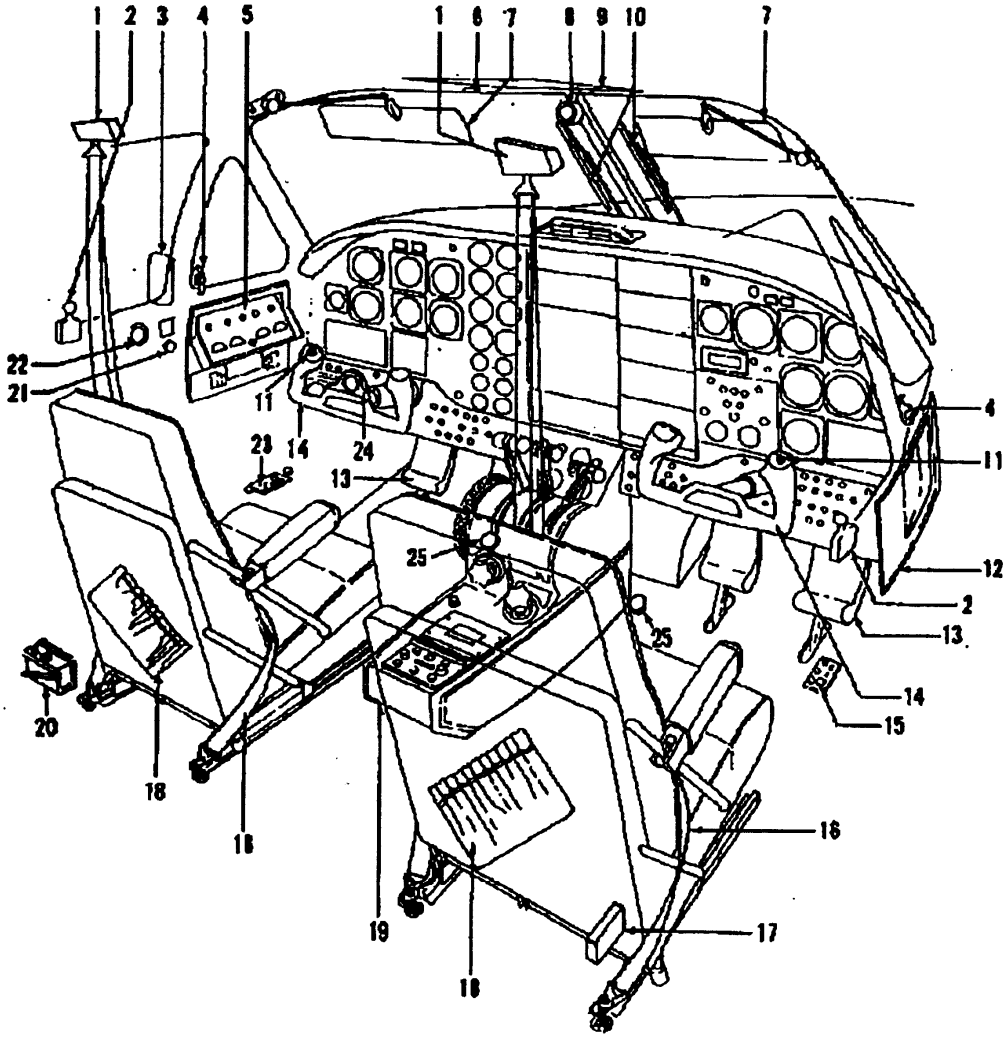


FIGURE 8. Example of turning radius and dimensions diagram

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 8 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 quality 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 panel 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 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



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. Copilots'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

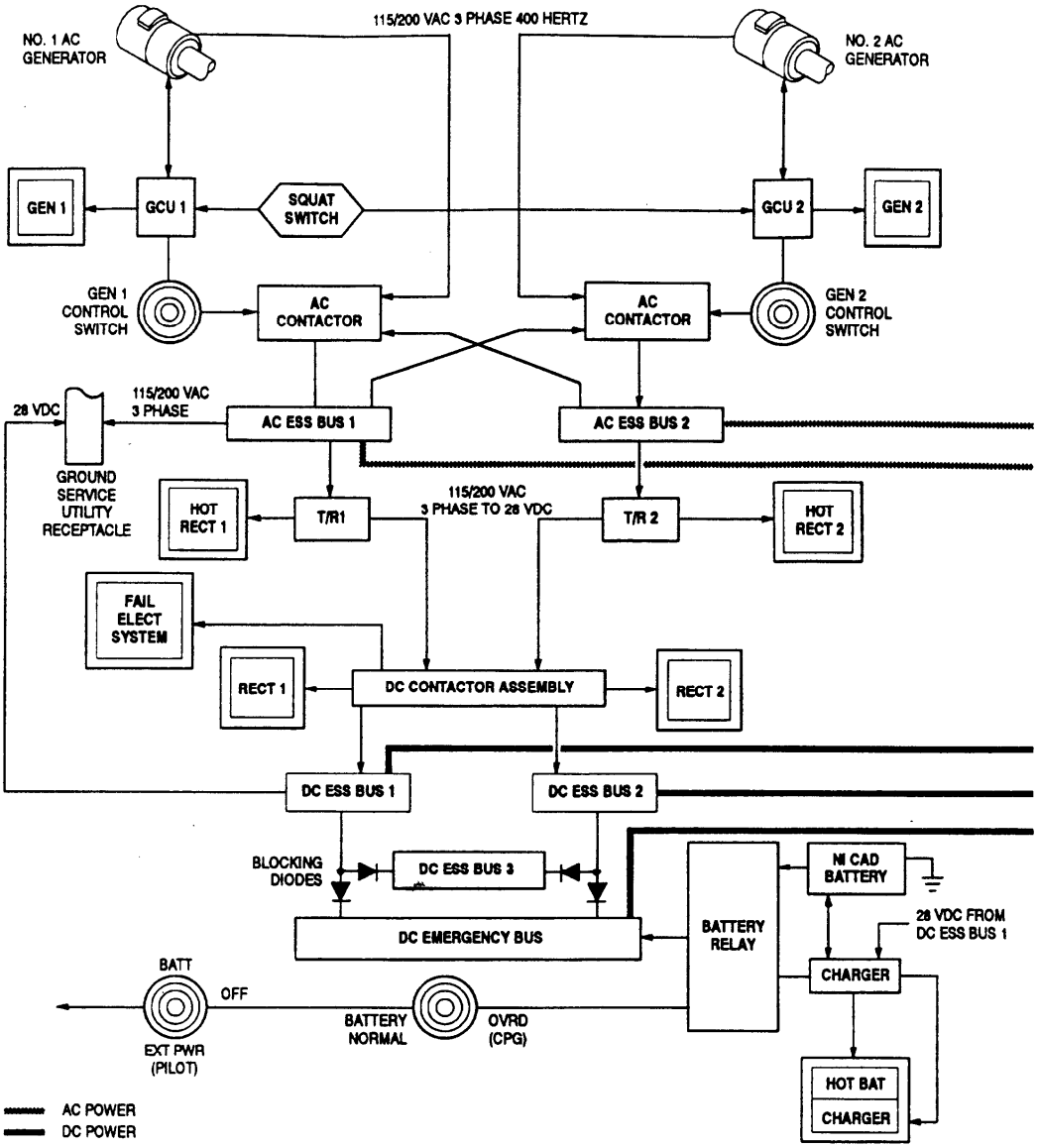


FIGURE 11. Example of electrical power supply and distribution system (sheet 1 of 2)

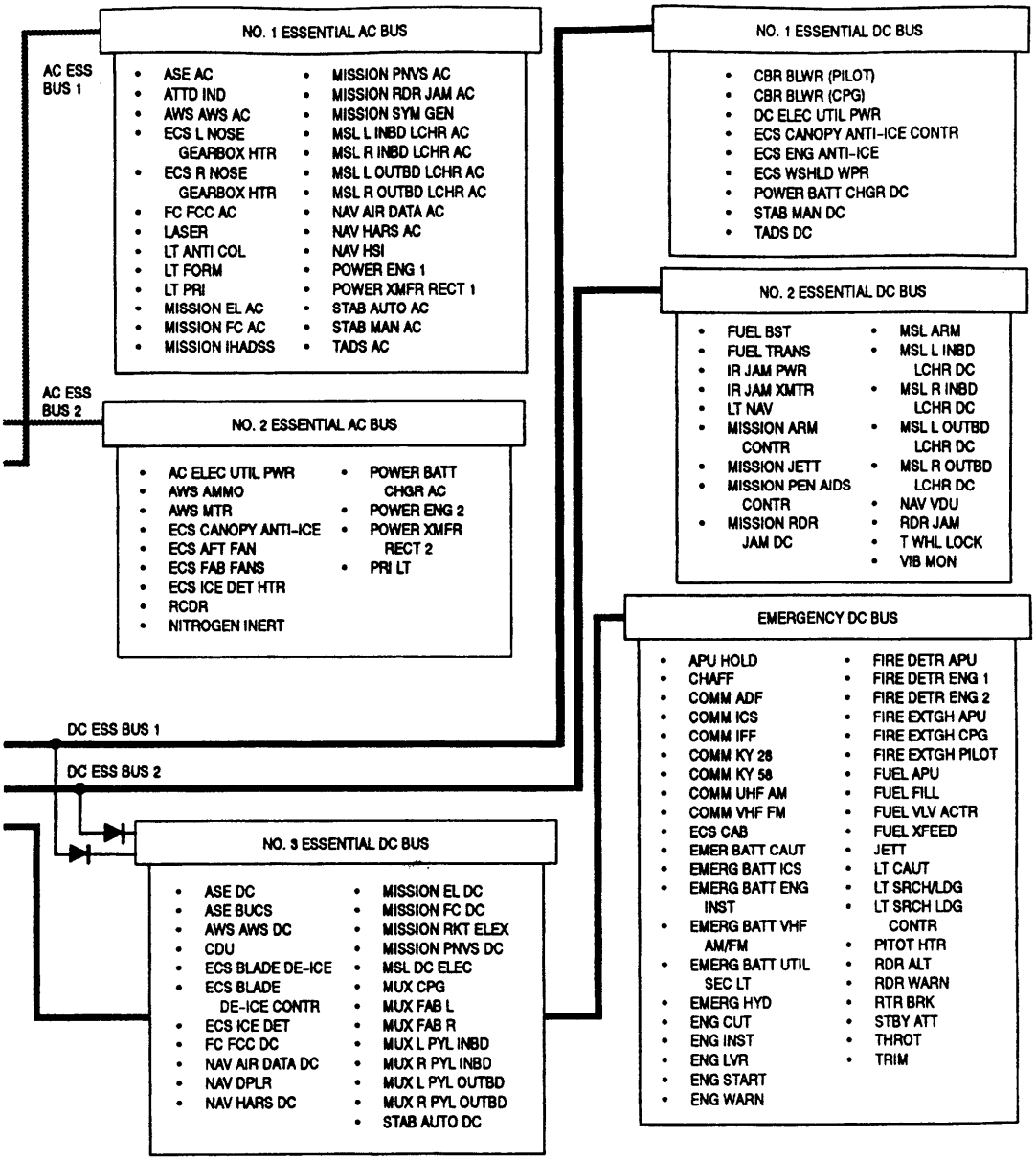
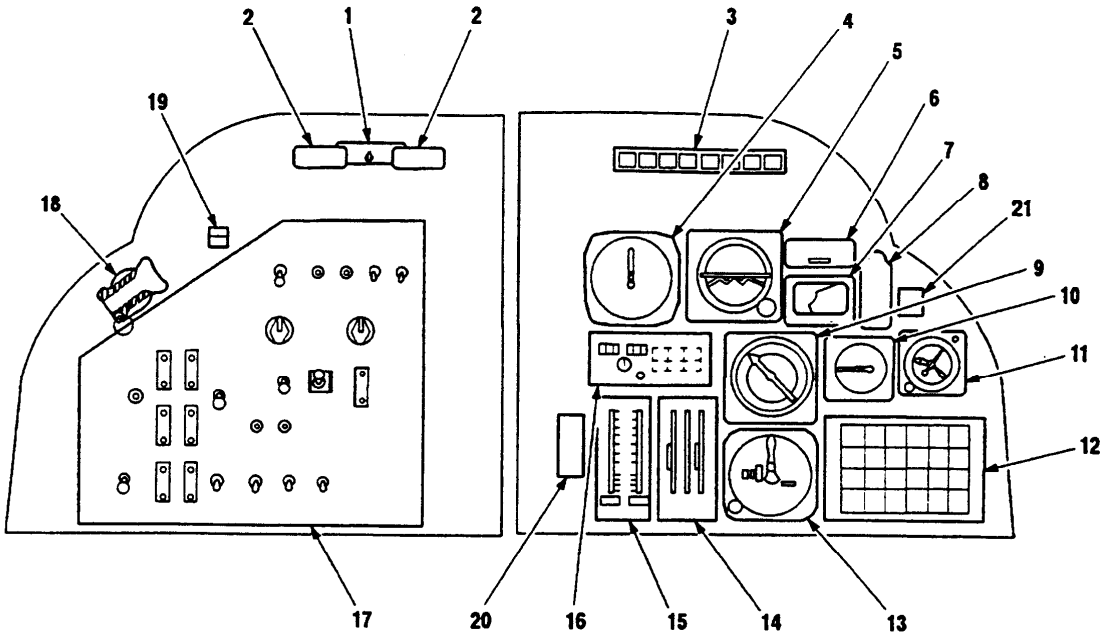
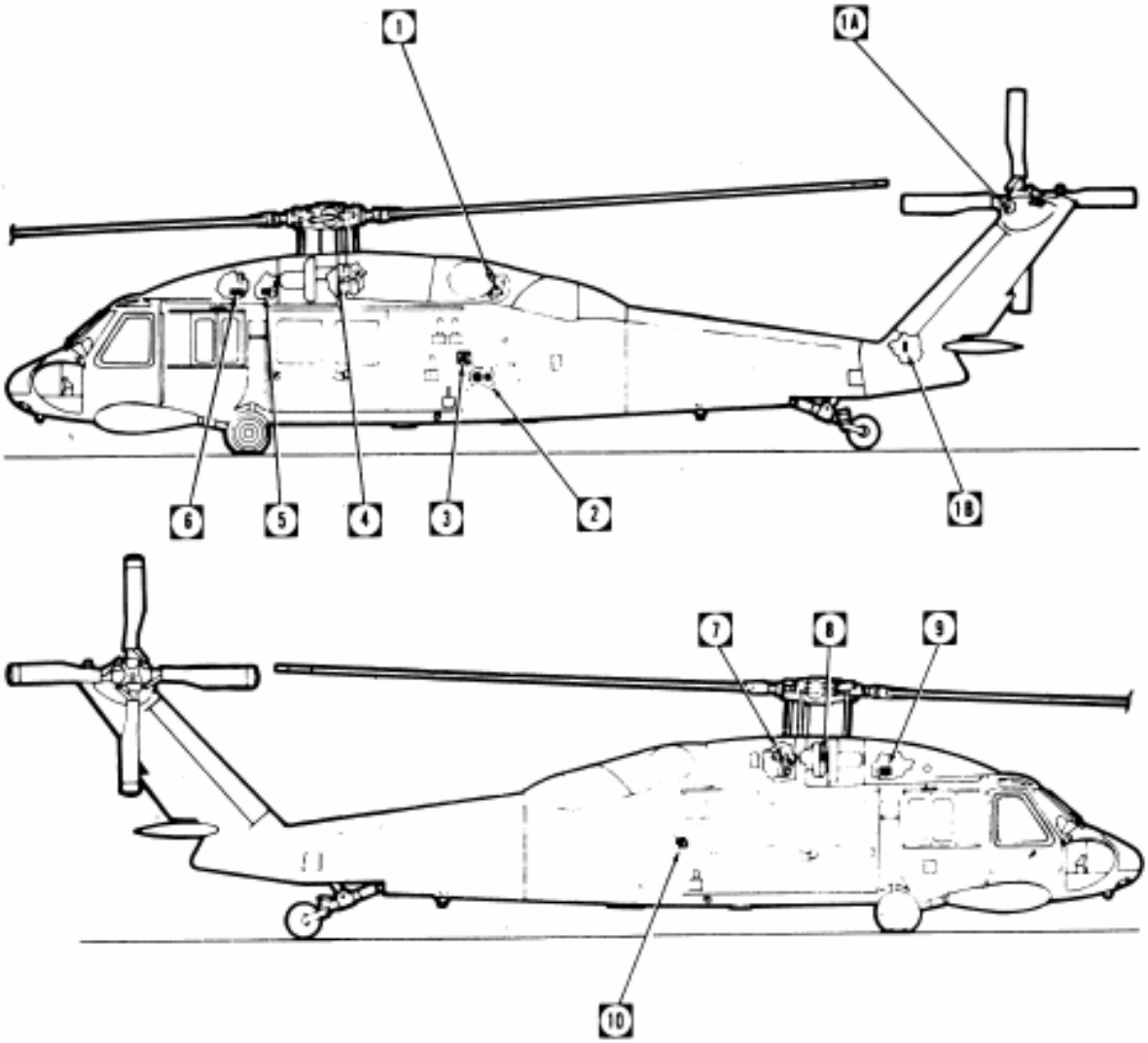


FIGURE 11. Example of electrical power supply and distribution system (sheet 2 of 2)



1. FIRE EXTINGUISHER BOTTLE SELECT SWITCH
2. ENGINE FIRE PULL HANDLES
3. MASTER CONTROL WARNING PANEL
4. AIRSPEED INDICATOR
5. REMOTE ATTITUDE INDICATOR
6. RADIO CALL PLACARD
7. STABILITOR POSITION INDICATOR
8. STABILATOR / AIRSPEED PLACARD
9. RADIO MAGNET INDICATOR (RMI)
10. VERTICAL SPEED INDICATOR (VSI)
11. CLOCK
12. CAUTION / WARNING PANEL
13. BAROMETRIC ALTIMETER
14. ENGINE ROTOR INDICATOR
15. ENGINE TORQUE INDICATOR
16. SELECTABLE DIGITAL DISPLAY PANEL
17. FIRE CONTROL PANEL
18. CANOPY JETTISON HANDLE
19. ARM SAFE INDICATOR
20. ENGINE INSTRUMENT DIM / TEST PANEL
21. FUEL TRANSFER INDICATOR (UNMODIFIED CAUTION / WARNING PANEL)

FIGURE 12. Instrument panel



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 REFULE PORT

FIGURE 13. Servicing diagram (sheet 1 of 2)

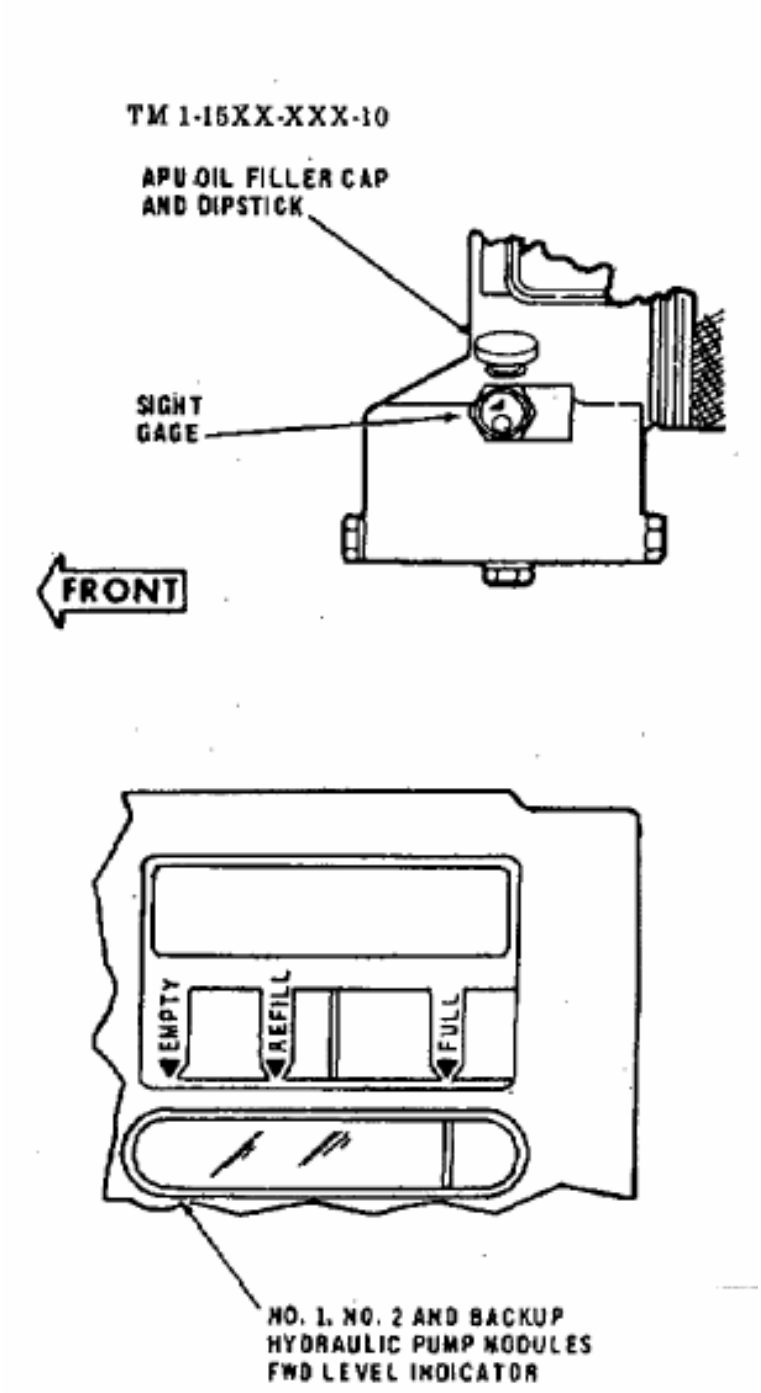


FIGURE 13. Servicing diagram (sheet 2 of 2)

Servicing Table of Approved Fuels, Oils, and Fluids

System	Specification	
Fuel……	MIL-DTL-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-PRF-23699	3, 4
	*MIL-PRF-7808	2, 4
Transmission……	**MIL-PRF-23699	3, 4
	*MIL-PRF-7808	2, 4
42° Gearbox……...	**MIL-PRF-23699	3, 4
	*MIL-PRF-7808	2, 4
90° Gearbox……	**MIL-PRF-23699	3, 4
	*MIL-PRF-7808	2, 4
Hydraulic System……	MIL-PRF-83282	5
Main Rotor Grip……	A-A-52039	6, 7
	**MIL-PRF-23699	3, 4, 6
	*MIL-PRF-7808	2, 4
	MIL-PRF-2104	6, 7
	MIL-PRF-46167	6, 7
Pillow Block Oil……...	**MIL-PRF-23699	3, 4
	*MIL-PRF-7808	2, 4
	MIL-PRF-2104	6, 7
	A-A-52039	6, 7
	MIL-PRF-46167	6, 7

FOOTNOTES

1 Army Standard fuel is MIL-DTL-5624 (JP-4) NATO code is F-40. Alternate fuels are MIL-DTL-5624 (JP-5) (NATO F-44) and MIL-DTL-83133 (JP-8) (NATO F-34). Emergency fuel is ASTM D910 (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-PRF-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-PRF-7808 NATO code is 0-148. For use in ambient temperatures below minus 32°C/25°F. May be used when MIL-PRF-23699 oil is not available. Not for use in main rotor hub P/N 204-012-101-31.

CAUTION

** Under no circumstances shall MIL-PRF-23699 oil be used in ambient temperatures below minus 32°C/25°F. 3 MIL-PRF-23699 NATO code is 0-156. For use in ambient temperature above minus 32°C/25°F. Not for use in main rotor hub P/N 204 –102-101-31.

4 Do not mix MIL-PRF-2104, A-A-52039, MIL-PRF-46167, MIL-PRF-23699, and for MIL-PRF-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.

5 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 is swallowed, do not induce vomiting, get immediate medical attention. When fluid is decomposed by heating, toxic gases are released.

6 Refer to stencil on grip assembly to determine proper lubrication requirements.

7 MIL-PRF-2104, A-A-52039, and MIL-PRF-46167 must be used in hub P/N 204-012-101-31as follows.

Average Temp Range	Specification
+ 5°C and above……..	MIL-PRF-2104, Grade 40 NATO Code 0-230
-18°C to +5 °C……	MIL-PRF-2104, Grade 30 NATO Code, 0-230 or A-A-52039, Grade 30
-29 ° to -18°C…….	MIL-PRF-2104, Grade 10 NATO Code, 0-230 or A-A-52039, Grade 10W30
-54 ° to -20°C ……	MIL-PRF-46167, DEXRON II Automatic transmission fluid.

Approved domestic commercial fuels (spec. ASTM D-1655-70):
Manufactures designation –

Jet B-JP4	Jet A-JP5 Type	Jet A-1-JPS 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.
	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	Mobile Jet A-1
Philjet JP-4	Philjet A-50	
Aeroshell JP	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	JP4 MIL-DTL-5624	
France	Air 3407A	
Germany	VTL-9130-006	UTL 9130-007/UTL 9130-010
Greece	JP-4 MIL-DTL-5624	
Italy	AA-M-C-1421	AMC-143
Netherlands	JP-4 MIL-DTL-5624	D. Eng Rd 2493
Norway	JP-4 MIL-DTL-5624	
Portugal	JP-4 MIL-DTL-5624	
Turkey	JP-4 MIL-DTL-5624	
United Kingdom (Britain)	D. Eng. Rd 2454	E. Eng Rd 2498

FIGURE 14. Example of table of approved fuels, oils, and fluids (sheet 1 of 2)

NOTE: Anti-icing and Biocidal Additive for Commercial Turbine Engine Fuel – The fuel system icing inhibitor shall conform to ASTM D 4171. The additive provides anti-icing protection and also functions as a biocide to kill microbial growths in helicopter fuel systems. Icing inhibitors conforming to ASTM D 4171 shall be added to commercial fuel, not contaminating an icing inhibitor, during refueling operations, regardless of ambient temperatures. Refueling operations shall be accomplished in accordance with accepted commercial procedures.

Approved domestic commercial oils for MIL-PRF-7808: Manufacturers designation –
PQ Turbine Oil 8365
ESSO/ENCO Turbo Oil 2389
RM-184A/RM-201A

CAUTION

Do not use Shell Oil Co., part No. 37, qualification No. 7D-1 oil (MIL-PRF-7808). It can be harmful to seals made of silicone.

Approved domestic oils for MIL-PRF-23699: Manufacturer 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

FIGURE 14. Example of table of approved fuels, oils, and fluids (sheet 2 of 2)

TM 1-XXXX-XXX-10

Table 4-21. Dispenser Control Panel/Indicator Functions

Control/ Indicator	Position	Function
CHAFF counter		Displays the number of chaff cartridges remaining in the payload module.
CHAFF counter knob		Adjust counter to correspond to number of chaff cartridges loaded in payload module.
ARM light		Indicates that the ARM/SAFE switch is at ARM, safety flag pin is removed, and payload module is armed.
ARM/ SAFE switch	ARM	Applies electrical power through safety flag switch to cyclic WAS for firing.
	SAFE	Removes power from dispenser subsystem.
MODE selector	MAN	Dispense one chaff cartridge each time the WAS chaff position is toggled.
	PGRM	Allows setting electronic module controls before flight to automatically dispense chaff according to predetermined number of chaff cartridge per burst and number of salvos.

FIGURE 15. Example of control and indicator standard table

TM 1-XXXX-XXX-10

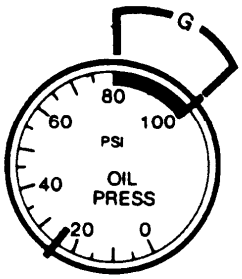
Table 4-21. Dispenser Control Panel/Indicator Functions

Control/ Indicator	Position	Function
CHAFF counter		Displays the number of chaff cartridges remaining in the payload module.
CHAFF counter knob		Adjust counter to correspond to number of chaff cartridges loaded in payload module.
ARM light		Indicates that the ARM/SAFE switch is at ARM, safety flag pin is removed, and payload module is armed.
ARM/ SAFE switch	ARM	Applies electrical power through safety flag switch to cyclic WAS for firing.
	SAFE	Removes power from dispenser subsystem.
MODE selector	MAN	Dispense one chaff cartridge each time the WAS chaff position is toggled.
	PGRM	Allows setting electronic module controls before flight to automatically dispense chaff according to predetermined number of chaff cartridge per burst and number of salvos.

FIGURE 16. Example of control display unit standard table

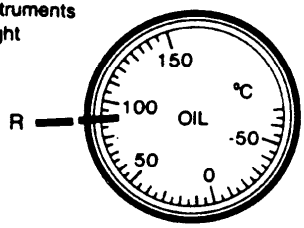
COLOR MARKING CODES

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



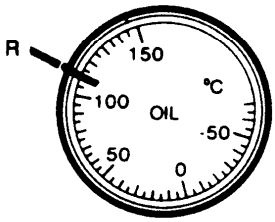
ENGINE OIL PRESSURE

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



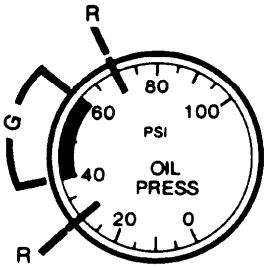
ENGINE OIL TEMPERATURE

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



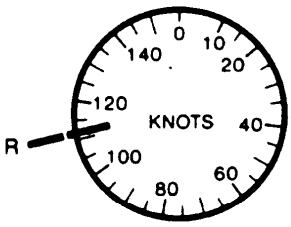
TRANSMISSION OIL TEMPERATURE

R 110°C Maximum



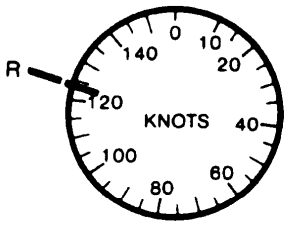
TRANSMISSION OIL PRESSURE

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



AIRSPEED
NOSE MOUNTED PITOT TUBE

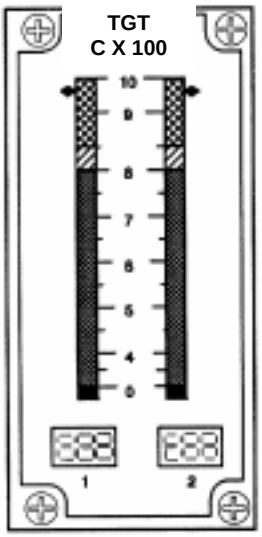
R 112 Knots Maximum
Refer to Figure 5-2, Airspeed Operating Limits for Additional Limitations.



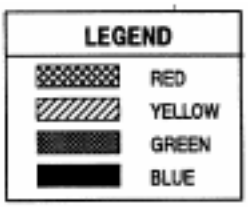
AIRSPEED
ROOF MOUNTED PITOT TUBE

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

FIGURE 17. Example of instrument/display operating ranges and markings (sheet 1 of 2)



NOTE:
LIMITS BASED ON
INDICATED TGT

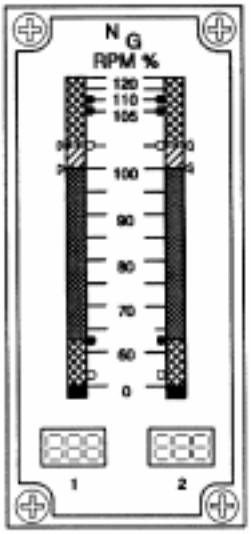


701 ENGINE TURBINE GAS TEMPERATURE (TGT °C)

	LIMITS	
RED	950	MAXIMUM
RED	917 – 950	TRANSIENT (12 SECONDS)
RED	867 – 917	SINGLE ENGINE CONTINGENCY (2.5 MINUTE LIMIT)
RED	867	AUTOMATIC DUAL ENGINE TGT LIMITING
YELLOW	852	MAXIMUM DURING START
YELLOW	805 – 887	IRP (30 MINUTES)
GREEN	805	MCP
GREEN	0 – 805	NORMAL OPERATION
BLUE		INSTRUMENT POWER ON

701C ENGINE TURBINE GAS TEMPERATURE (TGT °C)

	LIMITS	
RED	950	MAXIMUM
RED	904 – 950	TRANSIENT (12 SECONDS)
RED	867 – 904	SINGLE ENGINE CONTINGENCY (2.5 MINUTE LIMIT)
RED	867	AUTOMATIC DUAL ENGINE TGT LIMITING
YELLOW	852	MAXIMUM DURING START
YELLOW	852 – 867	IRP (30 MINUTES)
YELLOW	805 – 852	IRP (30 MINUTES)
GREEN	805	MCP
GREEN	0 – 805	NORMAL OPERATION
BLUE		INSTRUMENT POWER ON



ENGINE GAS GENERATOR SPEED (N_G) (RPM%)

		LIMITS	
RED	UPPER	102 – 105	TRANSIENT 12 SECOND MAXIMUM
YELLOW		99 – 102	30 MINUTE LIMIT
GREEN		63 – 99	NORMAL OPERATION
RED	LOWER	63	MINUMUM ENGINE OUT WARNING LIGHT SET AT THIS VALUE
BLUE			INSTRUMENT POWER ON
RED			BEGINNING OF A RED RANGE (FROM A OPERATING REFERENCE)
YELLOW			BEGINNING OF A YELLOW RANGE (FROM A NORMAL OPERATING RANGE)

FIGURE 17. Example of instrument/display operating ranges and markings (sheet 2 of 2)

AIRSPEED OPERATING LIMITS

EXAMPLE

WANTED

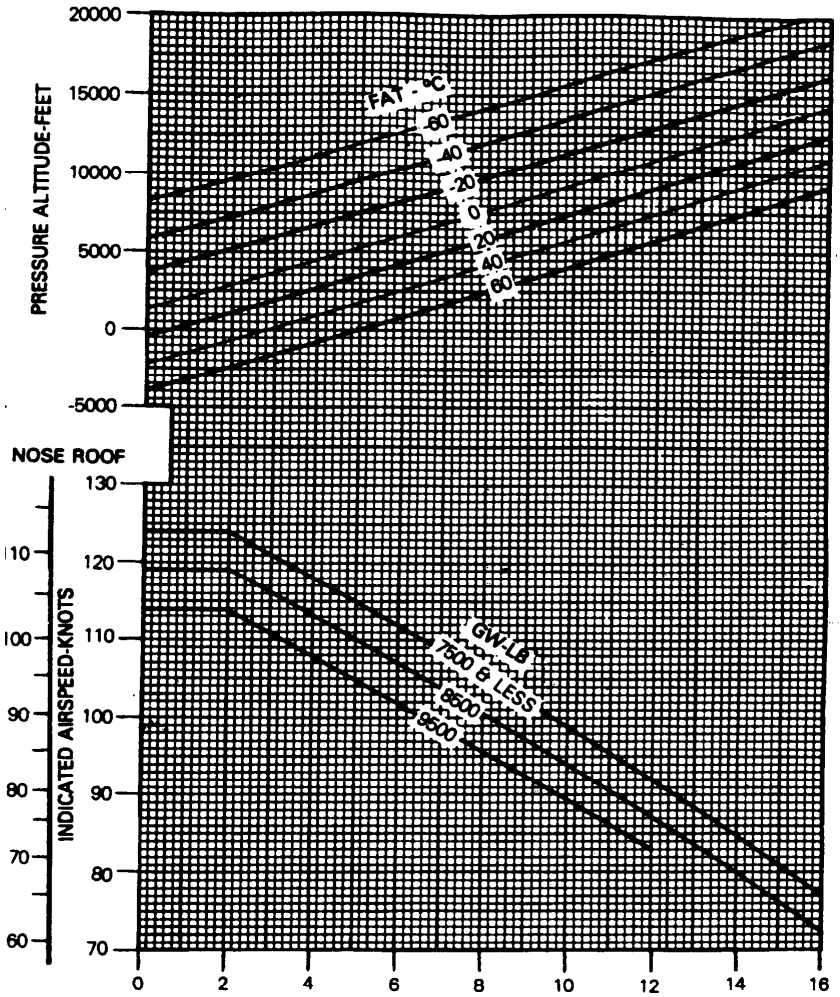
INDICATED AIRSPEED AND DENSITY ALTITUDE

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

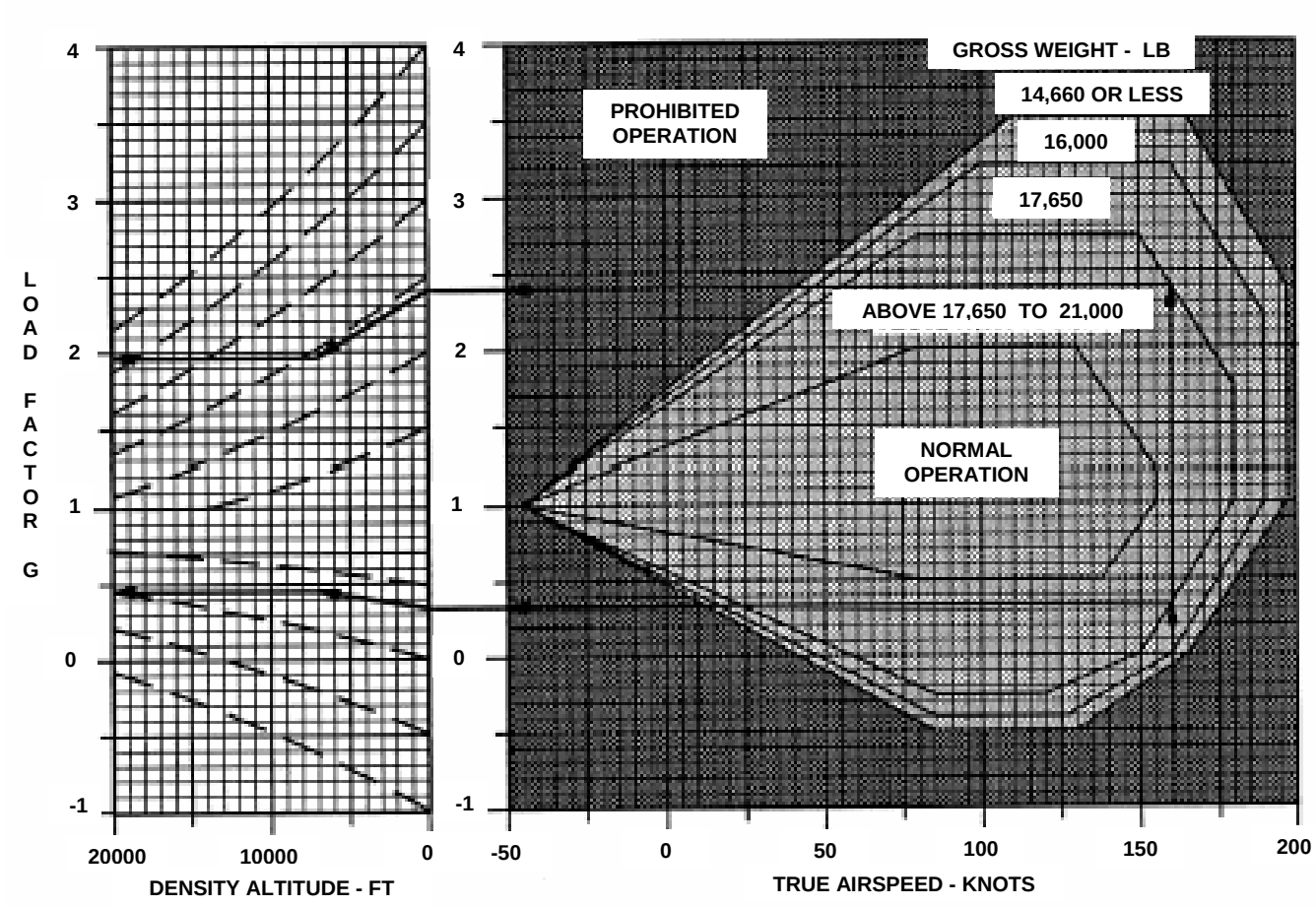


DENSITY ALTITUDE – 1000 FEET

DATA BASIS: DERIVED FROM FLIGHT TEST

FIGURE 18. Airspeed operating limits chart

FLIGHT ENVELOPE



EXAMPLE

WANTED

MAXIMUM AND MINIMUM LOAD FACTOR

KNOWN

GROSS WEIGHT = 17,650 POUNDS
DENSITY ALTITUDE = 7000 FEET
AIRSPEED = 160 KTAS

METHOD

ENTER AT V = 160 KT. MOVE UP TO UPPER AND LOWER ENVELOPE BOUNDARIES FOR GROSS WEIGHT = 17,650 POUNDS
MOVE LEFT TO DENSITY ALTITUDE OF ZERO FEET
SLIDE TO LEFT ALONG DASHED LINES TO 7000 FEET DENSITY ALTIDUE
MOVE LEFT TO LOAD FACTOR SCALE, READ MAX G = 1.96, MIN G = 0.46

FIGURE 19. Flight envelope chart

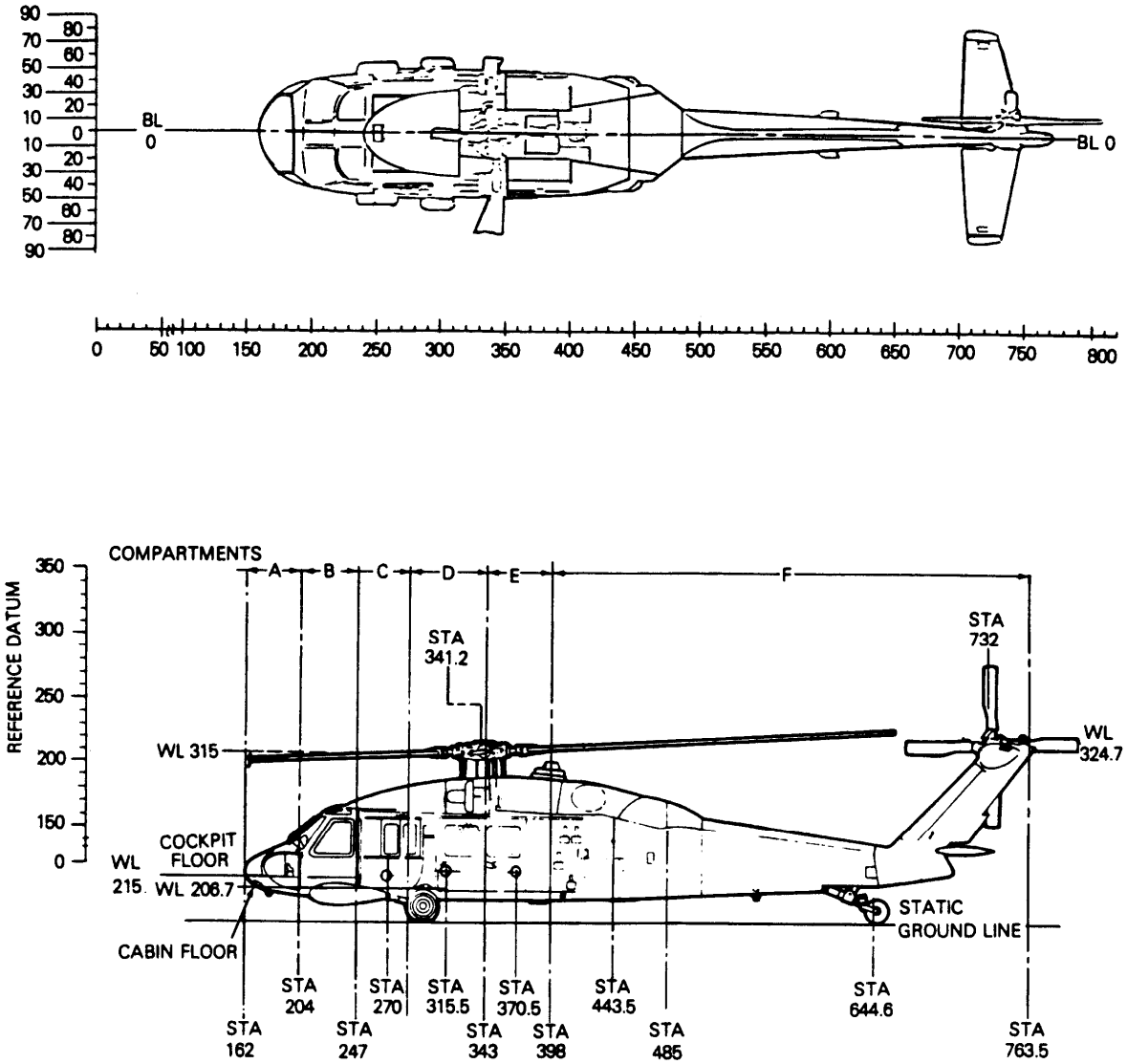
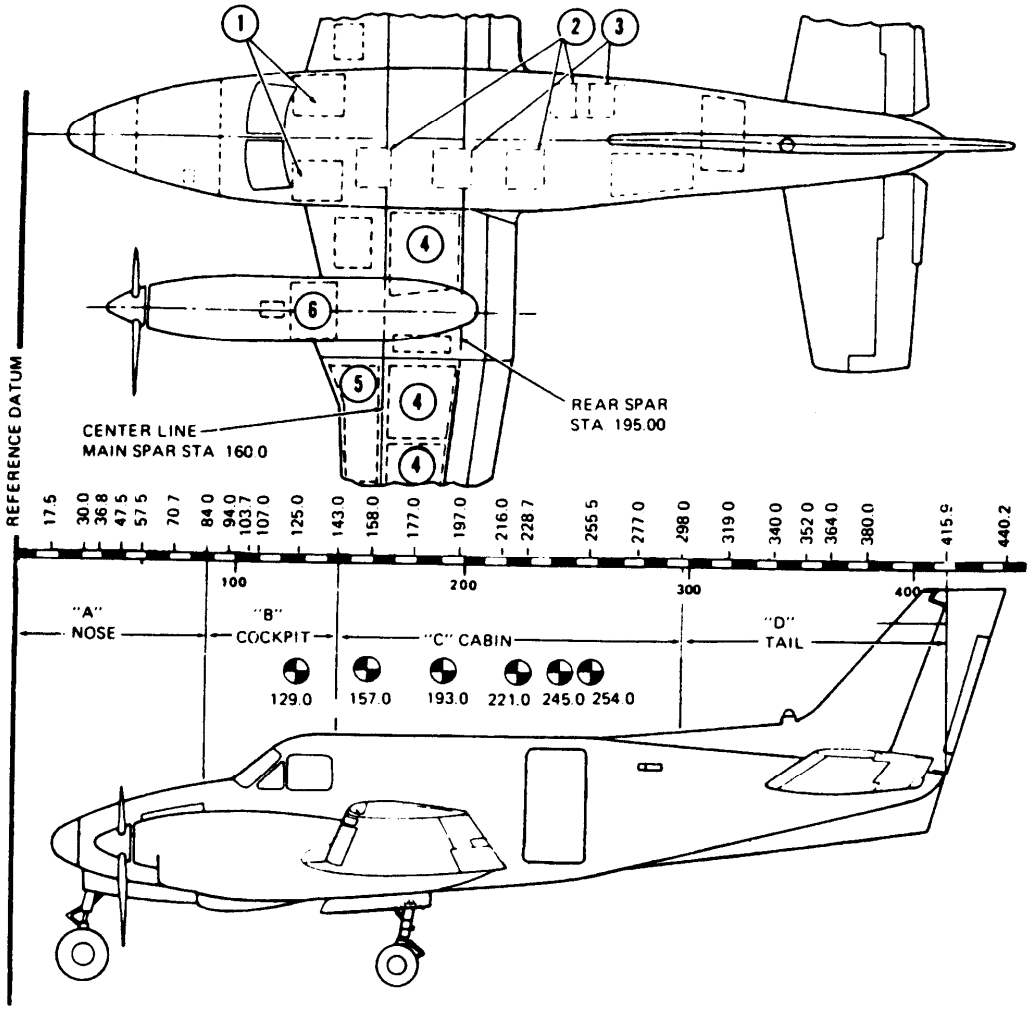


FIGURE 20. Aircraft compartments and stations (sheet 1 of 2)



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 Tanks

Denotes Seating Centroids

FIGURE 20. Aircraft compartments and stations (sheet 2 of 2)

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

ITEM	STA	WEIGHT LBS	MOM/1000
230–GALLON TANK (IB OR OB)	321	150	48
450–GALLON TANK (IB)	316	234	74

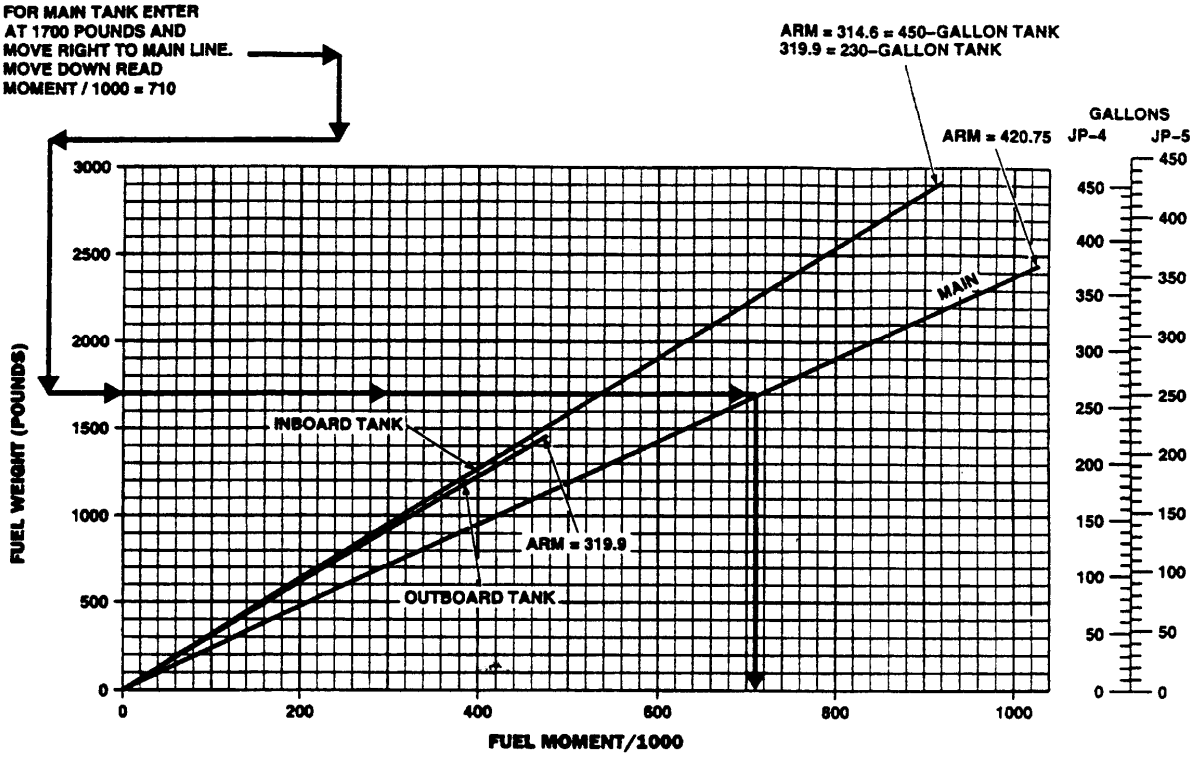
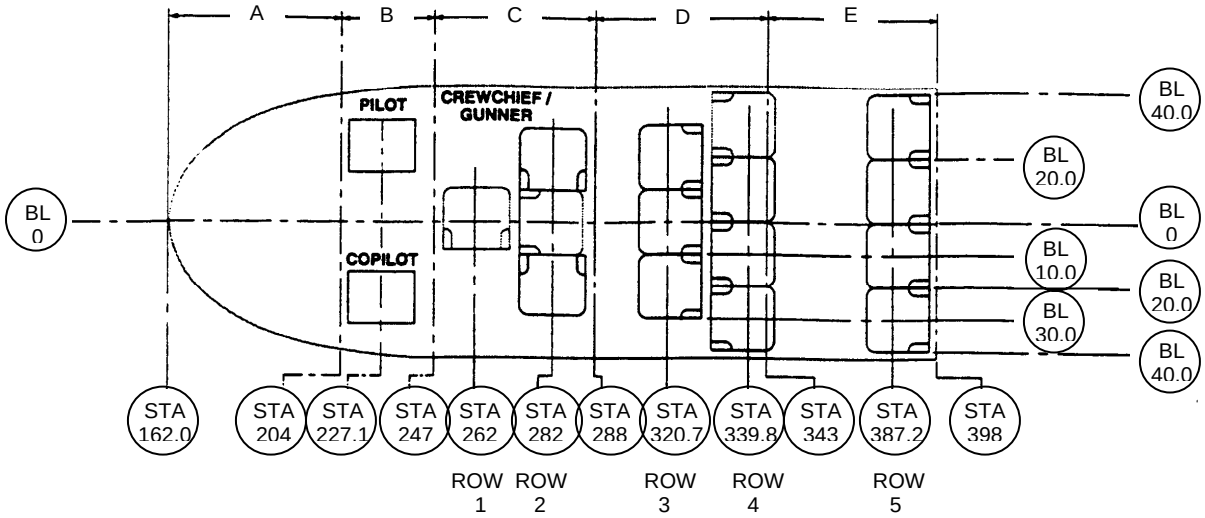


FIGURE 21. Fuel moment chart

PERSONNEL MOMENTS



SEAT WEIGHT – AND MOMENT TABLE*

ITEM	ROW	WEIGHT	MOM / 1000
CREWCHIEF / GUNNER (2) TROOPS (3) TROOPS (3) TROOPS (4)	2 3 4 5	43 48 48 63	12 15 16 25
TOTAL–12 SEATS		202	68
ALTERNATE SEATING (BROKEN LINES)			
FORWARD TROOP SEAT (1)	1	16	4
REAR FACING TROOP SEAT (1)	2	16	5
REAR FACING TROOP SEAT (1)	4	16	6
TOTAL–15 SEATS		250	83

*SEAT WEIGHT AND MOMENTS SHOULD BE INCLUDED ON CHART C

EXAMPLE

WANTED:

PESONNEL MOMENTS

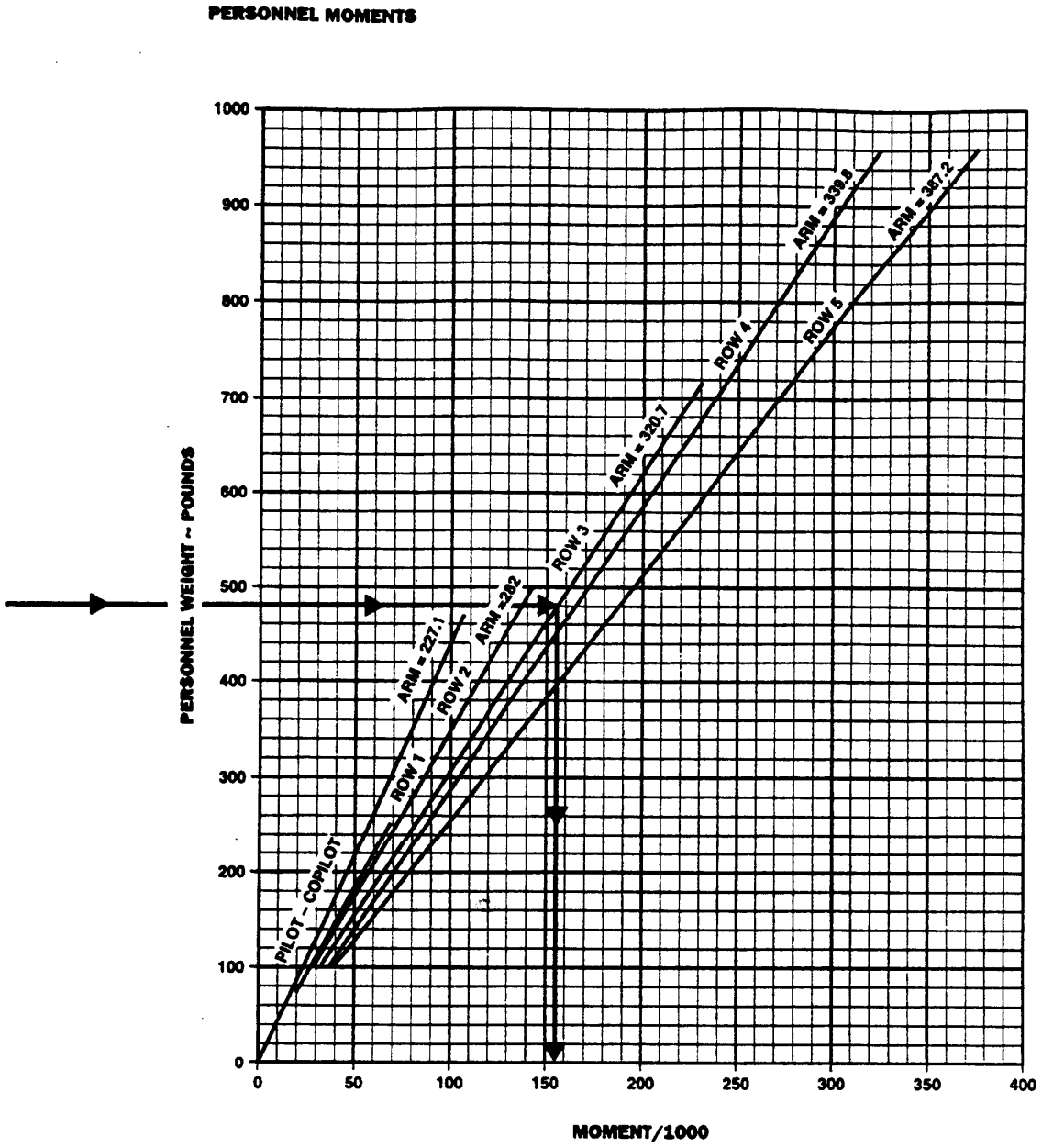
KNOWN:

2 PERSONNEL IN ROW 3
TOTAL WEIGHT 480 POUNDS

METHOD:

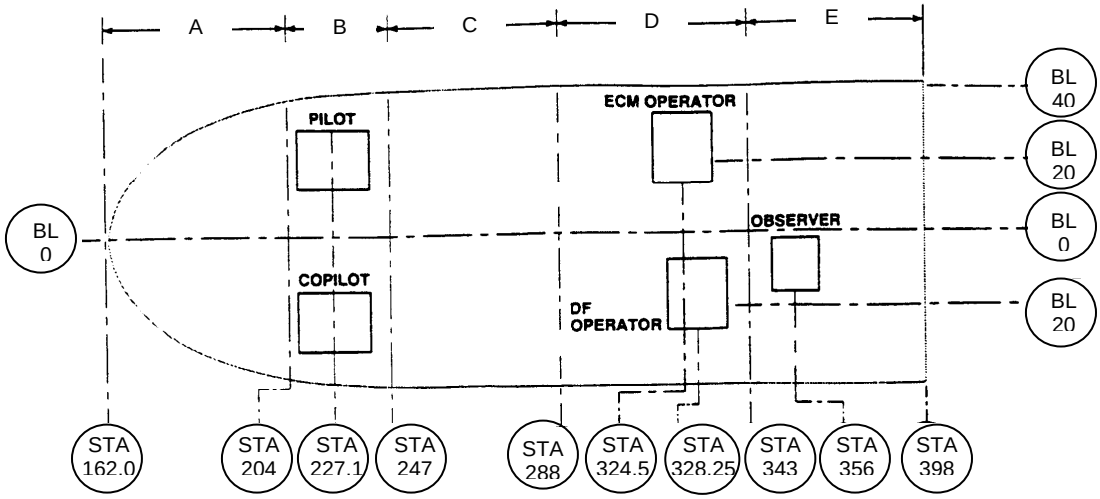
ENTER WEIGHT AT 480 POUNDS–MOVE RIGHT TO ROW 3.
MOVE DOWN. READ MOMENT / 1000=154

FIGURE 22. Personnel moments chart (sheet 1 of 3)



DATA BASIS: CALCULATED

FIGURE 22. Personnel moments chart (sheet 2 of 3)



* ITEM	STA	WEIGHT	MOM / 1000
OBSERVER SEAT	356.0	18	6
TOTAL – 1 SEAT	–	18	6

* SEAT WEIGHT AND MOMENTS SHOULD BE INCLUDED ON CHART C.

EXAMPLE

WANTED

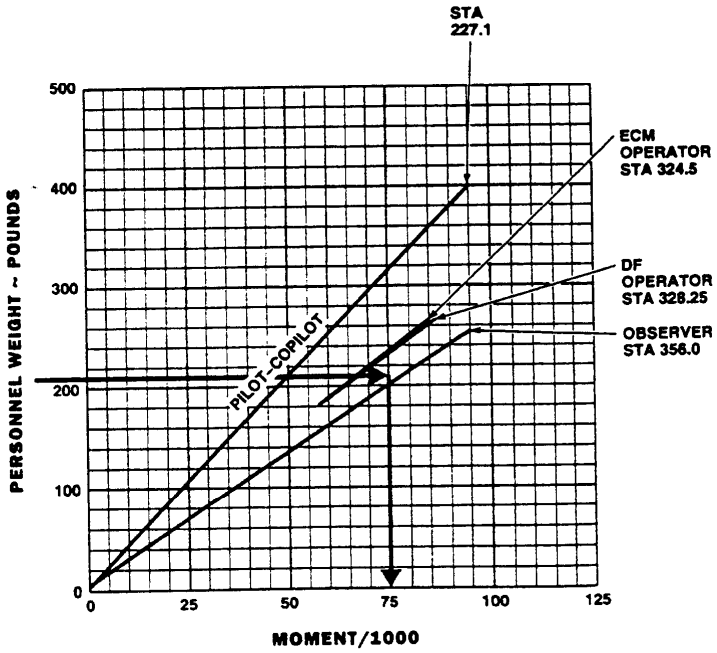
PERSONNEL MOMENTS

KNOWN

PERSONNEL AT STA 356
OBSERVER – 210 POUNDS

METHOD

ENTER WEIGHT AT 210 POUNDS – MOVE RIGHT TO OBSERVER ARC (STA 356.0) MOVE DOWN READ MOMENT / 1000 = 75



DATA BASIS: CALCULATED

FIGURE 22. Personnel moments chart (sheet 3 of 3)

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 Outboard Station 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 23. Armament loading data chart

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

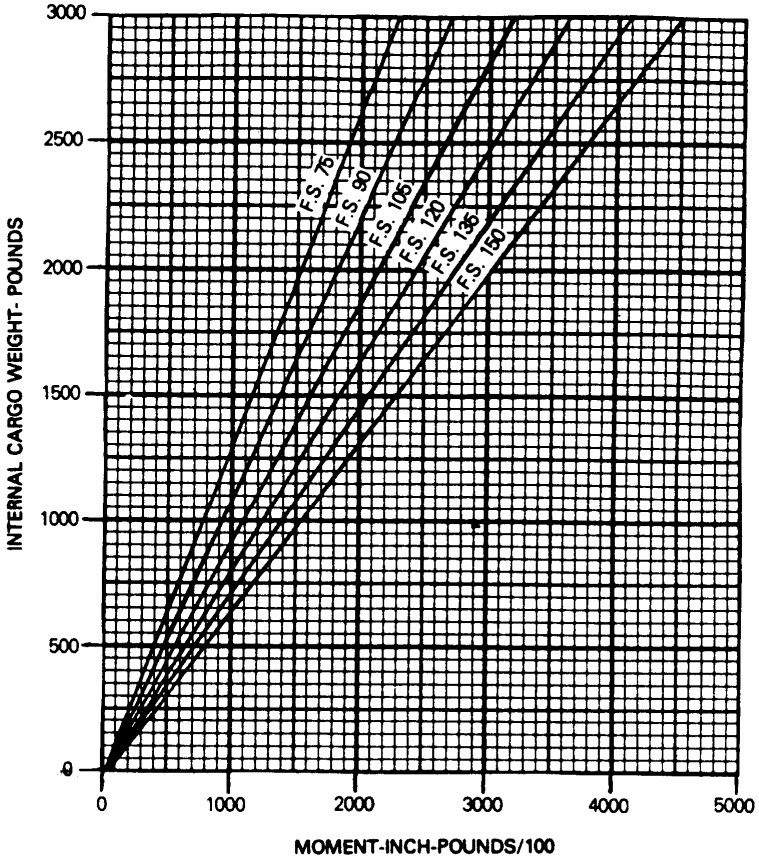


FIGURE 24. Cargo moments chart

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.

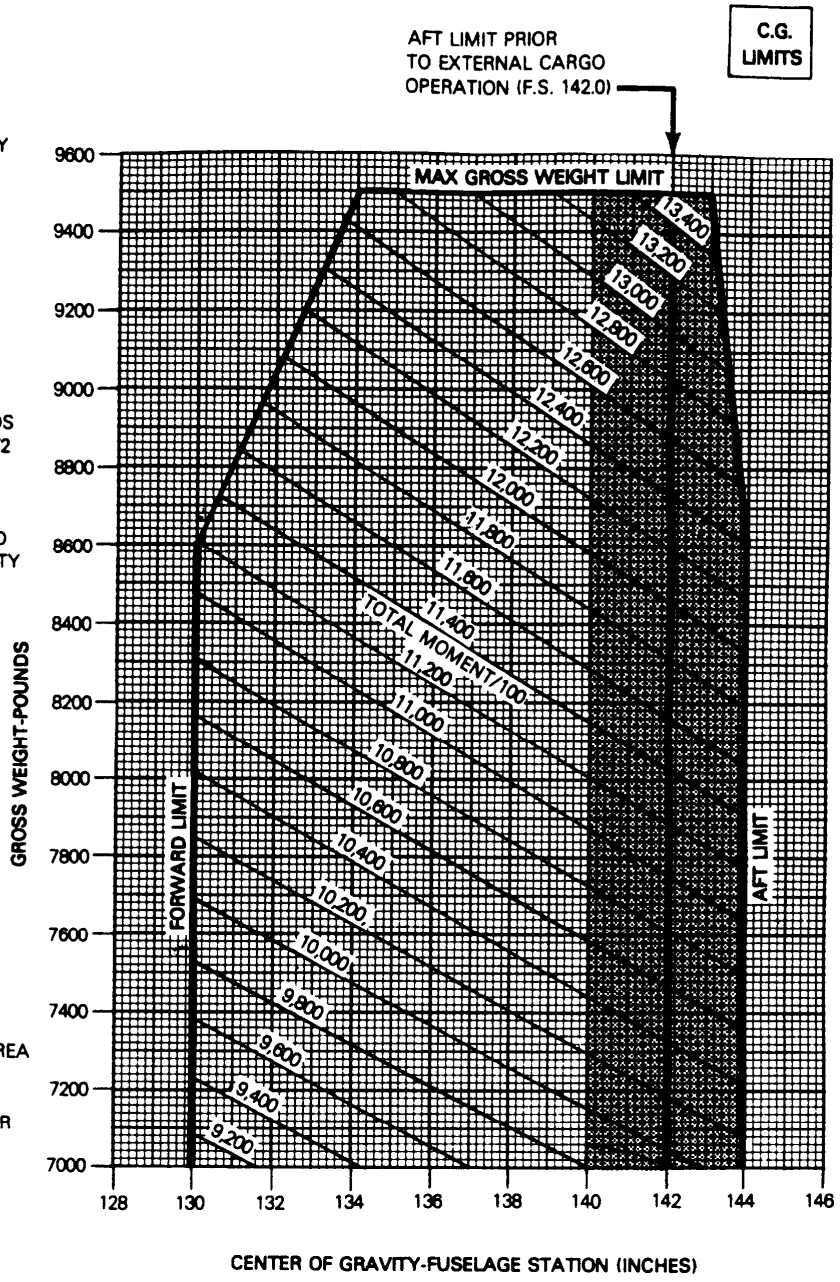


FIGURE 25. Center-of-gravity limits (sheet 1 of 2)

CENTER OF GRAVITY LIMITS

C.G. LIMITS

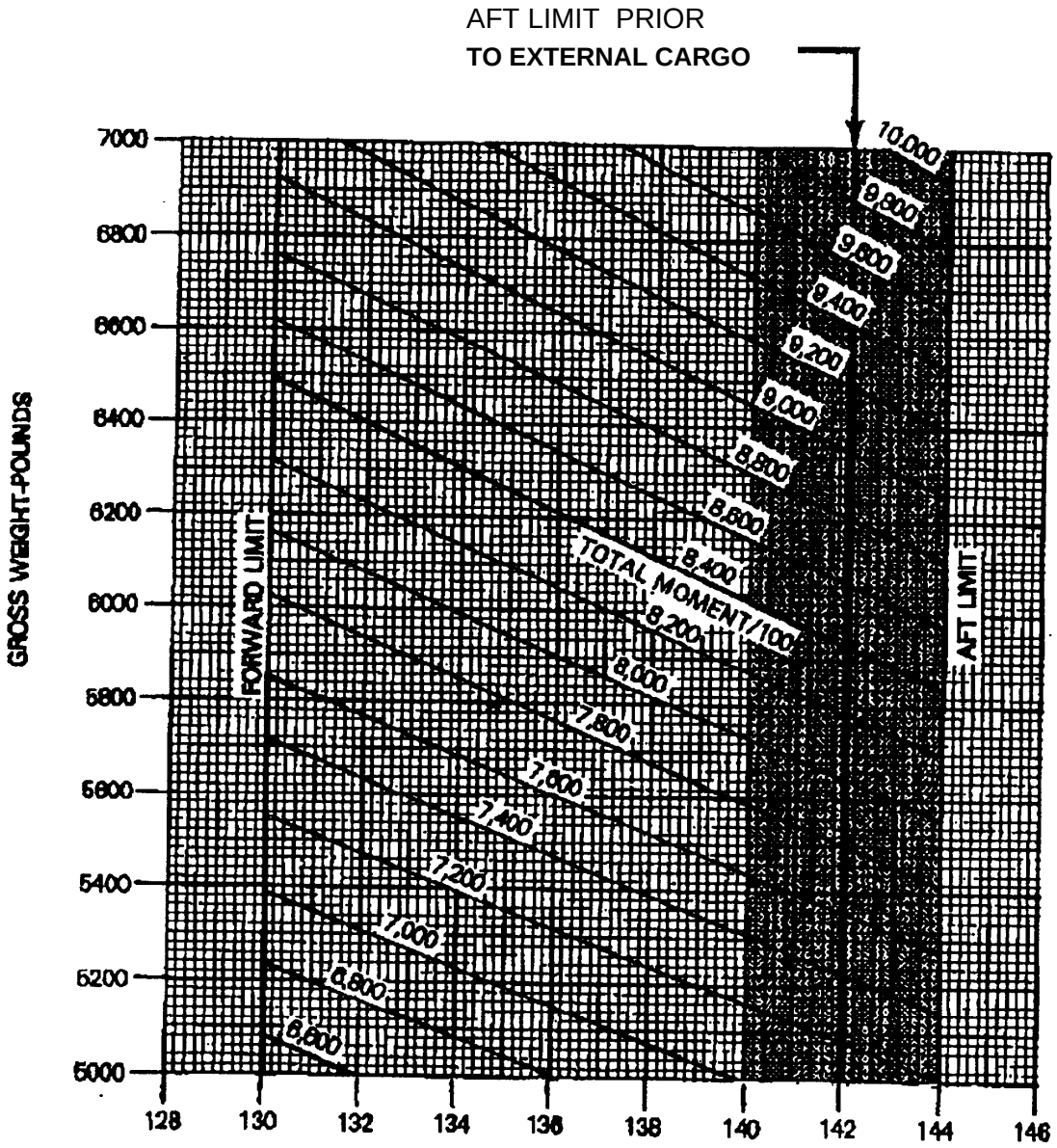


FIGURE 25. Center-of-gravity limits (sheet 2 of 2)

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

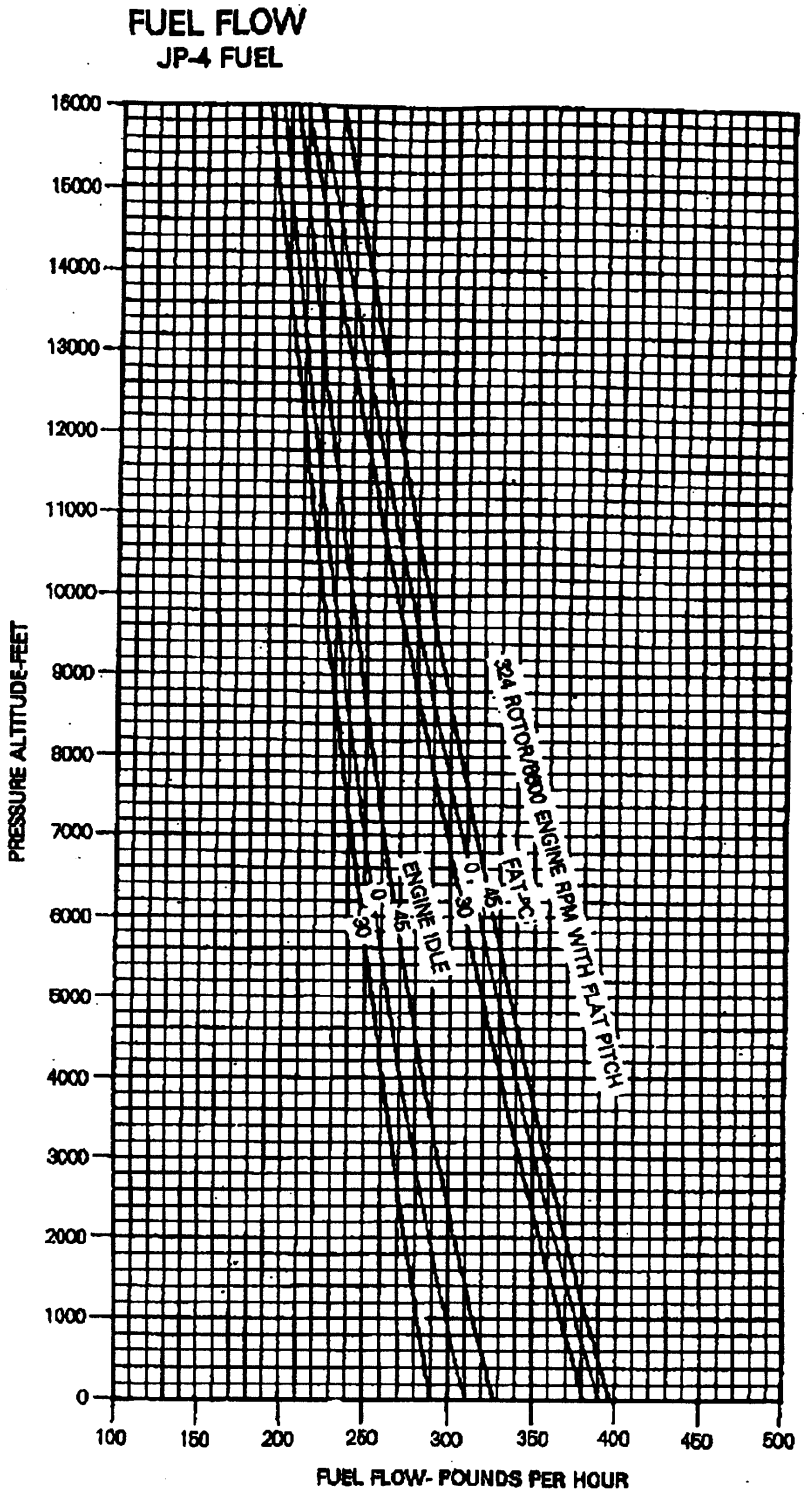


FIGURE 26. Fuel flow chart

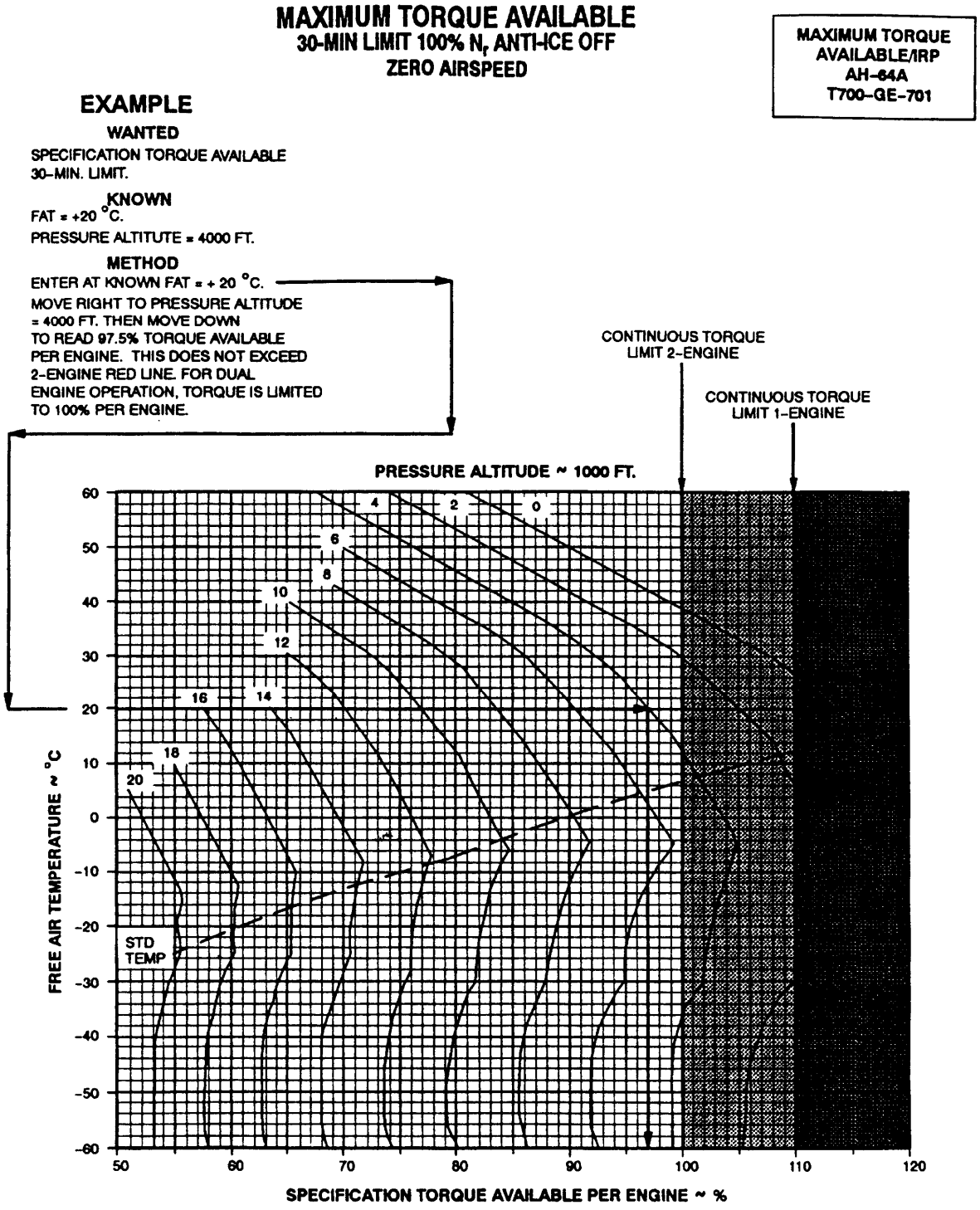


FIGURE 27. Maximum torque available (insert time) (RW)

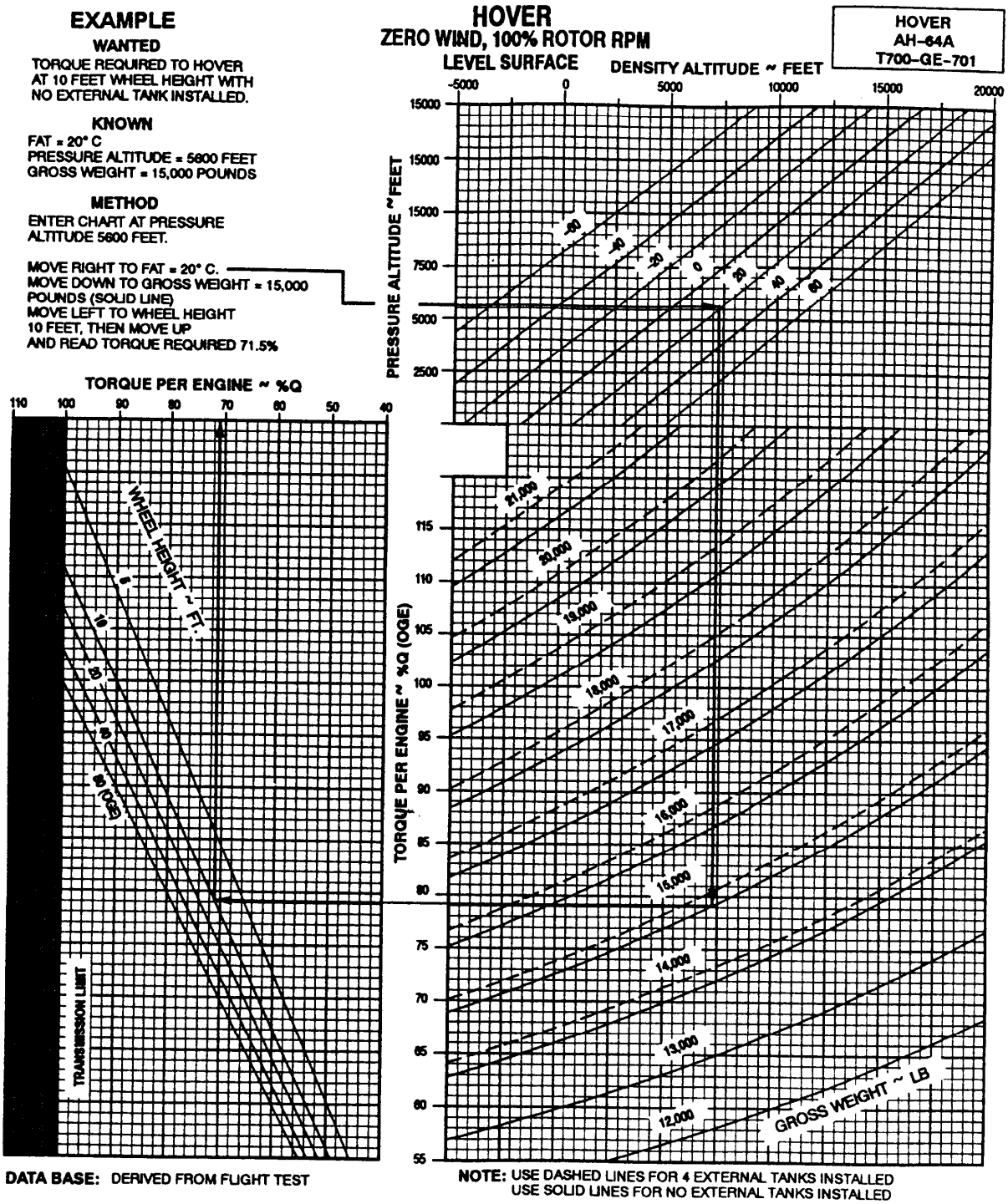


FIGURE 28. Hover chart

TAKEOFF

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

EXAMPLE I

WANTED

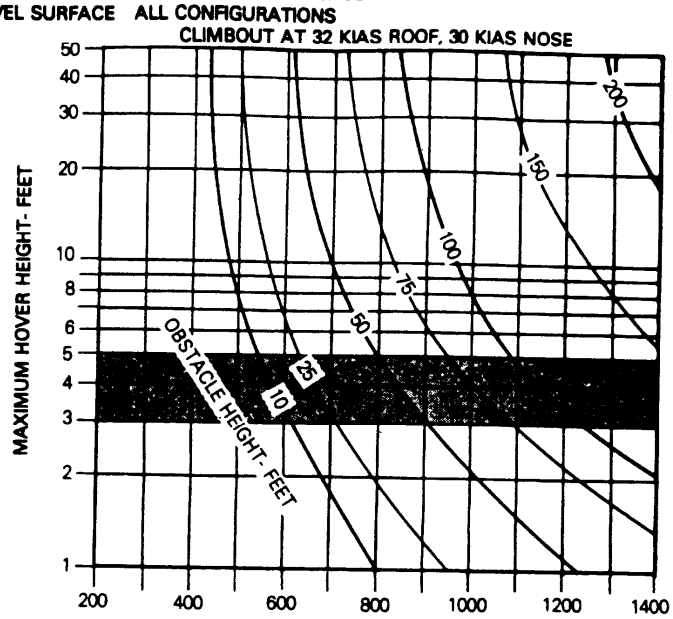
DISTANCE TO CLEAR OBSTACLE

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

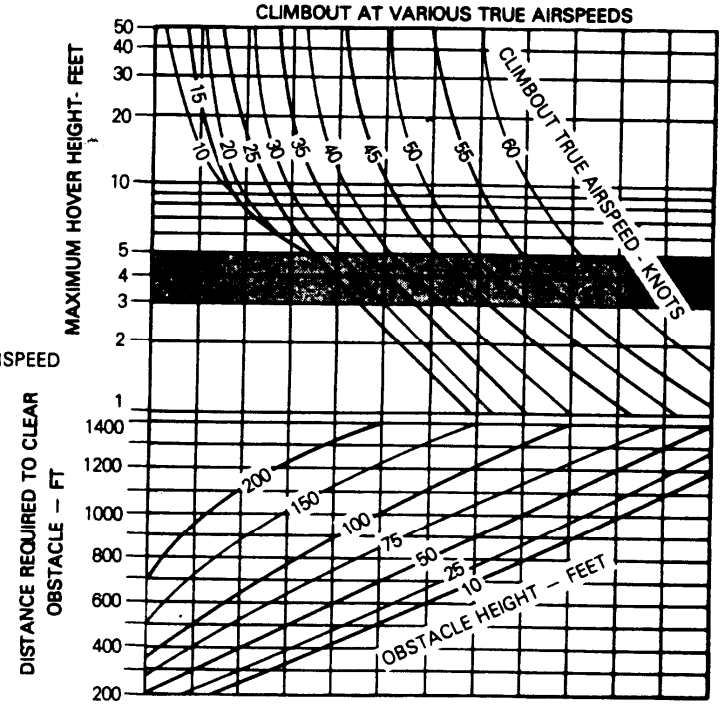


FIGURE 29. Takeoff chart

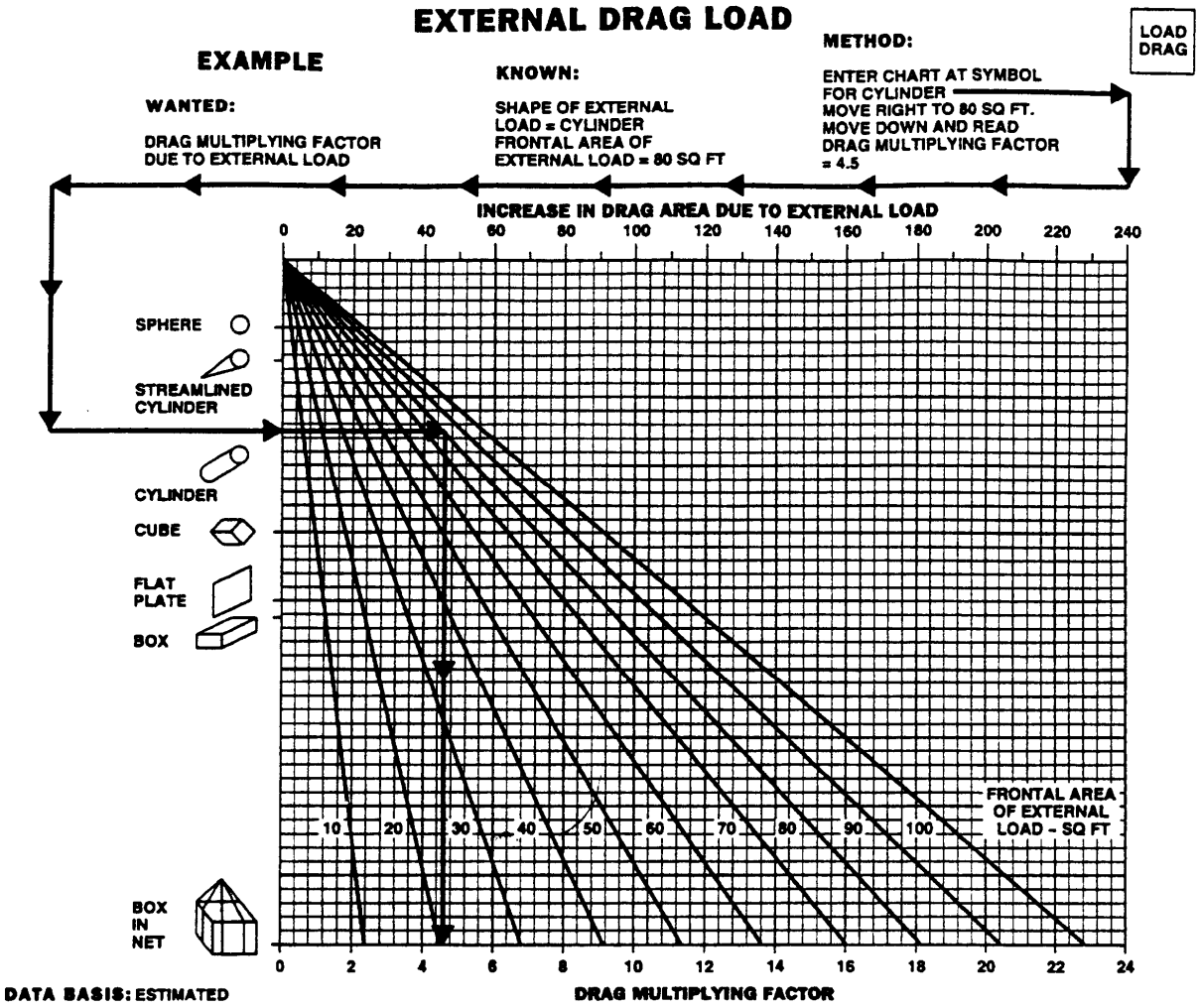
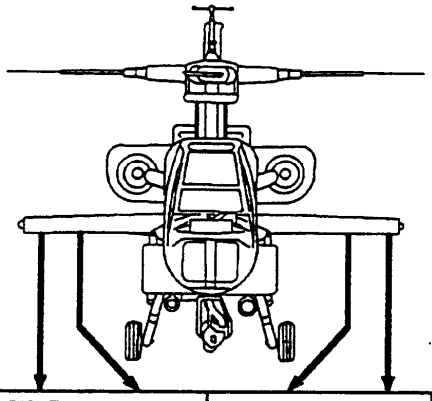


FIGURE 30. Drag chart (sheet 1 of 3)



RIGHT WING STORES		LEFT WING STORES		Δ F (SQ. FT.)	MULTIPLYING FACTOR
OUTBOARD	INBOARD	INBOARD	OUTBOARD		
				-8.0	-0.8
▯			▯	-6.9	-0.69
	▯	▯		-6.9	-0.69
▯	▯	▯	▯	-5.7	-0.57
	⊞	⊞		-6.1	-0.61
⊞			⊞	-6.1	-0.61
	○	○		-2.1	-0.21
○			○	-2.1	-0.21
⊞	▯	▯	⊞	-4.9	-0.49
▯	⊞	⊞	▯	-4.9	-0.49
▯	○	○	▯	-0.9	-0.09
○	▯	▯	○	-0.9	-0.09
⊞	⊞	⊞	⊞	-4.2	-0.42

▯ STORES PYLON (EMPTY)

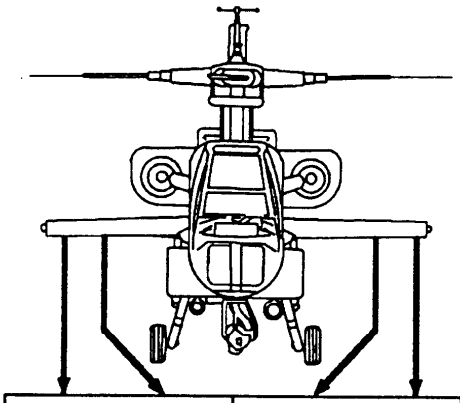
STORES PYLONS PLUS HELLFIRE MISSILE LAUNCHER (LOADED WITH 4 MISSILES)

⊞ STORES PYLONS PLUS 19 TUBE ROCKET LAUNCHERS (LOADED WITH 19 ROCKETS)

○ STORES PYLONS PLUS EXTERNAL FUEL TANK

CLEAN STATION

FIGURE 30. Drag chart (sheet 2 of 3)



RIGHT WING STORES		LEFT WING STORES		Δ F (SQ. FT.)	MULTIPLYING FACTOR
OUTBOARD	INBOARD	INBOARD	OUTBOARD		
				+5.2	+0.52
				0 (BASELINE)	0 (BASELINE)
				0 (BASELINE)	0 (BASELINE)
				+1.2	+0.12
				+1.2	+0.12
				+1.9	+0.19
				+1.9	+0.19
				+9.6	+0.96

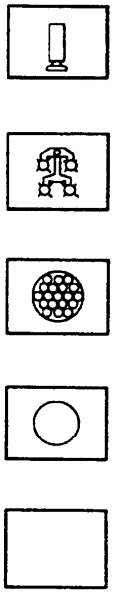


FIGURE 30. Drag chart (sheet 3 of 3)

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

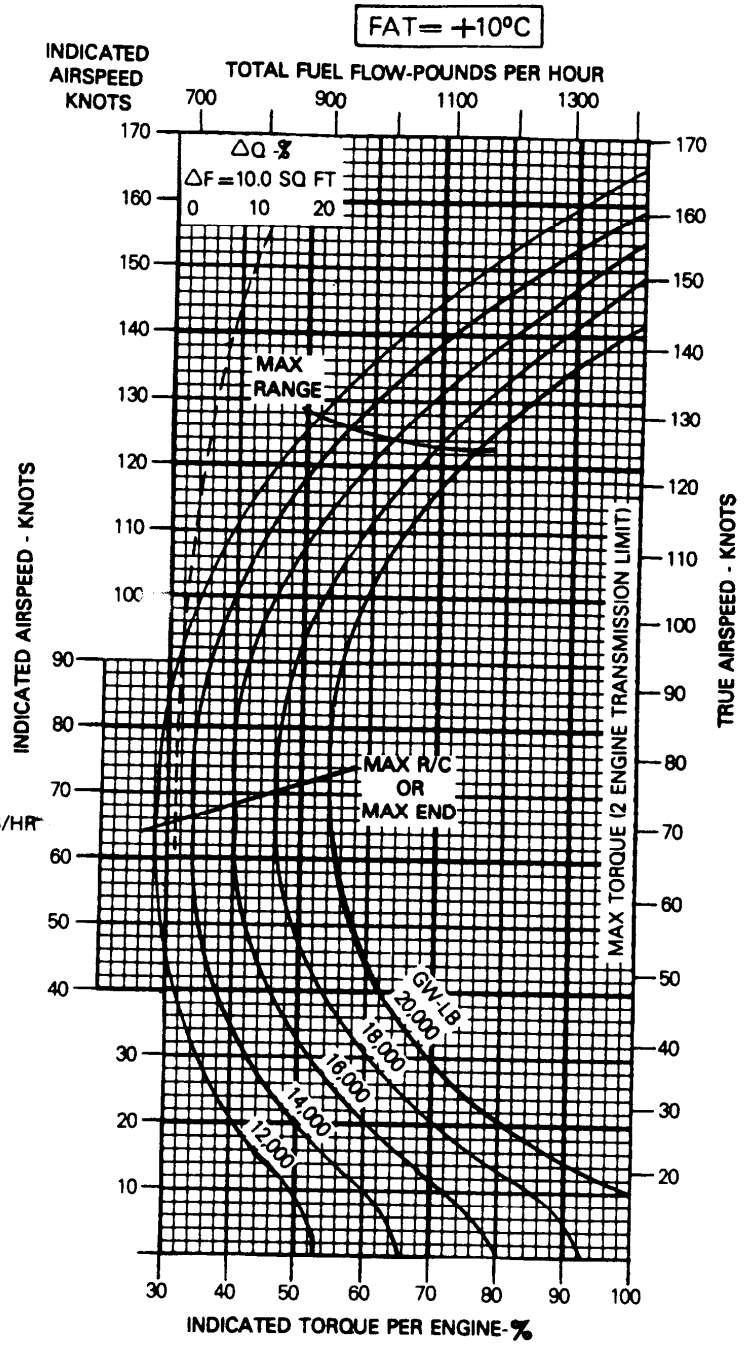


FIGURE 31. Cruise chart (RW)

CLIMB-DESCENT

314 ROTOR/6400 ENGINE RPM

EXAMPLE

WANTED

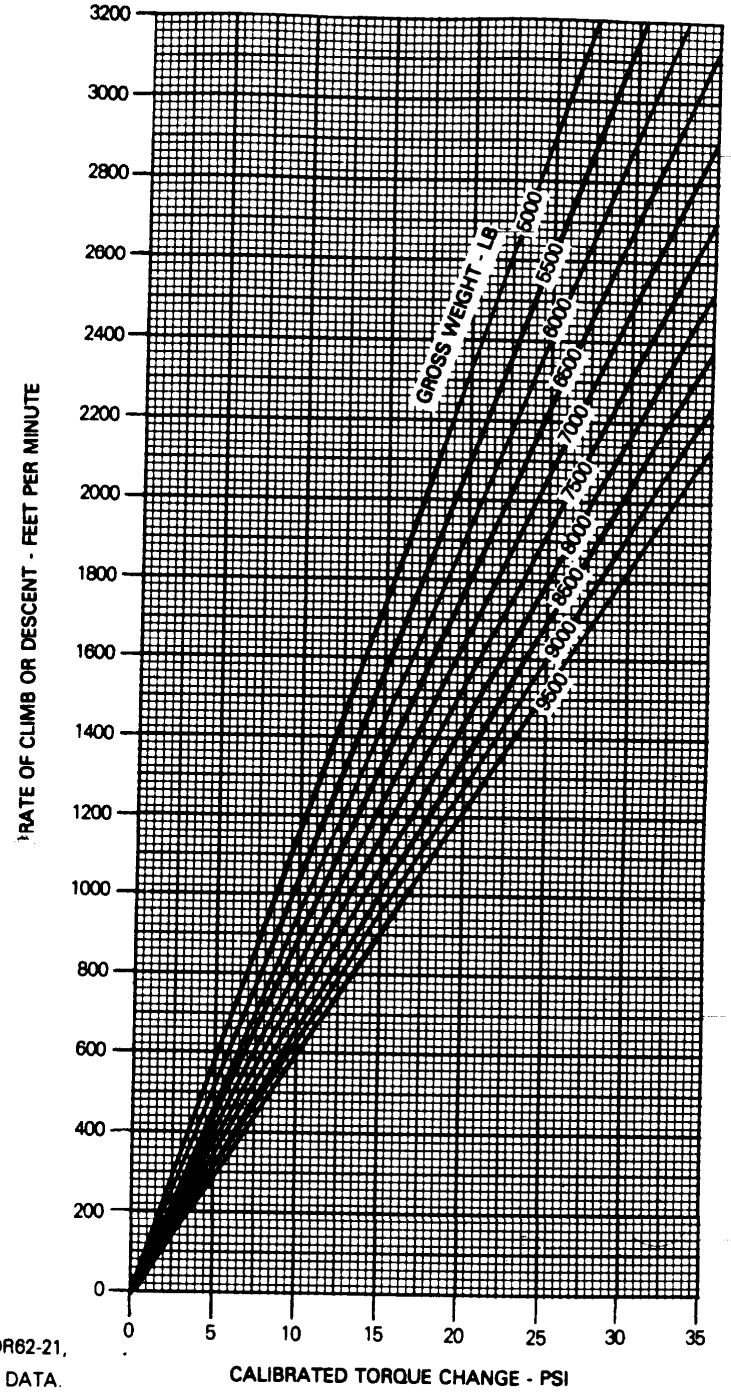
CALIBRATED TORQUE CHANGE
FOR DESIRED R/C OR R/D

KNOWN

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

METHOD

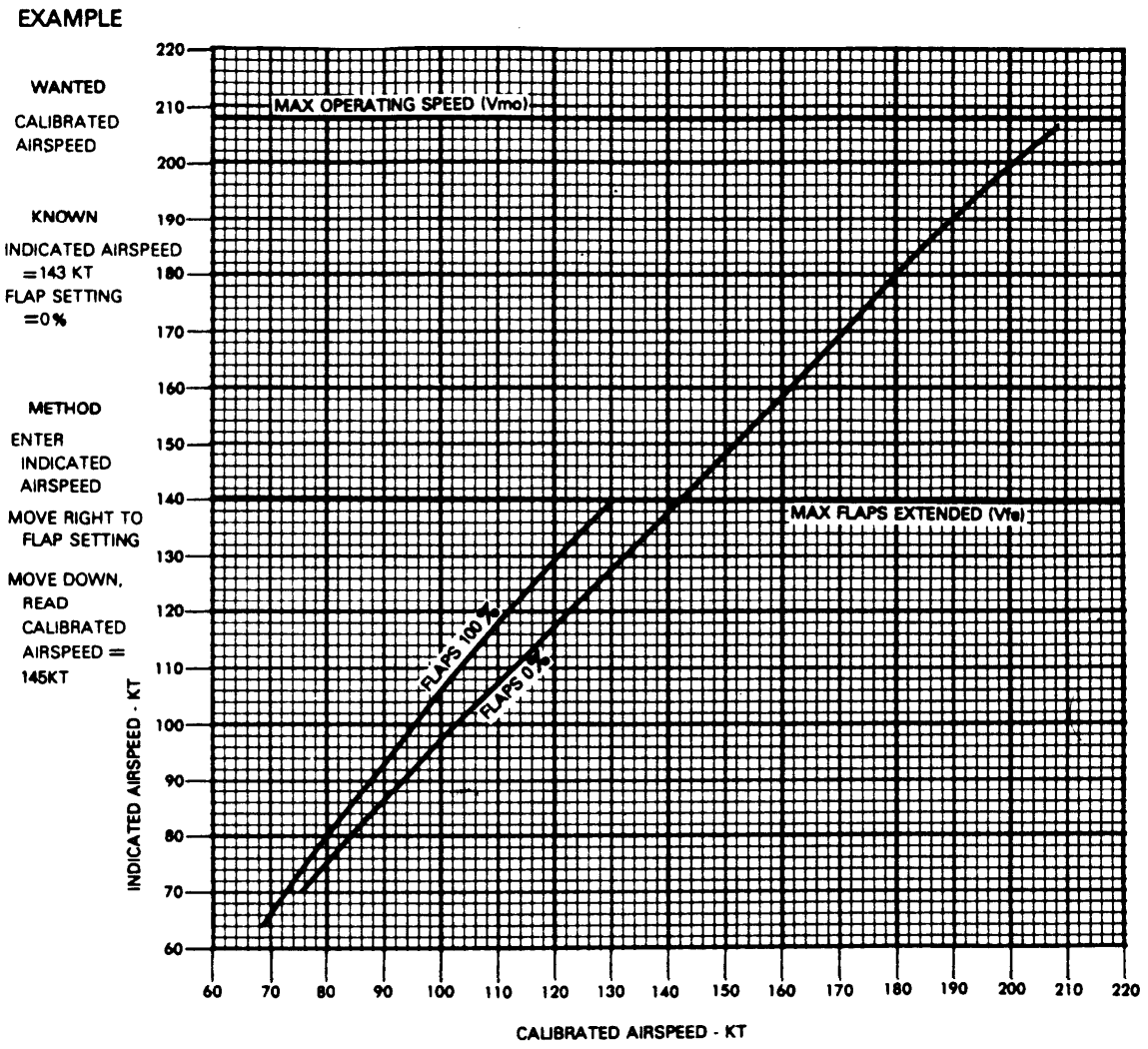
ENTER R/C
MOVE RIGHT TO GROSS WEIGHT
MOVE DOWN, READ CALIBRATED
TORQUE CHANGE = 12.5 PSI



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

FIGURE 32. Climb-descent chart

AIRSPEED CALIBRATION - NORMAL SYSTEM



DATA BASIS: DERIVED FROM FLIGHT TEST

FIGURE 33. Airspeed calibration chart (sheet 1 of 2)

TEMPERATURE CONVERSION/CORRECTION

TEMPERATURE CONVERSION
/CORRECTION
RU-21A, RU-21D
T74-CP-700

EXAMPLE

WANTED

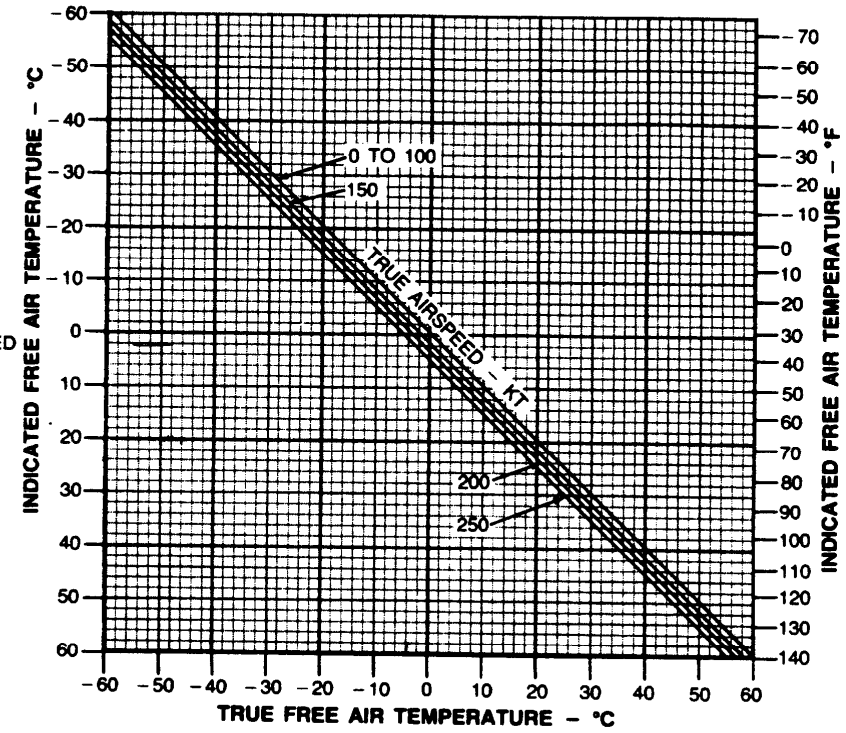
TRUE FAT

KNOWN

INDICATED FAT = −2°C
TRUE AIRSPEED = 154 KT

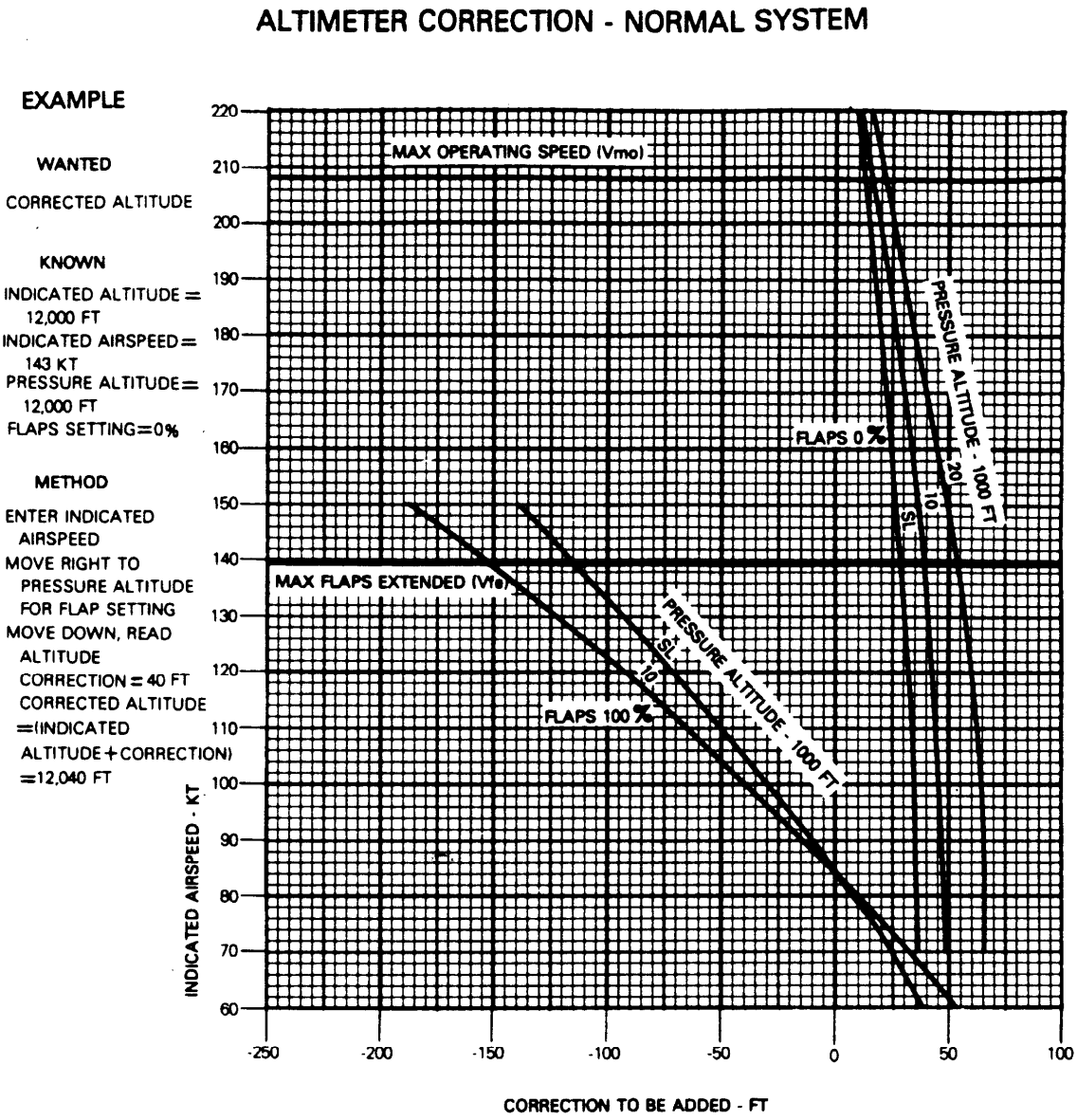
METHOD

ENTER INDICATED FAT HERE
MOVE RIGHT TO TRUE AIRSPEED
MOVE DOWN READ TRUE
FAT = −4°C



AP 001611

FIGURE 33. Airspeed calibration chart (sheet 2 of 2)



DATA BASIS: DERIVED FROM FLIGHT TEST

FIGURE 34. Airspeed-altimeter correction chart

CROSSWIND - TAKEOFF OR LANDING

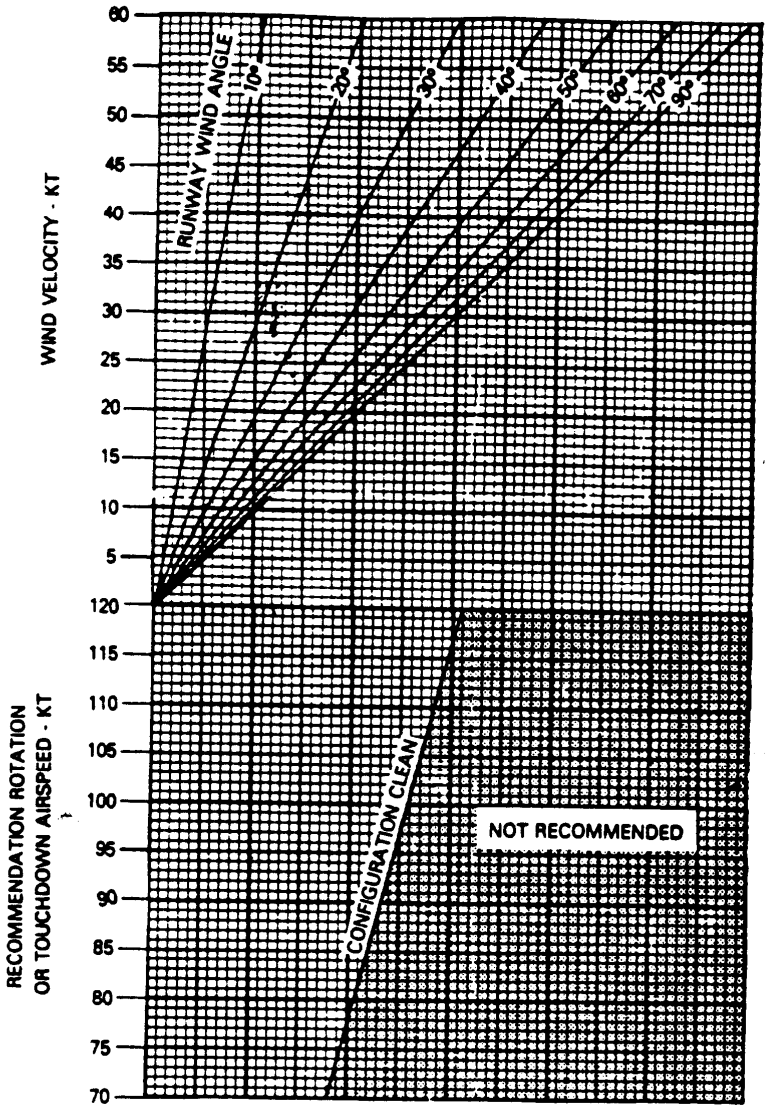
EXAMPLE

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 35. 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

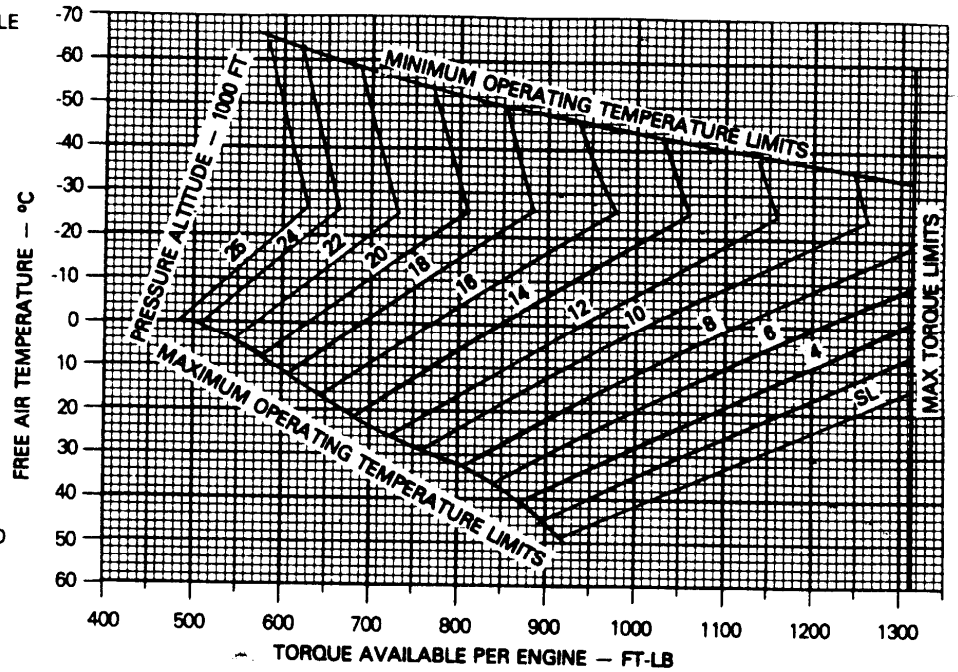
KNOWN

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 36. Torque available for takeoff chart (FW)

TAKEOFF - NORMAL

CALM WINDS FLAPS 0 PERCENT POWER - TAKEOFF

LEVEL HARD SURFACE

EXAMPLE

WANTED

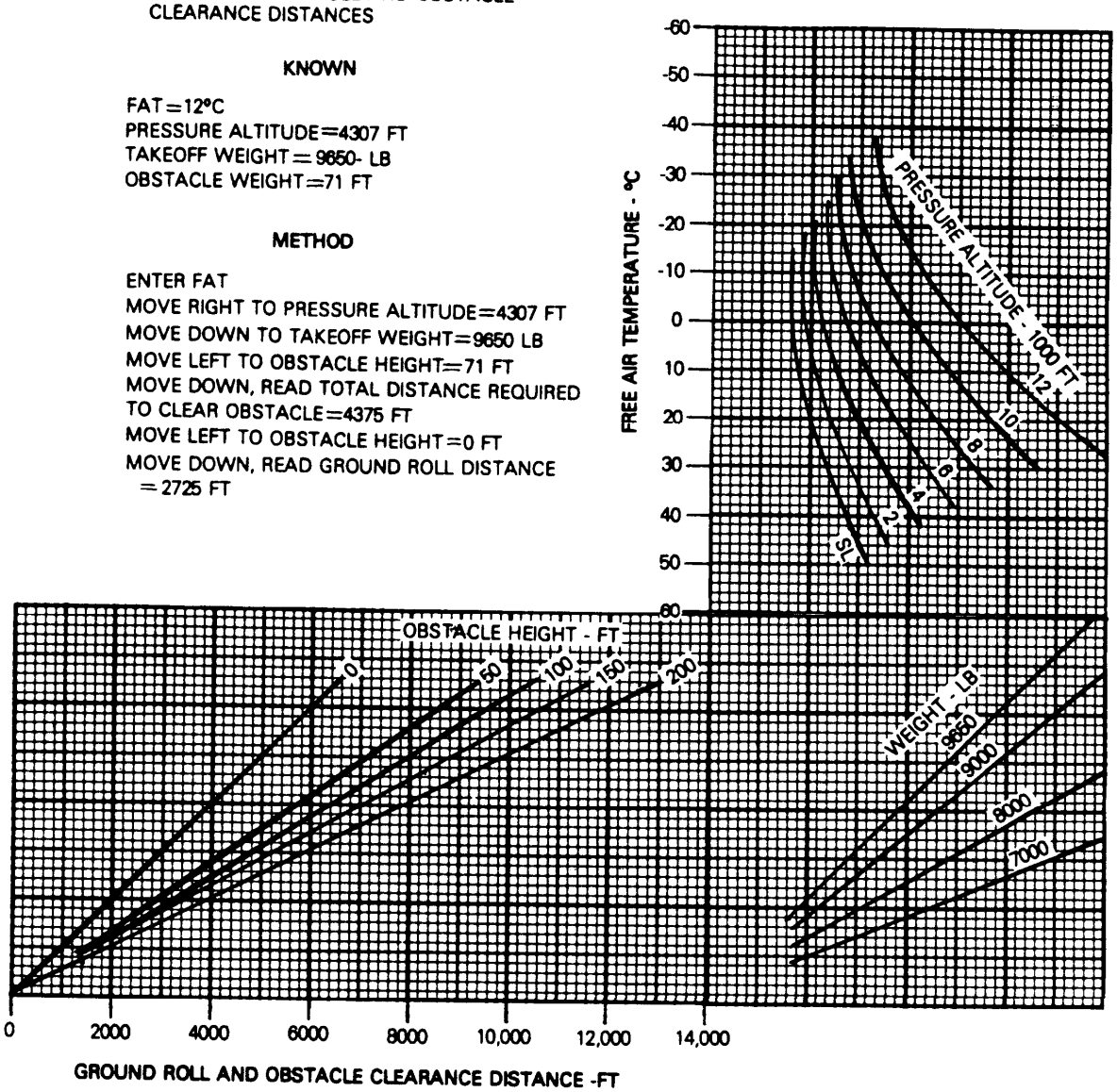
REQUIRED GROUND ROLL AND OBSTACLE CLEARANCE DISTANCES

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 37. Takeoff – normal chart (FW)

NORMAL ROTATION/TAKEOFF AIRSPEED

FLAPS 0 PERCENT

EXAMPLE

WANTED

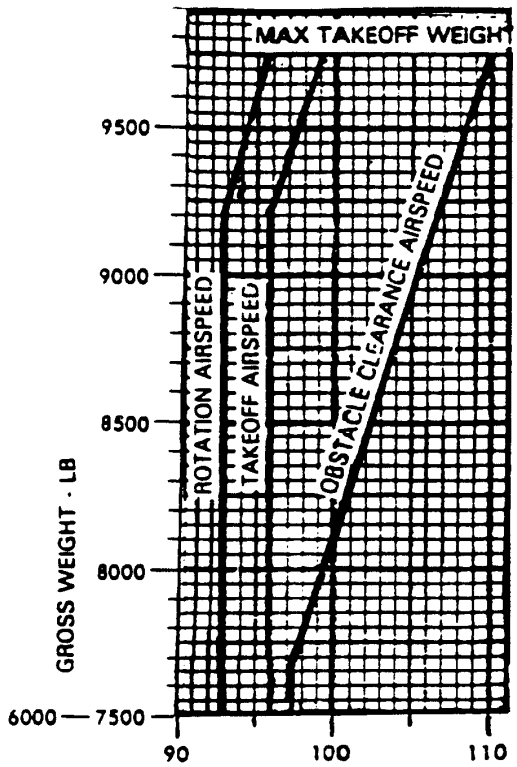
NORMAL ROTATION, TAKEOFF, AND OBSTACLE CLEARANCE AIRSPEEDS FOR KNOWN TAKEOFF WEIGHT

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 38. Normal rotation / takeoff airspeed chart (FW)

ACCELERATION CHECK

POWER – TAKEOFF CALM WINDS
FLAPS 0 PERCENT LEVEL HARD SURFACE

ACCELERATION CHECK
RU-21D
T74-CP-700

EXAMPLE

WANTED

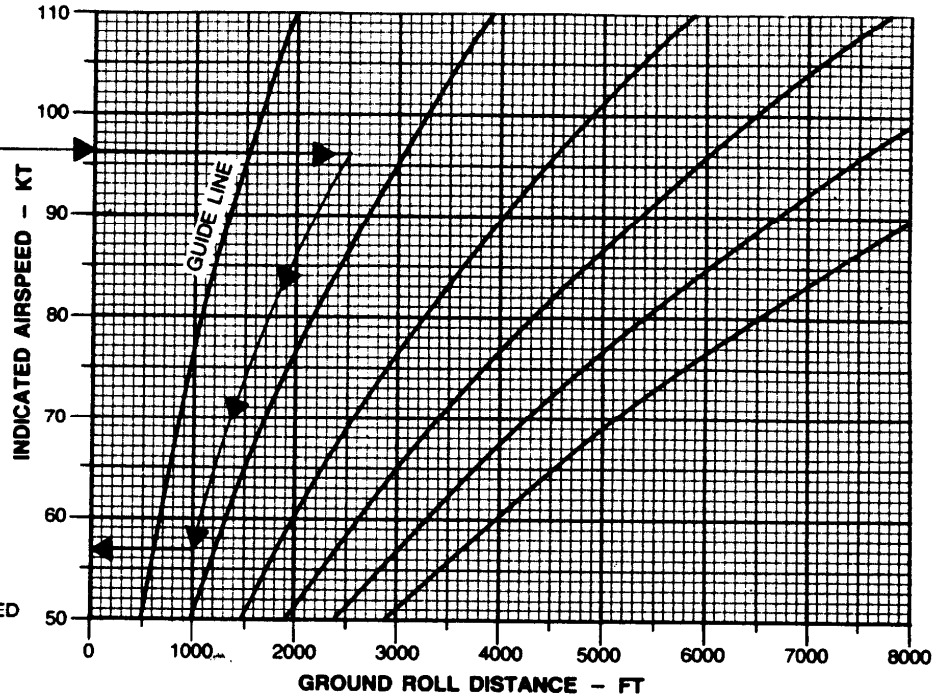
AIRSPEED REQUIRED AT VARIOUS ACCELERATION CHECK POINTS

KNOWN

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

METHOD

ENTER INDICATED AIR SPEED HERE
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

G
AP 001539

FIGURE 39. Acceleration check distance chart (FW)

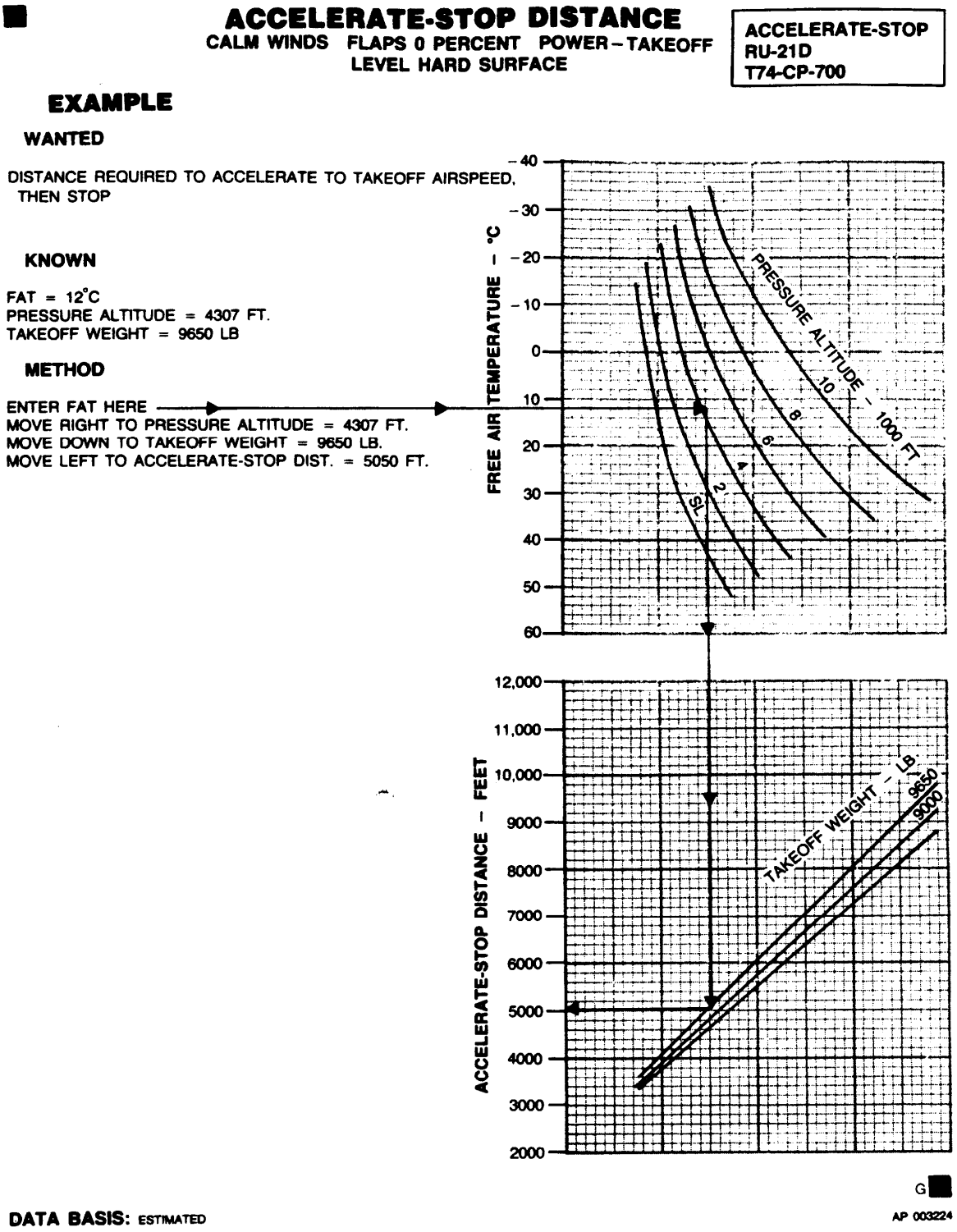


FIGURE 40. Accelerate – stop distance chart (FW)

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.

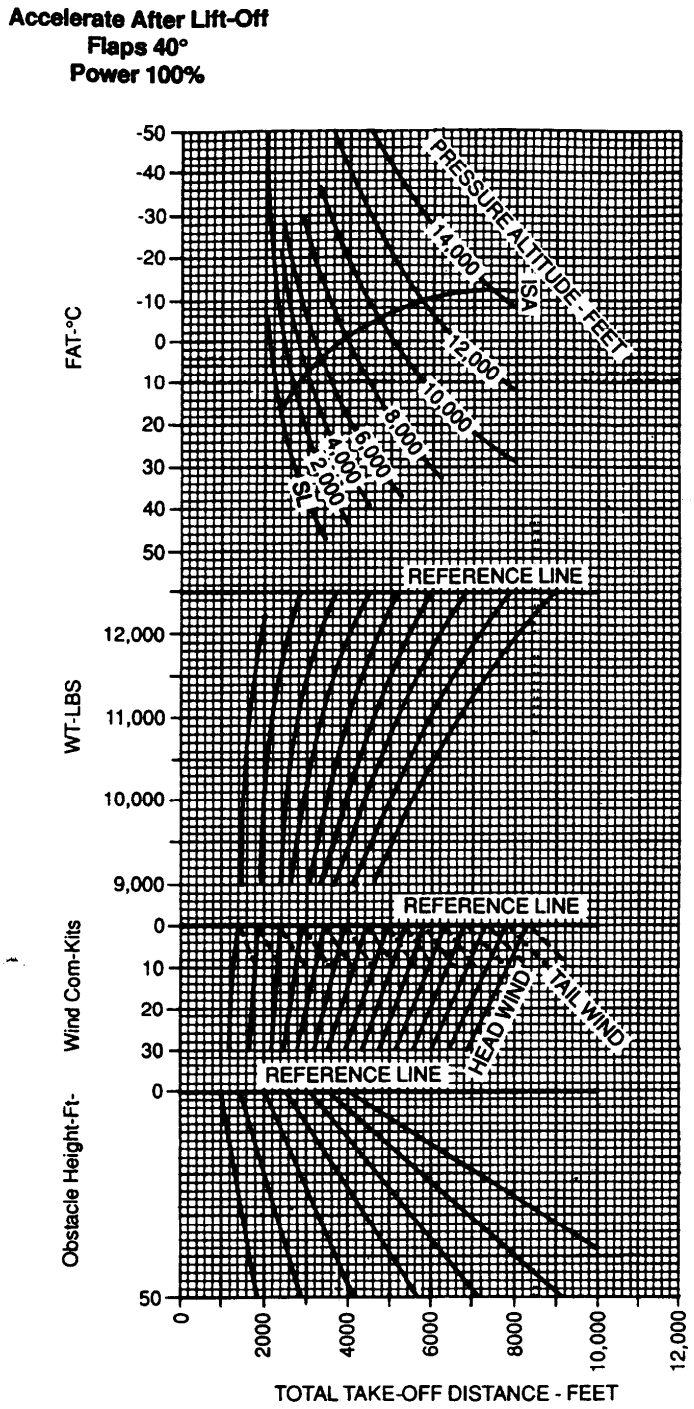


FIGURE 41. Accelerate after lift-off chart (FW)

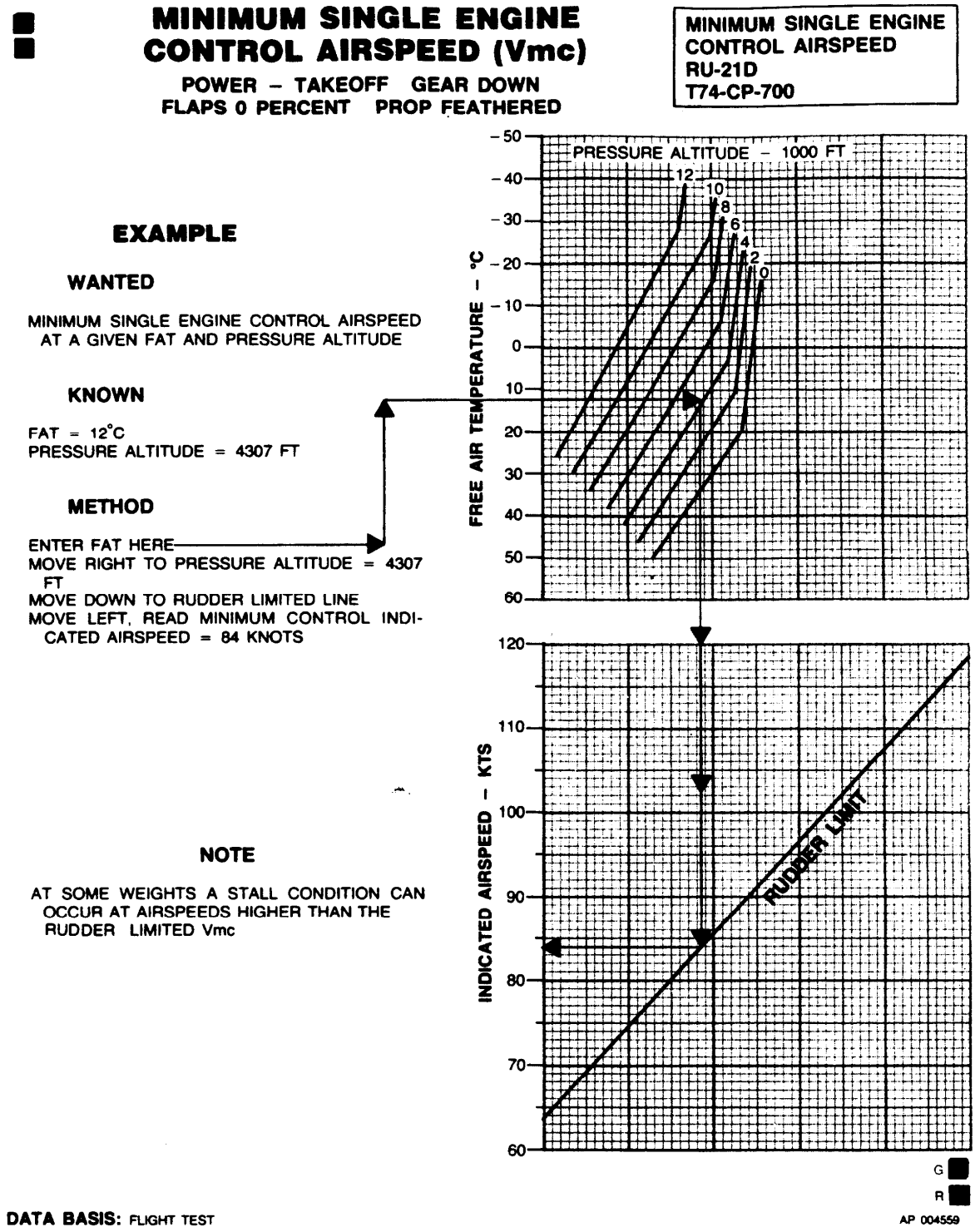


FIGURE 42. Minimum single engine control airspeed chart (FW)

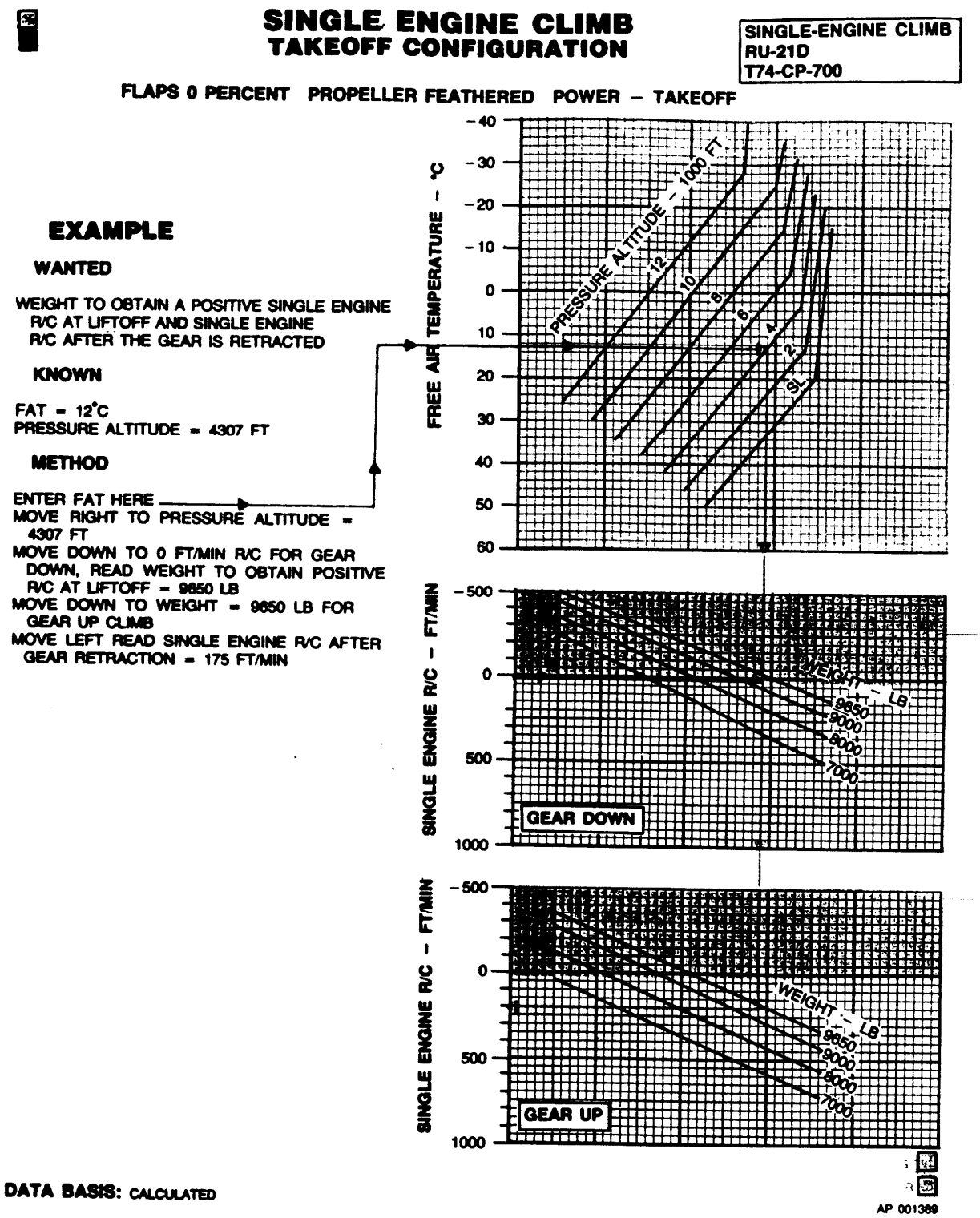


FIGURE 43. Single engine climb chart (FW) (sheet 1 of 2)

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%

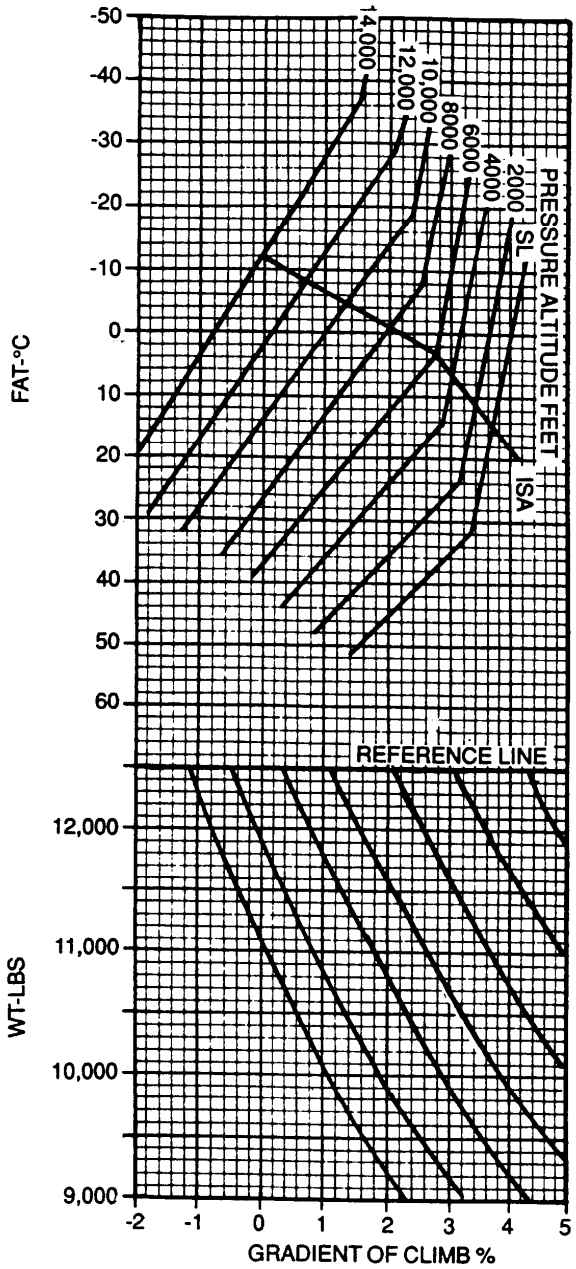


FIGURE 43. Single engine climb chart (FW) (sheet 2 of 2)

CRUISE CLIMB

GEAR UP FLAPS 0 PERCENT CALM WIND
POWER – MAXIMUM CRUISE CLIMB

CRUISE CLIMB
RU-21D
T74-CP-700

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

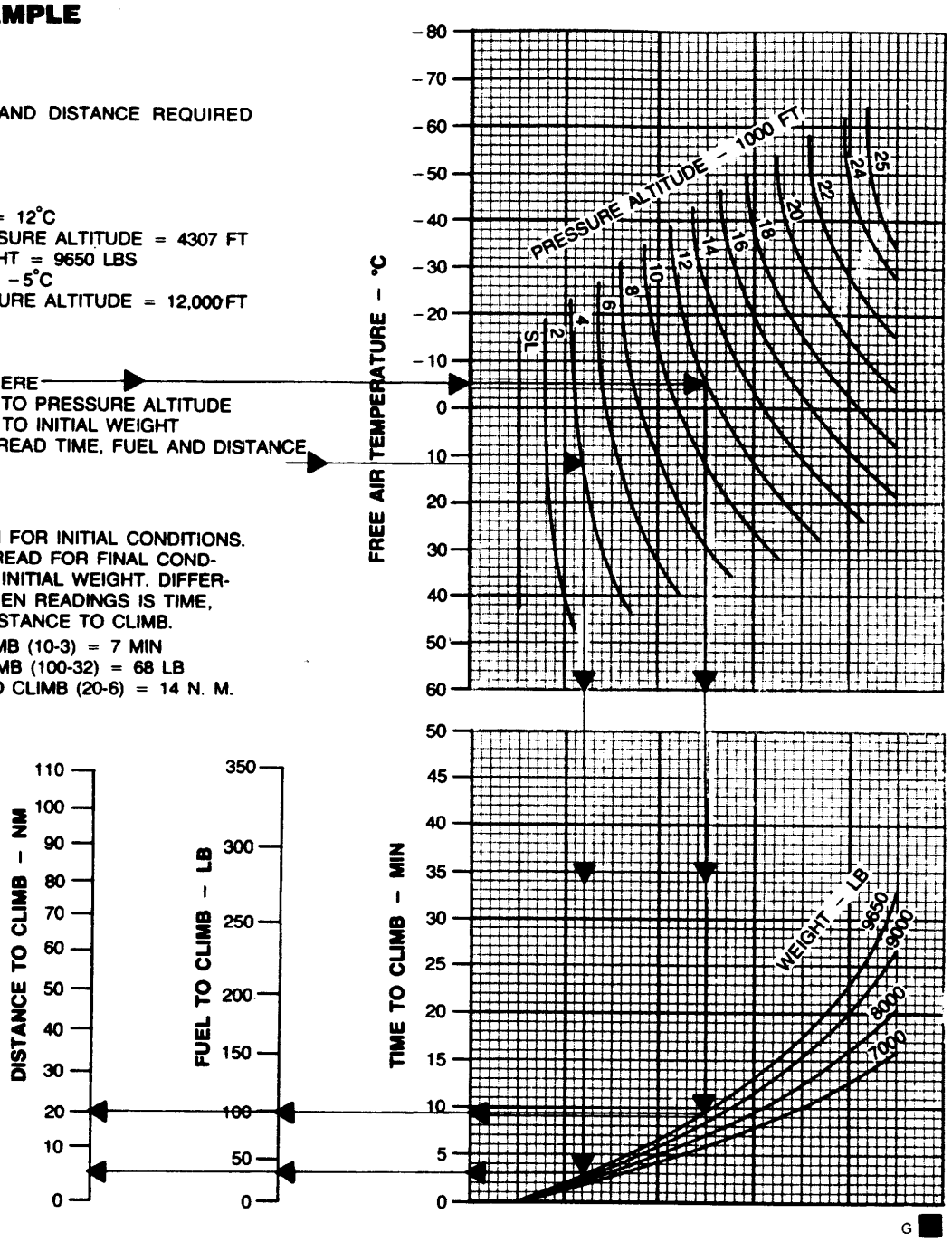
METHOD

ENTER FAT HERE
MOVE RIGHT TO PRESSURE ALTITUDE
MOVE DOWN TO INITIAL WEIGHT
MOVE LEFT, READ TIME, FUEL AND DISTANCE

NOTE

READ GRAPH FOR INITIAL CONDITIONS. SECONDLY, READ FOR FINAL CONDITIONS WITH INITIAL WEIGHT. DIFFERENCE BETWEEN READINGS IS TIME, FUEL AND DISTANCE TO CLIMB.

TIME TO CLIMB (10-3) = 7 MIN
FUEL TO CLIMB (100-32) = 68 LB
DISTANCE TO CLIMB (20-6) = 14 N. M.



DATA BASIS: FLIGHT TEST

G

AP 001391

FIGURE 44. Cruise climb chart

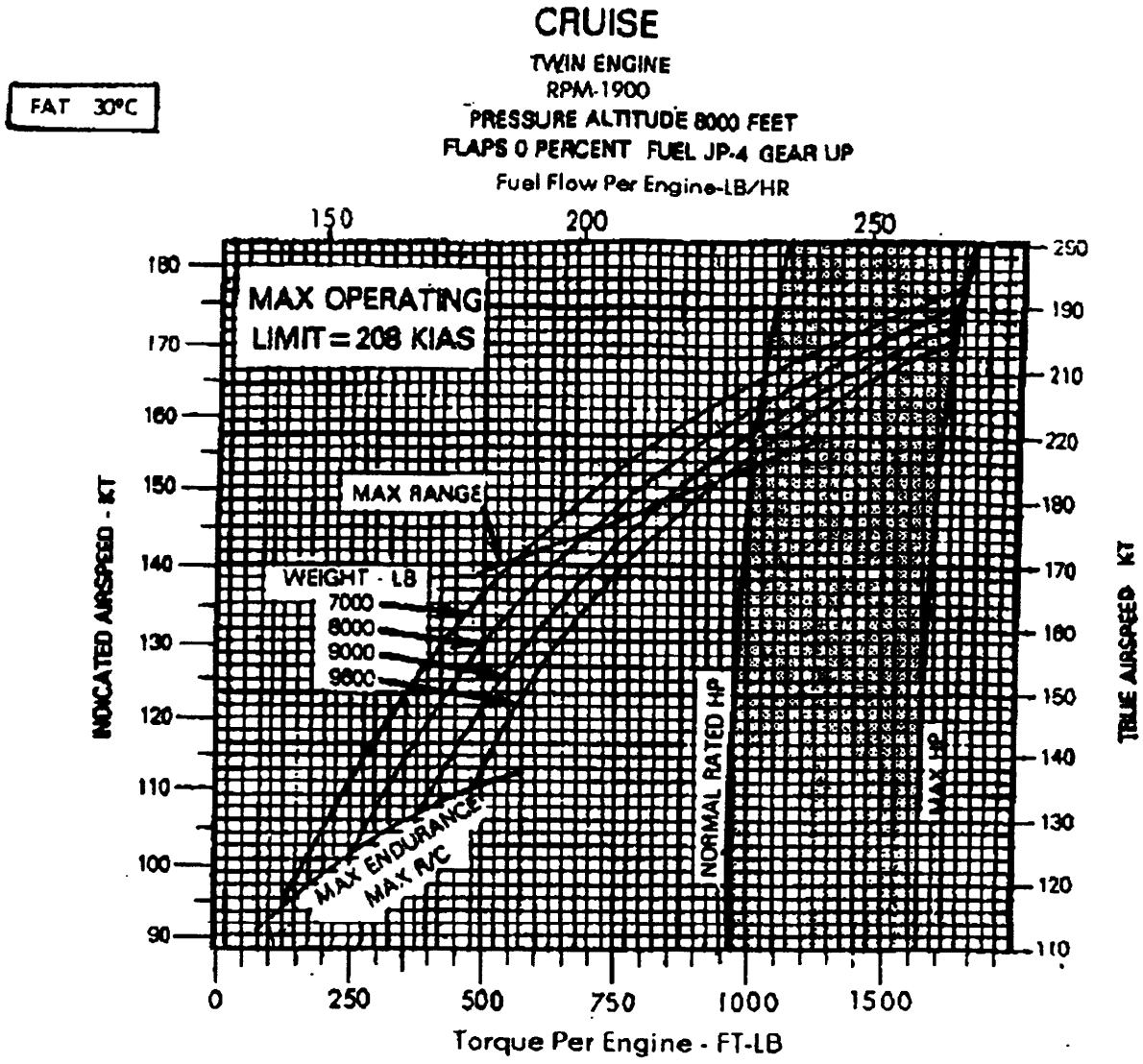


FIGURE 45. Cruise chart (FW)

CLIMB/DESCENT

CLIMB/DESCENT
RU-21D
T74-CP-702

EXAMPLE

WANTED

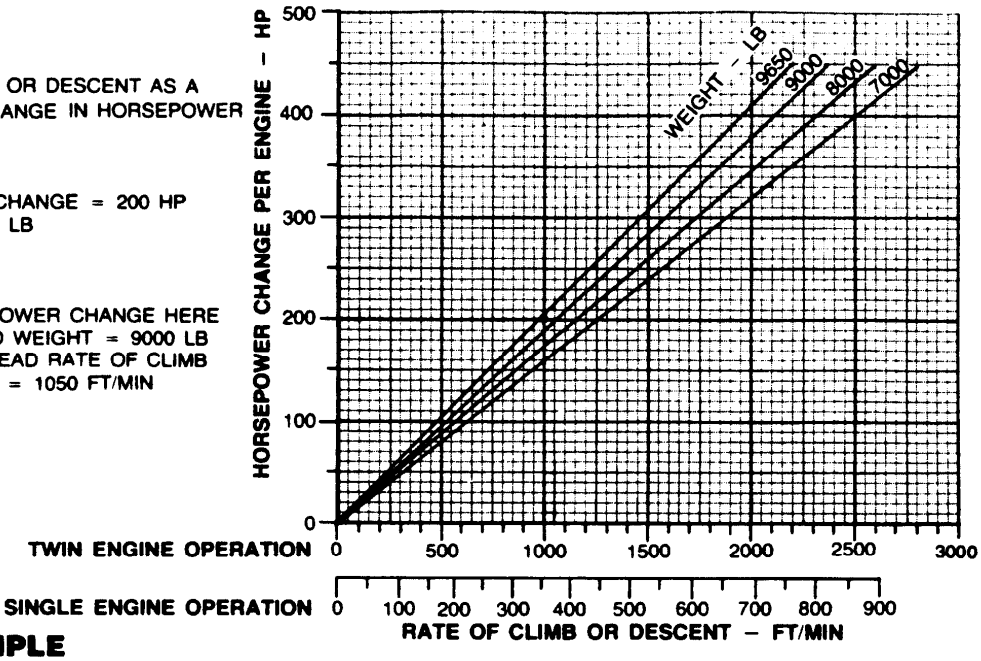
RATE OF CLIMB OR DESCENT AS A RESULT OF CHANGE IN HORSEPOWER

KNOWN

HORSEPOWER CHANGE = 200 HP
WEIGHT = 9000 LB

METHOD

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



EXAMPLE

WANTED

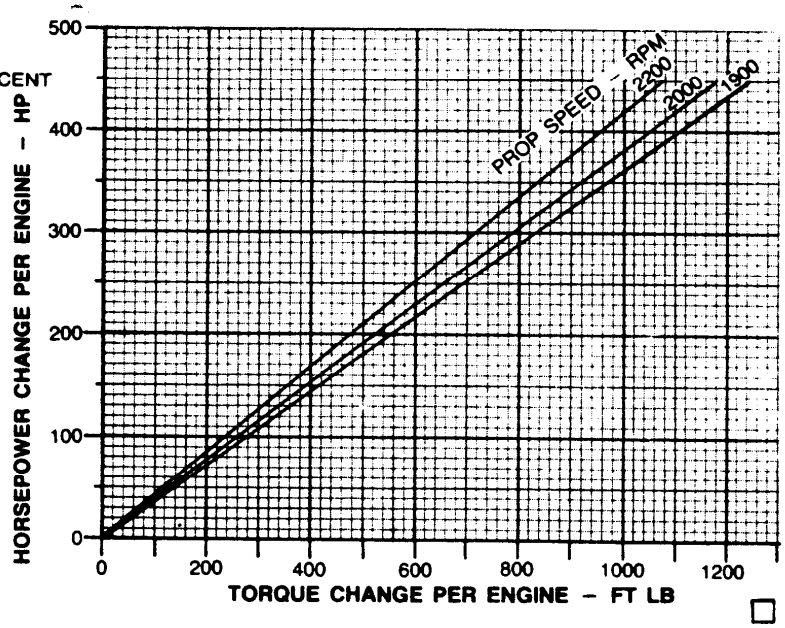
TORQUE CHANGE FOR CLIMB OR DESCENT AS A RESULT OF CHANGE IN HORSEPOWER OR RPM

KNOWN

HORSEPOWER CHANGE = 200
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

AP 001418

FIGURE 46. Climb/descent chart (FW)

APPROACH SPEED

GEAR DOWN

EXAMPLE

WANTED

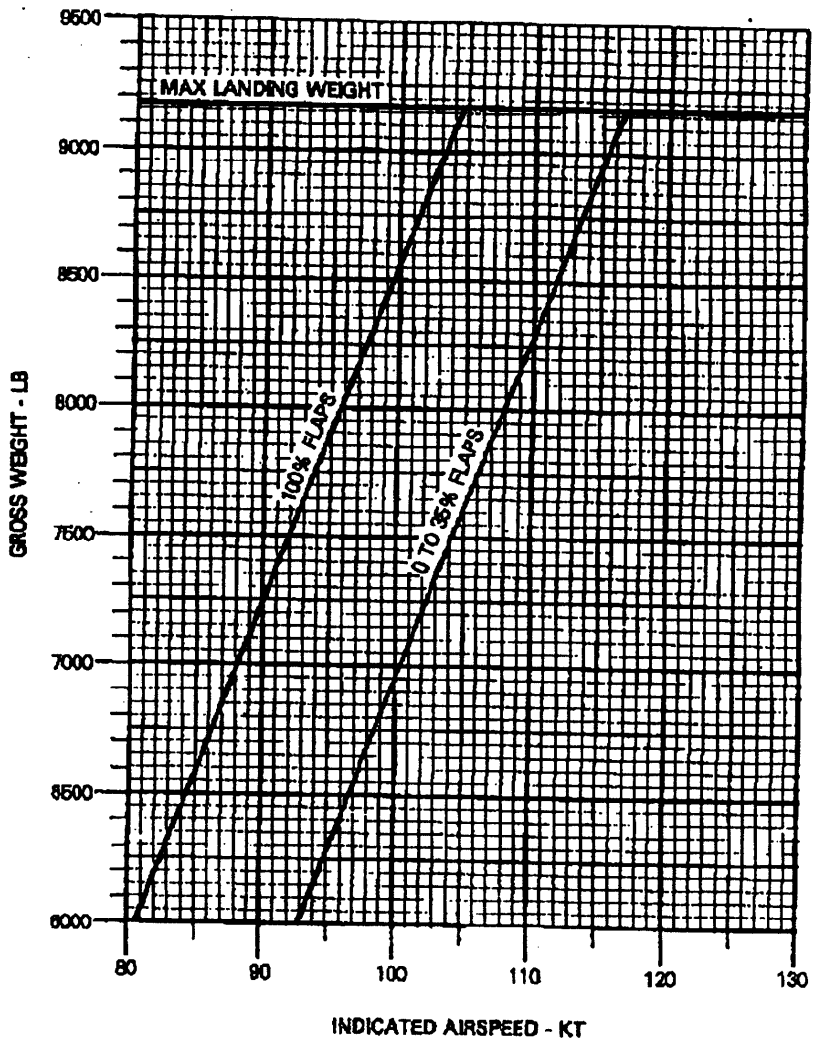
RECOMMENDED APPROACH SPEED FOR KNOWN WEIGHT

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 47. Approach speed chart (FW)

LANDING

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

EXAMPLE

WANTED

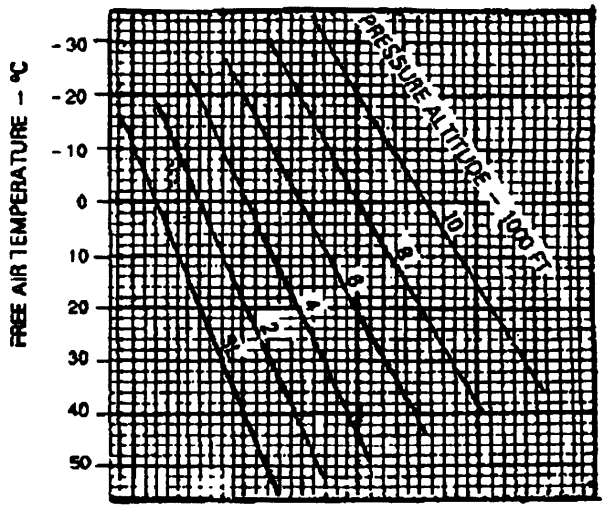
LANDING DISTANCE

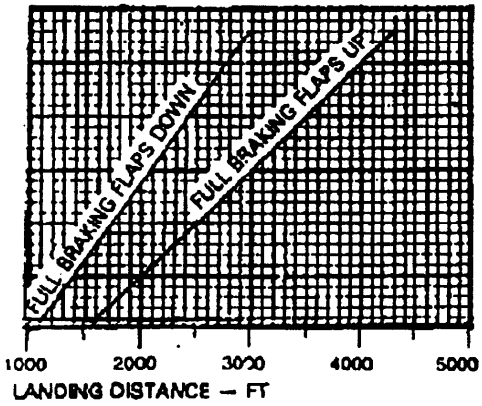
KNOWN

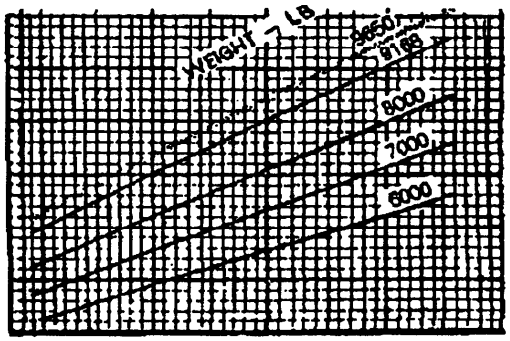
WEIGHT – 8855 LB
PRESSURE ALTITUDE – 4484 FT
FAT – 18°C
FLAPS DOWN

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 48. Landing chart (FW)

8-238. Starting Engines.

* (1.) BATT switch — ON.

2. CAUTION LT TEST switch--TEST. Check that all caution/advisories capsules and the two master caution lights on the instrument panel come on. Some of the caution capsules will be on before the system is checked.

3. Clocks — Running, Set as required.

F (4.) TROOP WARN ALARM and JUMP LTS — Two bells, two red, two green (as required).

F* 5. Fire guard posted — APU clear to start.

★* (6.) APU — Start as follows:

a. APU switch — RUN for 3 to 5 seconds.

b. APU switch — START for 2 seconds, then RUN.

CAUTION

If the start is not completed, or the APU is automatically shut down, wait one minute for cooling before attempting a restart. Failure to allow the APU to cool may cause a premature shutdown on restart due to overtemperature. If the start is not completed, set the APU switch to OFF, check the BITE indicators in the ESU, and record the display for maintenance.

c. APU ON indicating light — Check on.

d. UTIL HYD SYS caution — Check out. If the light does not go out within 30 seconds after APU ON indicating light comes on, APU switch OFF.

* (7.) APU GEN switch — ON. No. 1 and No. 2 RECT OFF caution capsules out.

NOTE

If either HYD FLT CONTR caution capsule does not go out in 30 seconds, after the PWR XFER switches are set to ON, set the PWR XFER switch to OFF. Do not fly the helicopter.

* (8.) PWR XFER — PWR XFER 1 and 2 switches — ON. Check HYD FLT CONTR caution capsules out.

F* 9. MAINTENANCE PANEL — Check.

a. GND switch — TEST, then RESET.

b. GROUND CONTACT indicating lights — Check on.

c. Systems — Normal.

* 10. Avionics — On as required.

O 11. HUD — ON. As required.

★F 12. CARGO HOOKS HOIST/WINCH — Check operation as required. Refer to Chapter 4, Section III.

F 13. ANTI-ICE systems — Check as required.

a. PITOT switch — ON. Physically check for pitot tube and yaw port heat. Then switch OFF.

b. W/S switches — ON. Physically check for windshield heat. Then switch OFF.

F 14. SLT-FIL switches — Check and set as required.

* 15. PARKING BRAKE — Set.

16. CRUISE GUIDE indicator — Check for pointer in white test band when the CGI TEST switch is at FWD and AFT TEST.

F* 17. Altimeters — Set and check as follows:

a. Barometric altimeter — Set and check.

b. Radar altimeter — ON and set.

18. FIRE DETR switch — TEST. Check fire warning lights on, release switch, and check fire warning lights out.

* 19. Fuel quantity — Check as required.

* 20. Cyclic trim indicators — Check GND position.

F* 21. Rotor blades — Check position. Make sure that a rotor blade is not within 30° of the centerline of the fuselage throughout control check.

* 22. AFCS SYSTEM SEL switch — Check as follows:

a. Select individual system and check opposite AFCS caution capsule remains on.

b. Select BOTH and check both AFCS caution capsules go out.

c. AFCS SYSTEM SEL switch — OFF.

★F* 23. Flight control travel and hydraulics — Check as follows: (For thru flights, complete steps b thru e with FLT CONTR switch — BOTH).

FIGURE 49. Example of amplified checklist format and style

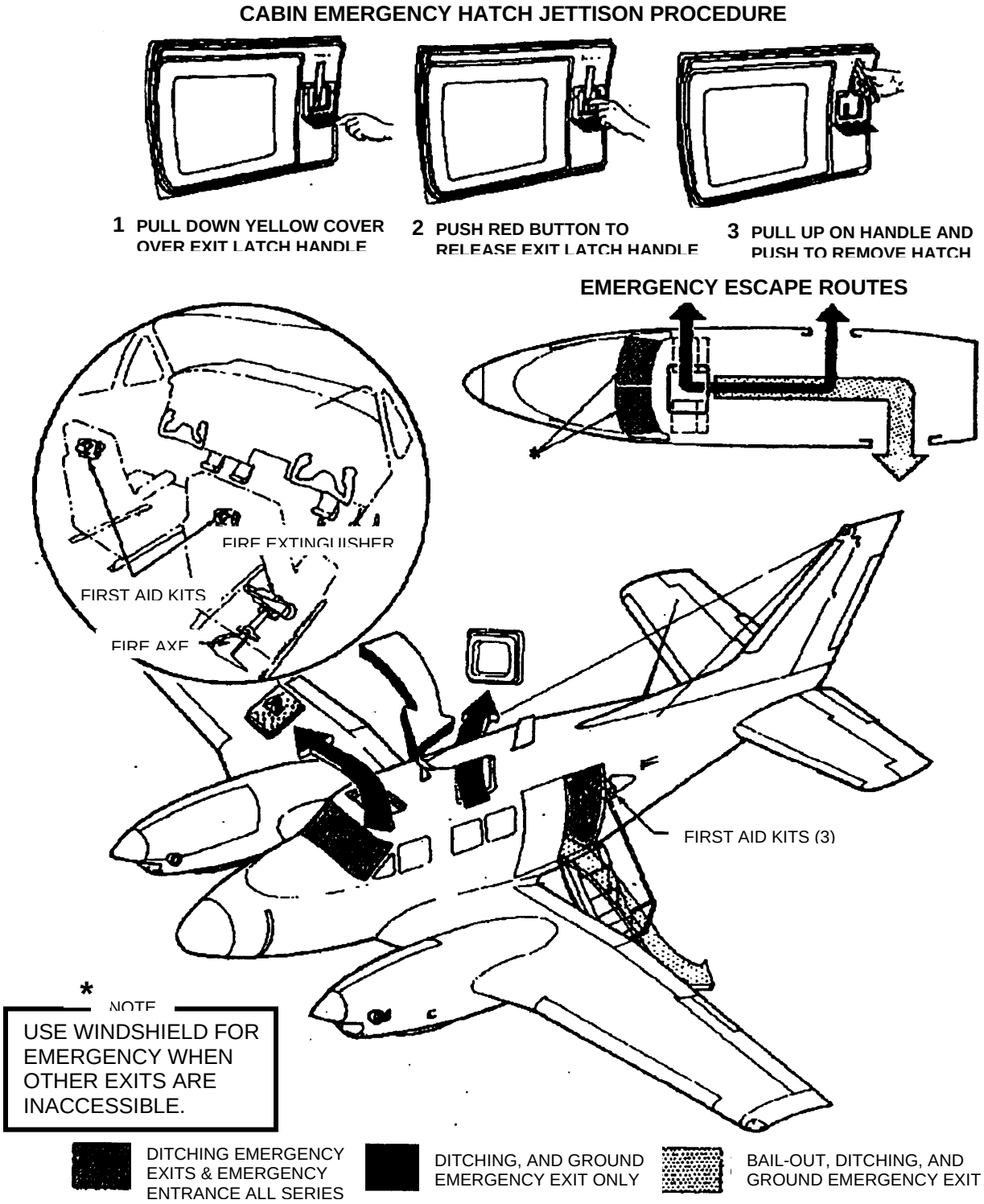


FIGURE 50. Emergency equipment and emergency exits (sheet 1 of 2)

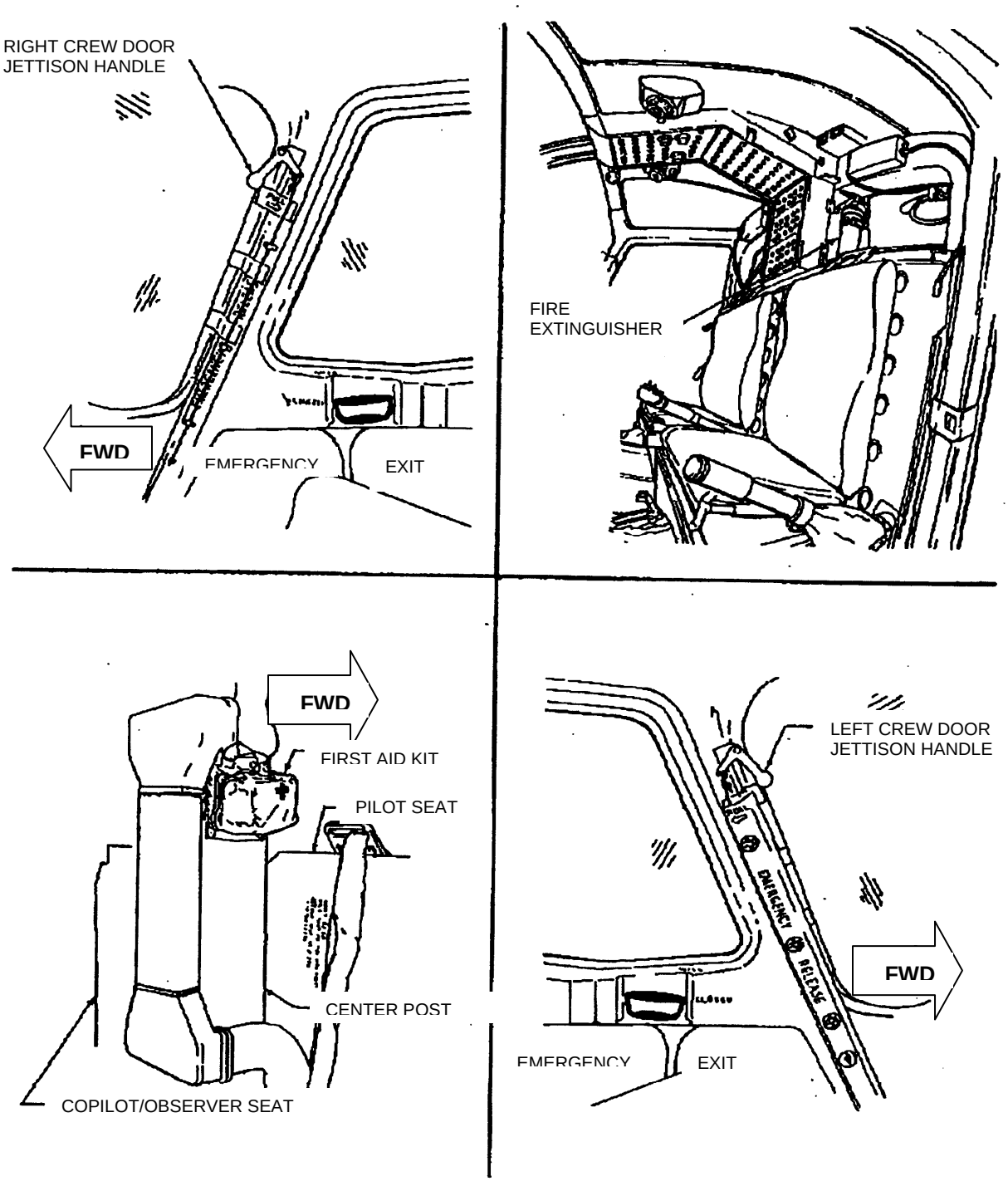


FIGURE 50. Emergency equipment and emergency exits (sheet 2 of 2)

MAXIMUM GLIDE DISTANCE

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

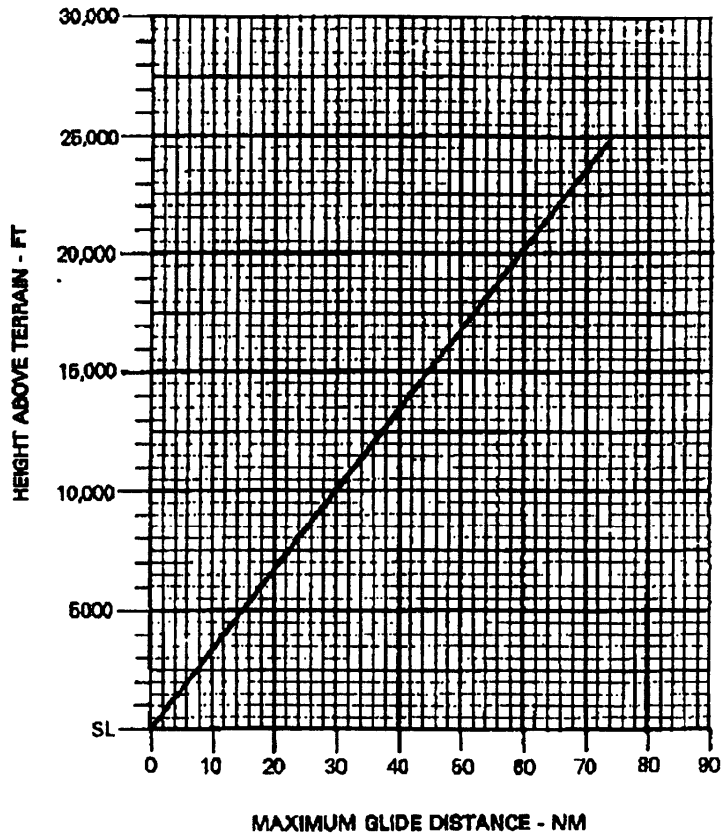
WEIGHT - LBS.	BEST GLIDE SPEED KIAS
9650	112
9000	108
8000	102
7000	94
6000	87

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 51. Maximum glide distance (FW)

AUTOROTATIONAL GLIDE

EXAMPLE

WANTED

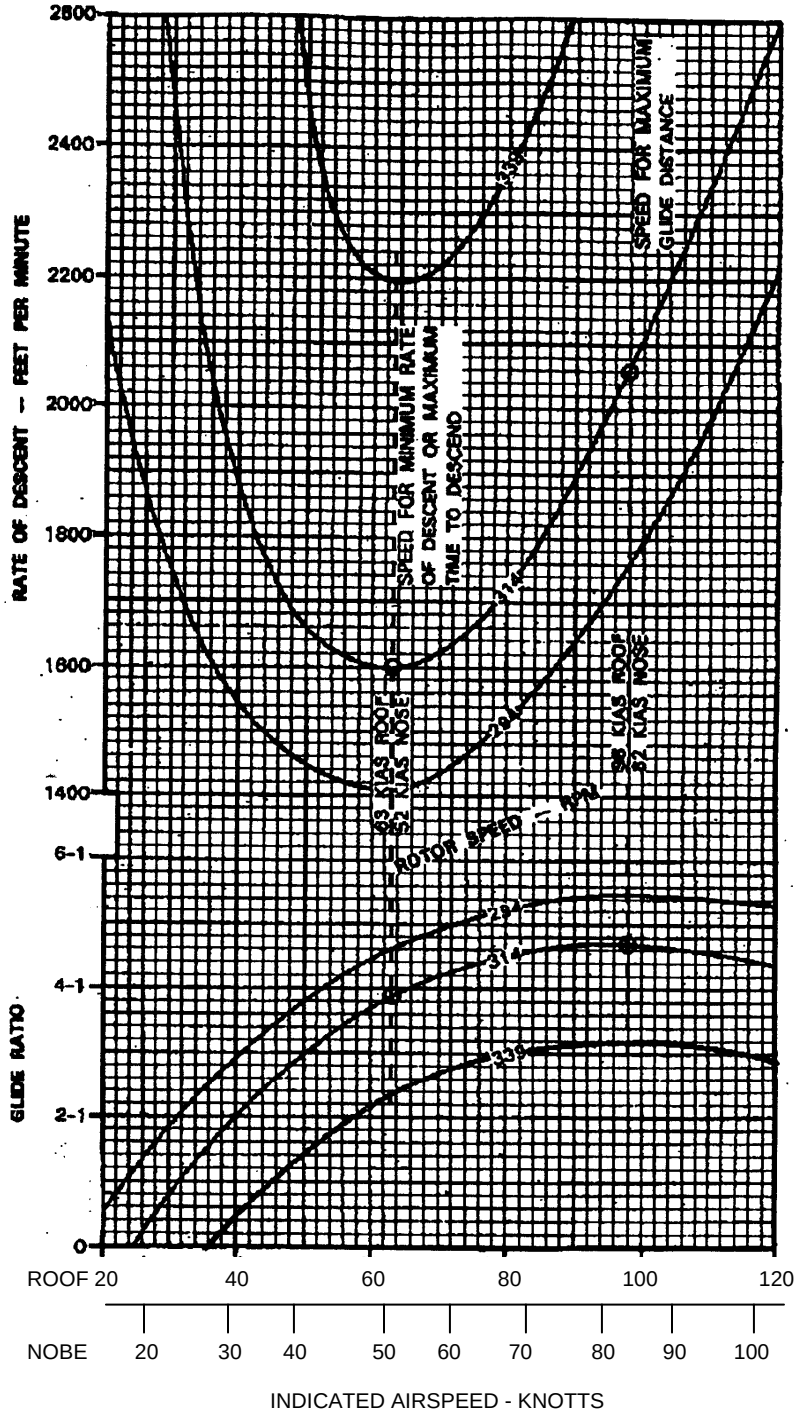
GLIDE RATIO AND RATE OF DESCENT

KNOWN

AIRSPEED – 80 KIAS ROOF
ROTOR RPM – 314

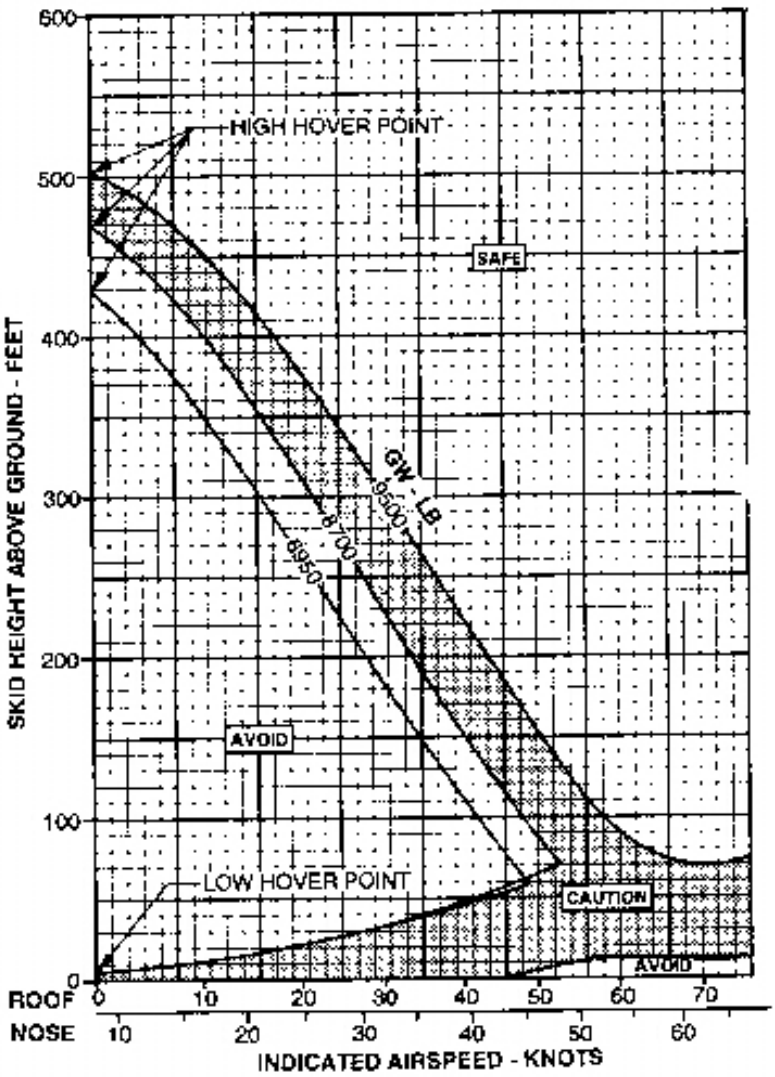
METHOD

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 52. Autorotational descent



DATA BASIS: DERIVED FROM FLIGHT TEST FTC-TDR 57.27 NOVEMBER 1964

FIGURE 53. Height velocity diagram

TM 1-XXXX-XXX-10

By Order of the Secretary of the Army:

Official:

PETER J.
SCHOOMAKER
General, United States Army
Chief of Staff

Sandra R. Riley
SANDRA R. RILEY
Administrative Assistant to the
Secretary of the Army
0230912

DISTIBUTION:
To be distibuted in accordance with Initial Distribution Number (IDN) 310293, requirements for TM 1-XXXX-XXX-10

FIGURE 54. Example of authentication page

These are the instructions for sending an electronic 2028

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, and 27.

From: "Whomever" <whomever@wherever.army.mil>
To: 2028@redstone.army.mil

Subject: DA Form 2028

1. ***From:*** Joe Smith
2. *Unit:* home
3. ***Address:*** 4300 Park
4. ***City:*** Hometown
5. ***St:*** MO
6. ***Zip:*** 77777
7. ***Date Sent:*** 19–OCT–93
8. ***Pub no:*** 55–2840–229–23
9. ***Pub Title:*** TM
10. ***Publication Date:*** 04–JUL–85
11. *Change Number:* 7
12. *Submitter Rank:* MSG
13. ***Submitter FName:*** Joe
14. *Submitter MName:* T
15. ***Submitter LName:*** Smith
16. ***Submitter Phone:*** 123–123–1234
17. ***Problem:*** 1
18. *Page:* 2
19. *Paragraph:* 3
20. *Line:* 4
21. *NSN:* 5
22. *Reference:* 6
23. *Figure:* 7
24. *Table:* 8
25. *Item:* 9
26. *Total:* 123
27. ***Text:***

This is the text for the problem below line 27.

FIGURE 55. Instructions for sending an electronic DA Form 2028 (sheet 1 of 3)

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25-30; the proponent agency is ODISC4.	Use Part II (*reverse*) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/ Supply Manuals (SC/SM)	DATE
TO: (*Forward to proponent of publication or form*)(*Include ZIP Code*)	FROM: (*Activity and location*)(*Include ZIP Code*)	

PART 1 – ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE

ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO. *	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON

* *Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/ AUTOVON, PLUS EXTENSION	SIGNATURE

DA FORM 2028, FEB 74 REPLACES DA FORM 2028, 1 DEC 68, WHICH WILL BE USED. USAPA V3.01

FIGURE 55. Instructions for sending an electronic DA Form 2028 (sheet 2 of 3)

TO: *(Forward direct to addressee listed in publication)*	FROM: *(Activity and location) (Include ZIP Code)*	DATE

PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	DATE	TITLE

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

PART III – REMARKS *(Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

FIGURE 55. Instructions for sending an electronic DA Form 2028 (sheet 3 of 3)

***TM 1-XXXX-XXX-CL**

TECHNICAL MANUAL

Operator's and
Crewmember's Checklist

ARMY
HELICOPTER
(EIC: RCD)

Disclosure Notice (If Applicable
Warning (If Applicable)
Destruction Notice (If Applicable)

Supersedure Notice (If Applicable)

HEADQUARTERS
DEPARTMENT OF THE ARMY
Day Month Year

FIGURE 56. Operator's checklist cover/title page

TM 1-XXXX-XXX-CL

C 1

CHANGE NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 1 May 2004

Operator's and Crewmember's
Checklist

Army Model
Helicopter
(EIC:RCE)

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited

TM 1-XXXX-XX-CL, 28 March 1998 , is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
E-13 and E-14	E-13 and E-14
-------	E-14.1/(E-14.2 blank)
P-3 – P-8	P-3 – P-8

2. Retain this sheet in front of manual for reference purposes.

FIGURE 57. Operator's checklist change transmittal page (sheet 1 of 2)

TM 1-XXXX-XXX-CL

C 1

By Order of the Secretary of the Army:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

Official:

SANDRA R. RILEY
Administrative Assistant to the
Secretary of the Army

DISTRIBUTION:

To be distributed in accordance with DA Form 12-31-E, block no. 0194, requirements for TM 55-XXXX-XXX-CL

FIGURE 57. Operator's checklist change transmittal page (sheet 2 of 2)

TM 1-XXXX-XXXCL

BEFORE EXTERIOR CHECK

WARNING

Do not preflight until armament systems are safe.

* 1. Publications — Check DA Forms 2408-12, -13-1, -14, -18, DD 364-4, 1896, local forms, -10, -CL.

* 2. Ignition lock switch — On.

3. EMERGENCY POWER panel — Check.

4. Cockpit area — Check condition, fire extinguisher, jettisonable door, sliding windows.

* 5. Forward transmission — Check oil level, filter button, cooler.

* 6. Forward transmission oil cooler inlet — Check.

7. Fuel sample — Check first flight of day.

INTERIOR CHECK

FORWARD CABIN

1. Flight control closet — Check jam indicators, thrust idler assembly, ILCA connecting links.
2. Heater Compartment — Check.
3. Emergency escape axe — Check.
4. Cabin door — Check.
5. Avionics equipment — Check security and gyros.
6. Fire extinguisher — Check.
7. Cabin escape panel — Check.
8. Transformer-rectifier air intake screens —Check.
9. Seats, litters, first aid kits, cargo, and jettisonable cabin windows — Check.
10. Utility hatch door and lower rescue door — Check.

O 11. Radar Altimeter (center cargo hook area) — Check Security, Lo Set Knob OFF, Dimming Control OFF.

N-1 C3

FIGURE 58. Example of condensed checklist/MTF (normal procedures) page

OPERATOR'S AND CREWMEMBER'S
CHECKLIST
OH–58A/C HELICOPTER
1 April 2003

DISTRIBUTION STATEMENTS A: Approved for public release; distribution is unlimited.

This manual supersedes TM 1–1520–228–CL, 28 July 2000.

HELICOPTER AND SYSTEMS

BEFORE EXTERIOR CHECK
1. Publications – Check.
2. Covers, locking devices, tiedowns (except main rotor), and grounding cables – Removed and secured.
3. Ignition switch – On.
4. Cockpit – Check.

EXTERIOR CHECK
1. Cabin interior – Check.
2. Fuselage (Area 1) – Check.
3. Tailboom (Area 2) – Check; tiedown removed.
4. Main rotor blade (Area 2) – Check, tiedown removed.
5. Tail rotor gear box – Check.
6. Tail rotor – Check.
7. Tailboom (Area 3) – Check.
8. Fuselage (Area 4) – Check.
9. Main rotor blade (Area 4) – Check.
10. **Fuselage top – Check.**
11. **Main rotor system – Check.**
12. **Fuselage (Area 5) – Check.**
13. **Cockpit – Check.**
14. **Fuselage (Area 6) – Check.**
15. **Crew and passenger briefing – Complete.**

BEFORE STARTING ENGINES
1. Shoulder harness lock(s) – Check.
2. Overhead switches and circuit breakers – Set.
3. GPU – Connect for GPU – start.
4. Avionics – Off and set.
5. Instrument panel instruments & switches – Check and set.
6. Flight controls – Check and set.
7. Throttle – Check. Move to open, then to idle stop; press idle release and close.

STARTING ENGINE
1. Freiguard – Post if available.
2. Rotor Blades – Check clear and untied.
3. Engine – Start.
4. GPU – Disconnect; then BAT switch – BAT, if required.
5. N2 – Stabilized.
6. THROTTLE ADJUST – 70 percent N1.
7. GEN switch – GEN.
8. DC amps – Check 60 or less.
9. INV switch – INV.
10. **Avionics – On.**

ENGINE RUNUP
1. Engine and transmission instruments – Check.
2. Throttle – Slowly increase to open. Set N2 to 100 percent.
3. HEAT and DEICE systems – Check if use is anticipated; then set as required.
4. Avionics – Check as required.
5. Flight instruments – Check and set.
6. Doors, armor side panels; and seat belts – Secure.
7. Health indicator test (HIT) – Check.
8. Deceleration check – Perform if required.

BEFORE TAKEOFF
1. N2 – 100 percent.
2. Systems – Check.
3. Crew, passengers, mission equipment, and seat belts – Check.
4. Avionics – As required.

HOVER CHECK
1. Flight controls – Check.
2. Engine and transmission instruments – Check.
3. Flight instruments – Check as required.
4. Power – Check.

BEFORE LANDING
1. Crew, passenger, and mission equipment – Check.
2. Landing light – As required.

ENGINE SHUTDOWN
1. Throttle – Engine idle; stabilize TOT for two minutes.
2. FORCE TRIM switch – FORCE TRIM.
3. FUEL BOOST switch – OFF.
4. NGW/LDG LTS – OFF.
5. Control friction – On.
6. Avionics – On.
O 7. **Overhead switches and circuit breakers – Set.**
8. Battery charge – Check.
9. Throttle – Close.
10. **Overhead switches – OFF as required.**
11. **Ignition switch – OFF (Keys as required.)**
O 12. **Doors – Close immediately after exiting.**

BEFORE LEAVING THE HELICOPTER
1. Main rotor blades – Tie down as required.
2. Walk–around – Complete.
3. DA Form 2408–12 and 2408–13–1–Complete.
4. Secure helicopter – As required.

THRU–FLIGHT CHECKLIST

PREFLIGHT
1. Covers, locking devices, tiedowns (except main rotor), and grounding cables – Removed and secured.
2. Ignition switch – On.
O 3. **Cargo/loose equipment – Check.**
O 4. **Auxiliary fuel cell – Check.**
5. Passenger and seat belts – Check.
6. Hydraulic reservoirs/servos and flight controls – Check.
7. Transmission compartment – Check.
8. Fuel – Check quantity.
9. Main rotor blade – Check, tiedown removed.
10. **Tail rotor gearbox – Check.**
11. **Tail rotor – Check.**

1

TM 1–1520–228–CL

12. **Engine Oil Level – Check.**
13. **Main rotor system – Check condition.**
14. **Crew and passenger briefing – Complete.**

BEFORE STARTING ENGINE
1. ANTI COLL LTS switch – As required.
2. POS LTS switch – As required.
3. BAT switch – As required.
4. GPU – Connect for GPU start.
5. Flight control – Check and set.
6. Throttle – Check. Move to open, then to idle stop; press idle release and close.

STARTING ENGINE
1. Freiguard – Post if available.
2. Rotor Blades – Check clear and untied.
3. Engine – Start.
4. GPU – Disconnect; then BAT switch – BAT, if required.
5. N2 – Stabilized.
6. THROTTLE ADJUST – 70 percent N1.
7. GEN switch – GEN.
8. DC amps – Check 60 or less.
9. INV switch – INV.
10. **Avionics – On.**

ENGINE RUNUP
1. Engine and transmission instruments – Check.
2. Throttle – Slowly increase to open. Set N2 to 100 percent.
3. Flight instruments – Check and set.
4. Doors, armor side panels; and seat belts – Secure.

BEFORE TAKEOFF
1. N2 – 100 percent.
2. Systems – Check.
3. Crew, passengers, mission equipment, and seat belts – Check.
4. Avionics – As required.

By Order of the Secretary of the Army:

Official:

ERIC K. SHINSEKI
General, United States Army
Chief of Staff

JOEL B. HUDSON
Administrative Assistant to the Secretary of the Army
0304902

To be distributed in accordance with Initial Distribution Number (IDN) 310239, requirements for TM 1–1520–228–CL.

FIGURE 59. Example of an alternate operator's checklist (sheet 1 of 2)

TM 1-1520-228-CL

EMERGENCY PROCEDURES

ENGINE MALFUNCTION
ENGINE FAILURE – HOVER
AUTOROTATE.
ENGINE FAILURE – LOW ALTITUDE/LOW AIRSPEED OR CRUISE
1. AUTOROTATE.
2. EMER SHUTDOWN.
ENGINE RESTART – DURING FLIGHT
1. Throttle – Close.
2. Attempt start.
3. LAND AS SOON AS POSSIBLE.
ENGINE COMPRESSOR STALL
1. Collective – Reduce.
2. ENG DEICE AND HTR switches – OFF.
3. LAND AS SOON AS POSSIBLE.
ENGINE OVERSPEED
1. Collective – Increase.
2. Throttle – Adjust.
3. LAND AS SOON AS POSSIBLE.
If RPM cannot be controlled manually:
4. AUTOROTATE.
5. EMER SHUTDOWN.
ENGINE UNDERSPEED
If powered flight with rotor in the green can be accomplished:
LAND AS SOON AS POSSIBLE.
If engine underspeed below 94% N_2, then:
1. AUTOROTATE.
2. EMER SHUTDOWN.
ENGINE SURGES
If surges in engine RPM are experienced:
1. GOV RPM switch – INCR.
2. Throttle – Adjust to 99% N_2.
3. LAND AS SOON AS POSSIBLE.
If engine surges are not controlled in steps 1 and 2 above:
4. AUTOROTATE.
5. EMER SHUTDOWN.
ROTORS, TRANSMISSION, AND DRIVE SYSTEMS MALFUNCTION
LOSS OF TAIL ROTOR EFFECTIVENESS (LTE)
1. Pedal – Full Left.
2. Cyclic – Forward.
3. As recovery is effected., adjust controls for normal flight.
MAIN DRIVESHAFT FAILURE
1. AUTOROTATE – Establish power on autorotation path.
2. EMER SHUTDOWN after landing.

CLUTCH FAILS TO DISENGAGE
1. Throttle – Close.
2. LAND AS SOON AS POSSIBLE.
MAST BUMPING
LAND AS SOON AS POSSIBLE.
FIRE
HOT START
1. STARTER switch – Press.
2. Throttle – Close.
ENGINE/FUSELAGE/ELECTRICAL FIRE – GROUND
EMER SHUTDOWN
ENGINE/FUSELAGE/FIRE –IN-FLIGHT
If Power-On landing:
1. LAND AS SOON AS POSSIBLE.
2. EMER SHUTDOWN after landing.
If Power – Off landing:
3. AUTOROTATE.
4. EMER SHUTDOWN.
ELECTRICAL FIRE – FLIGHT
1. BAT and GEN switches – OFF.
2. LAND AS SOON AS POSSIBLE.
3. EMER SHUTDOWN after landing.
SMOKE AND FUME ELIMINATION
1. Vents – Open.
2. DEICE & VMS SWITCH – ON.
ELECTRICAL SYSTEM MALFUNCTIONS
GENERATOR FAILURE – NO OUTPUT
1. GEN FIELD and GEN & BUS RESET circuitbreakers – Check in.
2. GEN switch – RESET, then GEN – Do not hold the switch in the RESET position.
If the generator is not restored, or if it goes off the line again:
3. GEN switch – OFF.
4. Turn OFF all unnecessary electrical equipment.
5. LAND AS SOON AS PRACTICABLE.
OVERHEATED BATTERY
1. BAT switch – OFF.
2. LAND AS SOON AS POSSIBLE.
3. EMER SHUTDOWN after landing.
HYDRAULIC SYSTEM MALFUNCTION
HYDRAULIC POWER FAILURE
1. Airspeed – Adjust.
2. HYD BOOST SOL circuit breaker – Out.
If hydraulic power is not restored:
3. HYD BOOST SOL circuit breaker – In.
4. HYD BOOST switch – OFF.
5. LAND AS SOON AS PRACTICABLE.
LANDING AND DITCHING
DITCHING – POWER ON
1. Doors – Jettison at a hover.

2

2. Crew (except pilot) and passengers – Exit.
3. Hover at a safe distance away from personnel.
4. AUTOROTATE.
5. Pilot – Exit when the main rotor stops.
DITCHING – POWER OFF
1. AUTOROTATE.
2. Doors – Jettison.
3. Crew and passengers – Exit when the main rotor stops.
FLIGHT CONTROL MALFUNCTIONS
1. LAND AS SOON AS POSSIBLE.
2. EMER SHUTDOWN after landing.
LIGHTNING STRIKE
LAND AS SOON AS POSSIBLE.
IN-FLIGHT WIRE STRIKE
LAND AS SOON AS POSSIBLE.

WARNING PANEL LIGHTS

WARNING LIGHT	CORRECTIVE ACTION
ROTOR RPM	Verify condition. Adjust collective.
MASTER CAUTION	Check for Caution Panel segment light illumination. If none, LAND AS SOON AS POSSIBLE.
ENGINE OUT	Verify condition. AUTOROTATE.
XMSN OIL PRESS (Red)	LAND AS SOON AS POSSIBLE.
XMSN OIL HOT (Red)	LAND AS SOON AS POSSIBLE.

CAUTION PANEL LIGHTS

CAUTION LIGHT	CORRECTIVE ACTION
FUEL BOOST	LAND AS SOON AS PRACTICABLE.
20 min fuel	LAND AS SOON AS PRACTICABLE.
FUEL FILTER	LAND AS SOON AS POSSIBLE.
ENG OIL BYPASS	LAND AS SOON AS POSSIBLE.
ENG CHIP DET	LAND AS SOON AS POSSIBLE.
XMSN CHIP DET	LAND AS SOON AS POSSIBLE.
TR CHIP DET	LAND AS SOON AS POSSIBLE.
INST INVERTER	Information/system status.
DC GENERATOR	Refer to emergency procedures.
HYD PRESS	Refer to emergency procedures.
IFF	Information/system status.
SPARE	LAND AS SOON AS POSSIBLE.

FIGURE 59. Example of an alternate operator's checklist (sheet 2 of 2)

*TM 1-XXXX-XXX-MTF

MAINTENANCE TEST
FLIGHT MANUAL

ARMY
HELICOPTER

Disclosure Notice (If Applicable)
Warning (If Applicable)
Destruction Notice (If Applicable)

Supersedure Notice (If Applicable)

HEADQUARTERS
DEPARTMENT OF THE ARMY
Day Month Year

FIGURE 60. Example of MTF cover

TM 1-XXXX-XXX-MTF

C 1

CHANGE NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 1 May 2004

Operator's and Crewmember's
Checklist

Army Model
Helicopter
(EIC:RCE)

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited

TM 1-XXXX-XX-MTF, 28 March 1998 , is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
2-5 and 2-6	2-5 and 2-6
-------	2-14.1/(2-14.2 blank)
4-3 – 4-8	4-3 – 4-8

2. Retain this sheet in front of manual for reference purposes.

FIGURE 61. Example of an MTF change transmittal page. (sheet 1 of 2)

TM 1-XXXX-XXX-MTF

C 1

By Order of the Secretary of the Army:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

Official:

SANDRA R. RILEY
Administrative Assistant to the
Secretary of the Army

DISTRIBUTION:

To be distributed in accordance with DA Form 12-31-E, block no. 0194, requirements for TM 55-XXXX-XXX-MTF

FIGURE 61. Example of an MTF change transmittal page. (sheet 2 of 2)

TM 1-XXXX-XXX-MTF

REPORTING OF 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) located in the back of the applicable Aircraft Operators manual direct to: Commander, U.S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5230. You may also submit your recommended changes by e-mail directly to 2028@redstone.army.mil or by fax (256) 842-6546/DSN 788-6546. A reply will be furnished directly to you. Instructions for sending an electronic 2028 may be found at the back of the Aircraft Operator's manual.

ENVIRONMENTAL/HAZARDOUS MATERIAL INFORMATION

This document has been reviewed for the presence of Class I Ozone Depleting Chemicals. As of 14 June 1995, the status is: All references to Class I Ozone Depleting Chemicals have been removed from this document by substitution with chemicals that do not cause atmospheric ozone depletion.

TABLE OF CONTENTS

SECTION		PAGE
I	Introduction	1-1
II	Maintenance Test Flight Checklist	2-1
	Prior to Maintenance Test Flight	2-1
	Before Interior Check	2-1
	Interior	2-5
	Forward Cabin	2-5

i

FIGURE 62. Example of MTF title page w/table of contents

PURPOSE OF TEST FLIGHT:	ACFT S/N:	DATE:
PILOT:	UNIT:	

SYMBOLS: √ = SATISFACTORY X = DEFICIENCY

PRIOR TO MAINTENANCE	7. DOPPLER UPDATE _____
TEST FLIGHT	INFLIGHT CHECKS
1. FORMS AND RECORDS	1. RAD ALT CHECK
2. FLIGHT READINESS INSPECTION	2. CONTROL RIGGING
BEFORE STARTING ENGINE CHECK	3. SCAS
1. FAT_____°	4. COLLECTIVE ANTICIPATOR CHECK
2. ALTIMETER	5. HYDRAULIC SYS CHECK
3. CWA SYSTEM	6. AUTOROTATION NR _____%
4. ENGINE HISTORY	7. VIBRATION ANALYSIS
5. MPD	8. PYLON ISOLATION MOUNT CHECK
STARTING ENGINE AND RUNUP	9. FLIGHT INSTRUMENTS
CHECKS	VSD PAGE
1. START PEAK TGT _____°C	AIRSPEED INDICATION
START TIME _____	HEADING INDICATION
2. CYCLIC FWD ____(lb) AFT _____	BAROMETRIC ALTIMETER
R____(lb) L____(lb)	VSI
COLLECTIVE ____(lb) T/R ____(lb)	ATTITUDE INDICATOR
3. HYDRAULIC SYSTEM	STANDBY FLIGHT INSTRUMENTS
4. ENG IDLE SPEED CHECK	SLIP INDICATOR
5. CONTROL OVERSPEED CHECK	STANDBY AIRSPEED INDICATOR
6. SCAS	STANDBY ATTITUDE INDICATOR
HEADING HOLD	STANDBY ALTIMETER
SCAS TEST	MAGNETIC COMPASS
7. COMPT BLWR	10. COMMUNICATION
8. DEFOG BLWR	FM 1 ____ UHF ____
9. HTR	FM 2 ____ HF ____
10. PITOT HTR	VHF ____ FM HOMING ____
11. FUEL BOOST	KY58 ____ TRANSPONDER ____
12. ENGINE ANTI ICE	KY75 ____ APR 39 ____
13. BATT PRHT	ATHS _____
14. INSTRUMENTS R/U	11. NAV SYSTEM
XMSN OIL P _____PSI	WAYPOINT 1 _____
XMSN OIL T _____°C	2 _____
ENG OIL P _____PSI	3 _____
ENG OIL T _____°C	CIRCULAR ERROR _____
NG _____% TGT _____°C	ENGINE SHUTDOWN CHECKS
MAST TRQ _____%	1. INSTRUMENTS S/D
ENG TRQ _____%	XMSN OIL P _____PSI
15. POWER ASSURANCE CHECK	XMSN OIL T _____°C
ALTIMETER _____(Hg) in	ENG OIL P _____PSI
PA _____ft FAT _____°C	ENG OIL T _____°C
TGT _____°C NG _____%	NG _____% TGT _____°C
ENG TRQ (chart) _____%	MAST TRQ _____%
ENG TRQ (indicated) _____%	ENG TRQ _____%
ENG HEALTH _____%	BATT V _____
AIRCRAFT HOVER CHECKS	2. THROTTLE CHECK
1. HOVER POWER NG _____%	3. POST TEST FLIGHT INSP
TGT _____°C TRQ _____%	4. COMPLETE UPDATE FORMS
2. CONTROL RESPONSE CHECK	AND RECORDS
3. SCAS	5. SPECIAL EQUIPMENT LIST
4. POWER CYLINDER CHECK	
5. ENGINE RESPONSE	
FUEL CONTROL CHECK	
6. HOVER BOB UP	

Sample

FIGURE 63. Example of MTF check sheet

TM 1-1520-XXX-MTF

SECTION IV. SPECIAL PROCEDURES

GENERAL This section contains special procedures which were referenced in Section II.

A. AFCS BITE CHECKS.

Reference: TM 55-1520-240-23

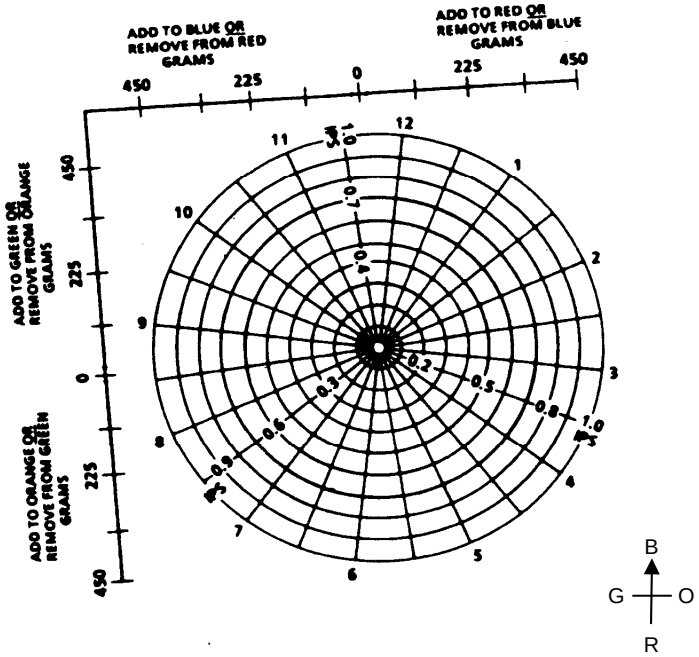
This test should only be performed to verify a suspected AFCS discrepancy. The bite test is performed by pressing the BITE switch on the AFCS computer. The bite associated with system No. 1 tests system No. 1 only and system No. 2 test system No. 2 only. The engine condition levers provide a bite interlock which prevents inadvertent bite operation during flight. The bite test can be interrupted during operation by moving the engine condition level out of the STOP position and back again, or by switching the AFCS to OFF.

1. Prior to activating the bite test, perform the following:
   a. Start apu and apply electrical and hydraulic power.
   b. Close all circuit breakers.
   c. AFCS SYSTEM SEL — NO. 1 or NO. 2 (do not select BOTH).
   d. CYCLIC TRIM — AUTO.
   e. Cyclic stick and directional pedals — Center.
   f. STEERING CONTROL panel — Knob centered.
   g. SWIVEL switch — LOCK.
   h. Radar altimeter — Set LO knob to 100 feet.
   i. Heading bug to heading of helicopter, then 30° clockwise.
   j. ENG CONDITION levers — STOP.
   k. Ensure left and right aft landing gear is in ground contact (Not on jacks).

4-1

FIGURE 64. Example of MTF special/detailed procedures page

TM 1-XXXX-XXX-MTF



Approximate Track Sensitivity 100% NR

P/C Adjustment	Track Change
1 Flat of Barrel	.1 Inch
1 Turn of Barrel	.6 Inch
½ Turn of Lower Rod End	.8 Inch
1° of Tab	. 1 Inch

NOTES

1. DATA OBTAINED AT 100% NR.
2. SET RPM TUNE DIAL TO 394.
3. SET STROBEX RPM DIAL TO 600.
4. USE FORE AND AFT ACCELEROMETER.

Figure XX. Fore and Aft Balance Chart at 100% NR.

FIGURE 65. Example of MTF charts and forms (sheet 1 of 2)

TM 1-XXXX-XXX-MTF

BLADE COLOR CODE	BLADE SERIAL NUMBER	TAB SETTING	NUMBER OF BALANCE WEIGHTS	
			212-010-710-1 WEIGHTS	970-4 WEIGHTS
BLUE				
ORANGE				
RED				
GREEN				

406010-308

Sample

Figure XX. OH-58D Rotor Smoothing Log

5-8

FIGURE 65. Example of MTF charts and forms (sheet 2 of 2)

TM 1-XXXX-XXX-MTF

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimenter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigrams = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 38.82 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

FIGURE 66. Example of metric conversion chart

APPENDIX A

STYLE AND FORMAT REQUIREMENTS FOR OPERATOR'S MANUAL

A.1 SCOPE

A.1.1 Scope. This appendix provides the style and format requirements for development and presentation of printed page-based Operator's manuals covered by this specification.

A.2. APPLICABLE DOCUMENTS

A.2.1 General. The documents listed in this section are specified in section A.3 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section A.3 of this specification, whether or not they are listed.

A.2.2 Government documents.

A.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-STD-40051-2	Preparation of Digital Technical Information for Page-Based Technical Manuals

(Application for copies of DOD documents should be addressed to the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094 or at http://www.dodssp.daps.mil.)

A.2.3 Non-Government publications. The following document forms a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation.

ASME Y14.38M	Abbreviations and Acronyms

(Application for copies of ASME publications should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017-2393.)

A.2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

A.3 STYLE AND FORMAT

A.3.1 Front matter arrangement. Unless otherwise specified (6.2), front matter preceding the first chapter of a TM shall consist of the following in the order specified:

a. Cover.

b. Warning page.

c. Change transmittal page.

d. List of effective pages.

e. Abbreviated title page/table of contents.

A.3.1.1 Cover. A cover shall be provided. Type sizes for the cover shall be such that all the information can be included within the prescribed area. Refer to Figure A-1 for applicable type styles an sizes.

A.3.1.2 Warning page. The warning page shall begin on the first right-hand page immediately following the cover. The page(s) shall be numbered with lower case letters.

A.3.1.3 Change transmittal page. When applicable, the change transmittal page (s) shall follow the warning page. The change transmittal page(s) shall not have page numbers.

A.3.1.4 List of effective pages. The list of effective pages shall be numbered with an upper case letter centered on the bottom of the page.

A.3.1.5 Abbreviated title page/table of contents. Space permitting, the abbreviated title page information and the table of contents shall be placed on the same page. If the title page information fills up most of the page, the table of contents may begin on the first right-hand page following the abbreviated title page. The abbreviated title page/table of contents shall be assigned sequential lower case Roman numerals, i.e., i, ii, iii, etc.

A.3.2 Size. Operator's TMs shall be prepared for a final trim size of 8 ½ inches wide by 11 inches in length. The usable area for preparation of the manuals shall be 7-¼ by 10 inches (including marginal copy).

A.3.3 Structure. The contents of the Operator's manual shall be structured as follows:

a. Chapters – divides TM into major divisions.

b. Sections – divides chapters into specific areas of coverage.

c. Paragraphs and subparagraphs – divide sections into specific topics.

A.3.3.1 Chapter and section requirements. As applicable, each chapter shall start on an odd numbered page. One 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 amount of space remaining for a heading and one entire line of text to start the next section.

A.3.3.2 Page arrangement. All text shall be arranged in a double column page. Each column shall be approximately 3-½ inches wide with a gutter approximately ¼ inch wide between the columns. When authorized by the acquiring activity (6.2), Operator's manuals shall be arranged in a single column page. Text shall be arranged in a 7 by 10 inch image area.

A.3.4 Text formatting. All text within the Operator's manual shall be formatted as instructed below.

A.3.4.1 Primary sideheads. Primary sideheads shall divide text within chapters or sections. There shall be at least one primary sidehead in each chapter or section. Primary sideheads shall begin two spaces below the preceding paragraph at the left margin. They shall be followed by a period and are stand alone (are not run in with text) (See Figure A-2).

A.3.4.2 Subordinate Sideheads. Subordinate sideheads shall begin two spaces below the preceding paragraph at the left margin and shall not be numbered. They shall be followed by a period. The text may begin on the same line separated by a period and two spaces. Second and subsequent subordinate paragraphs should, but are not required to, have a sidehead. The first letter of the first word and of each principal word shall be capitalized.

A.3.4.3 Paragraph numbers. Primary sideheads shall be numbered within the chapter (See Figure A-2). All paragraph numbers shall be preceded by the chapter number and a hyphen, e.g. the first primary paragraph of Chapter 1 would be 1-1, the second primary paragraph would be 1-2, etc., and followed by a period and two spaces.

A.3.4.3.1 First level subordinate paragraphs. The first level subordinate paragraph shall be numbered consecutively in lower case letters followed by a period and two

spaces. The first line of subordinate paragraphs shall begin indented from the left margin 0.2 inches, the remaining lines shall wrap back to the left margin

A.3.4.3.2 Second level subordinate paragraphs. The second level subordinate paragraph shall be numbered consecutively in Arabic numbers followed by a period and two spaces. The first line of subordinate paragraphs shall begin indented from the left margin 0.4 inches, the remaining lines shall wrap back to the left margin.

A.3.4.3.3 Third level subordinate paragraphs. The third level subordinate paragraph shall be numbered consecutively in lower case letters within parenthesis followed by two spaces. The first line of subordinate paragraphs shall begin indented from the left margin 0.67 inches, the remaining lines shall wrap back to the left margin.

A.3.4.3.4 Fourth level subordinate paragraphs. The fourth level subordinate paragraph shall be numbered consecutively in underlined Arabic numbers followed by a period and two spaces. The first line of subordinate paragraphs shall begin indented from the left margin 0.92 inches, the remaining lines shall wrap back to the left margin.

A.3.4.3.5 Fifth level subordinate paragraphs. The fifth level subordinate paragraph shall be numbered consecutively in underlined lower case letters followed by two spaces. The first line of subordinate paragraphs shall begin indented from the left margin 1.15 inches, the remaining lines shall wrap back to the left margin.

A.3.4.3.6 Sixth level subordinate paragraphs. The sixth level subordinate paragraph shall be numbered consecutively in underlined Arabic numbers within parenthesis followed by two spaces. The first line of subordinate paragraphs shall begin indented from the left margin 1.32 inches, the remaining lines shall wrap back to the left margin

A.3.4.4 Paragraph titles. The first word and main words in paragraph titles shall be capitalized. Second and subsequent lines of subordinate paragraphs shall begin at the left margin (See Figure A-2).

A.3.4.5 Procedural steps. Procedural steps shall begin two spaces below the preceding text, numbered sequentially with Arabic numbers, and indented five spaces from the left margin (Figure A-2). Substeps shall begin two spaces below the preceding step and indented an additional five spaces. Substeps shall be numbered sequentially with lower case letters within parentheses starting with (a). The text shall begin on the same line as the step number and be separated by two spaces. Carry over lines shall not return to the left margin but shall start under the first letter of the preceding line.

A.3.5 TM identification number. Unless otherwise specified by the acquiring activity (6.2), the publication number shall be the same as the TM number of the aircraft system, followed by "-10" for operator's manuals. The TM number shall appear centered in the top margin and in boldfaced type.

A.3.6 Joint manuals. When Operator's manuals are acquired by one Service for joint use with another Service, each Service's number shall be prefixed with the word "Army", "Navy (NAVSEA) (NAVAIR)", "Marine Corps", or "Air Force", as applicable. The acquiring activity's TM number shall be placed above the using activity's TM identification number. Paragraphs in joint publications which do not apply to all Services concerned shall be marked to indicate the Services to which they do apply.

A.3.7 Publication date. The publication date shall be the cutoff date from which no further changes to the TM are permitted without issuing a formal change. Unless otherwise specified (6.2), the publication date shall be the date at which the last material to be included was received. The date shall be written in the sequence: day; month; year, for example 23 June 1996.

A.3.8 Page numbers. Page numbers shall be located at the lower center of the page and shall be in boldfaced type. Even numbers, including zero, shall be assigned to left-hand pages and odd numbers to right-hand pages. Manuals divided into chapters shall contain consecutively numbered pages, tables and illustrations for the entire chapter. Page, table, and illustration numbers shall consist of the chapter number, followed by a hyphen, and then a second number representing the order within the chapter.

A.3.9 Text. The text shall be written in clear, simple, and concise language. Technical terms requiring special knowledge shall be avoided, except where no other wording shall convey the intended meaning. Procedures shall be broken down into distinct steps for accomplishment. All procedures called out shall be fully explained in logical completion sequence. Classified information shall not be included in any TMs.

A.3.10 Abbreviations. Abbreviations shall be written in accordance with ASME-Y14.38M. The first time an abbreviation is used in text, it shall be placed in parentheses and preceded by the word or term spelled out in full.

A.3.11 Acronyms. The first time an acronym is used in text, it shall be placed in parentheses and shall be preceded by the word or term spelled out in full. Acronyms used in figures and tables shall be spelled out in a footnote to the applicable figure or table.

A.3.12 Dimensional data. Except for weight and balance values in Chapter 6 of an Operator's manual, linear dimensions shall be stated in feet and inches or in inches and decimal fractions, unless otherwise specified by the acquiring activity (6.2). 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. All dimensions, tolerances, clearances, measurements, and decimal equivalents appearing in Chapters 8 and 9 of an Operator's manual shall be stated in bold capital lettering in the text and on illustrations.

A.3.13 Manufacturers' names. The use of manufacturers' names in the operator's manual shall be prohibited without prior approval of the acquiring activity (6.2).

A.3.14 Nomenclature. The nomenclature of items 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 shown on the placards. These items shall appear in text and procedural steps in boldfaced capital letters.

A.3.15 Warnings, cautions, and notes.

A.3.15.1 Use and placement.

a. A warning identifies clear danger to the person doing that procedure. A caution identifies risk of damage to the equipment. A note is used to highlight essential procedures, conditions, or statements. All warnings, cautions, and notes shall immediately precede the procedure/step to which they apply. Order of appearance shall be first warnings, then cautions, and lastly notes.

b. The header WARNING, CAUTION, or NOTE shall be bold and centered above the appropriate text. Headers shall not be numbered. When a warning, caution, or note consists of two or more paragraphs, the header WARNING, CAUTION, or NOTE shall not be repeated above each paragraph. Warnings, cautions, and notes on unrelated topics that pertain to the same procedural step(s) may be grouped under one heading. However, they shall be all warnings, or all cautions or all notes. They shall not be mixed.

c. When grouping warnings, cautions, or notes each warning, caution or note shall be separated by at least one line and may be bulleted.

d. Layout shall not result in warnings, cautions, and notes divided so first lines of text or groups of icons appear on one page and remaining lines or groups of icons on another.

e. Layout shall avoid warnings, cautions, and notes being placed on a different page than the paragraph to which they apply.

f. Warnings for hazardous materials/conditions shall include guidance pertaining to exposure (i.e., first aid treatment).

A.3.16 Appendixes. Appendixes shall immediately follow the last chapter of the TM and shall begin on a right-hand page. The title shall be written with all capitals, for example “APPENDIX A”. Pages, paragraphs, illustrations and tables shall be consecutively numbered in Arabic numerals preceded by the capital letter of the appendix, e.g. page A-17 (page) or Figure B-17.

A.3.17 Index. Unless otherwise specified (6.2), an alphabetical index shall be prepared. It shall begin on a right hand page. It shall list pertinent subjects under every topic for which users are likely to look. "See" and "see also" references may be included to guide the user to other pertinent entries. All applicable paragraph numbers for each item shall be indicated. Page numbers for indexes shall be consecutively numbered in Arabic numerals with the word "Index" preceding the page number. The index shall be located at the end of the publication but shall be located before foldout page(s). Each manual or volume in a set of manuals shall contain its own index. Refer to MIL-STD-40051-2 for the preparation requirements for a multi-volume index.

A.3.18 Amplified checklist. The checklist format for Chapter 8, normal procedures (3.2.10) shall be as shown in MIL-PRF-63029, Figure 49. All checklist titles, such as "BEFORE EXTERIOR CHECK" shall be boldfaced capital type. Checklist entries shall be listed numerically and shall be blocked. Checklist entries shall have the first letters of each line of type aligned. Placarded items shall be in boldfaced capital letters. Paragraphs shall have type returned to the left margin.

A.3.19 Emergency procedure pages. Emergency procedure pages (Chapter 9) of the operator's manual that contain emergency procedure information/steps shall have heavy black diagonal lines around three edges (Figure A-3).

A.3.20 Designator symbols. Designator symbols such as **B** shall be used in conjunction with text headings, text contents, and illustrations to show limited applicability of the material. If more than one model is described or the aircraft has a variety of configurations, one or more symbols may follow a text heading or illustration title to highlight that part of the text that pertains to the aircraft or systems in question. If the material applies to all series and configurations, no designator symbols shall be used. Where practicable, descriptive information shall be condensed and combined for all series to avoid duplication. A table showing designator symbols shall be included.

A.3.21 Referencing within a manual in PDF format. When a manual is required to be delivered in a PDF format, references to other descriptive information, maintenance tasks, or other data within the manual shall employ a hotspot to provide a link to the referenced data.

A.3.22 Revisions. When specified (6.2), a complete, updated, nonsuperseding, or a pickup revision shall be prepared. See 6.4 for definitions. Revisions shall incorporate current information from previously issued changes to the existing TM. Revisions or changes shall be published at the same frequency as other aircraft system manuals.

A.3.22.1 Renumbering and removal. In a complete revision, all pages, paragraphs, illustrations, and tables shall be renumbered, as necessary, to eliminate all number suffixes and to establish correct sequences. Complete revisions shall be prepared to current specifications and standards. In an update revision, suffixed paragraph, illustration, and table numbers shall be retained when use of the TM shall not be

substantially improved by renumbering. All change numbers and change dates shall be removed from pages. All partial pages, miniature pointing hands, shading screening, vertical lines in margin and other change symbols shall be eliminated.

A.3.22.2 Revision change symbols. When specified (6.2), after all previous change symbols have been eliminated, new change symbols shall be inserted to identify technical changes in text, illustrations, and tables that differ in the revision from those contained in the latest previous edition of the TM.

A.3.23 Changes. The change package shall conform to the format of the basic TM. Note: Changes shall be prepared for printing on the same size paper as the basic TM. The changes shall also incorporate all advanced change notices and resolution of outstanding deficiencies. Unless otherwise specified (6.2), when required, a change record shall be prepared. It should not back or be backed up. These pages shall not be numbered.

Use	BOOK	Preferred Font Type/Size	Capitalization	Leading	Vertical Spacing
Cover: Security Classification	-10, -CL, -MTF	Sans Serif Bold 14	Upper Case		
Cover TM No.	-10, -CL, -MTF	Sans Serif Bold 18 Centered	Upper Case		36 Points from Top of Page
Cover: Type of Publication	-10, -CL, -MTF	Sans Serif Bold 14 Centered	Upper Case		
Cover: Nomenclature of Equipment	-10, -CL, -MTF	Sans Serif Bold 20	Upper Case		
Cover: Availability, Supersession Notice, Disclosure Notice, Distribution Statement, Export Control Notice	-10, -CL, -MTF	Sans Serif Bold 10 Justified			
Title Block Page	-10, -CL, -MTF	Sans Serif 10	Upper and Lower Case		
TM Number	-10, -CL, -MTF	Sans Serif Bold 10 Centered	Upper Case		36 Points from Top of Page
Page No.	-10, -CL, -MTF	Sans Serif Bold 10 Centered			36 Points from Bottom of Page
Change No.	-10, -CL, -MTF	Sans Serif Bold 10 Centered	Upper and Lower Case		36 Points from Bottom of Page
Security Classification	-10, -CL, -MTF	Sans Serif Bold 14	Upper Case		36 Points from Top and Bottom of Page
Deleted Page Notation	-10, -CL, -MTF	Serif Bold 8	Upper and Lower Case	2	36 Points from Top or Bottom of Page
Chapter No. and Title	-10	Sans Serif Bold 14	Upper Case	6	48 Points Below TM Identification No.; 18 Points Above Text, Table or Illustration
Section No. and Title	'-10, -CL, MTF	Sans Serif Bold 14 Centered	Upper Case	6	28 Points Below TM Identification No. or Text of Previous Section; 24 Points Below Chapter Title; 18 Poinst Above Text, Table or Illustration

FIGURE A-1. Standard and alternate operators – type style and spacing requirements (sheet 1 of 3)

Use	BOOK	Preferred Font Type/Size	Capitalization	Leading	Vertical Spacing
Table of Contents, Safety Summary, Index, Glossary and Appendix Headings	-10, -MTF	Sans Serif Bold 14	Upper Case		48 Points Below TM Identification No.; 18 Points Above Text
Text	-10, -CL, -MTF	Sans Serif 10	Upper and Lower Case	1	18 Points Below TM Identification No. or Chapter/Section Title; 12 Poinst Above/Below Table or Illustration; 6 Points Above Page No.; 12 Points Above/Below Warning Caution and Note Headings
Formulas and Equations	-10, -CL, -MTF	Math 10	Upper and Lower Case	1	12 Points Above/Below Text, Table or Illustration
Primary Sideheads	-10	Sans Serif Bold 10	Upper and Lower Case	2	18 Pointa Below TM Identification No. or Chapter/Section Title; 12 Points Above/Below Text, Table or Illustration; 12 Points Above/Below Warning, Caution and Note Headings
	-CL, -MTF	Sans Serif Bold 14	Upper Case	2	18 Pointa Below TM Identification No. or Chapter/Section Title; 12 Points Above/Below Text, Table or Illustration; 12 Points Above/Below Warning, Caution and Note Headings
Subordinate Sideheads	-10	Saris Serif 10	Upper and Lower Case	2	18 Points Below TM Identification No. or Chapter/Section Title; 12 Points Below Table or Illustration; 12 Points Below Warning, Caution and Note Headings
	-CL, -MTF	Sans Serif Bold 12	Upper Case	2	18 Points Below TM Identification No. or Chapter/Section Title; 12 Points Below Table or Illustration; 12 Points Below Warning, Caution and Note Headings

FIGURE A-1. Standard and alternate operators – type style and spacing requirements (sheet 2 of 3)

Use	BOOK	Preferred Font Type/Size	Capitalization	Leading	Vertical Spacing
Figure No. and Title	-10, -CL, -MTF	Sans Serif Bold 10	Upper case for First Letter of each Principal Word	2	18 Points Below Illustration; 6 Points Above Page Number
Legend Text	-10, -CL, -MTF	Sans Serif 8	Upper Case for First Letter of First Word	1	28 Points Above Illustration
Legend on Artwork	-10, -CL, -MTF	Sans Serif 8	Upper Case	1	As Required
Table No. and Title	-10, -CL, -MTF	Sans Serif Bold 10	Upper Case for First Letter of Each Principal Word	2	18 Points Above Table; 18 Points Below TM Identification No.
Table Text	-10, -CL, -MTF	Sans Serif 10	Upper and Lower Case	2	
Rules	-10, -CL, -MTF	.75 Point Width			
Footnotes	-10, -CL, -MTF	Sans Serif 8	Upper and Lower Case	1	18 Points Below Text or Table
Warning and Caution Headings	-10, -CL, -MTF	Sans Serif Extra Bold 10 (Boxed)	Upper Case		12 Points Above and Below Text
Note Headings	-10, -CL, -MTF	Sans Serif Extra Bold 10	Upper Case		12 Points Above and Below Text
Maintenance Parts List, Numerical Index and Reference Designation Index Column Heads	-10, -CL, -MTF	Sans Serif 8	Upper Case	1	
Maintenance Parts List Text	-10, -CL, -MTF	Sans Serif 8 or 10	Upper and Lower case	1	
Numerical Index and Reference Designation Index Text	-10, -CL, -MTF	Sans Serif 8	Upper and Lower Case	1	12 Points Space after Every Tenth Entry
All type sizes may be plus-or-minus one point. Slight variations in spacing and leading are permitted. Final reproducible copy shall use above type sizes.					

FIGURE A-1. Standard and alternate operators – type style and spacing requirements (sheet 3 of 3)

TM 55-XXXX-XXX-10

CHAPTER 1
CHAP 1 TITLE

1-1. PRIMARY SIDEHEAD ____

a. 1st Level Sub Paragraph ____

(1) 2nd Level Sub Para

(a) 3rd Level Sub Para

1 4th Level Sub Para

a 5th Level Sub Para

(1) 6th Level Sub Para

Figure 1-1. Regular Figure Title

Figure 1-2. Deleted (title for deleted figure)

b. 1st Level Sub Para

1. 1st level procedural step followed by 2nd level steps. This has no title.

(a) 2nd level procedural step. Step2 also has no title.

(a1) Added 2nd level procedural step. Step2 also has no title.

(b) This is another second level procedural step.

1A. This is an added 1st level procedural step. This has no title.

2. 1st level procedural step. This has no title.

1-2. PRIMARY SIDEHEAD ____

Figure 1-1.1. Title For Added Figure

1-2A. ADDED PRIMARY SIDEHEAD ____

a. 1st Level Sub Para

b. 1st Level Sub Para

1-3. PRIMARY SIDEHEAD ____

a. 1st Level Sub Para

1-1/(1-2 blank)

FIGURE A-2. Example of text format

CHAPTER 9
EMERGENCY PROCEDURES

SECTION I. HELICOPTER SYSTEMS

9–1. Helicopter Systems.

This section describes helicopter systems emergencies which, may reasonably be expected to occur and presents the procedures to be followed. Emergency operation of mission equipment is contained in this chapter, insofar as its use affect safety of flight. Emergency procedures are given in checklist form when applicable. A condensed version of these procedures is included in TM 1-XXXX-XXX-10-CL.

9–2. Immediate Action Emergency Checks.

NOTE

The urgency of certain emergencies requires immediate and instinctive action by the pilot. The most important single consideration is helicopter control. All other procedures are subordinate to this requirement. The MASTER CAUTION should be reset after each malfunction to allow systems to respond to subsequent malfunctions. When appropriate, a check of the affected PDP for open circuit breakers should be accomplished, in some cases this may minimize or eliminate the emergency. An example of this would be an apparent failure of an instrument, whereas resetting the circuit breaker restores operation. If time permits during a critical emergency, jettison external loads, and lock shoulder harnesses.

Those steps that must be performed **immediately** in an emergency procedure are **underlined**. These steps must be performed without reference to the checklist (CL). When the situation permits, non-underlined steps will be accomplished with the use of the CL.

9–3. Definition of Emergency Terms.

For the purpose of standardization, the following definitions shall apply:

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

b. The term **LAND AS SOON AS PRACTICABLE** is defined as executing a landing at the nearest suitable airfield/heliport.

c. The term **AUTOROTATE** is defined as adjusting the flight controls as necessary to establish an autorotational descent and landing.

1. **Thrust control — Adjust** as required to maintain RRPM.
2. **Pedals — Adjust** as required.
3. **Cyclic — Adjust** as required.

d. The term **EMER ENG SHUTDOWN** is defined as engine shutdown **without delay**. Engine shutdown in flight is usually not an immediate action unless a fire exists. Before executing an engine shutdown, identify the affected engine by checking indications of torque, RRPM, N1, PTIT, engine oil pressure.

CAUTION

When in-flight shutdown of a malfunctioning engine is anticipated positive identification of the malfunctioning engine must be accomplished to avoid shutting down the wrong engine.

1. **ENG COND** lever — **STOP.**
2. **FIRE PULL** handle — **PULL** (engine fire only).
3. **AGENT DISCH** switch — **As required.** (engine fire only).

e. The term **ABORT START** is defined as engine shutdown to prevent PTIT from exceeding limits or whenever abnormal operation is indicated. If high PTIT was indicated, the engine must be motored to decrease PTIT below **260°C**.

1. **ENG COND** lever — **STOP.**
2. **ENG START** switch — **MTR** (if high PTIT is indicated).

NOTE

If a second engine start is to be attempted, wait at least **15** seconds after the N1 tachometer indicates **zero** before attempting start. This will allow sufficient time for fuel to drain from the combustion chamber.

FIGURE A-3. Example of emergency procedures page

APPENDIX B

STYLE AND FORMAT REQUIREMENTS FOR OPERATOR'S AND -CL CREWMEMBER'S CHECKLISTS

B.1 SCOPE

B.1.1 General. This appendix provides the style and format requirements for development and presentation of printed page-based –CL Operator's checklists and Alternate Operator's checklists.

B.2 STYLE AND FORMAT

B.2.1 Front matter arrangement. Unless otherwise specified (6.2), front matter preceding the first chapter of a checklist shall consist of the following in the order specified:

a. Cover.

b. Change transmittal page.

c. General information and scope.

B.2.1.1 Cover. A cover shall be provided. Type sizes for the cover shall be such that all the information can be included within the prescribed area.

B.2.1.2 Change transmittal page. When applicable, the change transmittal page(s) (MIL-PRF-63029, Figure 57) shall follow the cover. The change transmittal page(s) shall not have page numbers.

B.2.1.3 General information and scope page(s). The general information and scope pages shall be assigned sequential lower case Roman numerals, i.e., i, ii, iii, etc.

B.2.2 Size. The standard operator's checklist shall be prepared for a final page size of 4 ½ inches wide by 8 inches in length. See Figure B-1. The alternate operator's checklist shall be prepared for a final page size of 11 inches wide by 8-½ inches in length. The usable area for preparation of the alternate operator's checklist shall be 10 inches wide by 7-½ inches in length.

B.2.3 Type style. The standard operator's checklist type style, size and spacing shall be in accordance with Appendix A, Figure A-1. The alternate operator's checklist type style shall be a *sans serif* type. Type size and spacing shall be in accordance with Appendix A, Figure A-1.

B.2.4 Marginal copy. Marginal copy for standard and alternate operator's checklist TMs shall consist of the publication number, page number, and change number, when applicable.

B.2.5 Structure. The standard operator's checklist shall be divided into parts.

B.2.6 Part titles. Heading titles for the specific parts of the manual for normal procedures, emergency procedures, and performance data are not required.

B.2.7 Page numbers. Page numbers in the standard and alternate operator's checklist TMs shall consist of a capital letter and an Arabic numeral separated by a dash. The letter shall correspond to specific parts of the manuals, 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.

B.2.8 Primary sideheads. Primary sideheads shall divide text within sections. There shall be at least one primary sidehead in each section. They shall begin two spaces below the preceding paragraph at the left margin and shall not be numbered. They shall be followed by a period and are stand alone (are not run in with text).

B.2.9 Subordinate sideheads. Subordinate sideheads shall begin two spaces below the preceding paragraph at the left margin and shall not be numbered. They shall be followed by a period and two spaces. Second and subsequent subordinate paragraphs should, but are not required to, have a sidehead. The first letter of the first word and of each principal word shall be capitalized.

B.2.10 Subordinate paragraphs. Subordinate paragraphs shall have titles (subordinate sideheads). The paragraphs shall begin two spaces below the preceding paragraph at the left margin. The text may begin on the same line as the subordinate sidehead.

B.2.11 TM identification number. Unless otherwise specified by the acquiring activity (6.2), the publication number shall be the same as the TM number of the aircraft system, followed by "-CL" for operator's checklists. The TM number shall appear centered in the top margin and in boldfaced type.

B.2.12 Manufacturers' names. The use of manufacturers' names in the operator's checklists shall be prohibited without prior approval of the acquiring activity (6.2).

B.2.13 Change numbers and symbols. For standard operator's checklist TMs, each page (Figure 58) containing changed material shall bear the appropriate change number (C1, C2) and shall be located adjacent to the page number. Changes to the text, including new material or added pages shall be indicated by a vertical bar in the left margin extending close to the entire area of the material affected. Change symbols show current changes only. For alternate operator's checklist TMs, only revisions shall be prepared, therefore change numbers and symbols shall not apply.

B.2.14 Page arrangement. In the standard checklist, all text shall be prepared in a single column page. The alternate checklist shall be prepared in three columns equally spaced across the 11-inch page which is turned sideways. The alternate checklist shall be printed on card stock and consist of normal procedures on one side and emergency procedures on the opposite side.

For alternate operator's checklist TMs, 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).

B.2.15 Splitting of procedures. For standard operator's checklist TMs, whenever possible, material for in-flight emergency procedures shall be written so that the procedure is contained on a single page. Performance data and procedures such as exterior, interior and before leaving aircraft inspections need not meet this requirement. Each classification of emergency procedures such as engine, propeller/rotor, fire, and fuel shall begin on a new page. For alternate operator's checklist TMs, procedures may be split between columns but shall not be split between a page and the following page.

B.2.16 Fold-out pages. Fold-out pages for textural data shall not be used for operator's checklist TMs. However, for ease of use, graphs included in the checklist may be placed on a foldout page. When this is done, a blank apron shall be used. Foldouts containing graphs shall be located at the end of the checklist. Refer to 3.5.1.21.3 for identification and numbering of foldout figures and foldout pages.

B.2.17 Use of color. Only black print shall be used for operator's checklist TM's.

B.2.18 Definitions of symbols. Symbols used in the checklists shall be the same as those found in 3.2.10.3.2.

B.2.19 Emergency procedures pages. The -CL checklist pages that contain emergency procedure information/steps shall have heavy black diagonal lines around three edges (Figure B-2). However, for operator's alternate checklists, pace borders for emergency procedures shall be placed in the left and right margins only, instead of on three sides of the page.

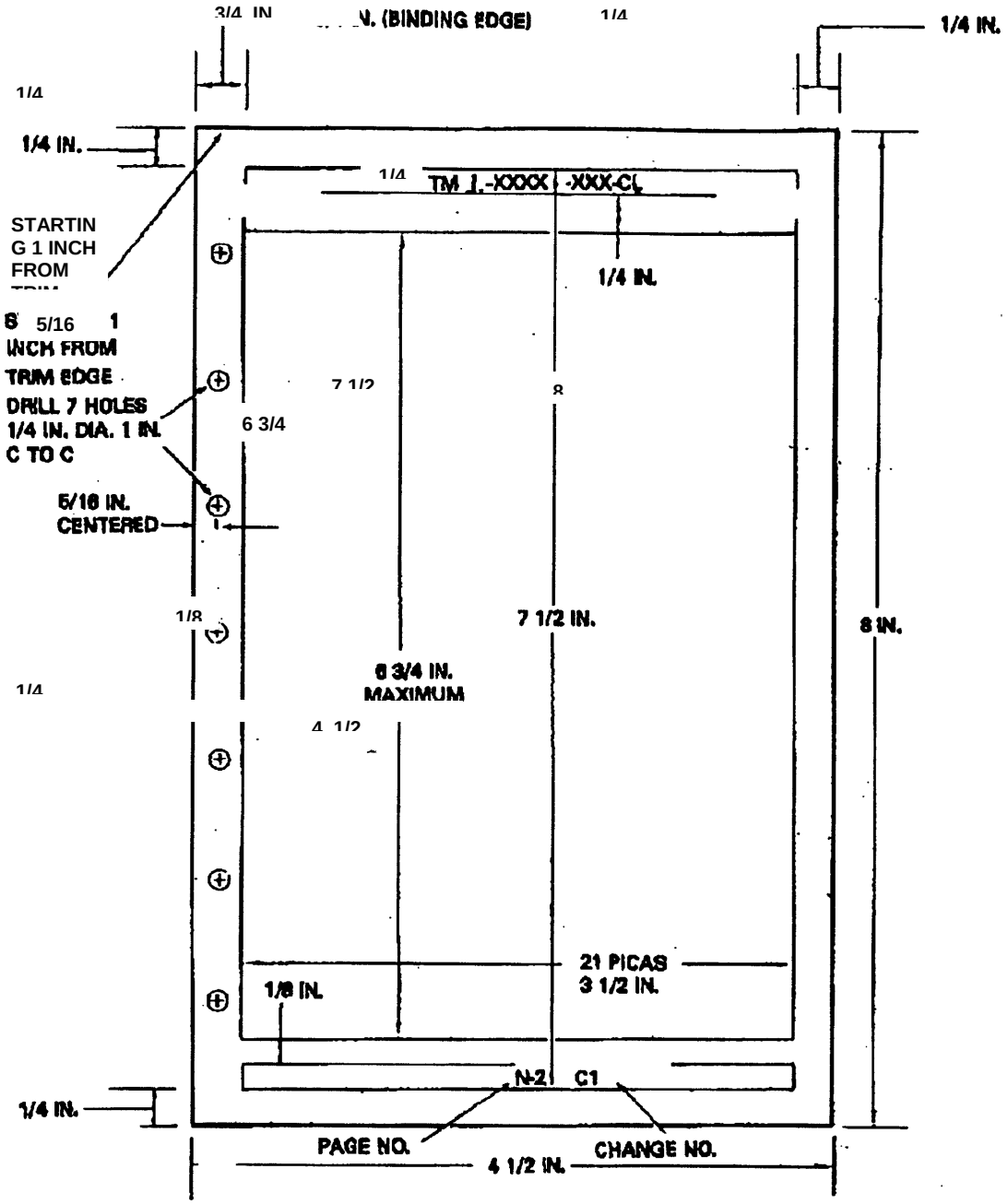


FIGURE B-1. Page dimensions for condensed checklist and MTF manual

TM 1-XXXX-XXX-CL

HYDRAULIC

NO. 1 or NO. 2 HYD FLT CONTR Caution

Fluid loss is evident:

Land as soon as possible.

Fluid loss is not evident:

1. **Land as soon as possible.**
2. **PWR XFER 1 or 2 switch (affected system) — ON.**

F 3. **MAINTENANCE PANEL — Monitor.**

High fluid temperature is evident:

Land as soon as possible.

NO. 1 and NO. 2 HYD FLT CONTR Caution

1. **PWR XFER 1 and 2 switches — ON.**
2. **Land as soon as possible.**

UTIL HYD SYS Caution

Fluid loss is evident:

1. **Land as soon as possible.**
2. **Isolation switch — OFF.**

High fluid temperature is evident:

Land as soon as possible.

Fluid loss is not evident:

APU — Start.

If pressure is restored:

1. Land as soon as practicable.

F 2. MAINTENANCE PANEL — Monitor.

If pressure is not restored:

1. **Land as soon as possible.**
2. APU — OFF.

E–15/(E–16 Blank) C3

FIGURE B-2. Example of condensed checklist (emergency procedures) page

APPENDIX C

STYLE AND FORMAT REQUIREMENTS FOR MAINTENANCE TEST FLIGHT MANUALS

C.1 SCOPE

C.1.1 General. This appendix provides the style and format requirements for development and presentation of printed page-based Maintenance Test Flight manuals (MTFs).

C.2 STYLE AND FORMAT.

C.2.1 Front matter arrangement. Unless otherwise specified (6.2), front matter preceding the first chapter of a checklist shall consist of the following in the order specified:

a. Cover.

b. Warning page.

c. Change transmittal page.

d. Abbreviated title page/table of contents.

C.2.1.1 Cover. A cover shall be provided. Type sizes for the cover shall be such that all the information can be included within the prescribed area.

C.2.1.2 Warning page. The warning page shall begin on the first right-hand page immediately following the cover. The page(s) shall be numbered with lower case letters.

C.2.1.3 Change transmittal page. When applicable, the change transmittal page(s) (MIL-PRF-63029, Figure 61) shall follow the warning page. The change transmittal page(s) shall not have page numbers.

C.2.1.4 Abbreviated title page/table of contents. Space permitting, the abbreviated title page information and the table of contents shall be placed on the same page. If the title page information fills up most of the page, the table of contents may begin on the page following the abbreviated title page. The abbreviated title page/table of contents shall be assigned sequential lower case Roman numerals, i.e., i, ii, iii, etc.

C.2.2 General information and scope. The general information and scope pages shall be assigned sequential lower case Roman numerals, i.e., i, ii, iii, etc.

C.2.3 Size. The standard operator's MTF manual shall be prepared for a final page size of 4 ½ inches wide by 8 inches in length. See Appendix B, Figure B-1. The alternate operator's MTF manual shall be prepared for a final page size of 11 inches wide by 8-½ inches in length. The usable area for preparation of the alternate operator's MTF manual shall be 10 inches wide by 7-½ inches in length.

C.2.4 Type style. The standard operator's MTF manual type style, size and spacing shall be in accordance with Appendix A, Figure A-1. The alternate operator's MTF manual type style shall be a *sans serif* type. Type size and spacing shall be in accordance with Figure 70.

C.2.5 Checklist format. All checklist titles shall be left justified and in 10 point boldfaced type (Figure C-1). The main titles shall not be numbered. Checklist entries shall be listed numerically in Arabic numbers in the order they are to be performed and shall be blocked. Checklist entries shall have the first letters of each line of type aligned. Placarded items shall be boldfaced capital letters. If a series of checks continues from a right-hand page to a left-hand page, requiring that the page be turned to continue the procedure, the checklist title shall be repeated at the upper comer of the left-hand page followed by "(Cont.)".

C.2.5.1 Primary sideheads. Primary sideheads shall divide text within sections. There shall be at least one primary sidehead in each section. They shall begin two spaces below the preceding paragraph at the left margin and shall not be numbered. They shall be followed by a period and are stand alone (are not run in with text).

C.2.5.2 Subordinate sideheads. Subordinate sideheads shall begin two spaces below the preceding paragraph at the left margin and shall not be numbered. They shall be followed by a period and two spaces. Second and subsequent subordinate paragraphs should, but are not required to, have a sidehead. The first letter of the first word and of each principal word shall be capitalized.

C.2.5.3 Subordinate paragraphs. Subordinate paragraphs shall have titles (subordinate sideheads). The paragraphs shall begin two spaces below the preceding paragraph at the left margin. The text may begin on the same line as the subordinate sidehead.

C.2.5.4 TM identification number. Unless otherwise specified by the acquiring activity (6.2), the publication number shall be the same as the TM number of the aircraft system, followed by "-MTF" for MTF manuals. The TM number shall appear centered in the top margin and in boldfaced type.

TM 1-XXXX-XXX-MTF

STARTING ENGINES

1. Personal equipment — Check.

B* 2. BATT switch — ON. Check BAT SYS MAL caution light out (may stay on until APU GEN is on if SLAB installed) and the following caution panel lights on:

XMSN OIL PRESS, L. FUEL PRESS, R. FUEL PRESS, XMSN AUX OIL PRESS, NO. 1 RECT OFF, NO. 2 RECT OFF, NO. 1 GEN OFF, NO. 2 GEN OFF, NO. 1 HYD FLT CONTR, NO. 2 HYD FLT CONTR, UTIL HYD SYS, NO 1 AFCS OFF, NO. 2 AFCS OFF, **714A** FADEC 1, FADEC 2, PARK BRK — ON.

3. Interphone — Check stations.

B 4. MASTER CAUTION LIGHTS TEST switch — TEST. Check that all **712** caution **714A** caution/advisory capsules and the two MASTER CAUTION lights on the instrument panel come on.

B 5. Clocks — check operation, set as required.

BF 6. TROOP ALARM and JUMP LIGHTS — Check operation as required.

a. TROOP ALARM switch — ON; the alarm should sound, then OFF.

b. TROOP JUMP LTS — PRESS-TO-TEST.

(1) Select RED.

(2) Select Green.

c. CABIN AND RAMP LIGHTS.

(1) Select NVG — Check cabin lights go from full bright to dim with rheostat.

(2) Select Red/White — Check cabin lights go from full bright to dim with rheostat.

(3) Check Troop Lights go dim when red/white is selected.

(4) Cabin and Ramp lights OFF — Check cabin and ramp lights off, troop lights return to bright.

2-34

FIGURE C-1. Example of maintenance test flight checklist page

APPENDIX D

STYLE AND FORMAT REQUIREMENTS FOR ILLUSTRATIONS AND GRAPHS

D.1 SCOPE

D.1.1 Scope. This appendix provides illustration and graph style and format requirements for the development and printing of Operator's Manuals, –CL Operator's checklists and Alternate Operator's checklists, and Maintenance Test Flight manuals (MTFs).

D.2. APPLICABLE DOCUMENTS

D.2.1 General. The documents listed in this section are specified in section D.3 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section D.3 of this specification, whether or not they are listed.

D.2.2 Government documents.

D.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-310	Global Climatic Data for Developing Military Products

(Application for copies of DoD documents should be addressed to the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094 or at http://www.dodssp.daps.mil.)

D.2.2.2 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 or contract.

AR 25-30

(Copies of these publications are available from the U.S. Army Publishing Directorate, Distributions Operations Facility, 1655 Woodston Road, St. Louis, MO 63114-6181.)

D.2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

D.3 STYLE AND FORMAT

D.3.1 Illustrations

D.3.1.1 General. Illustration formats shall be as specified by the acquiring activity in accordance with AR 25-30. Line drawings (black lines on white background) shall be used throughout the TM. Photographic illustrations may be used only when prior approval has been obtained from the acquiring 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 (MIL-PRF-63029, Figure 6). Broadsides (illustrations that have been turned 90 degrees on the page) shall not be used.

D.3.1.2 Lettering. Lettering and type on original artwork shall be well-defined and large enough to be easily read when the illustration is reproduced at page size. Lettering and type shall be in capital letters. The minimum type size shall be eight point. Spacing of letters and words shall be controlled to insure clear, legible copy.

D.3.1.3 Keys for illustrations. Keys shall, when feasible, be included on the illustration. Where keys are too numerous or the explanations too lengthy to fit within the illustration cropped area without crowding, they shall be placed in tabular form immediately above or below the illustration or on the facing page. These tables shall be considered as a text function.

D.3.1.4 Foldouts. Foldouts shall be kept to a minimum. When foldouts are provided they shall be placed at the end of the manual immediately following DA Form 2028. Foldouts shall have a blank apron. Foldouts shall be page numbered consecutively starting with FP-1, FP-2, etc. Foldouts shall be identified with figure titles and figure numbers and be consecutively numbered starting with FO-1, FO-2, etc.

D.3.2 Graphical data.

D.3.2.1 General requirements. Unless otherwise specified by the acquiring 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).

D.3.2.1 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, the text of this specification shall take precedence.

D.3.2.2 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 variations.

D.3.2.3 Priorities. Unless otherwise specified by the acquiring 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 ranges to be expected in operation shall be used. MIL-HDBK-310 can be used for reference for ranges of climatic data.

c. Provide adequate accuracy. The graphical presentation shall be readable over all ranges of the data. It shall also 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 shall be designed to directly provide the most commonly used parameters (for example, torque required to hover at known conditions of altitude, temperature, weight, and skid height). Less often used information, such as maximum temperature to hover at a given weight and altitude, shall be obtainable with additional effort.

e. Ensure standardization. Standardization tables are provided to ensure standardization of graphic illustrations. Type and spacing requirements are summarized in Figure D-1. Line requirements are summarized in Figure D-2. 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.

f. Place the graphs on the minimal number of pages, consistent with the importance of clarity and ease of use.

g. General appearance, cost, and ease of production shall be given consideration, but only as three of the lesser priorities.

D.3.2.4 Specific requirements for graphical data.

D.3.2.4.1 Titles. Titles for graphs shall be the most succinct title that adequately indicates the nature of the graphical data.

D.3.2.4.2 Condition heading. The range, parameter name, and units of each condition that apply to the data shall be listed with each condition separated. When abstract conditions (for example, clean configuration forward cg) are used, they shall be described in detail and/or quantified in the accompanying text. Conditions that apply to more than three similar graphs shall be listed only on the first example 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 affect the data shall not be listed. The effect of variation of each listed condition on the data shall be discussed in the 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.

D.3.2.4.3 Sub-graphs. For some graphical data, it may be desirable to include separate sub-graphs with data on the same general subject. Titles and conditions different from the main conditions shall be given for the sub-graphs.

D.3.2.4.4 Notes. Notes should not be used on graphs. Notes may be placed on areas adjacent to charts, 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.

D.3.2.4.5 Data basis. Data basis information shall include data type (for example, flight test, estimated, etc.) and each actual data source document used to compute the data presented.

D.3.2.4.6 Examples. An example shall be provided on the graphical data to demonstrate primary use of each type of graph. If there are two equally important uses of the charts, a maximum of two examples may be presented on the graph. 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 with the graphical data.

D.3.2.4.6.1 Example text. 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 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, parenthetically (below known parameter line) describe the most probable source, such as (from example 1) or (computed from winds aloft). The method for using the graph shall 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. The example text shall be located on the left side of the

graphical data. 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

D.3.2.4.6.2 Example values. Example values shall be chosen to represent reasonably critical conditions. Standard 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.

D.3.2.4.7 Scaling. Scale and data line increments shall conform to the rule of 1, 2, 5, or 10 minor divisions per major division, except as noted here. The preferred scale grid shall be five minor divisions per major division along each axis. Ten division grids are undesirable and shall be used only when absolutely necessary. Four division grids shall be used only with the permission of the acquiring activity (6.2). Asymmetrical (4 * 5) grids are permitted. For highly nonlinear variations approximately equal increments of the dependent variable(s) shall be used. The minimal minor grid spacing shall be six points, unless otherwise specified by the acquiring activity (6.2).

D.3.2.4.8 Units. Each parameter on the graph and its corresponding unit of measure shall be those most commonly used for the subject aircraft. If the parameter is available on an aircraft indicator, the units used on the graph shall be the same as those on the indicator. If the parameter is not on an aircraft indicator, 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 model to a newer model. When this occurs, the primary unit of measure shall be that associated with the new model. Where practicable, the primary unit shall be used on the primary scale and the unit associated with the older model 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.

D.3.2.4.9 Data range. The data range presented shall cover the full applicable range of data. Scales shall extend to the next major division beyond the extreme or limit value(s) and no further, unless specified by the acquiring activity (6.2).

D.3.2.4.10 Grid. The grid shall correspond to the primary scales. Grids shall be prepared to the graphical line standards (Figure D-2).

D.3.2.4.11 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 - pounds *1000). 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 increment, unless the secondary scale corresponds to markings on an aircraft indicator. In this case, the increment and value labeling shall be the same as those on the indicator.

D.3.2.4.12 Data line labels and values. Labels for data lines shall include the parameter name, multiplier, if any, units, and corresponding value. They shall be located approximately at the midpoint of, and oriented parallel to, the data line, as read from the bottom of graph. Data line labels and values shall be prepared in accordance with the graphical standards as shown in Figures D-1 and D-2. Labels shall minimally obscure the grids. Data line labels and values shall be located according to the following order of preference:

a. Parallel centered interrupting the line, alternately staggered to avoid masking a continuous area of the grid (shall be used for primary data line numbers).

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).

D.3.2.4.13 Primary data lines. Primary data lines shall be prepared in accordance with Figure 68. Scales shall be chosen so that the mid-range of approximately linear data are 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) when the separation decreases to ½-1 minor grid spacing, so that actual convergence does not occur.

D.3.2.4.14 Secondary data lines. Operating limits, restricted operating conditions, and optimum, recommended, or critical operating conditions shall be depicted, as applicable, on each graph. Secondary data lines shall be prepared in accordance with Figure 68.

D.3.2.4.15 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 corner. The sequence shall be for the user to enter on left of first graph, move right, reflect down at right angles, reflect left, and reflect down, 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.

D.3.2.4.16 Original graphical data designs. For original (sequential) graphical designs, the following requirements also apply.

a. Each "known" parameter shall 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.

	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 is 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 neat 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 ponts 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 known 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 minor grid division outside scale values	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 title	
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.

FIGURE D-1. Graphical type standards

	USE	COLOR	LENGTH	WEIGHT	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	½ to 1 minor grid division	1	Inside grid border major grid only
6.	Secondary Scale Tick Marks	Black	As required	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 Dashed	As required	1,0,00	Use for data beyond operating limits to aid interpolation

Line Definitions

Weight [1]	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 D-2. Graphical line standards